EFFECT OF LAND USE ON SOIL AGGREGATE PROPERTIES AND SOIL ERODIBILITY (K-FACTOR) IN SELECTED SOILS OF ENUGU STATE, SOUTHEASTERN NIGERIA.

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ABSTRACT

A study was conducted in six locations; Ugbo-Okpara(L1), Ugbo-Nabo(L2), Ugwogo-Nike(L3), Iyi-Ukwu(L4), Edem(L5) and Ngwo (L6) of Enugu State, South-Eastern Nigeria, to assess changes in soil aggregate properties and soil erodibility K in forest and cultivated soils. The experiment was arranged as a 2 x 6 factorial analysis of variance, replicated three times in complete randomized design. The numbers are two land use types and six locations The parameters evaluated were: size distribution of water stable aggregates (WSA), mean weight diameter (MWD), aggregate stability, soil erodibility K, dispersion ratio (DR) and water dispersible silt.(WDS). The locations differed significantly ($P \leq 0.05$) from each other in size distribution of WSA, mean weight diameter (MWD), aggregate stability, soil erodibility K, dispersion ratio and water dispersible silt. Compared to forest land use, cultivated land use, revealed a significant ($P \leq 0.05$) decrease in size distribution of WSA by 26.1% (>2mm), 13% (2-1mm), 30.5% (1 - 0.50mm) 6% (0.5-0.25mm) and significant ($P \leq 0.05$) increase of 31 % 17% 10% in size distribution of WSA < 0.25 mm, erodibility K and dispersion ratio respectively. Significant ($P \leq 0.05$) decline of 22%, 50%, 10%, in the cultivated land use were also observed in the MWD, aggregate stability and water dispersible silt respectively. The interaction of land use and location effect revealed a significant ($P \leq 0.05$) decrease in size distribution of WSA in all aggregate sizes >.25mm, MWD and aggregate stability in all cultivated locations compared to the adjacent forest locations except in L4 and L2. In L4, > 2 mm aggregate size and MWD was 47 and 18%, higher respectively in the adjacent cultivated sites, while12% higher aggregate stability and 45 %, 49% and 33% more WSA in 2 – 1 mm, 1.00 - 0.50 mm and 0.50 - 0.25 mm size fractions, respectively were recorded in the cultivated soil of L2 compared to their adjacent forest soils. Significant ($P \leq 0.05$) increase in erodibilty K was indicated in all cultivated locations except in L2 with significantly ($P \leq 0.05$) lower values compared with their adjacent forest locations. Water dispersible silt seem to be controlled by the intrinsic property of the soil while the dispersion ratio did not follow a well-defined trend in some locations. However, it was apparent that in majority of the locations, direction and magnitude of change in soil properties was controlled by textural characteristics and possibly by soil management regardless of land use.

Keywords: Land use, Aggregate size distribution, mean weight diameter, Aggregate stability, Erodibility k, Water dispersible silt, Dispersion ratio

