VARIATION IN BULK DENSITIES, ORGANIC CARBON AND WATER TRANSMISSION PROPERTIES UNDER FIVE DIFFERENT LAND USE TYPES IN IKOLE LGA OF EKITI STATE.

By

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CERTIFICATION

This is to attest and certify this project under the topic "Variation In Bulk Density, Organic Carbon And Water Transmission Properties Under Different Land Use Types in Ikole Local Government of Ekiti State'' to have met the requirement of a final year student project and the Federal Government Institutional principles and regulations guiding the Award Of Bachelor Of Agriculture(B. Agric) degree in Federal University Oye-Ekiti and approved to have contributed to knowledge and has given relevant information as regard the topic in view.

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DEDICATION

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

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ABSTRACT

Management practices to adopt in improving the land productivity has always been a challenge. The arable land used for farm practical year students and the fadama used for raising vegetables and maize during the dry season are spoken about as not very productive. This is due to the gross lack of information on both the physical and chemical properties of the soils under the different land use types in the Federal University Oye-Ekiti. These land use types continued for over three decades and now there is an urgent need to examine the variation in their physical properties of different soil type use. This research work was carried out on the variability in soils as indicated by analysis of the textural classes, organic carbon, bulk density and water transmission properties such as infiltration, porosity and hydraulic conductivity under five different land use types in Ikole Campus FUOYE. The Five land use types are Arable land, Fadama land, Cashew plantation, Oilpalm plantaion and Plantain plantation. The data obtained for the soil properties were subjected to statistical analysis using SAS package. Analysis of variance (ANOVA) was used compare the influence of the land use types on the measured soil properties using Tukey's Studentized Range (HSD) Test in a randomized complete block design (RCBD). Duncan multiple range tests were used to separate and compare the mean, alongside with correlation. The result shows that land use influences the soil physical, chemical and water transmission properties research on. The SOC mean of the plantain and oil palm land was similar but significantly differed from arable, fadama and cashew also cashew, arable and fadama soils are significantly different from each other respectively. Bulk density was highest soil under cashew land use type which did not differ from arable land. The plantain land and arable land was not significantly different from each other but differed from oilpalm and fadama land with similar values.

The saturated hydraulic conductivity was highest in soil under oil palm which differed significantly from other treatments, while arable land has the lowest which has resulted from continuous cultivation and livestock grazing. The cashew land has the lowest infiltration rate which is related to the high bulk density (compaction), soil texture, continuous cropping and other management practices. The correlation between hydraulic conductivity and clay was positive and significant (P=0.05). The relationship between bulk density and porosity was negative and highly significant ($P<0.001$).

CHAPTER ONE

1.0 INTRODUCTION

Soil, being an unconsolidated material on the earth crust supports plant growth and regulates water regime on the surface of the earth. In order for crops to attain optimum growth and productivity, certain parameters or properties within the soil profile must meet required levels and conditions. Such factors include: soil pH, infiltration, bulk density, moisture content, particle size (textural classification of soils), porosity, aggregate stability and organic carbon.

The continuous and effective use of agricultural land calls for sequential soil evaluation in order to have a productive output of the agricultural produce (Enwezor,*et al.* 1990). The dynamic soil nature describes the conditions of a specific soil due to land use and management practices (Karlen *et al.* 2003). Land use in a particular location is based on the extent to which the land characteristics match the use for which the land will be utilized (Verheye, 1986).

Several studies have been carried out to determine the spatial or temporal variability in soil physical properties (Cassel and Nelson, 1985; Mapa *et al.*, 1986) and their possible effects on model outcome (De Roo *et al.,* 1992). Ollagnier *et al.* (1978) observed that total soil carbon decreased by 60% and total nitrogen by 75% of the levels under adjacent forest in oil palm plantation of up to 14 years on an Ultisol in the Southern part of Cote d'Ivoire. Ogunkunle and Eghaghara (1992) also discovered the differences in pH, potassium (K), and soil temperature and the bulk density in the different land use types on an Alfisol.

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.

The main objective is to investigate the status of some selected soil physical properties and organic carbon variations due to different land use types.

