THE EFFECT OF LANDUSE ON THE PHYSICAL PROPERTIES AND ORGANIC CARBON OF SELECTED SOILS IN EKITI STATE

BY

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CERTIFICATION

This is to certify that this project titled "THE EFFECT OF LANDUSE ON THE PHYSICAL PROPERTIE AND ORGANIC CARBON OF SELECTED SOILS IN EKITI STATE" meets the requirement of a final year project and regulation governing the Award of Bachelor of Agriculture (B.Agric) degree of Federal University Oye – Ekiti and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This work is dedicated to God Almighty, Most Gracious, Most Merciful and to my father, Alhaji M.O. Alawaye Salmon and my mother Alhaja R.M. Alawaye.

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I am most grateful to God who directed me and saw me through the tough times in completing this work. The success of this achievement would not have been a reality without the prayers, financial assistance and moral advice of the following personalities.

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ABSTRACT

Forest soils in Ekiti state western Nigeria are destroyed due to agricultural activities. Information about the effect of land use on soil is important for soil sustainability and productivity. A study was conducted to investigate changes that may occur in the soil organic carbon content (SOC) and some selected soil physical properties due to conversion of forest to arable land. Six locations that were selected for this purpose include; Ona-Ara (L1), Asin (L2), Ijesa Isu (L3), Odo-Oro (L4), Asaba (L5) and Osin (L6) in Ikole and Oye Local Government Area in Ekiti state, southwestern Nigeria, Soil parameters evaluated include particle size distribution, bulk density, moisture content, total porosity and soil organic carbon. Disturbed and undisturbed samples were collected from six locations at each of the forest and adjacent cultivated sites from depth 0-10cm and 10-20cm. The experiment was arranged as a 2 ×2 × 6 factorial experiment for the factors landuse, depth and location with three replication in completely Randomized Block Design. The result indicated 70, 41, 17, 67 and 33% decline in clay, silt, SOC, porosity and moisture content of the soil respectively. Bulk density increased by 31% while 26% increase was recorded in the sand fraction. Increase in sand fraction implies loss of fine fractions which might be attributed to selective erosion. At the two different depths, result shows that cultivation caused a significant decline in all soil properties. Interaction of location and landuse showed that all the locations were adversely affected by landuse change, although in different degrees probably due to management system and inherent property of each locations. In conclusion, the study observed that cultivation of forest land resulted to degradation of soil organic carbon and physical properties which are crucial for sustainability and productivity.

Key words= Land use, Forest, Cultivated, Soil physical properties, SOC (soil organic carbon).

CHAPTER ONE

1.0 INTRODUCTION

One of the major problems affecting agricultural productivity in developing countries of the tropics which include Nigeria is land degradation. The intensity of cultivation resulting in opening up of new lands exposes the top soil to the elements of degradation which alters the natural ecological conservatory balances in the landscape. These imbalances will pose great difficulty for productivity increase to meet the food and fiber needs of a rapidly growing population. (Senjobi, 2007). Ahukaemere et al., (2012), stated that narrowing land: man ratio has given rise to the alteration of land use pattern and management method which include clearing of forest and continuous cropping with or without the use of external inputs. The high population increase poses a number of threats, such as the provision of adequate food, management of the soil resources to support food production, adequate soil information, the development of appropriate technologies for sustainable agricultural production and meeting the challenges of intensive agriculture. To have an in-depth knowledge and appreciate the burning issue of sustainability of soil productivity, we need to keep in mind the two determinant components, the chemical properties and physical properties of the soil (Schroth *et al.*, 2002).According to Singh (1997), agricultural quality of a land can be judged by the physico-chemical properties of its soils which will provide anchorage, water and nutrients to the plants.

Agricultural sustainability requires a periodic evaluation of soil fertility status. This is important in understanding factors which impose serious constraints to increased crop production under different landuse types and for adoption of suitable land management practices.

Information so generated could also be useful in adjusting present landuse types or in the development of appropriate landuse policy for a given area (Enwezor, et al. 1990).

With the clearing of the natural vegetation and subsequent conversion to arable farm land, the soil physical and chemical environment is easily lost because of the exposure to high temperature and high intensity tropical storm. Soil properties are continuously influenced by land use at various levels of management such as cropping system and the farming system. Also soil structure, amount of soil organic matter (SOM), water and nutrient holding capacity are all affected by land use (Oyetola and Agber, 2014). Farming practice like field crop production is an anthropogenic process which will definitely accelerates soil degradation when adequate soil conservation measures are not incorporated into the cropping system.

Senjobi and Ogunkunle, (2011) reported on the extent to which land use types could influence soil nutrients and productivity. An investigation was conducted in Ogun State, Nigeria in which land use types of arable cropping, oil palm and secondary forest were investigated and the result showed that soil nutrients varied from one land use type to another and soil depletion and degradation were very prominent under arable cropping than the oil palm and secondary forest. Intensive and continuous land use may cause important changes in soil physical and chemical characteristics and can also affect soil fertility, increase soil erosion or cause soil compaction. Land use changes through cultivation with time may rapidly diminish soil quality, as ecologically sensitive components of tropical soils are not able to buffer the effect of intensive agricultural practices (Oyetola and Agber, 2014).

Lal and Shepherd et al, (2005) noted that land use in tropical ecosystems could cause significant modifications in soil properties. Schipper, et, al. (2000) noted that such modifications could be physical, chemical or biological. Forest ecosystems are important both ecologically and economically. It is arguable that the most basic dynamic of the forest ecosystem is the forest soil.

The most common land use patterns in Ikole in Ekiti State include continuous cropping system of cassava cultivation, yam cultivation, maize cultivation and oil palm plantation. There seems to be little or no information on the effect of cultivation on the soil physico-chemical properties. It therefore becomes necessary to study the effect of land use systems on physical and selected soil organic carbon of soil in different location within Ikole Local Govermnet Area of Ekiti State, Nigeria. The major objective of this study is;

- To use some physical and chemical properties of the soil to evaluate changes that occurs in the soil when forest lands are converted to or compared to arable land.

The specific objectives are;

- To determine some physical properties of the soil in different locations and under different landuse types at two different depths.
- To quantify the soil organic carbon in forest and cultivated landuse types.

CHAPTER TWO

2.0 LIRERATURE REVIEW

2.1 Landuse Type Concepts

Land use systems, soil types, topography, and climatic conditions are factors which determine the rate of soil quality degradation (Singh et al., 1995; Saikhe et al., 1998). Also Maddonni et al. (2001) reported that land use affects basic processes such as erosion, soil structure and bulk density, nutrient cycling, leaching, organic carbon, and other similar physical and chemical processes (Jamala and Oke, 2014).

2.2 Effect of Landuse Types on soil physical properties

2.2.1 The Effect of Forest Conversion arable land on Particle Size Distribution

The information on particle size distribution is crucial for soil management. The quality of any soil is partly influenced by inherent composition which depends on geological materials. Attribute of inherent quality such as particle size distribution are mainly static and usually show changes over time (Brady and Weil 2008). However (Lal and Kimble 1997, Fearnside and Babosa 1998) have reported that decrease in clay content because of selective erosion is one of the changes known to result from forest conversion. Also (Brown and Lugo, 2000) stated that conversion of forestland to cultivated land seems to reduce clay and increase sand contents. Awotoye et al., (2013) indicate that the clay content increased in cultivated soils in Ap and B horizons and attributed this change to the grinding effect of cultivation on the surface horizons.