INTRODUCTION

Tillage operation is one of the activities that can affect soil aggregation and erodibility. Ngandeu *et al.* (2016) demonstrated that loss or decline in structural stability will lead to increase of soil erodibility. Eynard (2004) indicated that in humid tropics, where water is the primary factor controlling aggregate break down, assessment of stability of soil aggregates in water is used to evaluate variations in structure as a result of cultivation. Mbagwu (2003) reported that agents of aggregate stability are crucial in assessing the ease with which soils erode, the possibility of soils to crust or seal, soil permeability and quasi-steady state infiltration rates, seedling emergence and in inferring the potentials of soils to sustainability of crop production. Some researchers observed that the lower the Mean weight diameter (MWD) the greater the soil erodibility while the higher the Mean weight diameter the higher the resistance of the aggregates to detachability hence lower erodibility (Igwe and Ejiofor 2005). Tanghrkarrpang and Vityacan (2002) showed that aggregate size and stability was lower in the land under cultivation compared to forest and fallow. In their research work they reported degradation of arable soil cultivated for 100 years due to decline in the aggregate size distribution and water stable aggregate. Also Shresha *et al.*, (2007) observed that macro aggregates (>2mm) were abundant in forest (41–70%) while microaggregates were about 56 – 63 %, in the cultivated soils. Martel and Mac Kenzie (1980) compared the effects of different land use practices on soil quality and showed that conversion of forest to agricultural land use, was associated with loss of structural stability. This loss might be as a result of clearing the vegetative cover, inadequate residue input, tillage and fast mineralization of organic material. Research results by Bossuyt *et al.* *(*2002) indicated that leaf fall on forest floors add plant residue which increases aggregation. The removal of plant residue after harvest can result to decline in structural stability of the soil. Apart from macroaggregate stability some researchers have shown that micro aggregate stability is an essential property to be considered in estimating soil loss especially by water. Micro aggregate stability indices calculated from silt and clay fractions such as dispersion ratio and water dispersible silt have been used to evaluate the potential of the soil to erode by water (Igwe and Udegbunam 2008, Igwe, 2001; Igwe *et al.,* 1999).Silt by its characteristics is a primary soil particle that is most vulnerable to detachment and transportation by water. Some workers have postulated that DR and WDS can be used to predict potential soil loss but some have also indicated that in some situation these indices did not predict accurately soil erodibility (Igwe and Obalum 2013).

Soil erodibility is a measure of the extent to which soil erode which is related to the intrinsic property of the soil (Kukal *et al.,* 1991).The soil erodibility factor (K-factor) is a measurable characterization of the intrinsic erodibility of a particular soil; it is a measure of the sensitivity of soil particles to erosion by rainfall/rain drop and runoff (Bryan2000). The K factor operates on the basis that when the other factors that affect erosion are the same, different soils erode at different rates. This means that soils vary in their susceptibility to soil erosion. Nomographs relating K-factors to topsoil conditions are used to assess erodibilities of soil. K factor is determined from particle size distribution, structure, permeability, soil organic matter but does not take into cognizance of other properties that could affect erodibility. The knowledge of soil erodibility helps in erosion prediction and soil management. Soils with high erodibility are less resistant to erosive forces while low erodibility implies higher resistance to erosion. Singh *et al.* (2008) reported that added to erodibility K, soil aggregate stability is one of the factors controlling soil erodibility and the more stable a soil is, the less erodible the soil and vice versa. Excessive tillage is believed to increase aggregate disintegration leading to increased erodibility.

The objective of this research is to evaluate and compare the effect of land use change on soil erodibility K and aggregate stability properties of some selected soils in south eastern Nigeria.

MATERIALS AND METHODS

Study Area

Site Description

The study locations are in Enugu State and within the same agro – ecological zone of southeastern Nigeria. The soils were collected from Ugbo-Okpara (L1), Ugbo-Nabo(L2) Ugwogo- Nike (L3), Iyi-Ukwu (L4), Edem (L5) and Ngwo (L6). LI and L2 are between latitude 6^o 10' N and longitude7^o 25' E, L3, L4 and L5 are between latitude 6^o 26' N and longitude 7^o 29' E while L6 is between latitude 6^o 24' N and longitude 7^o 25' E.

The study area has a tropical wet and dry climate with the rainy season lasting from April to October and the dry season from November to March. The average annual precipitation is between 1600 - 1800 mm with average temperature of 28^oC

The vegetation is derived savannah with patches of forests. Farming is done with traditional tools like hoes and machete and on subsistent level. Preliminary information from farmers in all locations revealed that they practice shifting cultivation for not less than 20 years and some common crops planted include cassava (*Manihot esculenta*), cocoyam (*Colocasia spp.*), melon (*Citrilus viligaris*) and maize (*Zea mays*). Organic and inorganic manure were used as soil amendments in cultivated sites of all locations except in L1 and L2 where majorly organic amendments such as degradable house hold refuse and forest litter were used. Other cultural practices include bush burning, cover cropping, mulching and ridging. Okoye (2009) reported that in Enugu state melon (*Citrilus viligaris*) is planted partially to establish rapid ground cover adding that mulching and ridging are other cultural activities used for erosion control. Also, information from the indigenes showed that the forests have never been cleared, cultivated or burnt for about 100 years.