The specific objectives are to:

- determine soil organic carbon content, texture and bulk density of various landuse types.
- evaluate the soil water transmission properties (i.ehydraulic conductivity and infiltration capacity) in the study areas as influenced by land use.
- evaluate the influence of soil organic carbon content, bulk density, and texture on water transmission properties.

CHAPTER TWO

2.0 LITERATURE REVIEW

Land use involves the entire activities carried out by people on the soil. In this context, human management of soil is considered. Ogeh, J.S and Ogwurike, P.C (2006) observed that land use types significantly differed from each other in at least three properties. The oil palm and citrus differed in at least seven properties, arable and citrus in at least six and gmelina and citrus in at least six.

Research has shown that from three centuries ago and continuously, scientist have been witnessing the rapid and extensive environmental change due to land use effect. (Lambin *et al;* 2003). Land use and management influence soil properties and also enhance soil erosion processes. The adverse effect of the inappropriate land use entails land degradation and soil quality deterioration through loss of vegetative cover, top soil moisture, infiltration capacity, water storage, soil organic matter, fertility, resilience, natural regeneration capacity, and a lower water table, factors that are critical for soil health (Awdenegest Moges *et al,* 2013).

Awdenegest Moges *et al*, (2013) from the research work conducted in Ethiopia shows that soil quality assessment is valuable for evaluating ago-ecosystem sustainability, soil degradation, and identifying sustainable land management practices. In the study, they compared soil quality within culturally protected forest areas and adjacent grassland, grazing land, and farmland in Abo-Wonsho, Southern Ethiopia and soil analysis was done, the Soil textural fractions varied with land use and soil depths even though the textural class they got across all land use types was sandy loam, the soil bulk density, soil organic carbon (SOC), varied significantly and , respectively, with land use and soil depth, but other indicators reveals no significant difference.

Categorically, some soils e.g latosols under natural condition has a low fertility but it has been observed that they tends to change when used for agro-forestry activities, it tends toward a new state of equilibrium which may affect soil and water conservation and simultaneously decline crop production (Silva *et al;* 2000). Soil physical properties can be used to determine the soil quality and to indicate portions of land that has been disturbed, as well as disclose land use which will minimize further degradation (Arshad *et al.,* 1996).

In the tropical region, Hartemink *et al.,* (2008) studied the effects of land cover change on soil resources and the result showed that conversion of climax vegetation to human managed land use systems causing low soil structure stability, loss of organic matter, and reduction in soil organic carbon. Also, the use of machinery together with highly intensive soil tillage and inappropriate management of crop residue can restructure the soil, leading to compaction, affecting soil density, porosity, water infiltration, root growth and reducing crop yield (Tavares Filho *et al*; 2001; Tormena *et al.*;2002; Silva *et al.*;2005).

Lastly, the work done by Senjobi and Ogunkunle (2011) in Ogun state Nigeria, reveals that land use seriously influences soil nutrients availability and productivity, revealing that nutrient varies in soils, land use been the main determinant, after studying the effect of land use using (arable, oil palm and secondary forest) as a case study.

2.1 EFFECT OF LAND USE TYPES ON SOIL TEXTURE.

Soil texture refers to the relative proportions of sand, silt and clay on weight basis. The size groups are classified by International Society of Soil Science (ISSS) into clay (<0.002mm, silt (0.002 – 0.02mm), fine sand (0.02 – 0.2mm) and coarse sand (0.2 – 2.0mm), according to Bouyoucos, G.J. (1962). Particle size is a method of separating soil particles into various sizes. The hydrometer method was adopted in this research work (Agbenin, J.O, 1995).

From research points of view, soil physical parameters, especially, the soil textures can be used in determining soil susceptibility to erosion as discovered and stated by (cammeraat and Imeson, 1998). Erosion greatly influence soil texture, by reducing crop productivity because the nutrients are eroded away and the soil remains deficient of some essential & non-essential nutrient and make the soil unproductive especially for agricultural use, (Boukheir, 2008).