Bulk density, Porosity and Water Retention

High bulk densities create unfavorable environment for root growth and adequate aeration. Emadi et, al, (2008) quantified the effect of forest conversion into crop land during an 18 year period, found out that bulk density was increased by 16% leading to disruption of pores leaving the soil more susceptible to erosion. Garji et, al. (2006) noted that bulk density was significantly greater in ploughed horizon than in part of humus horizon of the forest. According to Mbagwu et al, (1984), bulk density of the soil is a reflection of total porosity. They indicated that the higher the bulk density of the soil the lower the porosity of the soil.

Awiti (2005), reported 4.2 to 3.3 times higher water content and noted a 71- 76% reduction in macro pore volume as a result of conversion of forest to cultivated soils, Arauyo et, al. (2004) investigated the physical quality of a red latosol in Brazil under cultivated and under native forest found significantly higher values of bulk density and lower values of porosity in cultivated areas.

Hudson (1994) noted that water retention depended soil texture, bulk density and organic matter content. He showed that soils with high amount of clay and organic matter content retained more gravimetric water than soils with high amount sand. An evaluation of many years of cultivation was reported to result in lower porosity when compared to the natural state (Brady and Weil 2008). Forest clearing and intensive cultivation may cause soil compaction, the effect of compaction degrades soil physical properties which lead to decreased total porosity, infiltration rate and available water capacity, decreased root penetration, gas exchange and an increase in bulk density (Sanchez, 1982). Hulugalle et al., (1984) noted that when there is alteration in soil physical properties attributed to mechanical methods of land clearing, it is reflected in the soil bulk density, and total porosity. Alegre et al.; (1986) found that compaction in soils increase bulk density of the surface soil.

2.3 Effect of Landuse Types on Soil Selected Chemical Properties

2.3.1 Organic Carbon

Soil organic carbon is an important component of the soil that controls many physical and chemical properties of the soil. Conversion of forest to arable land is usually accompanied by a decline in soil carbon which is linked to soil disturbance and change in plant litter composition (Yitbarek, 2013). Research has shown that plant residue addition in forest can increase soil carbon content (Bossuyt et, al. 2002) Spaccunni et, al. (2001) in evaluating soil structure degradation in Ethiopia and Nigeria concluded that in all agro ecological zones, soil organic carbon content was 2-4 times higher in forest than in cultivated soil.

Tangtrakamang and Vitykcan 2004) have shown that in all pools of soil organic carbon under forest soil were higher than in adjacent cultivated soils. The conversion of natural forest to other form of land use can cause loss of soil quality, lead to soil erosion and reduction in soil organic content (Chen et al., 2001).

In the forest land, much of the soil nutrient is stored in the trees, whose canopy protects the soil against the impact of the heavy rainfall and other weather elements in a delicate ecological relationship. Therefore, exposure of the soils by deforestation and bush burning leads to impaired nutrient status of the soil (Owusu-Bennoah, 1997). Fuller, (1995) and Anderson, (2003) noted that Forest soils maintain high levels of organic matter comparable to soil from the continuously cultivated fields. Litter-fall is a major contributor to soil organic matter in the forest ecosystem (Chen et al., 2000).

2.3.2 Selected Chemical Properties

Conversion of forest to cultivated land causes an variable changes in organic matter content resulted in nutrient imbalances, and reduction in water-holding capacity, nitrogen, calcium, magnesium, potassium, phosphorus, and cation exchange capacity (Brown and Lugo, 1990). There was a slight increase in pH after clearing and remained stable afterwards in the burned plots at all depths.

When forest land are converted to cultivated land there is an appreciable change in organic matter content resulted in nutrient imbalances, and reduction in nitrogen, calcium, magnesium, potassium and phosphorus, (Brown and Lugo, 1990). There are several changes in soil properties which occur after Clearing and burning of forest which generally occur within the first year. Among those changes, these exhibits rapid increase in the pH of soil after burning (McGrath et al., 2001). It was clearly indicated that soil pH had increased, and remained elevated, for more than 8 years after continuous cultivation. This reduction in the soil pH with continuous cultivation is caused by increased losses associated with lowered organic matter in the soils (Owusu-Bennoah, 1997)

By conversion of forest to field crops, Soil cation exchange capacity (CEC) increased (McGrath et al., 2001). Blake et al., (1999) found that the CEC of the soil under cultivated land increased with the depth, because the clay content increased. Also, they found that the CEC of the surface soil decreased by 47% during the last 100 years after forest conversion. However CEC appears to rise and remain elevated in pasture soils following conversion from forest (McGrath et al., 2001). Nair and Chamuah, (1988) reported that in some pine forest, the CEC value decreases with the depth. The percentage of base saturation is also higher in the surface soils as compared to subsurface layers, possibly, because of plant recycling (Seubert et al., 1977). There are several factors which contribute to the loss of N in shifting cultivation fields. When forest is cleared and burned, there is large losses of nitrogen that occur upon burning by volatilization and reduction of organic matter (Gimeno-Garcia et al., 2000; Gol and Dengiz, 2008). After clearing and crop harvest, the topsoil remains open for climatic conditions which allow for an increase in soil temperature and rates of microbial decomposition, and the lack of vegetation reduces plant uptake of mineralized N, which is then more vulnerable to losses by leaching (Alegre et al., 1999).

In the forest area, Phosphorus is considered a limiting nutrient for biological activity. The traditional slash and burning method produced more favorable change in supply of available soil phosphorus (Awotoye et al., 2013). There is a transformation of un-available phosphorus in soil into mineral forms readily available to plants which are caused by burning (Giardina et al., 2000).

Shukla and Agrawal, (1994) reported that available phosphorus in the top soil increased after few years of continuous cultivation. The total amount of available phosphorus in the soil was reduced during cropping and this was attributed to crop take and phosphorus remains become insoluble. Burning dried vegetation will result in higher concentration of Ca, Mg, and potassium in topsoil layer as compared to mechanical treatment (Alegre et al., 1988; Marafa and Chau, 1999). The basic cations in the ash will give marked increases in exchangeable Ca, Mg, and potassium level after burning (Stromgaard, 1991).

A lot still need to be done on the physico-chemical characteristic of Nigerian soils, although there have been previous research, we still need more research (especially in Ekiti state) so as to so as to understand and utilize such information to maximize crop production. This study is a contribution to make more data available on Ekiti soils in Nigeria.

CHAPTER THREE

MATERIALS AND METHOD

3.0 Description of the Study Area

The locations used for this study are Ona-Ara (L1) (latitude 070 47.375' and longitude E 005^0 30.968'), Asaba (L2) (Latitude 07^0 47. 170' and Longitude E005^0 30.072^2), Ijesa-Isu (L3 (07^0 46.716' and longitude latitude 005^0 30.604'), Asin (L4) (Longitude 97^0 45'183 and Latitude E 005^0 27.444), Odo-Oro (L5) (longitude $07^0$48.190' and latitude E005^0 31.214') and Osin-Ikole (L6) (longitude 07^0 48.120' and latitude E005^0 24.643') in Ikole Local Government Area of Ekiti State. The location are situated within the rainforest agro-ecological zone. The area enjoy rainfall between later March and October with some few days of occasional dry spell in August. The temperature of the area ranges between 21^0 C and 28^0 C with high humidity.

Farming is usually done with traditional tools such as hoes and machete and on subsistent level. Information from farmers in all locations revealed that they practice shifting cultivation and some common arable crop planted include cassava (Manihot esculen ta), cocoyam (Colocasia spp.), melon (Citrilus viligaris) and maize (Zea mays), vegetable (Amaranth spp.). Also, information from the indigenes showed that the forests have never been cleared, cultivated or burnt for about 100 years.

