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Profile Distribution of Soil Physicochemical Properties under Two Land Use Systems in Abakaliki, Southeastern Nigeria

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Abstract
Five profile pits were dug respectively in forest land use (20 m x 10 m) and continuous cropping land use (20 m x 10 m) to study profile distribution of physic-chemical properties of soil. Core and auger samples were collected from each horizon (0-15, 15-30, 30-45, 45-60 cm and 60-90 cm). The soil data were analyzed and result showed that textural class ranged from sandy clay loam (SCL) in forest land use to sandy loam (SL) in continuous cropping land use. Bulk density, total porosity, macro-porosity, micro-porosity, aggregate stability, mean weight diameter and hydraulic conductivity ranged from a mean of 1.42 g cm^{-2}, 46, 29, 21, 19.5, 51% and 46 $cmhr^{-1}$ to 1.48gcm^{-3}, 45, 38, 21,17.5, 1.57% and 43 $cmhr^{-1}$ for forest land use and continuous cropping land use, respectively. Soil pH, N, OC, P, Ca, Mg, K, Na, and CEC varied from a mean of 5.0, 0.21, 2.6%, 18.1 $mgkg^{-1}$, 2.12, 1.61, 0.31, 0.14 and 4.17 $cmolkg^{-1}$ in forest land use to 4.6, 0.11, 1.9%, 16.5 $mgkg^{-1}$, 2.12, 1.62, 0.12, 0.13 and 3.98 $cmolkg^{-1}$ in continuous cropping land use. The soil physicochemical properties consistently decreased within the profiles in the two land use systems. Aggregate stability (AS), hydraulic conductivity, total N, exchangeable K, Na and CEC at 60 to 90 cm depth were within limiting values for soil productivity in the two land use systems. Sound evaluation of physicochemical properties of soil is advocated for higher and sustainable productivity in Ebonyi State Nigeria.
Keywords: Continuous cropping, Forest Land use, Profile distribution, Soil Physicochemical Properties

1. Introduction

The extent of degradation depends on the major kinds of agricultural land use and practices entrenched in the management of land (Oldeman, 1994). According to Ajiboye *et al*. (2014), methods of soil management that are not ecological sound and compatible or wrongful allocation of soil resources for agricultural production as well as poor soil and crop management system lead to nutrient mining, accelerated erosion and disruption of soil nutrient cycles especially organic carbon (OC) and nitrogen (N) thereby reducing the sustainable use of such soils for effective crop production.

Profile distribution of physicochemical properties of soil is directly or indirectly related to nature of parent material and intensity of weathering. Akamigbo and Asadu (1983) attributed overlying soil materials to influence of parent materials. This was corroborated by Brady and Weil (2015) that nature of parent material profoundly influenced soil profile distribution of physicochemical properties and hence its productivity.

Distribution of physicochemical properties in soil profile could determine its resilience, use, planning and effective management for sustainable productivity. Chude *et al*. (2011) noted that soil properties are dominant factors affecting the use of soils. The success or otherwise of agricultural project hinges (Okolo *et al.,* 2014) on physicochemical properties of soil.

In Abakaliki agroecology, there is lack of documentation on profile distribution of soil physicochemical properties. Where, the information exists, it is not properly documented for scientific use. Yet, this is an area largely known for its agrarian activities indulging in production of various kinds of crops as well as forestry and other aspects of agriculture. There is need for proper study of profile distribution of physicochemical properties of soil of this area for sustainable soil engagement in agricultural enterprise. It is expected that the output from this research would help raise awareness of pedogensis of the soil and assist relevant stakeholders and farmers in planning for use and management of soil for productivity optimization. The objective of this research was therefore to study profile distribution of physicochemical properties of soil as well as bridge this gap in knowledge.