Erosion also destroys the structure of the soil, reduces soil water quality (Quinton & Catt, 2004), and most times the eroded materials from a land may be full of toxic substances (especially eroded soils from highly industrialized area) and are deposited on another (sloppy) farmland and causes low productivity in crop yield, (Poesen & Hook, 1997).

Furthermore, from research work conducted by (Awdenegest Moges *et al*, 2013) showing the clay fraction gotten from the work being less than 200 gkg^{-1} across all land use types and soil depths. He also discussed that the mean clay fraction was relatively higher (160 gkg^{-1}) under farmland and the least in the protected forest land (78 gkg^{-1}), and was also higher in the 10–20 cm soil layers across all land use types.

Also, soils that are predominantly sandy tend to be highly erosive because of their easy detachment and transportation of detached particles, (Egbai Oruk *et al,* 2012). Steep slope also tends to speeds up erosion, reduces the amount of water percolating through the soil and decreases the upper portion of the soil profile resulting in a relatively shallow and poorly differentiated soil profile (Sehgal, 1986;Ogunkunle & Onasanya, 1992; Ibanga, 2003; Adekoyade, 2007).

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

Bulk density of a soil is explains 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, J.O, 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, having a bulk density of $0.95MgM^{-3}$ and 250mg Pkg^{-1} of soil, does not contain more of P than a soil B having a bulk density of 1.36Mg M-3 and 200mg P kg-1 soil. In the example cited , the mass of P extrapolated to a hectare for soil-A, assuming a ploughing depth of 5 cm, will be 120kg/ha compared to soil-B having 170kg P/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 coparisons of different soils (Agbenin, J.O, 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) stated that the differences in soil bulk densities with soil depth was significant, higher in the lower (1040 Kgm^{-3}) than in the top surface soil layer (960 Kgm^{-3}), 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 as investigated by and 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) from their research work and experience stated 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. 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 from others that are not, According to the 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.

2.3 EFFECT OF LAND USE TYPES ON SOIL ORGANIC CARBON

Soil organic matter is composed of different compartments which differ from each other in biochemical composition, biological stability and carbon turnover rates (Paustian *et al,* 1992). In traditional farming systems, farmers' uses bush fallow, plant residues, household refuse, animal manures and other organic nutrient sources to maintain soil fertility and soil organic matter. (Mulongey and Merck, 1993). Amama *et al,* (2012) and Ceyhun (2009) reported that soil organic matter improved soil structure and its stability.

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 physico-chemical properties such as CEC, availability of nitrogen, phosphorus and sulphur, bulk density, aggregation, infiltration and water retention. Carbon is the main component of organic matter (Agbenin, J.O, 1995).

The soil organic matter decomposition has negative influences mainly on cation exchange capacity, 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 CO2 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 rȯle of soils in the global carbon system.

Both labile, mineral associated and humified soil organic fractions may show different susceptibility to land use and management effects. In cold and semiarid region, the carbon stocks in labile particulate soil organic carbon fraction constitute carbon which is varyingly and mostly affected by agricultural practices (Chan, 1997; Franzluebbers and Arshad, 1997).

A study conducted by Bayer *et al.* (2006) explains that the particulate soil organic carbon usually ranges between 30 to 40% of total organic carbon in most of Brazilian soils. Hot and humid environment also favours microbial activity that leads to intensive decomposition and humification of labile fractions as stated by (Bayer and Bertol, 1999) from the research work conducted. According to Chan (1997) and supported by Janzen et al. (1998), revealed that soil organic matter constituents ranged from labile compounds that mineralize during the first stage of decomposition to more resistant (mineral-associated soil organic carbon). They finalized on the point that soil organic matter changes occur primarily in the labile fraction. (Pillon, 2000) and (Burle et al., 2005) pointed out that Soil organic carbon storage in deeper soil layer has been related to the development of roots systems and to the amount of above ground biomass addition on the soil surface, meaning; trees greatly tends to supply organic carbon from their litters, as determined by the time duration and fallow period since the biomass increase with age.