The soils of Enugu State are ferrasols and are of sedimentary origin, (Balogun, 2000). According to Jungerius (1964) L1 and L2 are described as shallow brown soils derived from sandy shales, L3, L4 and L5 are red and brown soils derived from sand stones and shales while L6 is described as deep porous red soils derived from sandy deposits.

Soil sampling and analysis

Soil samples in each location were collected from forests and adjacent cultivated land (0.25ha) from 0 – 20 cm depth, in triplicates giving a total of 36 samples. The samples were air dried and sub-samples passed through 2mm sieve while the remaining samples were made to pass through 4.75mm sieve for the determination of aggregate size distribution of water stable aggregates. Percentage aggregate stability and Mean weight diameter were computed from size distribution of water stable aggregates

The distribution of water stable aggregates was determined by the wet sieving technique described by Kemper and Rosenau (1986). To separate the water stable aggregate, 25gm of the >2mm air dried aggregates was put on top of a nest of sieves measuring 1mm 0.5mm 0.25mm and pre-soaked for 10mins in water. The sieves and their content were oscillated vertically, once per second, in water 20 times. Care was taken to ensure that the soil particles on the topmost sieve were always below the water. The resistant aggregates on each sieve were oven dried at 105^oC for 24 hours and weighed. The mass of <0.25mm was obtained by difference between the initial sample weight and the sum of sample weight collected on the 2.00, 1.00, 0.50 and 0.25mm sieve nests.

The percentage ratio of aggregates in each sieve represented the water stable aggregate of size >2.00mm, 2 - 1mm, 1 - 0.50mm, and 0.50 - 0.25 mm and <0.25mm and was computed as follows:

$$WSA = \frac{Mr}{Mt} \times 100$$

Where;

Mr = mass of resistant oven–dry aggregates in the size class fraction after wet sieving.

Mt = the total mass of the initial material (25gm)

Percentage aggregate stability

Aggregate stability was calculated using this formula;

$$\%\ \text{Aggregate stability} = \frac{\text{wt. of WSA} > 0.50\ \text{mm} - \text{wt. of sand}}{\text{wt. of sample} - \text{wt. of sand}} \times 100$$

Where;

WSA = Water stable aggregates

Wt= weight

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Determination of macro aggregate stability (Mean-weight diameter of aggregates)

The mean weight diameter (MWD), another measure of stability was calculated using this formula:

$$\text{MWD} = \sum_{i=I}^{n} W_i X_i$$

Where;

W_i = weight of aggregate in the ith aggregate size range as fraction of dry weight of sample.

Xi = Mean diameter of any particular size range of aggregates separated by sieving.

Larger MWD value is manifestation of higher distribution of macro-aggregates and therefore, higher stability to erosion by water

Micro-aggregate stability indices

Dispersion Ratio (DR), and water dispersible silt (WDS) were calculated from data generated from Particle size analysis determined in water and chemical dispersant by the hydrometer method (Gee and Bauder, 1986).

DR= [% clay + % silt (water)]/ [% clay + % silt (NaOH).

WDS = % Silt in water.

Soil Erodibility K

To determine soil erodibility K.in the different locations the Nomograph method based on the work by Wischmeier *et al.* (1971) was used in the assessment (Fig. 1).

Parameters needed are as follows:

Percentage Silt (0.002-0.05mm), Very Fine Sand (0.05-0.1mm) and Sand (0.1-2mm).

Particle size distribution was measured by the hydrometer method as described by Gee and Bauder (1986).