2. Materials and Methods

2.1 Study Area

The study was carried out in Abakaliki metropolitan city, Ebonyi State, Nigeria. The area is located by Latitude 06^o 44'N and Longitude 08^0 65'E in the derived savannah of southeast agrocecological zone of Nigeria. Abakaliki urban has a land area of about 5,670 km^2 with a population of 141,438 (NPC, 2006). The area experiences bimodal pattern of rainfall which is spread from April-July and September- early November. There is a short spell in August which the residents normally refer to as "August break". At the beginning of rainfall, it is characterized by thunderstorm and lightening. There is minimum annual rainfall of 1700 mm with maximum of 2000 mm. The mean annual rainfall is 1800 mm. Temperatures vary from $27^{O}C$ for minimum usually experienced around periods of hamattan season to $31^{o}C$ for maximum which is common during hot dry season. The relative humidity during rainy season is 80% but declines to 60% during dry periods (ODNRI, 1989). The soil of the area is derived from sedimentary deposits from cretaceous and tritely periods. The soil is unconsolidated to 1m depth. Abakaliki Agricultural zone lies within "Asu River" group and consists of olive brown sandy shales, fine grained sandstones and mudstones. It belongs to the order ultisol and is classified as *typic Haplustult* (FDALR, 1985).

The vegetation of the area is characterized by growth of economic trees made up of trees of different species, herbs and shrubs. Yam, cassava, rice, cocoyam, potatoes and maize are among common staple food crops abundantly grown in the area.

2.2 Location of Sites

The sites were carefully identified using free survey technique. The first site was a forestry reserve established in 1964 by the then colonial administration. The forest measures 100 m x 100 m. *Gmelina aborea* of 8 m tall was the predominant tree. There is growth of grasses such as *Sida acuta*, *Tridax procumbense*, *Bahama* grasses as well as scanty tree canopies and twigs. The land is undulating with top soil sparsely covered with leaf litters.

The other site was continuously cropped land located at the Teaching and Research Farm of Faculty of Agriculture and Natural Resources Management, Ebonyi State University. The land area is 100 m x 100 m and is yearly put under cultivation for more than fifteen years. Common crops planted at the land were yam, cassava, maize and vegetables.

2.3 Soil Sampling

Global positing system (GPS) was used in locating sites for profile pits in the two land use systems. Five profile pits were sunk in each of the land use systems. Auger and Core samples were collected from 0-15, 15, 30-45, 45-60 and 60-90 cm depth, respectively in each profile pit and for the two land use systems. The auger samples were air dried at room temperature about 26^{OC}, ground and sieved with 2 mm sieve and used to determine chemical properties. Core samples were used for determination of physical properties.

2.4 Laboratory methods

Particles size distribution was determined using Gee and or (2002) method. Bulk density determination was done according to Blake and Hartge (1986) procedure. Total porosity and pore size distribution were determined as described by Obi (2000). The determination of saturated hydraulic conductivity was carried out using undisturbed soil core by the constant head method of Klute and Dirksen (1986). Aggregate stability was evaluated using the method of Kemper and Roseau (1986) as follows:

$$AS\% = \frac{Ma + S - Ms}{Mt - Ms}$$

Where:

AS% = Percent aggregate stability

Ma + S = Mass of the resistant aggregates plus sand (g)

Ms = Mass of the sand fraction alone (g)

Mt = Total mass of the sieved soil (g)

All soil samples that fell within 4.76 and 0.25 mm were used to express WSA > 0.25 mm as the index of stability. The method of Van Bavel (1950) as modified by Kemper and Rosenau (1986) was used to evaluate the mean weight diameter of aggregates. The expression is as:

$$MWD = \sum_{i=1}^{n} X_i W_i$$

where

MWD = mean weight diameter of water sable aggregate

X_i = mean diameter of each size fraction (mm)

W_i = proportion of the total sample weight (%SA) in the corresponding size fraction, after deducing the weight of stone.