Bernoux *et al.* (1998) stated that long practices of deforestation and/or replacement of natural forests by agro-ecosystem and uncontrolled overgrazing have been the major causes for soil erosion and climatic change. This is so because harvested trees are not replaced or re-grow and, thereby, exposing the soil, this result in the soil temperature rising above the tolerance level of soil micro-organisms thereby reducing their activities or cause their eradication from that habitat thereby affecting the soil physical and chemical properties. (Bernoux *et al.,*1998), also revealed that when erosion washes away the finer soil particles, organic matter and their colloids fractions, and since the materials enhances the microbiological activities and the cation exchange capacity of the soils which provides storage nutrients for plant, the removal of this particles and their colloids causes soil infertility (Assefa, 1978).

From the work done by Martin and Anikwe; (2010), He was able to revealed that the soil carbon stock in a 45-year old *Gmelina* forest was 8987 gC m^{-2}, whereas the parts of this forest, that were cleared and continuously cultivated for 15 years, had 75% lower carbon stock (1978gC m^{-2}). Meaning, the carbon content under continuous cropping and conventionally tillage practices soils experimented on was also 25% lower than the carbon stock of the soil cultivated by use of conservation tillage.

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).

The volume of soil that is lost to erosion during rain storm event is not only a function of slope, rainfall intensity or duration but a function of land cover condition.(organic matter), (Egbai Oruk *et al,* 2012).

The conversion of dense canopy ecosystem to other forms of land cover such as grassland may decrease the stock of soil organic carbon due to changes in soil moisture and temperature regimes, and succession of plant species with differences in quantity and quality of biomass returned to the soil, which also disrupt the richness of nutrient restored to the soil. The soil erosion intensity and amount of nutrient element loss varies depending on the vegetation type at a particular place and time. Because, the level of nutrient loss also depends on the ability of vegetation canopy to disrupt direct impact of rain drops on the soil surface (Iwara, 2011).

Offiong *et al*, (2009) in the research work done; compared the soil properties in secondary forest, a rubber plantation and soil adjoining the road in Tinapa area of Cross River State. The result reveals that the levels of organic matter, total nitrogen and cation exchange capacity were substantially higher in soils under dense vegetation than in soil adjoining the road.

Hu *et al*. 2006, (2007) also reported that urban areas have intensive human activities, and soil quality in urban areas is closely related to human health at food safety.Mbagwu and Picolo (1990) explained that the increase in soil organic matter was found to increase the aggregation of acid ultisol.

Furthermore, Benjamin *et al* (2007) reported that perennial cropping system was more effective in improving soil physical properties than pastures and grasses. Also, Yifru and Taye (2011) in his research work said soil organic carbon and total nitrogen were high in natural forest but low in cultivated fields. Although, some other scientist stated it in their research work, such as (Eyayu *et al* 2010; Nyssen *et al* 2008;Amare 2007; Fantaw 2007; Belay 2002;Kebrom and Hedlund 2000). On a Contrary opinion to this affirmative studies saying it's not so. Geissen *et al* (2009) in Mexico concluded that land-use change did not lead to change in some soil chemical properties rather to change in soil physical properties.

Research work conducted by (Awdenegest Moges *et al*, 2013), they discovered soil organic carbon content to be very low in farmland (18.4 gKg^{-1}), and low (26.0–29.7 gKg^{-1}) in other land use types (although the valves gotten from other land use types are still greater than the farmland, due to the fact that there is always continuous cultivation of farmland), indicating that soils under the protected forest and adjacent land use types are threatened by the continuous animal encroachment, human interference, and intensive agricultural production systems.

2.4 EFFECT OF LAND USE TYPES ON INFILTRATION

Infiltration denote the entry of water usually from the soil surface and vertically downward the soil. The infiltration capacity of soil is defined as the maximum rate at which water enters the soil when water is applied faster than it can infiltrate (Agbenin, J.O, 1995).

The term infiltration refers to the process, by which rainwater passes through the ground surface and fills the pores of the underlying soil (Morammad Farhan Bin

Salleh, November, 2006). Infiltration capacity of a soil shows to be higher in the beginning of infiltration event, but slowly decreases with time, this varies with water content, texture and structure of the soil, vegetation cover, land use type and some other factors (Agbenin, J.O, 1995).