3.1 Soil Sampling and preparation

A stratified random sampling that divides the sampling plot into three subdivisions or replicate was adopted to sample soils (Petersen and Calvin, 1986). Two land use namely: Arable cropping (cultivated) and Natural Forest land were studied from six different locations. The virgin forest is adjacent to the cultivated land with the same slope. At each of the location land use type, an area of 20m by 20m was identified with the aid of tape measurement from which the soil samples were taken. Soil samples from 0 - 10 and 10 - 20 cm depth were collected from cultivated and forest land in triplicate using bucket auger and cutlass. The soil samples were air dried, grounded and passed through a 2mm sieve after which the soil samples were taken to the laboratory for analysis. Core samplers were used in collecting soil samples from 0 – 10 and 10 – 20cm in triplicate. A total number of forty eight (48) cores samples were taken in each location.

3.1.2 Laboratory analysis

The <2-mm air-dried sieved samples were used for the analysis of soil pH, Particle size distribution, the soil nitrogen, Organic carbon and the organic matter content of each sample was determined by multiplying percentage (%) carbon by a factor 1.724. Soil Bulk density was determined using cylinder method. Soil porosity was estimated from the bulk density data at an assumed particle density of 2650 kgm^{-3}.

3.1.3 Physical analysis

Bulk density: Bulk density (B_D) was measured by the core method, as described by Blake and Hartge (1986). Soil samples were taken with core method and oven dried for 24 hours at 100^0C. At each of the sampling location, core samples from 0 – 10cm and 10 – 20cm were taken in triplicate and were used in determining bulk density, porosity and moisture content.

The bulk density was calculated as follows;

$$B_D = \frac{\text{Oven dry mass of soil (g)}}{\text{Volume of soil (cm}^3\text{)}}$$

Total porosity (P_t): Total porosity which is the percentage of bulk volume not occupied by solids was calculated from bulk density assuming a particle density (Pd) of 2.65 gm^{-3}.Total porosity was calculated as follows;

$$\text{Total porosity (Pt)} = 1 - (B_D / P_D) \times 100$$

Where;

B_d: Bulk density

P_d; Particle density

Particle size distribution: Particle size distribution of less than 2 mm fine earth fraction was measured by the hydrometer method as described by Gee and Bauder (1986).

Calculations

$$\%\ \text{silt + clay} = \frac{\text{40 sec reading} + (0.3 \times b)}{\text{Weight of sample (50g)}} \times \frac{100}{1}$$

Note: b is the temperature different between that of the soil suspension and 20^0 C

$$\%\ \text{Clay} = \frac{\text{2-hrs reading} \times 100}{\text{Weight of sample}}$$

$$\%\ \text{silt} = (\text{silt + clay}) - \text{clay}$$

$$\text{Total sand} = 100 - (\text{silt + clay})$$

3.2 Chemical analysis

Hydrogen ion activity (pH Determination):10 g of 2 mm sieved soil was weighed into a **beaker,** **20 ml of distilled** water was added, stirred and the suspension was allowed to stand for 30 minutes with occasional stirring. The electrode of the pH was inserted into the partially settled suspension inside the beaker and the pH was measured without stirring.

Organic carbon: The soil organic carbon was determined by Walkey and Black wet oxidation method as modified by (Nelson and Sommer, 1996). 1 gm. of air-dry soil was weighed into a 500-ml conical flask, 10ml 0.167M $K_2Cr_2O_7$ was added using pipette, 20 ml concentrated H_2SO_4 was added and the beaker was swirled to mix the suspension. After 30 minutes, 100 ml distilled water was added then 7 drops of 1, 10-Phenanthrolin monohydrate.

0.5M ferrous sulphate solution was used in titration until the colour changes from light brown to green and finally to brisk red as the end point.

Calculation

$$\% \text{ organic carbon} = \frac{(B-T) \times M \times 0.003 \times 1.33 \times 100}{wt}$$

B = Blank titer value

T = Sample titre value

M = Molarity of Fe $(SO_4)_2\,6H_20$

Wt. = Weight of soil sample used

Exchangeable Cations: Exchangeable were determined by Summation Method using flame photometer and Atomic absorption spectrophotometer. Air dry soil (10g) was weighed (2mm sieved) into a beaker and one hundred (100ml of extracted solution (1M Na ammonium acetate) was added. The suspension was subjected to shaking for one hour and filtered.

Exchangeable Ca and Mg were determined by atomic absorption spectrophotometry while the concentration of exchangeable K and Na were determined by flame photometry.

Determination of available P: Available phosphorus content of the soil samples were determined by the Bray – 1 method as modified by Olesn & Sommer (1994). 2g of 2mm sieved soil sample was weighed into an extracting bottle while 15ml of the extracted solution was added and shaken for one minute. The suspension was filtered and the available phosphorus was determined.

Total nitrogen: The total nitrogen content of the soil samples were determined by Kjeldahl method. 0.1g of the sieved soil was measured into a Kjeldahl digestion flask, K_2SO_4 and concentrated H_2S0_4 was added and heated for two hours. The digest was then transferred to the Kejldahl distillation flask after which the total nitrogen was determined by titrating with hydrochloric acid.

3.3.0 STATISTICAL ANALYSIS

The experiment was arranged as a 2 ×2 × 6 factorial experiment for the factors landuse, depth and location with three replication in completely Randomized Block Design using GenStat Discovery Edition 4 Where the F – values were significant at P-0.50, the mean were separated using the FLSD.

Table 1: Selected chemical properties of forest and cultivated soils

LOCATION	LANDUSE	PH	Pz mg/Kg	Total N	Na mol/kg	Ca mol/kg	Mg	K
L1	CR	4.55	2.8	0.35	0.07	1.8	1	0.12
L1	FR	5.4	1.09	0.42	0.05	2.5	1	0.17
L2	CR	5.2	7.2	0.2	0.05	1.8	0.6	0.07
L2	FR	5.35	0.54	0.5	0.06	2.6	0.8	0.13
L3	FR	5.17	4.56	0.28	0.15	1.2	0.6	0.13
L3	CR	5.61	4.36	0.48	0.22	2.2	0.6	0.13
L4	CR	5.46	0.47	0.22	0.11	0.05	2.5	0.6
L4	FR	5.73	5.13	0.38	0.03	2.5	0.8	0.11
L5	CR	5.35	0.47	0.38	0.23	2.8	0.8	0.16
L5	FR	5.64	4.86	0.58	0.06	2.7	0.9	0.11
L6	CR	5.39	0.21	0.6	0.14	3.2	1	0.42
L6	FR	5.77	3.11	0.58	0.25	3.2	1.6	1

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Effect of Landuse Types on the Soil Physical Properties

4.1.1 Particle size Distribution

The result of the particle size distribution in cultivated and forest soil is presented in the Table 2. This indicates that there is a significant difference ($P \leq 0.05$) between the landuse types in the particle size distribution. Significantly ($P \leq 0.05$) higher content of sand and lower clay with silt were recorded in the cultivated land. Except for clay, depth has no significant difference on silt and sand (Table 3). The significant increase of clay with depth might be due to clay illuviation. The significant difference between the two landuse types for particle size values may be due to selective loss of fine particles arising from forest conversion to arable land. This is in agreement with the work of Klimowicz and Uzaiak, (2001) who reported selective loss of clay due to forest conversion to arable land.

The interaction of landuse types and depth in Table 3 showed that there is a significant difference ($P \leq 0.05$) in clay content with lower value in cultivated land compared to higher value for forest land in both depths it also shows that there is significant difference in sand content with higher value in cultivated land and lower value in the forest land at D1 and D2 respectively. The results of this study are consistent with work done by Khademi H. (2003).