Soil pH was evaluated using soil/ water solution ratio of 1: 2.5. The pH values were read off using Beckman zeromatic pH meter (Peech, 1965). Total nitrogen was determined using the micro-Kjeldhal distillation method of Bremner (1996). Available phosphorus determination was done using Bray-2 method as described in Page *et al.* (1982). Organic-carbon determination was carried out by Nelson and Sommers (1982) method. Exchangeable calcium (Ca) and magnesium (Mg) were determined by titration method (Mba, 2004). Sodium (Na) and potassium (k) were extracted with IN ammonium acetate solution (NH_4 OAC) and determined using flame photometer. Cation exchange capacity (CEC) was determined by ammonium acetate (NH_4 OAC) displacement (Jackson, 1958).

2.5 Data Analysis

Data collected from soil and laboratory were evaluated with standard deviation (Steel and Torrine, 1980).

3. Results and Discussion

Table 1 shows profile distribution of particle sizes of soil and textural classes under two land use systems. The particle size distribution within the profiles in the two land use systems did not vary appreciably. The sand, silt and clay fractions varied from a mean of 36, 36 and 28% in forest land use to 31, 42 and 29% under continuous cropping land use system. The particle size distribution maintained a particular trend within the profiles in the two land use systems. Under forest land use, the sand fraction generally decreased within the profile recording least value in 60 – 90 cm depth. Conversely, the silt and clay fractions increased within the profile giving highest values for 60 – 90 cm depth. However, the textural class remained sandy clay loam in all the depths within the profile.

The sand and silt fractions decreased within the profile with least values for 60 – 90 cm depth for continuous cropping land use. Clay faction in contrast to its trend under forest land use did not maintain any particular trend within the profile but recorded highest value in 60 – 90 cm depth. The textural class remained sandy loam throughout the profile.

The decrease of sand fraction within the profile in the forest land use system could be attributed to displacement action due to increase of silt and clay fractions within the profile (Table 1) as well as influence of weathering. The argillation of fine particles down the profile is attributable to cracks and channels created by plant roots. These observations are in line with the report of Nwite (2002) that sand fraction decreased within the soil profile while silt and clay fractions increased down the soil profile. Mbah (2004) corroborated that silt and clay fractions increased as the depth of soil increased but sand fraction decreased within soil depth. The inverse in silt fraction under continuous cropping land use could be attributed to continuous cultivation which caused increase in deposition of silt particles on upper horizons (Table 1). Soil fine particles are associated with high water retention, nutrient supply capacity and soil strength. The Textural classes of sandy clay loam and sandy loam respectively are rated high in terms of aeration propensity, water retention and nutrient capacity. According to Foth and Turk (1992), texture has good relationship with nutrient storage, water retention, porosity and specific surface area, soil compatibility compressibility (Smith *et al.,* 1998) which affects inherent productivity of the soil. These intrinsic properties of soil could buffer the soil against degradative forces such as drought, low nutrient supply or poor aeration and generally enhance its productive capacity. The differences in soil texture in the two land use systems could be linked to degree of weathering and influence of anthropogenic activities on parent materials.

Table 1. Particle Size Distribution under two Land use systems

		Forest Land System		
Soil Depth (cm)	**Sand (%)**	**Silt (%)**	**Clay (%)**	**Texture**
0-15	56±0.707	28±1.414	16±0.707	SCL
15-30	40±0.707	35±0.707	25±0.707	SCL
30-45	35±0.707	35±0.707	30±0.707	SCL
45-60	30±0.707	38±0.707	31±0.707	SCL
60-90	20±0.707	42±0.707	38±0.707	SCL
Mean	**36**	**36**	**28**	
		CONTINUOUS CROPPING LAND SYSTEM		
0-15	38±0.707	48±0.707	14±0.707	SCL
15-30	35±0.707	45±0.707	28±0.707	SCL
30-45	32±0.707	42±0.707	26±1.225	SCL
45-60	28±1.440	39±0.707	33±0.707	SCL
60-90	20±0.500	35±0.707	45±0.707	SCL
Mean	**31**	**42**	**29**	

