STUDY OF SOIL ORGANC CARBON AND LAND USE IN FEDERAL UNIVERSITY OYE-EKITI, IKOLE CAMPUS, EKITI STATE NIGERIA.

BY

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DEDICATION

This work is dedicated to God, most blessed, helper, strengthener, author and finisher of knowledge.

CERTIFICATION

This is to certify that **OMOTAYO**, Best Ayoyimika, an undergraduate student in the Department of Agricultural and Bioresources Engineering, Federal Universiy Oye-Ekiti with Matriculation Number ABE/13/1043, has successfully carried out and completed this project work in partial fulfilment of the requirements for the award of the degree of Bachelor of Engineering in Agricultural and Bioresources Engineering. The work embodied in this report is original and has not been submitted in part or full for any other Diploma or Degree in this University or any other University.

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ABSTRACT

The amount of soil organic carbon (SOC) stored in a particular soil is influenced by several factors including climate, vegetation type and age, land management, soil properties and current and past land use. The impacts of land use types on soil organic carbon were assessed. Four land use types were used in the study. Sampled soils were taken at depth of 0 – 45 cm and at intervals of 15 cm. The soil samples were examined in accordance with the standard methods. The data were analyzed using descriptive statistics. The findings revealed that the textural classes were silty clay, silty clay loam and clay loam. The first two classes were common to all locations and the last class was occurred only in University oil plantation. The results showed that mean soil organic carbon content was higher under the oil palm plantation land use [D] compared with other land use types at 0 – 15 cm soil depth (2.87 g kg^{-1}), which was 11.5, 20.2 and 76.0 %% more than in the Faculty of Agriculture Teaching and Research farm land A], the cashew plantation land [B] and the Agricultural and Bioresources experimental farm land [C] respectively. This could be attributed to greater inputs of vegetation (litter fall) and reduced decomposition of organic matter. Similarly, the lowest soil organic carbon content under land use type C could be due to reduced inputs of organic matter and frequent tillage which encouraged oxidation of organic matter. The finding indicated that the means of SOC in land use types were no significantly different (P = 0.05) except land use type C. The soil bulk density showed significant variation (p □ □□□□□ with the soil depth. These results indicated that soil bulk density increases with decreases soil organic carbon and porosity. The soil porosity content variation with land use types was attributed to variation in soil organic carbon and soil texture. .Conclusively, land use type influenced soil organic carbon content.

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CHAPTER ONE

1.0 INTRODUCTION

Soil is a living, breathing, natural entity comprised of minerals, soil organic matter (SOM), water, and air. It provides a habitat for organisms recycles waste products, filters water, serve as an engineering material and a medium for plant growth (Brady and Ray, 2017). It being an unconsolidated material on the earth crust supports plant growth and regulates water regime on the surface of the earth. It plays a key role in the carbon (C) geochemical cycle because they can either emit large quantities of carbondioxide (CO_2) or on the contrary they can act as a store for C (Smith et al., 2000). The dynamic soil nature describes the conditions of a specific soil due to land use and management practices (Karlen *et al.* 2003)

1.1 Soil Organic Carbon (SOC)

Soil organic carbon (SOC) is a complex of organic compounds in the form of soil organic matter (SOM). SOC is part of the natural carbon cycle and originally comes through the process of photosynthesis. It represents a key indicator for soil quality, both for agricultural functions (production and economy) and for environmental functions (C sequestration and air quality) (Follett et al., 2012). It is the organic component of soil, including small (fresh) plant residues and small living soil organisms, decomposing (active) organic matter, and stable organic matter (humus) (Lal, 2008). It includes everything in or on the soil that is of biological origin irrespective of origin or state of decomposition. It plays important roles in maintaining soil structure, improving soil water retention, fostering healthy soil microbial communities, providing fertility for crops and serving as a reservoir of nutrients for crops, provides soil aggregation, reduces compaction, and reduces surface crusting (Powlson et al., 2011). The amount of SOC is a balance of C inputs and C losses of organic material (Burke et al., 1989). In the soil ecosystem, the rate of decomposition and accumulation of soil organic matter is determined by soil properties such as texture, pH, temperature, moisture, aeration, clay mineralogy and soil biological activities (Kell, 2011). Hence, the total amount of organic matter in the soil is influenced by soil properties. SOM takes a central role in maintaining soil health because it affects soil physical, chemical, and biological functions, and is also critical to ensure secure food production (Dungait et al., 2012). The amount of soil organic carbon (SOC) stored in a particular soil is influenced by several factors including slope length and gradient, climate, vegetation type and stand age, land management and soil properties such as soil type, soil depth, soil texture, pH, bulk density, clay content and current and past land use (Follett et al., 2012).