Percentage Organic Matter

Percentage Organic matter = 1.724 * Percentage Organic Carbon

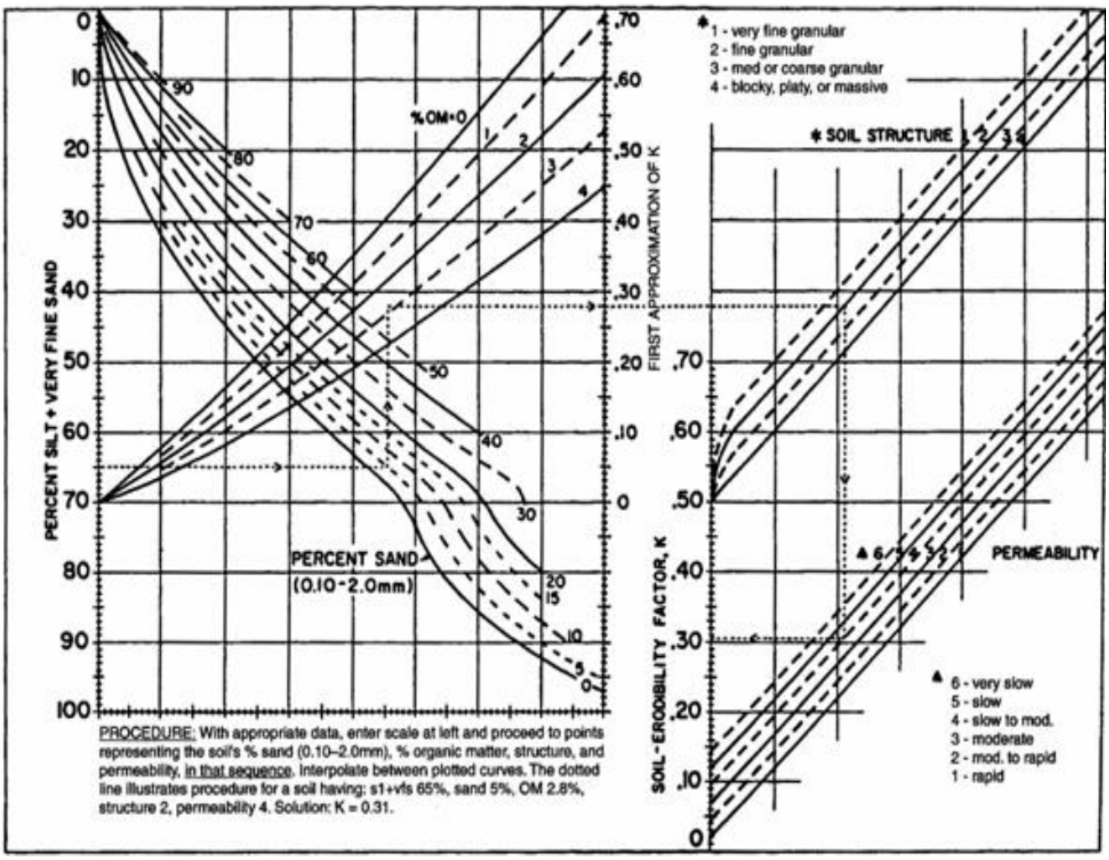
Organic carbon was determined by the Walkley and Black method as modified by Nelson and Sommer (1982)

Soil Structure Class: Structure was determined by considering the shape, arrangement and size of aggregates.

Permeability Class

This involved determination of hydraulic conductivity of the soil by Klute and Dirksen (1986) and transferring the data generated to Permeability class ratings prepared by Oneal 1951.

The above parameters were inputted into the erodibility Nomograph (Fig.1) to obtain the K-factor for the soils in the different locations.



PROCEDURE: With appropriate data, enter scale at left and proceed to points representing the soil's % sand (0.10–2.0mm), % organic matter, structure, and permeability, in that sequence. Interpolate between plotted curves. The dotted line illustrates procedure for a soil having: s1+vfs 65%, sand 5%, OM 2.8%, structure 2, permeability 4. Solution: K = 0.31.

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Figure 1: Nomograph for assessment of the "K" factor of soil erodibility (. Wischmeier, Johnson and Cross 1971)

Statistical Analysis

Data generated from the study were subjected to a 6 x 2 factorial analysis of variance (ANOVA) in completely randomized design using Genstat Discovery edition software. These numbers represent the two (2) land use types and six (6) locations. Where the F - values were significant at P=0.05, the means were separated by the least significance difference (LSD) test.