SCL-Sandy Clay Loam, SL-Sandy Loam

3.1 Profile Distribution of Physical Properties of Soil

Distribution of physical properties within the profiles under two land use systems is shown in Table 2. The physical properties of bulk density, total porosity, macro-porosity, micro-porosity, aggregate stability, mean weight diameter and hydraulic conductivity varied from a mean of 1.42 g cm^{-3}, 46, 29, 21, 19.5, 1.51% and 46 $cmhr^{-1}$ for forest land use to 1.48 g cm^{-3}, 45, 28, 21, 17.5, 1.57% and 43 $cmhr^{-1}$ for continuous cropping land use respectively. Bulk densities generally varied in the two profiles under the two land use systems although higher in continuous cropping land use compared to forest land use. Furthermore, bulk densities increased within the profiles in the two land use systems. Total porosities varied appreciably within the profiles under forest land use and also under continuous land cropping system. However, the total porosities did not vary as much within the profile in continuous cropping land use system. Generally, total porosities decreased within the profiles under the two land use systems and reflected the trend of bulk densities within the profiles. Macro-porosity (air filled porosity) was generally higher under forest land use system than in continuous cropping land use system. The macro-porosity decreased within the profiles under the two land use systems. Similarly, micro-porosity (water filled porosity) of continuous cropping land use seemed to be generally higher when compared to those of forest land use system. Furthermore, micro-porosities decreased within the profiles under the two land use systems. The macro-porosity and micro-porosity showed reciprocal relationship with total porosity and bulk density in their trends of values within the profiles.

Aggregate stability in the two profiles of forest and continuous cropping land use systems showed little variation but values generally decreased as depths increased. However, the values of aggregate stability of forest land use were higher compared to those of continuous cropping land use. Mean weight diameter of forest land use was higher and varied from those of continuous cropping land use system. Furthermore, the values of mean weight diameter decreased within the profiles in the two land use systems, respectively. Variations of values in mean weight diameter within the profiles were higher under forest land use than in continuous cropping land use system. The values of hydraulic conductivity showed little variation within and across the profiles in the land use systems. However, the values decreased down the profiles both in forest and continuous cropping land use systems.

The lower bulk density of 0-15 cm depth in the two profiles could be attributed to higher organic carbon on the horizons compared to those of lower depths (Table 3). Furthermore, it could be due to higher total porosity in the depth than in the lower depths in the two profiles of two land use systems (Table 2). Lower bulk density in 0-15 cm depth of forest land use when compared to that of continuous cropping land use could be as a result of higher organic carbon (Table 3) compared to the one obtained in continuous cropping land use.

Leaf fall and its decay and incorporation into the soil could also be one of the reasons for lower bulk density in the 0-15 cm depth of forest land use system. Increased bulk densities as depths of soil increased in the two profiles of the two land use systems suggest increased overburden and/or pressure from above as well as compaction and low presence of organic carbon in the lower depths (Table 3). This observation is in line with Mbah (2004) report that bulk densities increased as depth of soil increased. The generally higher total porosities in the forest land use compared to continuous cropping land use could be attributed to channels created by roots during their proliferation on one hand and on the other lower bulk densities resulting from higher organic carbon (Table 3). Continuous cropping compacts soil and reduce its porosity as well as increase its bulk density (Nwite, 2015). Lower total porosities within the soil depths in the two land use systems could be attributed to higher bulk densities and low organic carbon (Tables 2 and 3).