1.2 Land Use Changes

Land use changes, are known to be important drivers for soil redistribution, by influencing surface runoff, erosion and sedimentation process. Many researchers such as Chen *et al.* (2001), Conant *et al.* (2003), Hacisalihoglu (2007), Khormoli *et al.*(2009) and Saraswathy et al. (2007) reported that change of land uses include long term cultivation, deforestation, urbanization, or overgrazing caused significant variations in soil properties, terrestrial cycles and reduction of output and that the conversion of natural forest and plantations to other forms of land use can provoke soil erosion and lead to a reduction in soil organic matter content, loss of soil quality and modification of soil structure and its stability. Land use change such as forest clearing, urbanization, cultivation and pasture introduction are known to result in changes in soil properties (Houghton *et al.* 1999), yet the sign and magnitude of these changes varies with cover and management (Baskin and Binkley 1998; Celik 2005). Most changes in land use affect the amount of carbon held in vegetation and soil, thereby, either in releasing carbon dioxide (a greenhouse gas) to, or removing it from the atmosphere. The greatest fluxes of carbon result from conversion of forests to open lands (and vice versa) (Houghton and Groodale, 2004).

1.3. PROBLEM STATEMENT

In Makurdi, North Central Nigeria a study was undertaken to determine the effects of three land use types on selected physico-chemical properties and obviously, soils under different land use, climatic conditions and environmental exposure have been shown to exhibit contrasting characteristics, which can potentially affect future use of such land (Ovie *et al.*, 2013). It is prominent inside the school farms that the various land use types affect the nutrient status of the soil. The soil degradation also differs with different land use types that include different management practices. Also, there is scanty or no information as regard the state of the soil physical properties and organic carbon of the different land use types in Federal University Oye –Ekiti (Ikole campus). However, this knowledge is needed to safeguard the different land use types from further degradation. Lastly, the outcome of the study will further provide base line information for future work on the prediction of flooding, erosion control, irrigation, crop and soil management practices in the area.

1.4. OBJECTIVES

The general objective of this study is to evaluate the variations of some selected soil physical properties, organic carbon and water transmission properties under different land use types.

The specific objectives are:

1. To determine the soil physical properties (i.e. particle size analysis, soil temperature, bulk density and the elevation of the land) as influenced by land use
2. To evaluate the soil water transmission properties (i.e. hydraulic conductivity and water holding capacity) in the study areas as influenced by land use.
3. To determine the soil chemical properties (i.e. soil organic carbon) as influenced by land use.

1.5 JUSTIFICATION

Land use changes (LUC) has contributed to soil degradation and soil loss, leading to a decrease in soil Carbon and Nitrogen storage worldwide (Eaton *et al.*, 2008) It is therefore important to understand the relationship between land use type, soil aggregate, carbon and nitrogen sequestration in order to maintain soil aggregate stability to protect soil efficiency, productivity, and to minimize soil losses

1.6 SCOPE OF STUDY

The study carried out focused on the effects of various **Physical properties**(soil textural class),**Water transmission properties**(Infiltration rate, Gravimetric moisture content,Soil porosity), **Chemical properties**(Bulk density, Organic carbon, Organic matter, pH) on various soil types in the different land use type in Federal University Oye-Ekiti, Ikole Campus, Ekiti-State, Nigeria.

CHAPTER TWO

2.0 LITERATURE REVIEW

Agricultural practices can render a soil either a sink or a source of atmospheric carbon dioxide (CO2), with direct influence on the greenhouse effect (Lugo and Brown, 1993; Lal et al., 1995). Several papers demonstrated Carbon sequestration in soils associated with crop rotation in tropical ecoregions (*Bernoux et al., 2006*).

Carbon sequestration is the process involved in carbon capture and the long-term storage of atmospheric carbon dioxide(*Sedjo, Roger et al, 2012*). or other forms of carbon to mitigate or defer global warming. It has been proposed as a way to slow the atmospheric and marine accumulation of greenhouse gases, which are released by burning fossil fuels (*Hodrien, Chris October 24, 2008*). Carbon dioxide (CO_2) is naturally captured from the atmosphere through biological, chemical, and physical processes. Artificial processes have been devised to produce similar effects, including large-scale, artificial capture and sequestration of industrially produced CO_2 using subsurface saline aquifers, reservoirs, ocean water, aging oil fields, or other carbon sinks.

Carbon sequestration processes include:

1. "The process of removing carbon from the atmosphere and depositing it in a reservoir. "When carried out deliberately, this may also be referred to as carbon dioxide removal, which is a form of geoengineering.
2. Carbon capture and storage, where carbon dioxide is removed from flue gases (e.g., at power stations) before being stored in underground reservoirs.
3. Natural biogeochemical cycling of carbon between the atmosphere and reservoirs, such as by chemical weathering of rocks.