The percentage of silt in arable land is significantly lower than that of forest land at the two depths under consideration.

Table 2: Effect of Landuse Types on particle size distribution of the Soil

Landuse	Clay (%)	Sand (%)	Silt %
FR	24.59	61.07	14.35
CR	7.42	84.06	8.53
LSD $_{(0.05)}$	**1.086**	**1.333**	**0.898**

FR= Forest. CR=Cropped.

Table 3: Interaction of Landuse Types and Depth on the physical properties of the soil

Depth	Landuse	Clay %	Sand %	Silt %
D1				
	CR	7.33	83.81	8.66
	FR	25.42	61.35	13.32
D2	CR	7.52	84.32	8.39
	FR	23.72	60.78	15.48
LSD $_{(0.05)}$		**1.536**	**1.885**	**1.269**

D1= 0 – 10, D2= 10-20cm, CR= Cropped land, FR= Forest land

The interaction of landuse types and location showed that clay (Fig 1) and silt (Fig 3) were significantly lower with higher sand (Fig 2) fractions in all cultivated locations compared to their respective adjacent forest sites. This trend was observed in all six locations with varied values which may be due to location effect. The data in Fig. 2 revealed that there was 28.29%, 27.7%, 24.37%, 28.72%, 27% and 19.09 % higher sand content in cultivated sites of L1, L2, L3, L4, L5 and L6 respectively.

The reduction in fine materials and increase in sand fractions may likely be linked to disintegration of soil particles by tillage, exposure of soil surface to impact of rain and subsequent selective loss of soil article by erosion. Yaser, (2015) have shown that conversion of forest land to arable land predispose the soil to erosion by water with the consequent reduction of fine materials.

The interaction of landuse types and location effect on silt content of the soil is shown in Figure 3. The result shows a significant higher ($P \leq 0.05$) silt content in the forest land as compared to the cultivated land in L1, L2, L3, L4, L5 and L6.

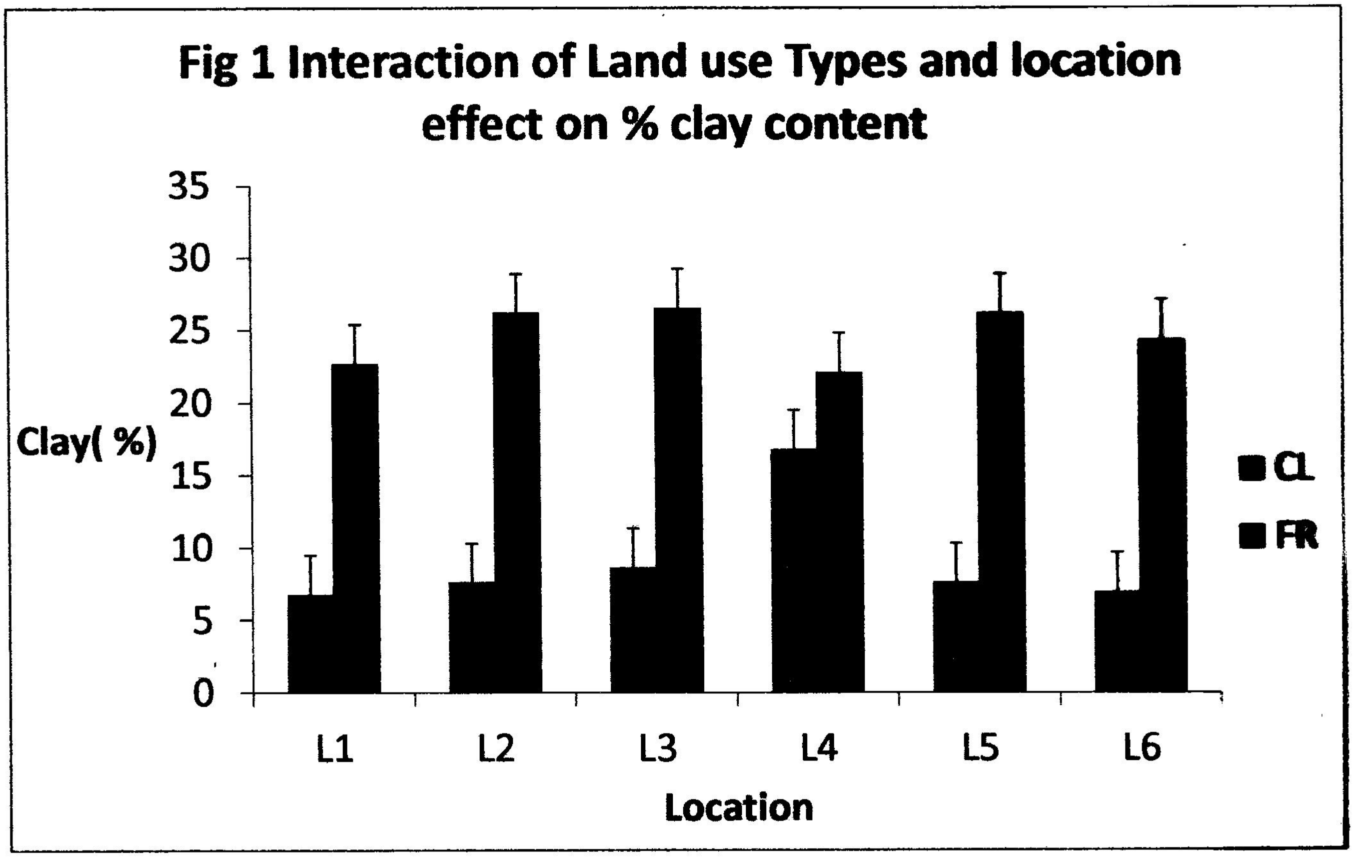


Fig 1 Interaction of Land use Types and location effect on % clay content
Clay(%)
35
30
25
20
15
10
5
0
L1
L2
L3
L4
L5
L6
Location
CL
FR