Higher macro-porosity in forest and use when compared to continuous cropping land use could be due to lower bulk densities and higher total porosities in the land use system (Table 2). Continuous cropping caused soil compaction which reduced macro-porosity. Lower macro-porosity in the lower profiles could be attributed to higher bulk densities and low total porosities (Table 2). Anikwe (2000) reported that higher bulk densities and soil total porosities within the soil profile reduced macro-porosity in the lower depths. However, the generally higher micro-porosity under continuous cropping land use compared to forest land use could be due to effect of soil compaction which created smaller pores in the soil. Furthermore, micro-porosity followed the trend observed in bulk density, total porosity and macro-porosity by decreasing with increase in soil depth in the two land use systems. Increase in micro-porosity could as well lead to water logging and poor aeration cumulating in soil low productivity. Obi (2000) noted that poor aeration and water logged conditions were detrimental to soil productivity. Hydraulic conductivity was generally higher under forest land use compared to continuous cropping land use system. This suggests that there could be higher water transmission in forest land use than continuous cropping land use. Higher water transmission in forest land use could have been facilitated by pores and channels created by roots. Ezeaku and Anikwe (2006) pointed out that channels and pores created by roots and organisms increased water transmission in soil. Generally, hydraulic conductivity decreased as the depths increased in the profiles in forest and continuous cropping land use systems. This could be attributed to decreased porosity, macro-porosity and micro-porosity within the profiles in the two land use systems (Table 2).

The higher aggregate stability in forest land use than continuous cropping land use system could be attributed to higher organic carbon in the soil (Table 3). Furthermore, decrease of aggregate stability within the depths in the two profiles could be linked to low levels of organic carbon as depths increased. Mean weight diameter being an index of stability followed the same trend as aggregate stability in the profiles under forest land use and continuous cropping land use systems. High Values of aggregate stability and mean weight diameter (MWD) encourage soil structural stability (Obi, 2000). This would increase resilience of soil against erosive forces and increase its water retention and nutrient supplying capacity.

Table 2. Profile Distribution of Physical Properties of Soil under two land use Systems

Soil Depth (cm)	BD (gcm^{-3})	TP (%)	Macp(%)	Micp (%)	AS (%)	MWD (mm)	HC ($cmhr^{-1}$)
Forest Land System							
0-15	1.2±1.001	55±1.118	35±0.707	20±0.707	22.4±0.707	1.80±0.071	52±2.120
15-30	1.30±1.005	51±1.225	32±0.707	19±0.707	20.2±0.707	1.60±0.071	48±0.707
30-45	1.45±0.018	45±1.118	27±0.707	18±1.414	18.8±0.707	1.51±.071	46±1.414
45-60	1.55±0.414	42±1.414	26±0.707	16±1.414	18.6±0.707	1.42±0.071	44±1.414
60-90	1.60±0.012	39±0.707	24±0.707	15±±1.414	17.4±0.707	1.20±0.071	41±1.414
Mean	**1.42**	**46**	**29**	**21**	**19.5**	**1.51**	**46**
Continuous Cropping Land System							
0-15	1.30±0.15	51±0.707	33±0.707	28±0.907	20.2±0.707	1.60±0.141	48±1.414
15-30	1.49±0.11	47±0.707	27±0.707	20±0.707	18.0±0.707	1.40±0.141	45±0.707
30-45	1.47±0.01	45±0.500	26±1.414	19±0.007	17.6±0.707	1.32±0.071	44±1.414
45-60	1.55±0.10	42±0.707	24±0.707	18 ±0.707	16.5±0.707	1.26±0.045	42±1.212
60-90	1.59±0.10	40±0.707	24±1.414	18±1.414	15.3±0.707	1.22±0.071	38±0.707
Mean	**1.48**	**45**	**28**	**21**	**17.5**	**1.37**	**43**

BD- Bulk Density, TP-Total Porosity, Macp- Macroporosity, Micp- Microporosity, AS- Aggregate Stability, MWD- Mean weight diameter, HC- Hydraulic conductivity

3.2 *Profile Distribution of Chemical Properties of Soil*

Profile distribution of chemical properties of soil under forest land use and continuous cropping land use systems is shown in Table 3. The result showed that pH values are generally higher and slightly varied under forest land use compared to those of continuous cropping land use system. The pH values decreased with depth under the two land use systems. Similarly, total nitrogen was higher in forest land use and showed little variations within the depths than when compared with those of continuous cropping land use system. Furthermore, the total nitrogen values decreased down the profiles under the two land use systems. Organic carbon was generally higher under forest land use and slightly varied within the depths compared to the ones obtained in continuous cropping land use system. The values of organic carbon, nevertheless, decreased within the profiles under the two land use systems. Available phosphorus was higher in forest land use than under continuous land use. Variation in available phosphorus was more pronounced in continuous cropping land use than when compared with forest land use system. Generally, available phosphorus decreased with increase in depth in the two profiles of the two land use systems.