The change in forest ecosystem to other forms of land uses leads to the stock of soil organic carbon due to change in soil moisture and temperature regimes and succession of plant species with difference in quantity and quality of biomass returned to the soil (*Offiong and Iwara, 2012*)

2.1 RELATIONSHIP BETWEEN LAND USE AND CARBON DIOXIDE

It has been estimated that about 40% of CO_2 emissions over the last two centuries came from land use change (primarily deforestation), while 60% came from fossil fuel burning (*DeFries et al., 1999*). About 40% of total CO_2 emissions remained in the atmosphere. This means that terrestrial ecosystems took up about a third of all emissions (*Prentice et al., 2001; House et al., 2002*) through a combination of ecosystem processes whose relative importance is still not firmly established but that probably include growth of replacement vegetation on cleared land (*McGuire et al., 2001; Goodale et al., 2002*); agricultural and forest management (*Spiecker et al., 1996; Houghton et al., 1999*); other land management practices such as fire suppression leading to woody encroachment (*Houghton et al., 1999*) and fertilizing effects of elevated CO2 and nitrogen deposition (*Lloyd, 1999*).

2.2 EFFECT OF LAND USE TYPES ON SOIL TEXTURE

Soil is a dynamic and living entity used to produce goods and services of value to humans. As soon as land is newly put into production as the soil degradative processes are set in motion triggering deterioration of soil structure and disruption of carbon cycles and depletion of soil nutrient reserves (*Gaston et al., 2001*). But in practice the use to which a land is put may not be related to the soil type because decisions on land use will rest on farmer's capability and not the evaluator. Under small scale peasant agricultural land use and soil type are rarely closely associated due to constraints like land tenure system, financial status of farmers, lack of relevant information or ignorance of farmers (*Ogunkunle and Eghaghara, 1992*). Different land use types often occur on similar soils or same land use type on dissimilar soils.

2.3 INFLUENCE OF LAND USE ON VEGETATION

Effects on vegetation and species distribution were documented in different ecosystems following anthropogenic activities (*Six et al., 2000; Bruun et al., 2001; Foster et al., 2003*). Land use-induced changes in nutrient availability may influence secondary succession and biomass production (*Foster et al., 2003*) and reduce Soil Organic Carbon (SOC) which plays a crucial role in sustaining soil quality, crop production and environmental quality (*Doran and Parkin, 1994*). Such changes directly affect soil physical, chemical and biological properties, such as soil water retention and availability, nutrient cycling, gas flux, plant root growth and soil conservation (*Gregorich et al., 1994; Ubuoh et al., 2013*).

2.4 EFFECT OF LAND USE TYPES ON SOIL BULK DENSITY, POROSITY AND SOIL MOISTURE CONTENT

Bulk density of a soil is the ratio of the mass of the soil to its volume, which is usually expressed in gram per centimetre cube (g/cm^{-3}) or mega gram per metre cube (Mg/M^{-3}) (*Agbenin,, 1995*). From the manual he explained that using nutrient mass available in soil to compare the fertility status of different soils is more realistic than the use of crude concentration which neglect the differences in bulk density and consequently mass of soils. He gave a scenario that, if a soil-A=0.95 $^{Mg}/_{M^3}$ and 250$^{mgP}/_{Kg}$ of soil, does not contain more of P than a soil B having a bulk density of 1.36$^{Mg}/_{M^3}$ and 200$^{mgP}/_{Kg}$ soil. In the example cited, the mass of P extrapolated to a hectare for soil-A, assuming a ploughing depth of 5cm, will be 120$^{kg}/_{ha}$ compared to Soil-B having 170$^{kg}/_{ha}$ even though actual concentration of P in soil-A was more than that in soil-B. The above example explains how concentration variable could be influenced for purposes of soil fertility evaluation and comparisons of different soils (*Agbenin, 1995*). *Awdenegest Moges et al, (2013)*, In their work, the overall mean soil bulk density gotten did not show any significant difference with respect to land use types and the interaction effects, they also stated that soil bulk density under different land use types generally ranges from 970 (in the farmland) to 1040 Kgm^{-3} (in the open grassland).

Several studies conducted, also reported that land use types and their interactions did not affect the soil bulk density, while some other studies found that bulk density significantly varied with land use types due to differences in the land management and land use histories (*Awdenegest Moges et al, (2013)*. Also, *Awdenegest Moges et al, (2013)* stated that the differences in soil bulk densities with soil depth was significant higher in the lower than in the top surface soil layer, indicating the tendency of bulk density to increase with depth due to the effects of weight of the overlying soil and the corresponding decrease in soil organic matter content, Soil density as a soil property is affected by the vegetation cover, amount of organic matter and land use management (*Silva et al, 2000*). Research has also shown that increase in organic material in Sandy soils has resulted in reduced bulk density, reduced compaction, increased water retention and unsaturated hydraulic conductivity (*Larson and Allmaras 1971*).