Results and Discussion

Aggregate size distribution of water stable aggregates

Result on the effect of location on aggregate size distribution of water stable aggregate is shown in Table 1. The effect of location was significant ($P \leq 0.05$) in each aggregate size hence the differences observed among locations. However, a non-significant ($P \leq 0.05$) effect was observed only between L1 and L4 in 1mm – 0.5mm WSA. Variations in the aggregate size distribution could be attributed to differences in soil mineralogy (Six *et al.* 2004), variations in vegetation and quality of crop residue (Juna, 1993). The land use effect was evaluated (Table 2) and the result revealed that forest conversion led to a significant ($P \leq 0.05$) decrease in the size distribution of water stable aggregates in the cultivated land use. The magnitude of the decrease was 26.1, 13, 30.5 and 6 % in WSA.>2 mm, 2 - 1 mm, 1 - 0.50 mm and 0.50 - 0.25 mm respectively. On the contrary there was a significant ($P \leq 0.05$) increase of 31 % in the distribution of WSA < 0.25 mm in the cultivated land use compared to the forest. Many researchers have shown that forest conversion to cultivation results to decrease in soil quality evidenced by a reduction in aggregate size distribution (Karinatitake and Van Es, 2002). Gagic *et al.*,(2006) reported a reduction in aggregate size distribution of WSA from 67.7 % to 74 % and 37.1 % to 39.2 % when forests are converted into arable land use. Holeplass *et al.,* (2004) added that lower WSA in cultivated soils may be due to cumulative effect of tillage, frequent trafficking as result of farm operations and rain drop impact. To explain the higher distribution of WSA < 0.25 mm in the cultivated land use, Adesodun *et al.,* (2007) and Spaccini *et al.,* (2001) posited that cultivation caused a decline in the distribution of macro aggregates and increased the fraction of the smaller sized aggregates.

Furthermore, the interaction between land use and location (Table3) was significant ($P \leq 0.05$). From the result, it was apparent that distribution of WSA was more in the forest locations compared to the adjacent sites except in L2 and L4. In >2 mm aggregate size of L4, there was 47 % higher content of WSA in the cultivated land use, while in L2, 45 %, 49 % and 33 % more WSA in 2 – 1 mm, 1.00 - 0.50 mm and 0.50 - 0.25 mm size fractions were indicated respectively in the cultivated soil compared to the adjacent forest soil. From the results, these deviations in L2 and L4 demonstrate that the effect of cultivation may be determined by location differences in soil properties. For instance, in l2 the cultivated site had higher clay content compared to the adjacent forest location (Osakwe and Igwe, 2013) which probably resulted to higher aggregation. No reason within the scope of this research was identified for the contrary result in L4 except that type and quality of organic material could be suggested. Nevertheless, one observation that was consistent in all locations was the increasingly higher content of WSA < 0.25 mm in cultivated locations relative to their adjacent forest land. This implies reduction in the structural stability of the soil, making it more prone to soil erosion. Whalen and Chang (2002) have used smaller aggregates < 0.25 mm as an important indicator of soil degradation.

Table 1: Effect of location on aggregate size distribution of water stable aggregates

Parameter		Aggregate sizes (mm)			
Location	4.75-2	2-1	1-0.5	0.5-.25	<.25
L1	36.7	9.6	8.6	14.5	30.6
L2	56.4	13.9	4.8	8.2	16.9
L3	16.7	6.6	10.7	18.0	48.1
L4	19.1	13.1	8.6	12.2	47.1
L5	8.2	12.4	14.9	15.6	59.4
L6	4.7	9.5	21.8	32.4	31.7
LSD $_{(0.05)}$	1.69	0.85	0.73	1.04	2.04

Table 2: Effect of land use on soil aggregate size distribution

		Aggregate Sizes (mm)				
Land use	4.75-2mm	2-1mm	1-0.5mm	0.5-.25mm	<0.25mm	
CL	20.1		10.0	9.5	16.3	44.2
FR	27.2		11.5	13.6	17.3	30.4
LSD $_{(0.05)}$	0.98		0.49	0.42	0.61	1.17