The Surface and sub-surface of soil conditions influence the infiltration rates; surface conditions determine the availability of water, while the subsurface conditions govern the ability of the available water to infiltrate (Morammad Farhan Bin Salleh, November, 2006).

Houghtalen, (1992) stated thatInfiltrometers are usually classified as rainfall simulators or flooding devices. Formerly, artificial rainfall is simulated over a test plot and the infiltration is calculated from observations of rainfall and runoff, (Morammad Farhan Bin Salleh, November, 2006). Estimation of infiltration based on hydrograph analyses have the advantage over infiltrometers of relating more directly to prevailing conditions of precipitation and field. (Morammad Farhan Bin Salleh, November, 2006).

An estimated 400 million hectares of land have been abandoned due to soil erosion over the past 50 years as a result of inefficient infiltration. Flanagan, (2001). Brown *et al.* (1997) reported that an estimated 40% of the world's cultivated area has been damaged by mismanagement since 1950. Morgan (1995) attested that erosion rate data should also be taken and interpreted cautiously, because rates vary with the size of the area being considered. This also is spoken of by Kohnke and Bertrand (1959).

Moreover, infiltration characteristics keep a close relationship with the soil structure and have been proved to be a good indicator of changes in soil physical and biological properties (Radke and Berry. 1993). Water infiltration affects crop production and the volume, transport route and quality of agricultural drainage (Mukhtar *et a.,* 1985).

Several factors that include soil slope, soil texture, structure, vegetation cover, management systems, antecedent water content and soil organic matter is capable of affecting the infiltration rate (Radke and Berry 1993). Macro-pores in soils are defined for soil aeration and soil water infiltration, why micro-pores are responsible for retaining and storing water in the soil for sequential use of plants. Soil water on soil surface is stored in micro-depressions, infiltrates into the soil profile or moves downhill as overland flow. The amount of infiltration and the infiltration rate as shown to depend on the characteristics of the soil (Morgan, 1995). Effects of soil erosion can be divided into on-site and off-site effects (Boardman *et al,* 1990; Lal, 1990).The on-site effects are important for agricultural fields, and cause phenomena like the disruption of soil structure, soil infertility, seedlings loss and reduction of soil depth. While the off-site effects include sedimentation downstream, contamination of drinking water supplies, siltation of reservoirs, and flooding (Boardman et al., 1990; Lal, 1990).

Sfeir-Younis and Dragun (1993) stated that the upstream effects also include the on-farm losses in productivity and inter-farm damages to irrigation terraces, roads, bridges etc., while downstream effects are related to the off-site effects as discussed above. Plant cover protects soil against erosion by reducing water runoff (Rey, 2003;Puigde fabregas, 2005, Durán *et al.*, 2006a; 2007) and also increasing water infiltration into the soil profile (Ziegler and Giambelluca, 1998; Wainwright *et al.*, 2002).

Research studies have tried to predict the rate of water-induced soil erosion, andto evaluate possible measures to reduce its negative effects, the studies includes empirical field studies and studies using models to predict the level of erosion, although many studies have combined the two, using field tests to generate model parameters (Mutchler *et al.*, 1988; Van Dijk, et al., 1996; Wu, 2000).

The overland flow caused by the high intensity rainfall exceeding the infiltration capacity of the soil and the lack of storage in the soil due to saturation. Few studies have tried to quantify the effects of the spatial heterogeneity of saturated conductivity on model outcome (De Roo *et al*, 1992). However, there is serious need of several research works to be conducted on infiltration, its significant role and factors contending against it actualization.

2.5 EFFECT OF LAND USE TYPES ON HYDRAULIC CONDUCTIVITY

Hydraulic conductivity is defined as the ability of the soil as a porous medium to conduct the flow of water through it. Soils with more macro-pores (sandy soils) have higher saturated hydraulic conductivity than with more micro-pores (clayey soils) (Agbenin, J.O, 1995).

The principle used is "Darcy's law of flow"; Darcy's law of flow through a porous medium, when applied to vertical movement of water, states that the flux of water is directly proportional to the hydraulic gradient (f) (Agbenin, J.O, 1995).

Mathematically expressed as: $Q = k. f$

Where k is the hydraulic conductivity.