Additionally, the excessive increase in bulk density lowers the physical quality of soil. The critical density limit for normal growth of plant root system as reviewed by Arshad *et al*, (1996) is 1.40 kg dm-3, which is generally accepted. Bohn *et al.*, (2001) reported that the acceptable range of bulk density is 1.3 to 1.4 g cm-3 for inorganic agricultural soils.
Furthermore, increasing agricultural activities causes modification in soil structure, change in soil aggregate shape, size and stability (*Emadi et al, 2008*). It also interferes with the soil density and reduces porosity (Tavares Filho *et al.*; 2001; Silva *et al.*; 2005). Emadi *et al*, (2008) and Khresat *et al* (2008) reported that bulk density of surface soil was lowest in plantation soil compared to grassland vegetation because of enhanced soil organic matter. A land that is constantly graze upon will have high level of compaction (FAO (2006b) rating of total porosity, the per cent total porosity of surface soil for all the land units were very high. In terms of soil physical fertility, the total porosity observed on all land units could enable the soils to provide good aeration for plants and microorganisms.

2.5 INFLUENCE OF LAND USE ON SOIL ORGANIC CARBON

Plenty of influential work reported by various researchers has suggested that SOM can improve the formation of soil aggregates and increase the mechanical stability of aggregates by binding soil mineral particles, which determines the coherence of inter-particle bonds (Mayer et al., 2010; Somasundaram et al., 2016, Peng et al., 2015). Similarly, the presence of soil organic carbon (SOC) in different soil layers or in aggregate sizes is imperative for soil quality assessments, which can be easily lost in the erosion process (since large aggregates are more stable). However, in existing studies, limited information is available on the effects of carbon content in different soil layers of different land-use systems. Previous studies (*Curtin et al., 2010; Jiao et al., 2016*) suggested that macro-aggregates in the soil are stabilized mainly due to carbohydrate-rich roots

Soil organic matter is a vital component to be considered in agricultural production systems because of its beneficial effects on soil productivity and fertility. Its affects the physio-chemical properties such as CEC (cation exchange capacity), availability of nitrogen, phosphorus and Sulphur, bulk density, aggregation, infiltration and water retention. Carbon is the main component of organic matter (*Agbenin, 1995*). The soil organic matter decomposition has negative influences mainly on cation exchange capacity (CEC), nutrient availability, aggregate stability and microbial activity (*Bayer and Mielniczuk, 1999*). Therefore, organic carbon is used to determine organic matter level in soils. Soil is a major carbon sink, stores two or three time more carbon from plant and animal residues than that which exists in the atmosphere as CO_2 and 2.5 to 3 times as much as that stored in plants in the terrestrial ecosystem (*Post et al, 2000; Houghton and Skole, 1990*). *Schimel et al. (2000)* explains that the knowledge of the spatial distribution of soil organic carbon is an important requirement for understanding the role of soils in the global carbon system.

Land use practices affect the distribution and supply of soil nutrients by directly altering soil properties and by influencing biological transformations on the rooting zone (*Murty et al. 2002*).Changes that occur in land use affect the amount of carbon held in vegetation and soil, (*Houghton and Groodale, 2004*) declares that the greatest fluxes of carbon result from conversion of forests to open lands and vice versa. Sequestration of atmospheric CO_2 into soil and soil organic carbon dictates acquisition of the research data on equilibrium level of soil organic carbon pool under different land use and associated soil management practices and the rate of change of soil organic carbon pool with change with change in land use and management (*Hao et al, 2002*).Preferentially; at different spatial and time interval, vegetation cover helps in protecting the soil from harsh climate conditions (especially soil erosion). The presence of dense vegetation affords the soil adequate cover thereby reducing the loss of macro and micro nutrients that are essential for plants growth and energy fluxes (*Iwara et al, 2011*).

2.6 SOIL ORGANIC MATTER ROLES

SOM takes a central role in maintaining soil health because it affects soil physical, chemical, and biological functions, and is also critical to ensure secure food production. The process of decomposition is key to the cycling of macronutrients ((e.g. nitrogen (N), phosphorus (P), and sulfur (S)), and its effective management can reduce the need for fossil fuel consumption to supply nitrogen (N) fertilizer (*Dungait et al., 2012*). A wide range of roles SOM takes in soils have been cited by a number of researchers (*Watts et al., 2006; Powlson et al., 2011*). The benefits (*Blair et al., 2006a, b; Lal, 2004c*) of increased SOM include:

• Improved soil physical properties such as soil aggregation, water infiltration, hydraulic conductivity, and water holding capacity.