Exchangeable cations of calcium (Ca), magnesium, (Mg), potassium (K) and sodium (Na) generally did not show much variations across the two profiles and within the depths in the two land use systems. However, Ca, Mg and Kg were higher under forest land use than in continuous cropping land use system except in 60-90cm depth for ca and mg. Sodium content was about same in the depths for the two profiles except that it appreciated at 0-15 cm depth in continuous cropping land use than under forest land use. These exchangeable cations generally decreased within the profiles in the two land use systems. The trend of cation exchange capacity within and across the two profiles reflected the concentrations of exchangeable cations. However, the cation exchange capacity showed little variations across and within the two profiles in the two land use systems. Generally, pH, N, OC, P, Ca, Mg, K, Na and CEC in forest land use varied from a mean of 5.0, 0.21, 2.6%c, 18.1 $mgkg^{-1}$, 2.1, 1.65, 0.31, 0.14 and 4.17 $cmgkg^{-1}$ to 4.6, 0.11, 1.9%, 16.5 $mgkg^{-1}$, 2.12, 1.62, 0.12, 0.13 and 3.98 $cmolkg^{-1}$ in continuous cropping land use system, respectively.

Higher pH values under forest land use when compared to continuous cropping land use could be attributed to decomposed leaf fall and litter in the soil which increased organic carbon content in the land use (Table 3). Low pH in continuous cropping land use could be as a result of continuous cultivation that caused depletion of nutrients on one hand and on the other accumulation of ions arising from acidifying fertilizer such as ammonium sulphate (NH_4 SO_4^{2-}) applied on maize crops. According to Unamba-Okpara (2000), ammonium sulphate decreases soil pH because of its acidifying nature. The decrease in soil pH within the profiles under the two land use systems suggests depletion of nutrients as depths increased. This observation is in line with the report of Asadu and Nweke (1999) that pH decreased within the profile depths. The soil pH across and within the depths in the two profiles under the two land use systems ranged from slightly acidic to extremely acidic (60-90cm) depth (Landon, 1991).

Similarly, higher total N and organic carbon (OC) within the depth of profile under forest land use compared to continuous cropping land use system is attributable to degraded and decomposed organic litter deposits from forest trees that permeated into the soil. Okonkwo *et al.* (2011) noted that deposit of organic materials improved total N and organic carbon contents of soil. Low total N and OC in continuous cropping land use entailed poor content of organic debris and incorporation or dissipation due to tillage. The decrease of total N and OC content within the depths in the two profiles could be due to leaching action as facilitated by rainfall. Obi (2000) reported that rainfall leached soil nutrients such as total N and OC beyond 1m of soil depth. Total N and OC could be rated as low to medium (Landon, 1991) from 0-60cm depth and very low to low (FMARD, 2002) in 60-90 cm depth. Furthermore, higher available phosphorus in the forest land use relative to continuous cropping land use could be attributed to improved total N and OC contents in the soil (Table 3). Higher available phosphorus in forest land use could have stemmed from readily available and decomposed organic deposits from forest trees. However, low available phosphorus in continuous cropping land use could be attributed to poor deposits of debris on the soil as well as continuous cultivation and usage by crops. The decrease of available phosphorus as depth increased in the two profiles depicts leaching and fixation by clay content especially as it decreased with depths (Table 3). Available phosphorus ranged from medium (0-60 cm) to low (60-90cm) depths (Enwezor *et al*., 1982) in the two profiles. The generally higher exchangeable cations under forest land use and within the profile than in the continuous cropping land use could be attributed to improved organic carbon and available phosphorus contents of the soil (Table 3). Agboola (1985) reported that increased contents of organic carbon and available phosphorus led due to higher exchangeable cation contents of soil. Akamigbo and Asadu (1985) reported that organic carbon contributed up to 70% increase in exchangeable cations. However, low exchangeable cations in continuous cropping land use suggests depletion of nutrients due to continuous cultivation and crop usage. Mbah (2004) noted that continuous cultivation depleted soil nutrients due to crop exploitation for their photosynthetic process. The decrease of exchangeable cations with increase in depth in the two profiles under two land use systems could be due to leaching losses or fixation by clay minerals. Exchangeable cations suffer leaching losses in tropical regions (Nnoke, 2009). The higher cation exchange capacity under forest land use compared to continuous cropping land use could be attributed to improved exchangeable cations in the soil (Table 3). The cation exchange capacity decreased with increase in depths in the two profiles of the two land use systems. Cation exchange capacity was very low (Asadu and Nweke, 1999) in the two profiles of two land use systems.