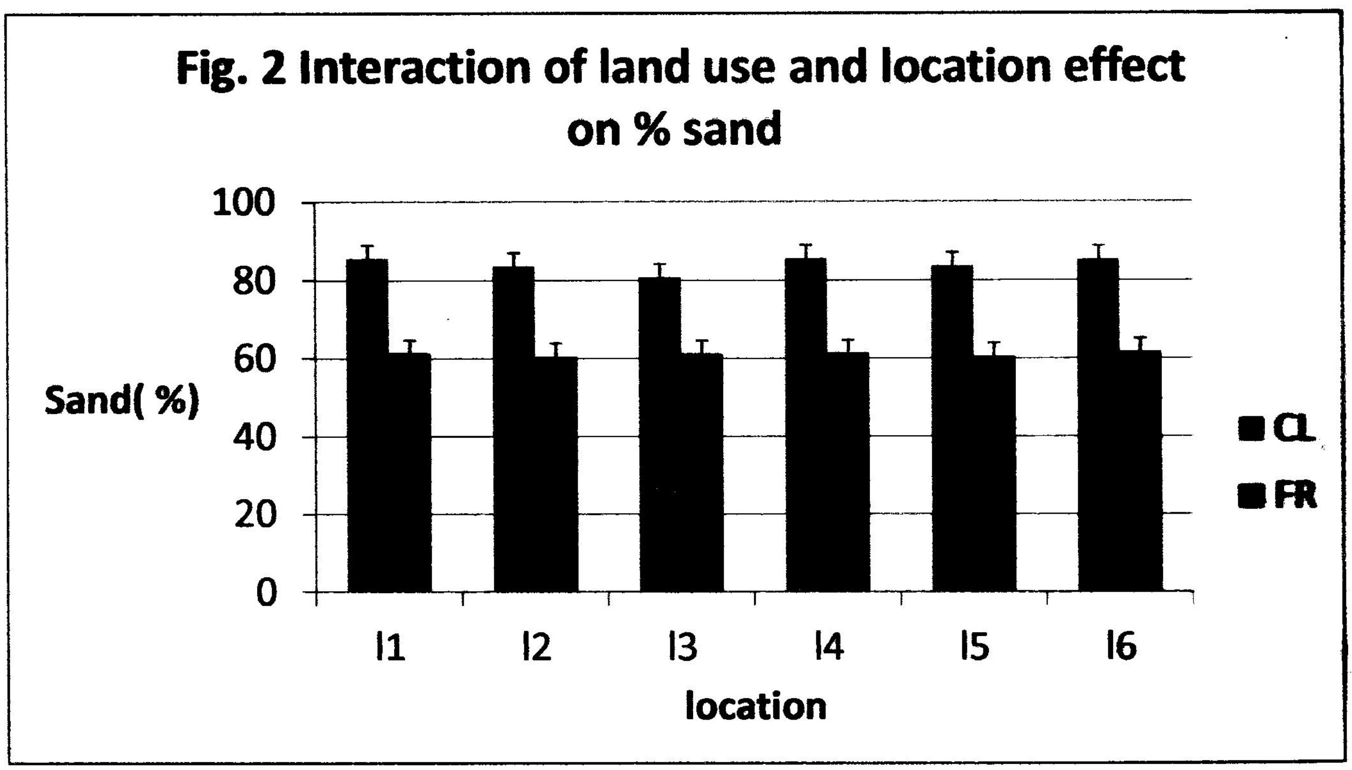


Fig. 2 Interaction of land use and location effect on % sand
Sand(%)
100
80
60
40
20
0
l1
l2
l3
l4
l5
l6
location
CL
FR

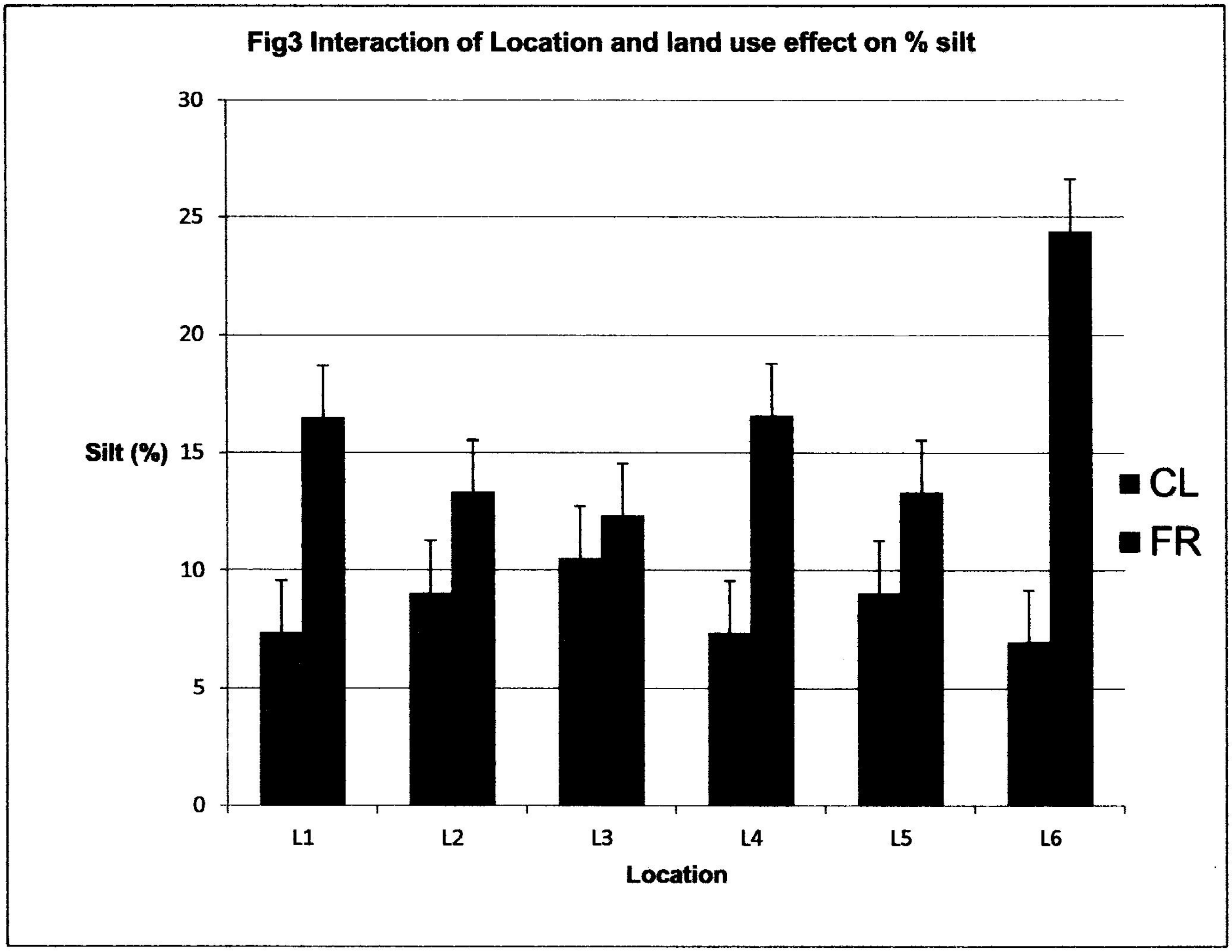


Fig3 Interaction of Location and land use effect on % silt
Silt (%)
30
25
20
15
10
5
0
L1
L2
L3
L4
L5
L6
Location
CL
FR

4.1.2 Bulk Density

The result of bulk densities under different landuse types are presented in Table 4. The cropped land had significantly higher value of 2.37 g cm^{-3} when compared with forest landuse types with 1.76 g cm^{-3}. The forest landuse types consistently recorded lower bulk densities across the six locations under consideration in this study.

The lower bulk density value in the forest may be attributed to higher soil organic carbon content (Fig 7). This is supported with the report of Yaser (2015) that low bulk density in the natural forest may be due to high amount organic matter content. Consequently, lower organic carbon will lead to increase in bulk density of the cultivated land area. Similarly Emadi et. al, (2008) and Oguike and Mbagwu, (2009) found out that bulk density increase with cultivation.

The interaction of landuse and depth is shown in Table 5. The result indicated that there is a significant difference in bulk density with higher value of 2.38 g cm^{-3} in cultivated land compared with forest land area with 1.71 g cm^{-3} at 0 – 10cm. The result in Table 5 also shows a significant difference in bulk density with 23.4 % increase in cultivated land at 10 – 20 cm depth. Similar finding was reported by Celik (2005) that deforestation and subsequent tillage practices resulted in increase in bulk density for surface soil.

The result of the interaction of landuse and location on bulk density is shown in Fig 4 signify that landuse type and depth has effect on the bulk density of the soil. Cultivation significantly increased the bulk density by 19, 20, 33, 21, 19 and 41% in L1, L2, L3, L4, L5 and L6 respectively. It was observed that the highest increase in bulk density was indicated in L6.