• Reduced risk of soil erosion.

• Increased soil biological heath.
• Increased agricultural productivity.
• Reduced needs for fertilizers, pesticides, and water.

A SOC concentration of less than 2% (or 3.4% SOM) is considered to be the threshold value below which soil function is impaired (*Greenland et al., 1975; Lal, 2004c*). Although there is little quantitative evidence for such a threshold (*Loveland and Webb, 2003*), *Janzen (2006)* proposed that the bioavailability of SOM is the major influence on soil properties. However, the general responses of soil organic C stocks in terrestrial ecosystems to changes in environmental conditions remains unclear, especially temperature and precipitation, and their combined effect (*Wu et al., 2011*).

In contrast, in addition to leading to increased atmospheric CO2 concentrations, losses of SOM could have adverse impacts on soil quality, agricultural production, and the environment. The adverse impacts (*Lal, 2004c, Whitbread et al., 1998*) include:
• Depletion of plant nutrients (e.g. N, P, S).
• Increased soil bulk density.
• Loss of soil structure.
• Decreased water-holding capacity and hydraulic conductivity.
• Decreased cation-exchange capacity.
• Increased soil erosion and leaching of pesticides and heavy metals.

2.7 Factors Affecting the Soil Organic Carbon Storage (SOC Sequestration)

Soil organic carbon originally comes from atmospheric CO_2 that is captured by plants through the process of photosynthesis. The amount of Soil organic carbon is a balance of Carbon inputs and Carbon losses of organic material (*Burke et al., 1989*).

In natural ecosystems, rainfall and temperature are primary factors determining plant biomass

determine the equilibrium SOC level. When additions of organic C equal the losses of organic C, equilibrium SOC levels are reached. In agricultural systems, SOC turnover rates and equilibrium levels are further impacted by management practices. For example, a substantial portion of fixed C from the process of photosynthesis is removed during the harvest, with 30-50% of fixed C as aboveground dry matter typically being removed for cereal crops (Hay, 1995; Johnson et al., 2006), with the remaining 50-70% of the annual fixed C as aboveground residues and belowground residues (e.g. root biomass).

Retaining crop residues generally greatly reduces soil erosion and minimizes water losses during fallow periods (*Radford et al., 1992; Thomas et al., 2007b*). However, crop residues retained on the surface of the field make only a small contribution to longer-term soil C stocks (*Kirkby et al., 2006*). In contrast, belowground residues (e.g. root biomasses) represent direct inputs into soil systems, being major contributors to SOC stocks (*Jobbáby and Jackson, 2000*). Roots generally decay slower than aboveground residues (*Rasse et al., 2005*).

Major C losses are from mineralization of organic materials and soil erosion (*De Jong and Kachanoski, 1988; Paustian et al. 1997*). Erosion has been a major loss mechanism for SOC from agro-ecosystems, which accounts for an estimated 20-50% of historic C losses (*Lal, 2004b*). Eroded SOC can be a net sink for or a net source of CO2 depending both on the frame of reference and on the fate of this eroded material (*Stallard, 1998; Yoo et al., 2005*). Conventional cultivation practices promote the mineralization and losses as CO_2 of the more labile SOC fractions. Soil management practices such as conservation farming are designed to increase C inputs and minimize the C losses that are characteristics of traditional cultivation practices.

SOC, a major source of system stability in agro-ecosystems, is controlled by many factors that have complex interactions (*Burke et al., 1989*). These factors include soil properties, climate conditions (temperature and precipitation), and land use and management practices (*Baldock and SKjemstad, 1999*).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 General description of study location

The study area covers four different farm locations within the Federal University Oye-Ekiti, Ikole Campus which include the Agricultural and Bio Resources Engineering Experimental farm, Oil palm plantation, Cashew plantation, and the Faculty of Agriculture Teaching and Research Farm. The study area is located in the tropical climate with two distinct seasons of wet (March – October) and the dry seasons (November – March). The area has mean annual rainfall of about 1400 mm and temperature ranges between 22.2^{0}C and 32^{0}C.

3.1.1 Brief description of each site

The oil palm plantation land (latitude 07^O 48.351 and longitude 005^O 29.558) is moderately sloppy, and there is presence of some common weeds like Elephant grass (Sida acuta) and presence of worm casts. Small farm implements (e.g. cutlass, hoes) used for the continuous agricultural practices were found on the site. The oil palm plantation land has a shady environment due to the canopy provided by the oil Palm trees; soil temperature around this area was around 22^{O}C.