Table 3. Profile Distribution of Chemical Properties of Soil under two Land Use Systems

				FOREST LAND SYSTEM					
					←	cmolkg^{-1}	→		
Soil Depth (cm)	**pH(kcl)**	**N(%)**	**OC (%)**	**P(mgkg^{-1})**	**Ca**	**Mg**	**K**	**Na**	**CEC**
0-15	5.5±0.071	0.28±0.001	3.9±0.010	26.5±0.707	2.80±0.005	1.82±0.014	0.70±0.007	0.15±0.007	5.47±0.140
15-30	5.3±0.071	0.28±0.001	3.6±0.005	20.8±0.492	2.10±0.012	1.80±0.005	0.30±0.007	0.14±0.011	4.33±0.005
30-45	4.9±0.403	0.27±0.001	2.6±0.007	16.2±0.500	2.00±0.005	1.80±0.007	0.25±0.007	0.14±0.071	4.19±0.011
45-60	4.8±0.071	0.11±0.001	1.6±0.014	15.7±0.071	1.90±0.005	1.60±0.007	0.20±0.011	0.13±0.007	3.83±0.007
60-90	4.3±0.111	0.11±0.001	1.4±0.007	11.5±0.707	80±0.007	1.01±0.005	0.10±0.005	0.12±0.011	3.5±0.003
Mean	**5.0**	**0.21**	**2.6**	**18.1**	**2.12**	**1.61**	**0.31**	**0.14**	**4.17**
				CONTINUOUS CROPPING LAND SYSTEM					
0-15	5.4±0.071	0.22±0.001	3.6±0.014	21.5±0.000	2.55±0.007	1.88±0.007	0.19±0.001	0.17±0.014	4.79±0.007
15-30	4.8±0.071	0.12±0.001	2.1±0.001	18.6±0.707	2.20±0.007	1.80±0.005	0.14±0.005	0.14±0.005	4.28±0.014
30-45	4.5±0.071	0.08±0.001	1.4±0.001	15.2±0.014	2.00±0.10	1.70±0.007	0.12±0.011	0.13±0.005	3.95±0.170
45-60	4.5±0.071	0.08±0.001	1.4±0.001	12.8±0.707	1.92±0.007	1.50±0.005	0.08±0.007	0.12±0.007	3.62±0.007
60-90	3.9±0.403	0.07±0.001	1.0±0.001	14.2±0.071	1.90±0.014	1.20±0.005	0.06±0.007	0.09±0.005	3.27±0.007
Mean	**4.6**	**0.11**	**1.9**	**16.5**	**2.12**	**1.62**	**0.12**	**0.13**	**3.98**

4. Conclusion

The results of this study have shown that physicochemical properties of soil could be distributed spatially within the profile. The physicochemical properties of soil are generally higher under forest land use when compared with that of continuous cropping land use system. Physicochemical properties generally showed the same trend of decrease as depths of soil increased under the two land use systems. Essentially, forest land use due to its more improved physicochemical properties would be more productive since it could be buffered and resilient to degradative forces. Therefore, sound and proper evaluation of physicochemical properties of soil is important for enhanced and sustainable soil productivity.

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