The hydraulic conductivity depends on both the soil texture and on the soil structure. The soil texture has been considered a static property, while the structure changed dynamically,

which in-turn may vary in space as well as in time, depending on soil type and soil management (the land use), (Cassel and Nelson, 1985; Mallants et al, 1996; Fohrer *et al*, 1999).

Furthermore, Messing and Jarvis (1993) in their research work discovered significant changes in soil physical properties as regard land use. Mapa *et al*, (1986) shows that four soil-water properties (i.e. sorptivity with positive head, sorptivity with negative head, soil hydraulic conductivity and the soil-water retention characteristic) undergoes significant temporal changes due to wetting and drying as a result of tillage practices.

Adequately, they also discovered the major differences in calculated water content profiles between simulations using parameters measured before irrigation events and those using parameters measured after such events. As reviewed that infiltration is the force behind the generation of overland flow, while only few studies have addressed the effects of the heterogeneity of soil hydraulic properties in space and time in relation to soil erosion

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 General description of study location

The study area covers five different farm locations within the Federal University Oye-Ekiti, Ikole Campus which include the Oil palm plantation, Cashew plantation, Plantain plantation, Lowland (Fadama) and the Arable land. The 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 1400mm 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 slopy, and there is presence of some common weeds like Sida acuta, Elephant grass, Chromolaena odorata, and presence of worm casts. Small farm implements (e.g cutlass) used for the continuous agricultural practices were found on the site.

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, Sida acuta, Chromolaena odorata, presence of mottles and plinthites and also termitarium.

The arable land (latitude 07^{O} 48.439 and longitude 005^{O} 29.869) is slightly slopy, there is presence of worm cast, and termitarium, presence of plinthites and concretions in some part, and common weeds present include Sida acuta, chromolaena odorata, elephant grass, stubborn grass, and crops like cassava, yam, and vegetables.

The low land occupies the valley bottom of the slopy land and marshy land. There is presence of common weeds like Sida acuta and crops like vegetables (Amaranthus, Talinum triangulare), maize, tomatoes. The soils are compacted due to grazing of livestock (cattle and sheep) on the field, the fadama land lies between (latitude 07^{O} 48.464 and longitude 005^{O} 29.523).

The Plantain and banana plantation (latitude 07^{O} 48.442 and longitude 005^{O} 29.513) is a slopy land, there are presence of worm casts, common weeds like Cyprus rotundus, Chromolaena odorata, Sida acuta,Talinum triangulare,

3.2 Soil sampling and preparation

Each study location or land use types were divided into four using a stratified random sampling method (Peterson and Calvin, 1986). Soil samples were collected with soil auger to the depth of 0-15cm and 16-30cm. The soil samples were air dried under room temperature, crushed and allowed to pass through 2 mm sieve size.

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 sec and the first temperature was taken using the thermometer. After 2 hours, the second hydrometer reading and temperature were taken.

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 samplers from 0-15 cm depth and the bulk density was then calculated as given below.

$$BD = MS/V_B$$

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

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 fomula; $(\Theta g) = W_2 - W_3 / W_3 - W_1$

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

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

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

S = soil water sorptivity 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

Saturated hydraulic conductivity

Saturated hydraulic conductivity (Ks) is estimated by the constant head soil core method as described by Reynolds (1993).

Soil samples were taken using core soil samplers, the core soil samplers were allowed to pre-soak in the water overnight. Water was allowed to move through the soil in a core with a height of 4cm and 4.3cm diameter under constant head and the quantity of volume of water flowing through the soil samples was measured at every two minutes. Saturated hydraulic conductivity (Ks) was estimated by constant head core method using the following relationship.

$Ksat = QL / Aht$ (cm^{-1})

Where;

Ksat = saturated hydraulic conductivity (cms^{-1})

Q= volume of water discharged at constant flow (cm^3)

L= length of soil sample

H= total head difference across the flow path of length L (cm)

A= cross-sectional area of the soil sample (cm^2)

t= time (seconds)

3.2.3 Chemical Property

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

SOM (g/kg of soil) = Organic Carbon X 1.724

3.2.4 Data Analysis

The data generated was subjected to statistical analysis using SAS package version 9.3, 2011. Analysis of variance (ANOVA) was used compare the influence of the land use types on the measured soil properties using Tukey's Studentized Range (HSD) Test in a randomized complete block design (RCBD).