The cashew plantation land (latitude 07^O 48.186 and longitude 005^O 29.808) is a plain land, located at the upper slope and has common weeds like elephant grass, and also termite molds. It also has a shady environment due to the canopy provided by the cashew trees; soil temperature around this area was around 24^{o}c

The Agricultural and Bio Resources Experimental Farm (latitude 07^O 48.439 and longitude 005^O 29.869) is slightly sloppy, there is presence of worm cast, and termite molds, and concretions in some part, and common weeds present include_elephant grass, stubborn grass, and crops like cassava, and vegetables. The soils are compacted due to grazing of livestock (cattle and sheep) on the field. It doesn't have a shady environment, due to absence of trees on the farmland, and therefore soil temperature around this area was around 25°c

The Faculty of Agriculture Teaching and Research Farm occupies the valley bottom of the land There is presence of common weeds and crops like cassava, vegetables (Amaranthus, Talinum triangulare), maize, tomatoes. The soils are compacted due to grazing of livestock (cattle and sheep) on the field, the teaching and research farm land lies between (latitude 07° 48.464 and longitude 005° 29.523). Soil temperature around this area was around 24°c

3.2 Soil sampling and preparation

In each study location or land use types, Soil samples were collected with soil auger to the depth of 0-15cm, 16-30cm, and 31-45cm. The soil samples were air dried under room temperature, crushed and allowed to pass through different sieve sizes, for different laboratory tests.

3.2.1 Physical Soil Properties

Particle Size Analysis

The hydrometer method as described by Bouyoucos (1962) was used for the particle size analysis. 50g of sieved soil measured inside a container and 25ml of calgon added and shook with mechanical shaker for 5 min, the suspension was transferred to a 1-l capacity cylinder and dilute to the mark, it was then stirred for few minute with plunger and the first hydrometer reading was taken after 40 seconds and the first temperature was taken using the thermometer. After 2 hours, the second hydrometer reading and temperature were taken. A simple soil textural class chart was used in classifying the textural class of the soil according to Hunt and Gikes (1992).

Bulk density The soil bulk density was determined using a core sampler as described by Anderson and Ingram (1993). The soil samples were taken with the core sampler from 0-15, 15-30 cm, and 30-45cm depth and the bulk density was then calculated as given below.

$$BD = \frac{MS}{VB}$$ -- Equation 3.1

Where; **BD**=bulk density (glcm^3)

MS=mass of oven dried soil at 105°c for 24 hours (g)

V_B= volume of bulk soil or core (cm^3)

Total porosity

The total porosity was estimated from particle and bulk density valves using the following equation; **total porosity** = $1-(BD/PD)*100$--------------------------Equation 3.2

Where; BD=Bulk density (g/cm^3)

PD=particle density (2.65g/cm^3)

Gravimetric moisture content

The soil moisture content was determined from the ration of mass of water to mass of dry soil using the following formula; $(\Theta g) = W_2-W_3/W_3-W_1$-------------------------- Equation 3.3

Where; W_1 = weight of empty core sampler

W_2= weight of moist soil

W_3= weight of oven dried soil

3.2.2 Water transmission properties

Infiltration rate determination

The double ring infiltrometer of 30 cm height with two concentric rings of inner and outer diameter of 30 cm and 60 cm respectively was used. The infiltrometer used was driven into the cleared soil surface to a 5 cm depth; the outer ring of the infiltrometer was filled with water to maintain the same water head with inner ring. The water was ponded to 20 cm height at the inner ring and the rate of fall was taken at four minutes' interval. This was attempted in four different places in each land use types under study. The generated data was fitted into Philip (1957) model as follows.

$I= At + St^{1/2}$ .... eqn 1---------------------------Equation 3.4

Where; $dI/dt = A + \frac{1}{2} S^{-1/2}$ .... eqn 2------------------ Equation 3.5

A = Transmissivity i.e. steady state rate of flow due to effect of gravity

S = soil water absorptivity of the soil (cm min^{-1}), which is the influence of the soil water (matric suction &conductivity) in the wetting process.

I = cumulative infiltration (cm)

t = time (min)

I = infiltration rate

3.2.3 Chemical Properties

Organic Carbon Determination (Walkley – Black Method)

Walkley and Black (1934) wet digestion method was used to determine soil organic carbon content and per cent soil organic matter was obtained by multiplying per cent soil organic carbon by a factor of 1.72. (Nelson and Sommers, 1996).

0.5g of sieved soils was weighed into 250ml conical flask and 10ml of 1N $k_2Cr_2O_7$was added, 20ml of conc $H_2SO_4$was also added and mixed, then allowed it to stand to cool down for 30min and added 200ml distilled water. The suspension was filtered and 3 drops of indicator was added, and afterward titrated the filtrate with 0.4 N $(NH_4)SO_4FeSO_4.6H_2O$.An end point is then gotten, that is from dark green through blue to maroon colour.