Table 4: Effect of Landuse Types on Soil Organic carbon & Physical Properties of the Soil

Landuse	OC (%)	MC (%)	Porosity (%)	BD(gcm^{-3})
FR	1.94	30.47	34.00	1.76
CR	1.63	18.37	11.00	2.37
LSD $_{(0.05)}$	**0.216**	**2.489**	**1.782**	**0.083**

FR= Forest. CR=Cropped. OC= organic carbon. MC= moisture content.

Table 5: Effect of Landuse Types and Depth on Soil Organic carbon & Physical Properties of the Soil

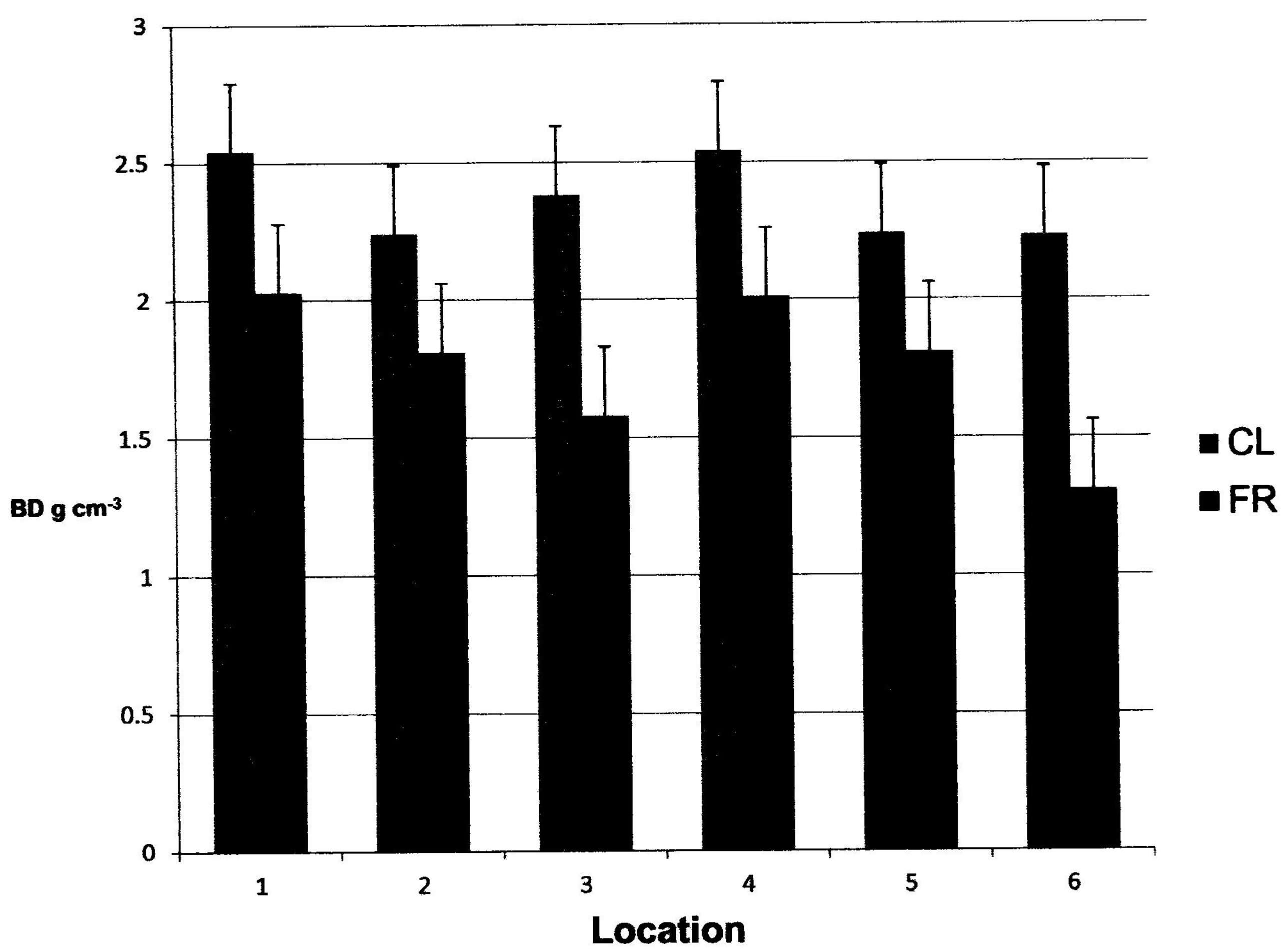
Depth	Landuse	OC (%)	MC (%)	Porosity (%)	BD (gcm^{-3})
D1	CR	1.20	19.13	16.85	2.38
	FR	2.06	31.54	29.74	1.71
D2	CR	1.09	17.62	13.99	2.35
	FR	1.82	29.40	28.33	1.80
LSD$_{(0.05)}$		**0.306**	**3.521**	**2.520**	**0.118**

OC=Organic carbon. MC=Moisture content. BD=Bulk density. D1= (0 – 10cm) D2 = (10 – 20 cm).

The reason was not clearly identified but may be attributed to management practices. The consistent increase in bulk density all the analyzed data buttresses the point that cultivation can increase the bulk density of forest soils. This results support those of Celik, 2005 that deforestation and subsequent tillage practices resulted in increase in bulk density for surface soil. Many other researchers have shown that increases in bulk density as a result of forest conversion to arable land were a reflection of soil degradation that has occurred (Guisler 2006, Mbagwu et, al. 2001).

The implication of high bulk density in cultivated land is reduction in total porosity, pore aeration, problem of root penetration and seedling emergence.

Fig 4 Interaction of landuse Types and Location on Soil Bulk Density



4.1.3 Total Porosity

The results of the total porosity under the two different landuse types are presented in Table 2. The forest landuse type had higher total porosity value of 34.00% when compared with cropped land with the value of 11.00%.

The result revealed that there was a significant difference ($P \geq 0.05$) in porosity due to landuse types. This difference may be attributed to frequent agronomic practices and human trafficking effect which compress the soil pores and further increases the soil bulk density. Intensive soil cultivation which may increase the soil bulk density is intimately related with reduced porosity and alteration of pore size distribution (Obi, 1989, Ojeniyi, 2000). It was also reported by Akinola, (2012) that when soil is tilled, total porosity is increased by up to 10 – 15% of the original value.

The interaction of Landuse and depth on porosity is shown in Table 5. The result indicated that there is a significant difference ($P \geq 0.05$) in total porosity of the landuse types. At 0 – 10cm the porosity in forest landuse was 54.13 % higher compared to the cultivated landuse. At 10 – 20cm depth the porosity of the forest landuse was 56.41 % higher compared to the cultivated landuse. This result revealed that landuse has significant effect on the porosity of the soil across the two depths. The result demonstrated that porosity is dependent on bulk density of the soil (Table 5), which shows that the higher the bulk density the lower the porosity. This is in agreement with Celik (2005) who noted that depending upon increases in bulk density, total porosity decreased accordingly.

Considering the combined effect of landuse and location on porosity (Fig 5) it was observed that porosity in all the cultivated sites of the six location was significantly lower in the adjacent forest sites, this finding is similar to that observed by Osakwe, 2010 who reported lower porosity in arable land compared to forest soils in al Altisol. The low porosity is likely due to the fact that tillage tends to destroy large ores and decrease total porosity this is consistence with the work of Raisaih et al, (2004). The implication of theses adverse effect is that infiltration and percolation might be limited and hence favor surface runoff again aeration might be reduced thus affecting adequate supply of oxygen for plant root and aerobic soil organism.