Duncan multiple range tests were used to separate and compare the mean, alongside with correlation

CHAPTER FOUR

4.0 RESULT AND DISCUSSION

4.1 Effect of land use types on soil organic carbon and particle size.

Organic carbon

The result of soil organic carbon and particle size distribution are presented in Table. Organic carbon differed significantly ($P \leq 0.001$) among the land use types. Martin and Anikwe, (2010) had observed that organic carbon decreased in a continuously cultivated land than a land that is not always cultivated.

The SOC mean of the plantain and oil palm land was similar but significantly differed from arable, fadama and cashew also cashew, arable and fadama soils are significantly different from each other respectively. This shows that the SOC level in the plantain and oil palm land are not distinctively 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.

Plantain soil has the highest SOC content while Cashew has the lowest level of SOC which might have been so as a result of agricultural activities and misuse of land even as attested to by Murty *et al.* (2002) saying changes that occur in land use affect the amount of carbon held in vegetation and soil.

Particle size distribution

The mean sand content in plantain, oilpalm, fadama, arable, and cashew is not significantly different from each other. This means that there no significant difference between the sand content across all the land use types respectively. Plantain land has the highest sand content, which did not differ from fadama land, oilpalm, cashew, and arable land.

The arable land had the highest clay content (23.64%) while plantain land had the lowest (13.64%). The clay content levels in cashew soil, fadama soil, plantain soil and arable soil are not different from one another but the highest value in the arable land differed significantly from plantain.

The silt content was not different among the land use types. However, plantain contained the highest silt (6.84%) while the least was observed in cashew land (5.34%)

Table 1: effect of land use on soil organic carbon and particle size distribution

Landuse	Mean			
	SOC (g/kg)	Sand (%)	Clay (%)	Silt (%)
Plantain	2.10a	79.52	13.64b	6.84
Oilpalm	2.08a	77.27	17.14ab	5.59
Fadama	2.02b	77.77	15.89ab	6.34
Arable	1.70c	70.52	23.64a	5.84
Cashew	1.21d	72.77	21.89ab	5.34

Means with the same letter are not significantly different

SOC= soil organic carbon.

4.2 Effect of land use types on soil bulk density, soil gravimetric water content and porosity.

Bulk density

Table 2 shows that bulk density was highest soil under cashew land use type which did not differ from arable land. The plantain soil (1.66) and arable soil with (1.76) was not significantly different from each other but differed from oilpalm and fadama land with similar values. 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.

Gravimetric water content (GWC)

Gravimetric water content (GWC) was highest in the fadama land and differed significantly from plantain, arable and cashew soils which showed no significant differences among themselves. GWC of oil palm was the least. This is related to decrease in bulk density. The highest GWC under fadama land is as a result of the gradient of the land and some other management practices.

Porosity

Soil porosity under the oil palm and fadama land were highest and not significantly different. Also, were followed by plantain and arable land while arable and cashew land use did not differ significantly from each other. The soil under fadama land shows the highest level of soil porosity while the one under cashew appeared to be the lowest. 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. 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.

Table 2: effect of land use on BD, GWC and particle POROSITY

Landuse	Mean		
	BD (g/cm^3)	GWC (%)	Porosity (%)
Plantain	1.66b	30.48b	37.23b
Oilpalm	1.39c	18.21c	47.60a
Fadama	1.39c	50.28a	47.57a
Arable	1.76ab	30.55b	33.66bc
Cashew	1.83a	32.36b	30.98c

Means with the same letter are not significantly different

BD= bulk density, GWC= gravimetric water content.

4.3 Effect of land use types on soil water properties

Table 3 shows the mean values of saturated hydraulic conductivity and infiltration rate for the 5 land use types.