Table 3: Interaction of land use and location on aggregate size distribution of water stable aggregates

Parameter			Aggregate sizes (mm)							
	4.75-2		2-1		1-0.5		0.5-.25		<.25	
LOC/LU	FR	CL	FR	CL	FR	CL	FR	CL	FR	CL
L1	50.1	23.3	10.1	9.1	5.8	11.4	10.6	18.3	23.4	37.9
L2	65.2	47.5	9.8	17.9	3.2	6.3	6.8	9.7	15.2	16.6
L3	17.0	16.3	7.1	6.0	15.4	5.9	22.4	13.6	38.1	58.2
L4	13.2	25.0	15.0	11.1	12.7	4.4	16.5	7.8	42.6	51.7
L5	9.6	6.8	16.9	7.8	19.7	10.1	16.0	15.2	37.8	60.8
L6	7.8	1.5	10.0	9.0	24.9	18.7	31.9	32.9	25.4	37.9
LSD $_{(0.05)}$	1.5		1.2		1.03		1.52		1.17	

.LOC: Location, LU: land use, FR: Forest, CL: Cultivated

Mean Weight Diameter (MWD)

Mean weight diameter (MWD) is an index that gives information on the distribution of aggregate sizes which will be used to correlate with such factors as erosion, infiltration and aeration (Hillel 1998). The effect of location on the MWD presented in Table 4 revealed significant ($P \leq 0.05$) differences among locations. The average values in the six locations varied from 0.6 to 2.2 mm with L 6 and L2 recording the lowest and highest value respectively. Again from the result, it appeared MWD was controlled by proportion of WSA >1 mm (Table 1) as was observed that L2 with the highest MWD recorded, the highest WSA in >2mm and 2 – 1mm size fraction This is in accord with the work of Gajic *et al.,* (2006) who attributed the decline in MWD to a decrease in the distribution of water stable aggregate > 1 mm.

The effect of land use on MWD was assessed and the result (Table 5) indicated that forest conversion to arable land led to about 22 % decline in the MWD. This is in agreement with the work of Emadi *et al.,* (2008) who reported higher MWD in forest soils, compared to the adjacent cultivated soil. A reduction in MWD of WSA infers a decline in the resistance of the aggregates to soil erosion. Soils with lower MWD will be more easily detached by erosive forces while aggregates with higher MWD will demonstrate higher resistance to impact of raindrop.

The interaction of land use and location on MWD of WSA (Table 6), revealed that forest conversion significantly ($P \leq 0.05$) resulted to a decline in MWD in all locations except L4 in the cultivated land use. It was in the magnitude of 43 %, 19 %, 13 % 35 % and 33 %, in L1, L2, L3, L5 and L6 respectively. The contrary result of 18% lower MWD in the forest land use of L4 compared to the adjacent cultivated soil could be as result of over 50% more WSA in >2mm size fraction(Table 3) in the cultivated land use which implies an improvement in the inherent property of the soil due to cultivation.

Table 4: The effect of location on mean weight diameter (MWD) percentage aggregate stability (%AS), dispersion ratio (DR) and water dispersible silt (WDS) and soil erodibility k (EK)

		Parameter			
Location	MWD (mm)	AS (%)	DR	WDS (%)	EK
L1	1.6	21.1	0.65	23.29	0.103
L2	2.2	19.1	0.65	16.56	0.085
L3	0.9	24.5	0.65	28.51	0.153
L4	1.0	24.6	0.65	23.51	0.165
L5	0.8	31.5	0.6	18.51	0.170
L6	0.6	22.7	0.75	3.0	0.62
LSD $_{(0.05)}$	0.08	1.46	0.01	0.63	0.004

Table 5: Theeffect of land use on mean weight diameter (MWD) percentage aggregate stability (%AS), dispersion ratio (DR) and water dispersible silt (WDS) and soil erodibility k (EK).