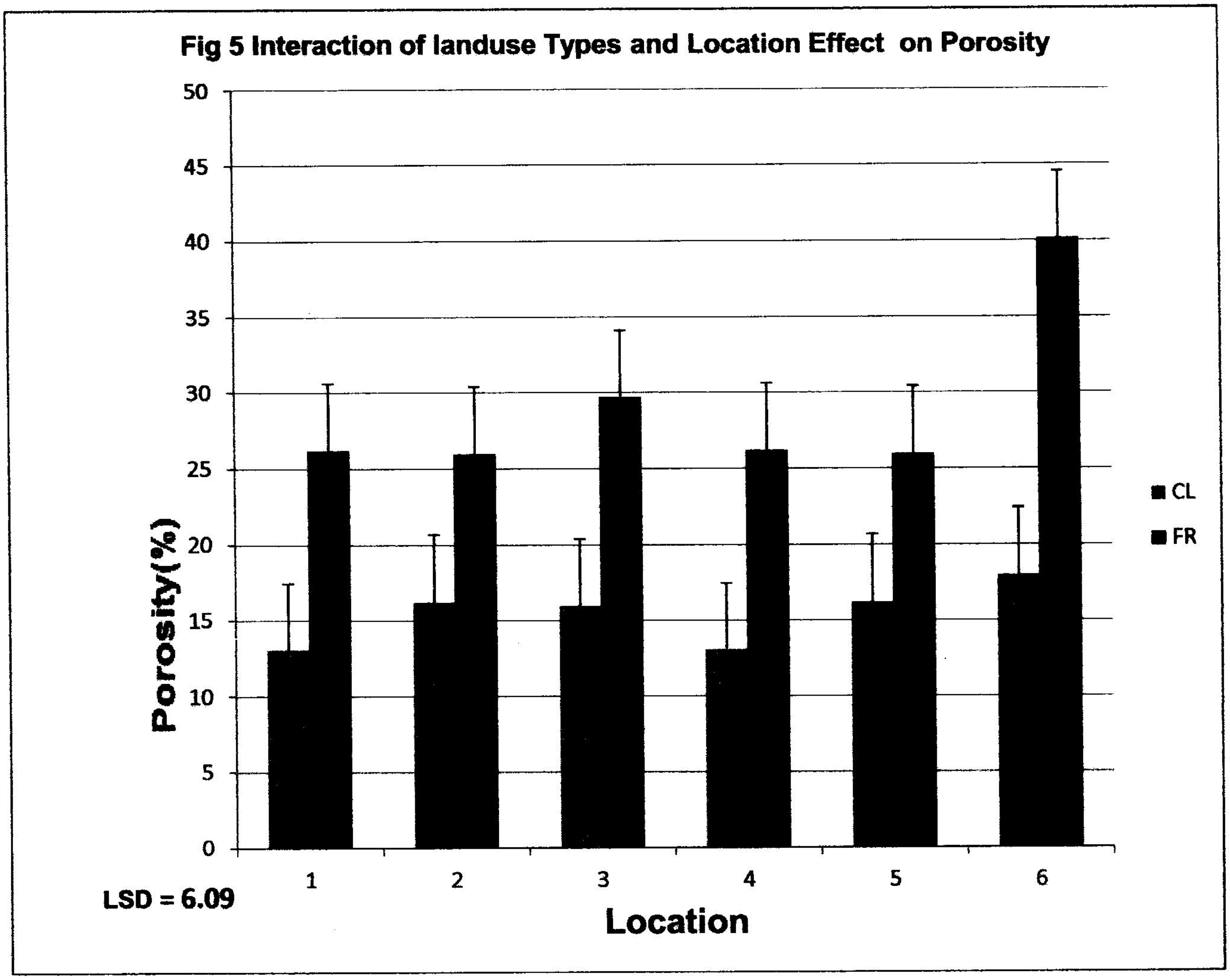


Fig 5 Interaction of landuse Types and Location Effect on Porosity
Porosity(%)
50
45
40
35
30
25
20
15
10
5
0
1
2
3
4
5
6
Location
CL
FR
LSD = 6.09

4.1.4 Moisture Contents

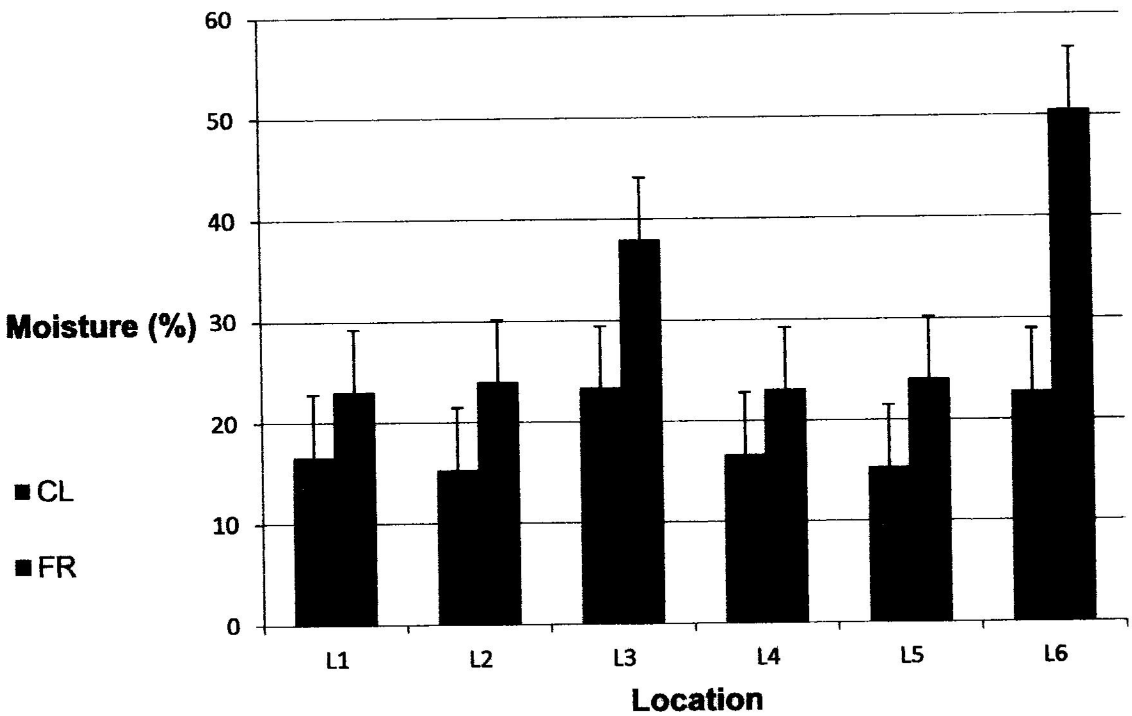
The moisture content values under the two different landuse types are shown in Table 4. The forest landuse type and cropped landuse types had the moisture contact values of 30.44% and 18.37% respectively. From this result, there is significant difference ($P \geq 0.05$) between the two landuse types. The higher moisture content in the forest land may be attributed to higher organic carbon content (Table 4) and higher clay content (Table 2) which enhances moisture content in the soil.

The interaction of landusse and depth presented in Table 5 shows that there is significant difference in moisture content between the landuse types at the two different layers. The forest have relatively significantly higher moisture content value of 31.54 % compared to cultivated land with 19.13 % at 0-10cm and at 10- 20cm, the forest land moisture content was 40 % higher than the cultivated land. The lower moisture content may be attributed to the removal of soil cover which exposes the soil surface to soil erosion and also initiate the water loss to the atmosphere through evaporation. This is in agreement with Brady and Weil, (2008).