Saturated hydraulic conductivity

The saturated hydraulic conductivity was highest in soil under oil palm which differed significantly from other treatments. Cashew, plantain, and fadama land did not differ in hydraulic conductivity. The saturated hydraulic conductivity under plantain and arable lands appeared not to be significantly different from each other. The least value in arable land has resulted from continuous cultivation and livestock grazing. Mapa et al. (1986) had noted changes in hydraulic conductivity and infiltration under different land use/ management practices. Also, Cassel and Nelson, (1985); Mallants *et al.*, (1996) observed that the texture of the soil affects the hydraulic conductivity of the various land use types.

Infiltration rate

The mean infiltration rates are; plantain soil has (12.65), oilpalm soil has (9.81), fadama soil has (13.48), arable soil has (3.82) and cashew has soil (14.34). Infiltration in plantain land, fadama land and cashew land are not significantly different from each other but different from all other land use types considered.

The cashew land has the lowest infiltration rate which is related to the high bulk density (compaction), soil texture, continuous cropping 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 3: effect of land use on soil water transmission properties

Landuse	Mean SHC (m/s)	Infiltration (mm/hr)
Plantain	0.69bc	12.65a
Oilpalm	5.90a	9.81b
Fadama	0.81b	13.48a
Arable	0.54c	3.82c
Cashew	0.93b	14.34a

(Means with the same letter are not significantly different).

SHC= saturated hydraulic conductivity.

4.4 Correlation of the physical, chemical and water transmission property studied

Table 4 shows the relationships between the physical, chemical and water transmission properties of the soil across all the land use types. The correlation between hydraulic conductivity and clay was positive and significant (P=0.05). However, the relationship between bulk density and porosity was negative and highly significant (P<0.001) while there is no relationship between all other properties. The result means clay content of the soils across the land use influence the saturated hydraulic conductivity. Also, the bulk density tends to affect the porosity of the soils across the land use types while the other property tends not to affect each other.

Table 4: **Correlation table for soil physical, chemical and water transmission properties**

	BD	GWC	Porosity	SHC	SOC	Sand	Clay	Silt
BD	1	-0.43409	-1***	-0.733	-0.632	0.887	-0.573	-0.368
GWC		1	0.434	0.001	-0.394	-0.678	0.077	0.763
Porosity			1	0.733	0.632	-0.887	0.573	0.368
SHC				1	0.593	-0.727	0.951*	-0.341
SOC					1	-0.245	0.323	-0.118
Sand						1	-0.708	-0.332
Clay							1	-0.431
Silt								1

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This research work shown that land use greatly affects soil properties such as organic carbon, particle size distribution, bulk density, porosity, infiltration and hydraulic conductivity. Therefore, agricultural lands need to be adequately monitored for proper management.

5.2 Recommendations

- The arable and cashew land requires 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 school farm especially the arable land should be avoided.
- The lowland can be best used to grow lowland rice during the rainy season and growing vegetables and maize when the rains cease.

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APPENDIX

Appendix 1: Anova table for soil particle size distribution and soil organic Matter

SOV	DF	Mean squares			
		SOC (g/kg)	SAND (%)	CLAY (%)	SILT (%)
Rep	1	0.033***	99.225*	62.500*	4.225ns
Land use	4	0.284***	28.338ns	35.088*	0.725ns
Mean		1.823	75.570	18.440	5.990
CV (%)		0.861	4.244	10.414	23.462

Rep = replicate, CV =coefficient of variation, SOC = soil organic carbon, * =significant, ** = very significant, ns= non-significant, * =highly significant.**

Appendix 2: Anova table for soil physical and water transmission properties.

Mean squares						
SOV	DF					
		Infiltration (mm/hr)	BD (g/cm^3)	GWC (%)	POROSITY (%)	SHC (m/s)
Rep	3	3.855ns	0.003ns	17.468ns	3.614ns	0.009ns
Land use	4	72.908***	0.170***	528.307***	242.608***	21.289***
Mean		10.819	1.606	32.374	39.407	1.775
CV(%)		13.034	5.543	15.194	8.522	9.409

Rep = replicate, CV =coefficient of variation* =significant, ** = very significant, ns= non-significant, * =highly significant, BD= bulk density, GWC = gravimetric water content, SHC= saturated hydraulic conductivity.**