Calculations

If X ml 0.4$(NH_4)2SO_4FeSO_4.6H_20$ were used for titration of the dichromate solution.

Organic carbon (g/kg of soil) = $\frac{meqofCr2O7-meqFe-NH4-SO4}{weightofsample}$ X 100---------------Equation 3.6

Soil organic matter (SOM g/kg of soil) = Organic Carbon X 1.724------------------Equation 3.7

PH

Hydrogen ion activity or pH is a fundamental chemical property of a soil that should be determined. Even if no further test is carried out on the soil, a number of inferences on the chemical and fertility status of a soil can be made from its PH. The PH can simply be defined by the equation:

$pH = -\log_{ah}{}^{+} = -\log_{cH}{}^{+}.\, fH^{+}$----------------------Equation 3.8

Where ${}^{a}H^{+}$ is hydrogen ion activity and ${}^{C}H^{+}$ is hydrogen ion concentration and ${}^{f}H^{+}$ is the activity coefficient of hydrogen ion.

Apparatus used in the determination of pH include pH meter, paper portion cups or 200ml beakers, stirring rods/spatula, washing bottle and Standard buffer solutions (pH 4 and 7)

150g of <2mm sieved soil samples was poured into 200ml beaker with distilled water, and the soil mass was allowed to be thoroughly wetted by capillary action of the water. Sample was thoroughly shaked by a mechanical shaker. The glass and calomel electrode were inserted to take the PH measurement. The PH reading is taken again to obtain a value somewhat constant

CHAPTER FOUR

4.0 RESULT AND DISCUSSION

4.1. Particle size distribution and Textural classification in the studied areas

Table 1 shows particle size distribution at different soil depths and under different land uses studied. University Oil palm plantation (D) has the highest sand content (60.8%), while Department of Agricultural and Bioresources Engineering experimental farm (C) has the least with 24.8%. The agricultural and bio resources land(C) had the highest mean clay content (55.2%), University Oil palm plantation (D) had the lowest (29.2%). The silt content was different among the land use types. However, land use B contained both the highest and lowest mean silt of 27.6% and 4.6% respectively. There is no significant difference between the sand content across all the land use types respectively. The textural classes identified include silty clay, silty clay loam and clay loam. The first two classes were common to all locations and the last class occurred only in University oil plantation.

Table 1: Soil Textural Classification of Locations in Federal University Oye Ekiti in Ikole Campus, Ekiti State

Sampling Location	Depth (cm)	Sand (%)	Clay (%)	Silt (%)	Textural Class
Faculty of Agriculture Teaching and Research Farm (A)	0 – 15	44.8	39.2	16	SILTY CLAY
	15 – 30	44.8	31.2	24	SILTY CLAY LOAM
	30 – 45	32.8	49.2	18	SILTY CLAY
University Cashew Plantation(B)	0 – 15	42.6	30.1	27.6	SILTY CLAY LOAM
	15 – 30	53.2	42.2	4.6	SILTY CLAY
	30 – 45	31.7	35.8	12.5	SILTY CLAY LOAM
Department of Agricultural and Bio-resources Experimental Farm (C)	0 – 15	44.8	37.2	18.09	SILTY CLAY LOAM
	15 – 30	24.8	51.2	24	SILTY CLAY
	30 – 45	26.8	55.2	18	SILTY CLAY

University Oil Palm Plantation (D)	0 – 15	32.8	37.2	10	SILTY CLAY LOAM
	15 – 30	60.8	29.2	10	CLAY LOAM
	30 – 45	28.8	51.2	20	SILTY CLAY

4.2 Effect of land use types on soil chemical and physical properties

4.2.1. Organic carbon

The result of soil organic carbon is presented in Table 2. Martin and Anikwe, (2010) had observed that organic carbon decreased in a continuously cultivated land than a land that is not always cultivated.

Agricultural and bio resources land (C) has the lowest SOC content while cashew has the highest level of SOC as presented in the Table 2. The SOC mean of the Land use type A and D was similar but significantly differed from B and C. The SOC level in the cashew(B) and oil palm land(D) are not distinctively different from each other mainly because they are tree crop plantations and the land undergo no or minimum disturbance from anthropogenic activities.

Yifru and Taye (2011) confirmed that soil organic carbon tends to be high in natural forest but low in cultivated fields. This finding collaborates with Murty *et al.* (2002) saying changes that occur in land use affect the amount of carbon held in vegetation and soil.