Interaction of landuse and location as shown in Fig. 5 indicated that soil moisture content in each cultivated location was significantly lower than in the forest soil. The greatest decline was observed in L6 with about 50% lower moisture content. The chemical properties (Table 1) in L6 of the forest landuse indicated highest values in the pH, N, Ca, Mg, and Na suggesting that the management system or inherent property of the soil mostly likely affected the moisture content.

Soil water content controls soil water availability, nutrient uptake and translocation in plants. Therefore reduction in soil water content arising from landuse change is not desirable since it can lead to impairment in optimum crop production.

Fig 6 Interaction of land use and location on soil moisture content



4.2 Soil Organic Carbon

The result of SOC as affected by landuse types is shown in Table 2. Cultivation causes 15.97% decline in SOC in the forest landuse. The significantly high accumulation can be attributed to litter fall on forest floors. Also the canopy in forests reduces the temperature of the soil thus reducing soil organic breakdown and its consequent accumulation. This is in agreement with Nega and Heluf, (2013), as it was reported that losses of forest soil organic carbon were due to the effect of intensified cultivation of arable land coupled with tillage practice, complete removal of crop residue from cultivated field and use of crop residue as source of fuel wood.

The interaction of depth and landuse (Table 5) was observed to cause 10.43% and 11.56% decline of soil organic carbon in 0-10cm and 10-20cm respectively. This result implied that soil organic loss occurred at 0 - 20cm which is the ploughing depth in agricultural soils.

Soil organic carbon is a crucial component ofS the soil controlling or affecting the physical, biological and chemical properties of the soil. Decline in the soil property will invariably affect crop productivity.

The interaction of landuse types and location is shown in Fig 7. It was noted that in all locations, soil organic carbon was significantly lower compared to the adjacent forest site. The result showed 25.47%, 29.35%, 46.61%, 26.48%, 48.67% and 58.53% decline in L1, L2, L3, L4, L5 and L6 respectively.

The differences observed in the location suggest that effect may be location specific or due to management practice. The lowest decline was recorded in location L1 while the highest decline was observed in location L6.

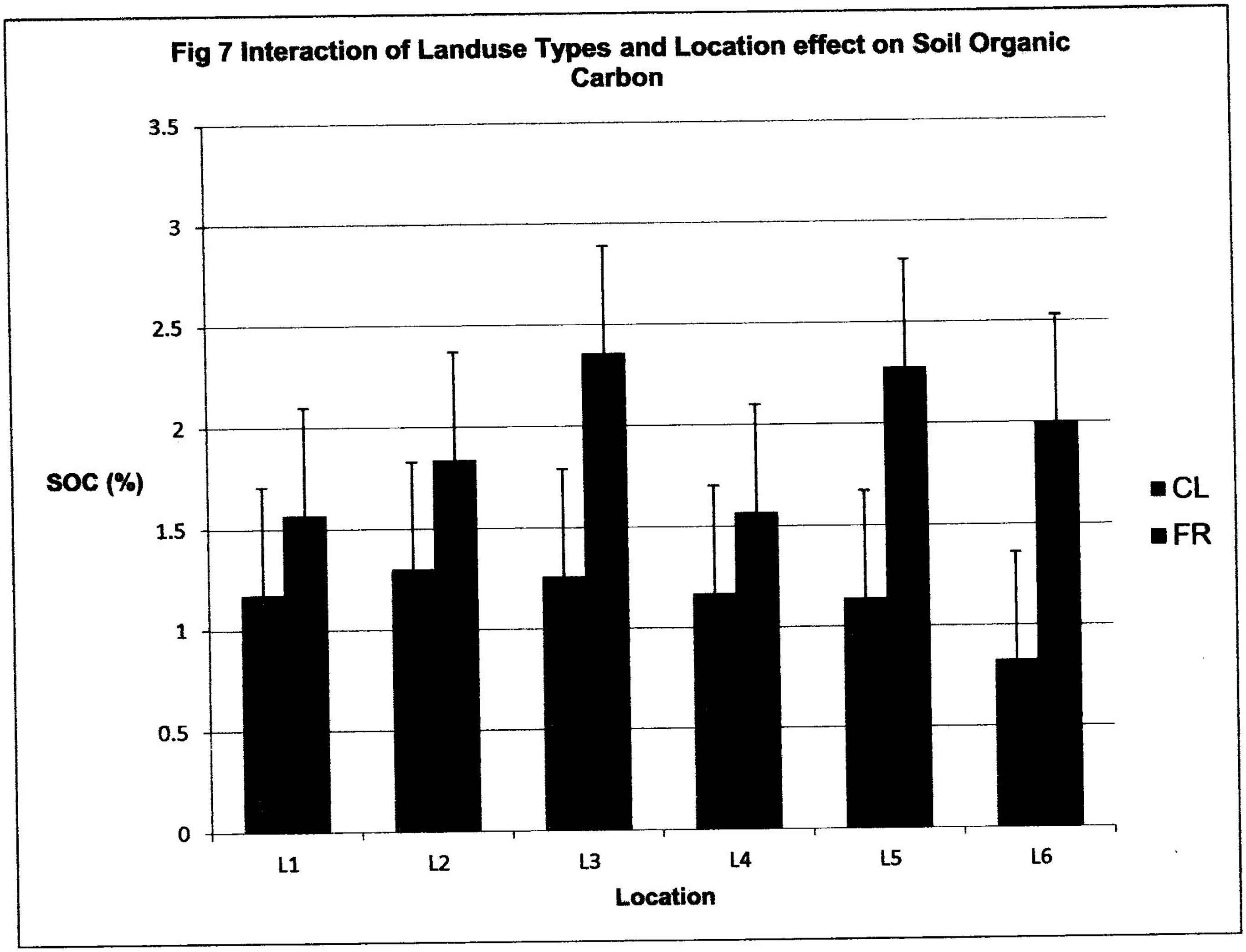


Fig 7 Interaction of Landuse Types and Location effect on Soil Organic Carbon
SOC (%)
3.5
3
2.5
2
1.5
1
0.5
0
L1
L2
L3
L4
L5
L6
Location
CL
FR

Although the reason for the variation or degree of effect on each location was not identified, but the chemical properties of the soil showed that the forest soils in L6 had highest values in pH, total N, Na, Ca, Mg and K, (Table 1). Probably the management practice or rate of cultivation intensity in L6 may explain the exploitation of the fertility status of this location. Also decline in SOC in cultivated locations compare with the forest may be attributed to the loss of fine material evidenced in all cultivated locations.

Soil organic carbon is a dynamic property of the soil controlling many important soil processes. Reduction in this crucial soil property as a result of forest conversion to arable land lowers soil productivity and sustainability.

CHAPTER FIVE

SUMMARY AND CONCLUSION

The result from this study showed that cultivation of forest soil caused a reduction in soil quality indicators evidenced by a significant decline in SOC. It is possible that excessive tillage and removal of vegetative cover predispose the soil to rapid mineralization of SOC and its subsequent loss. Removal of crop residue can also deplete the level of SOC. The significant reduction in fine particles and increase in sand particles may be due to susceptibility of bare soils to erosion. The bulk density in the cultivated landuse significantly increased with a corresponding decline in the total porosity, Moisture contents in cultivated soils were found to be significant lower compared to the forest landuse. This trend in loss of soil quality was observed in the two depths and also across the six locations.

In conclusion, this study indicated that conversion of forest land to arable land can result to depletion of soil organic carbon and the physical properties of the soil which are crucial for soil sustainability and productivity.

RECOMMENDATION

Manuring, proper residue management, mulching may be recommended to alleviate the problems associated with cultivation. But in areas of low input agriculture, clearing of forests for intensive cultivation might pose a serious threat to soil sustainability and thus should be avoided.

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