	PARAMETER				
Land use	MWD (mm)	AS (%)	DR	WDS (%)	E.K
CL	1.0	16.0	0.70	17.80	0.242
FR	1.3	31.8	0.63	20.0	0.201
LSD $_{(0.05)}$	.05	0.8	0.01	0.61	.003

Table 6: **The Interaction of land use and location on mean weight diameter (MWD) percentage aggregate stability (AS), dispersion ratio (DR) water dispersible silt (WDS) and soil erodibility k (EK)**

Parameter	MWD (mm)		AS (%)		DR		WDS (%)		EK	
LOC/LU	FR	CL	FR	CL	FR	CL	FR	CL	FR	CL
L1	2	1.1	22.4	19.8	0.6	0.7	17.3	29.3	0.9	0.12
L2	2.4	2.2	17.8	20.3	0.6	0.7	15.8	17.3	0.11	0.06
L3	0.9	0.8	21.2	17.7	0.7	0.6	29.8	27.2	0.16	0.21
L4	0.9	1.1	37.9	11.3	0.7	0.6	31.2	15.8	0.12	0.21
L5	0.9	0.6	45.1	17.9	0.6	0.6	21.8	15.2	0.13	0.21
L6	0.7	0.5	36.7	8.7	0.7	0.8	21.8	15.2	0.60	0.64
LSD $_{(0.05)}$	0.12		2.07		0.01		1.0		.01	

LOC: Location LU: land use, FR: Forest, CL: Cultivated

Aggregate stability

Amazketa (1999) remarked that aggregate stability is a soil quality indicator relating to sustainability in crop production. Considering the six locations (Table 4), average values varied between 19.1 % and 31.5 %. The significant ($P \leq 0.05$) different values among the six locations (except between L3 and L4) implies that aggregate stability is dependent on location.

Land use (Table 5) significantly ($P \leq 0.05$) resulted to about 50% decline in the aggregate stability of cultivated soils compared to the forest soils. The decline could be due to reduction in MWD (Table 4) and possibly due to reduction in soil organic carbon arising from tillage. Eynard *et al.* (2004) posited that in many soils, intensive cultivation degrades the soil structure, which is reflected by a decrease in stability of soil aggregates.

Furthermore, the interaction of land use and location on aggregate stability presented in Table 6 showed that apart from L2, all other locations showed significantly ($P \leq 0.05$) higher stability values in the forest soils, compared to the adjacent cultivated land use. In L2 aggregate stability was favoured by cultivation evidenced by a 12% increase compared to the adjacent forest site which could possibly be attributed to organic farming practiced in this location. The addition of different types of organic material with different composition can affect soil properties through improved aggregation. Nevertheless, lower stability experienced with forest conversion to crop land has been widely discussed by Lal and Kimble (1997); Six *et al., (*2000) and Hayness *et al*., (1997). Lower stability implies loss of macro aggregates which influence porosity, infiltration and root development.

Soil Erodibility K

The average values of Soil erodibility K in the six locations ranged from 0 .085- 0.62 (Table 4). Significant($P \leq 0.05$) effect observed among locations could be attributed to differences in soil properties in these locations. L6 exhibited the highest erodibility K which is expected because the soil is derived from sandy deposits as indicated in the site description of this locationwhile soils in L2 derived from sandy shales demonstrated the lowest erodibility K which might be linked to relativelyhigher clay content associated with shale.

The main effect of land use on soil erodibility K was assessed and the result presented in Table 5 indicated that land use caused significant ($P \leq 0.05$) increase in soil erodibility K evidenced by 17% higher value in the cultivated land use compared to the forest. Increase in soil erodibility K implies greater vulnerability to soil erosion. Furthermore, the Interaction of land use and location revealed 27, 29, 42.8, 38 and 6% increase in cultivated sites of L1, L3, L4, L5 and L6 respectively compared to the adjacent forest sites. This increase could be due to disintegration of soil aggregates into smaller fractions during tillageresulting to loss of fine materials and faster mineralization of soil organic carbon. On the contrary, L2 demonstrated 45% lower soil erodibility K in the cultivated site compared to the forest location implying more resistance to erosive force.The consistent contrary result of improvement in soil properties evaluated in cultivated site of L2 may be linked to the use of organic materials as soil amendment.