4.2.2. Organic Matter

The soil organic matter is as a result of decaying materials falling on the surface of the soil, dead animals buried in the soil and the amount of humus content present in the soil. In Land Use B, has the highest soil organic matter with 2.76, which might be as result of leaves, and decayed fruits falling on the ground, followed by land use A which has an SOM of (2.00) and land use C has the least value of 0.4 (Table 2)

4.2.3. Bulk Density

Table 2 shows that bulk density was highest under land use type B which differs from the other land use type. The land use type B (1.66) and D with (1.64) was not significantly different from each other but differed from A and C land. This result agrees with Corsini and Ferraudo (1999), and Silva *et al.*, (2000) that soil density is affected by the vegetation cover, amount of organic matter and land use management.

4.2.4. Gravimetric water content (GWC)

Gravimetric water content (GWC) was highest in the land A and differed significantly from B, C and D which showed no significant differences among themselves. GWC of C was the least. This is related to increase in bulk density. The highest GWC under land A is as a result of the gradient of the land and some other management practices.

4.2.5. Porosity

Soil porosity under the land use A and B land were highest. Also, were followed by C and D land while land B and C land use did not differ significantly from each other. The soil under land use C and D shows the lowest level of soil porosity while the one under A appeared to be the highest. This result appears to be so due to several factors in the study area that include, grazing of livestock on the land, continuous land cultivation, organic matter, soil texture,- gradient, built up machine activities. The work done by Larson and Allmaras (1971) saying, increase in organic material in sandy soils has resulted in reduced bulk density, reduced compaction and enhanced porosity.

4.2.6 Infiltration rate

The mean infiltration rates are; A has (12.65), B has (14.34), C soil has (6.82), D has (9.81). The land use C has the lowest infiltration rate which is related to the high bulk density (compaction), soil texture, built up machinery activities and other management practices. Radke and Berry 1993) observed that include soil texture, organic matter and management (land use) of the soil affects infiltration rate.

Table 2: Physical and Chemical Properties soil in the Study Areas

LOCATIONS					
Parameters	Depth (cm)	A	B	C	D
pH	0-15	6.6	6.1	7.7	5.27
	15-30	7.03	5.9	4.12	4.43
	30-45	7.32	5.7	5.52	7.6

Temperature (^0C)	0-15	25	22	26	21
Organic Carbon (g/kg)	0-15	2.54	2.29	0.69	2.87
	15-30	2.09	2.11	0.25	0.79
	30-45	0.86	1.96	0.23	0.19
Organic Matter(g/kg)	0-15	3.93	3.94	1.19	4.95
	15-30	3.6	3.78	0.43	1.36
	30-45	1.48	3.38	0.4	0.93
Bulky Density (g/cm^3)	0-15	1.39	1.83	1.66	1.39
	15-30	1.32	1.84	2.01	2.32
	30-45	1.31	1.23	1.78	1.21
Porosity (%)	0-15	48	31	38	48
	15-30	51	31	25	13
	30-45	50	54	33	55
Infiltration rate (mm/hr)	Null	12.65	14.34	6.82	9.81
Gravimetric moisture content	0-15	50.28	32.36	30.48	18.21
	15-30	52.18	32.20	26.32	26.53
	30-45	51.34	52.60	28.34	49.37

CHAPTER 5

CONCLUSION

The effects of land use types on soil organic carbon and other soil properties such as soil organic matter, bulk density, porosity were assessed. Three textural classes in the study areas were Silty Clay Loam, Silty Clay and Clay Loam. According to this study, we were able to observe that Land use C, has the lowest soil organic matter and soil organic carbon levels , having a value of less than 2% and 3.4% respectively, whereas land use B was differs ,having an average value of greater than 2% and 3.4% respectively, according to *Greenland et al., 1975; Lal 2004c*. We can conclude that Soil Organic Carbon is a function of the Soil Organic Matter, Bulk density, and porosity, as we have seen from the analysis, that the value of these factors , significantly have an impact in the level of Soil Organic Carbon.

RECOMMENDATIONS

- The agricultural and bio resources experimental farm land require some essential agricultural practices such as application of manure, zero or minimum tillage, mixed cropping so has to enhance productivity.
- Grazing of livestock in the ABE experimental farm especially should be reduced to the barest minimum, to avoid excessive bulk density values.
- The Cashew Plantation's PH can be reduced by reducing the amount of decaying fruits deposited on the farmland in order to reduce the PH of the soil.
- The lack of tree canopy in the Agricultural and Bio resources farm land is one of the reason why the SOC stock on the land use has reduced significantly, because heat and UV light exposure has been found to be one of the major factors that causes the reduction in SOC stocks.
- In general, Land management practices should be practiced in all of the various land use type, to sustain or improve the various land properties.

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