Dispersion Ratio

The main effect of location on Dispersion ratio as shown in Table4 indicated that average values ranged from 0.6 -0.75. The highest DR was indicated in L6 which was significantly ($P \leq 0.05$) different from other locations.Soils derived from sandy deposits (L6) are likely to exhibit higher dispersion compared to soils derived from shale because of their high sand content. No significant ($P \leq 0.05$) difference was observed among L1, L2, L3 and 4 but they were significantly ($P \leq 0.05$) different from L5. The variations could be ascribed to differences in parent material and also soil management practices.

Also, theeffect of land use on soil dispersion ratio was assessed and the result presented in Table 5. Land use caused significant ($P \leq 0.05$) increase in soil Dispersion ratio evidenced by 10% higher value in the cultivated land use compared to the forest. Interaction of land use and location did not reveal a definite trend as observed in other soil properties evaluated. Significantly higher values in cultivated sites of L1, L2,L6 were observed compared to their adjacent forest locations while a non-significant value was observed in L5. Significantly lower values were shown in cultivated locations of L3 and L4 compared to their forest sites.

Increase in dispersion ratio means increased release of colloidal materials and consequent clogging of soil pores, sealing and crusting which are signs of soil degradation. Also when soils are dispersed, the particles are easily carried by runoff enhancing soil erosion. The transportation of these colloidal material especially clay with its associated plant nutrients can result to loss of plant nutrients and decline in soil fertility. It is therefore crucial for sustainability of crop lands to embark on conservative measures that will enhance a buildup of soil organic matter.

Water dispersible silt

Water dispersible silt gives information on amount of silt released when soils are immersed in water. The effect of location onWDS was assessed and result presented in table 4. Average values in the six locations studied ranged between 3% and 28%.The wide variation in these locations could be due to differences in parent materials previously noted under description of the study area.

Land use effect on WDS was evaluated and result presented in Table 5.There was significant ($P \leq 0.05$) effect due to land use evidenced by 11% higher value in the forest land use compared to the cultivated land use. In cultivated soils, tillage causes loss of fine materials which may result to decline in silt content of arable lands compared to forest soils. Some researchers (Igwe and Udegbulam 2008) noted that amount of WDS harvested when soil is in contact with water is positively correlated with total silt content of that soil hence higher WDS in forest land use.

Furthermore,the interaction of land use and location was significant ($P \leq 0.05$) showing 9, 49, 30 and 50% higher values in forest sites of L3, L4, L5 and L6 respectively compared to their adjacent cultivated sites. But in cultivated sites of L1 and L2 a reverse trend of 41 and 9% higher value was recorded compared to their adjacent forest locations respectively.The reason for the contrary result in L1 and L2 could be due to inclusion of different types of organic materials with varied composition in the cultivated site.Increase in the soil organic carbon content may alter the behavior of the soil such as release of WDS. Shaw *et al.,* (2002) indicated that differences in the dynamic soil surface properties such as soil organic carbon may result in differences in dispersed particle amounts. This research have shown that WDS may be controlledby variations in intrinsic property of the soil, land use and soil management in each location

Conclusion

The study has been able to demonstrate that Land use practices that involve conversion of forest to arable land affects soil properties as indicated by decline in aggregate size distribution of WSA, mean weight diameter(MWD), aggregate stability and increase in soil erodibility K and dispersion ratio.The degree of effect on soil properties evaluated varied among locations which was attributed to differences in intrinsic properties of the soil at each location and partly by soil management. On the contrary, one out of the six locations consistently exhibited enhancement in soil properties at the cultivatedsite compared to its adjacent forest site possiblyas a result of addition of different types of organic materials to the soil.

Result obtained from this study may serve as a guide for choice of appropriate land use and application of adequate conservation measures for sustainability of arable lands in the study area.

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