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Macro and Micronutrient Status under Different Land Use Types in the University of Benin

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ABSTRACT

This experiment was conducted to ascertain the macro and micronutrient status of soils under different land uses: Arable, Fallow, Residential, and Silvicultural land. Three different sites were carefully selected for each land use (replicates). Auger points were taken at 0-15 cm and 15-30 cm depths for each location, and samples were collected for laboratory analysis. Parameters measured included pH, TOC, TN, Av. P, K, Ca, Mg, Na, S-SO4, B, Cl, Cu, Fe, Mn, Mo, Zn, and soil particle contents. Results showed that pH in the top 15 cm ranged from very slightly acidic in silviculture and arable land to moderately acidic in fallow land, while residential land was neutral. pH, TOC, N, P, K, Ca, Mg, Na, and sand content all had their highest values in the topsoil (0-15 cm), except at the pH depth (15-30 cm) of Residential and Silvicultural land, K at Silviculture, and Clay contents. At the 0-15 cm depth, arable land had the highest significant ($p<0.05$) values of boron, manganese, and molybdenum and recorded the least value of Fe (258.7 mg/kg). Residential area had the highest values of Cl, Cu, Fe, and Zn (20.93 mg/kg). Silvicultural land had the highest values of B and the least significant ($p<0.05$) values of Cl, Mn, and Zn at 0-15 cm. While in the 15-30 cm depth, B, Cl, and Cu contents did not differ significantly across land uses. Fe and Zn recorded their highest significant values in residential, while Mn and Mo had their highest values in the arable land.

INTRODUCTION

Soil plays a vital role in determining the sustainable productivity of an agro-ecosystem. Sustainable productivity of soils depends upon its ability to supply essential nutrients to the growing plants. Field trials have shown that the deficiency of micronutrients in soils has become a major constraint to the productivity and sustainability of soil (Jiang *et al.* 2009). Successful agriculture requires the sustainable use of soil resource, because soil can easily lose its quality and quantity within a short period of time for different reasons such as intensive cultivation, leaching and soil erosion (Kiflu & Beyene, 2013). Different land use systems influence availability of macro and micronutrients by altering their distribution and including a change or changes in their chemical forms by influencing soil pH, organic matter, clay content and submergence (Doran & Gregorich, 2002). Among the nutrients, nitrogen (N) is the fundamental nutrient that needs the most for crop production while N deficiencies result in yellowing crop leaves and reduce tillering of cereal crops. Next to N, phosphorus (P) is a vital nutrient for plant growth and productivity that modifies cell division, enzyme activity, and carbohydrate processes. Moreover, phosphorus also plays a vital role in cellular processes by maintaining membrane structure, synthesizing bimolecular, and forming high-energy molecules (Malhotra *et al.*, 2018).

On the other hand, the four essential micronutrients that exist as cations in soils unlike to boron and molybdenum are zinc (Zn), copper (Cu), iron (Fe) and manganese (Mn). Adsorption of micronutrients, either by soil organic matter or by clay-size inorganic soil components is an important mechanism of removing micronutrients from the soil solution (Foth & Ellis, 1997).

Land use influences soil aggregation, aggregate stability and overall soil health. It greatly influences many soil physical properties which affects the quality attributes and fertility of the soil. Land use changes affect many natural resources and ecological processes such as surfaces runoff and changes in soil resilience to environmental impacts (Ozdemir *et al.*, 2007).

Land use changes such as forest clearing, urbanization, cultivation and pasture introduction are known to result in changes in soil properties. However, land use may be the dominant factors of soil properties under small catchment scale; land use and soil management practices influence the soil nutrients and related soil processes, such as erosion, oxidation, mineralization, and leaching, etc. Moreover, soils through land use change also produce considerable alteration, and usually soil quality diminishes after the cultivation of previously untilled soils. Several authors have indicated that the availability of micronutrients in soils depends on soil pH, organic matter content, adsorptive surfaces and other physical, chemical and biological conditions in the rhizosphere (Kabata & Pendias, 2001, Yadav, 2011).

Therefore, this research was initiated to investigate the macro and micronutrient status of soils under different land uses in University of Benin. The specific objective of this study was to ascertain the macro and micronutrient status of soils under different land uses in University of Benin, Benin City, Edo State.

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LITERATURE REVIEW

Soil

In the glossary of Soil Science Terms (Brady and Weil, 2008), soil is defined as "the collection of natural bodies occupying parts of the Earth's surface that is capable of supporting plant growth and that has properties resulting from the integrated effects of climate and living organisms acting upon parent material, as conditioned by topography over periods of time." This definition takes cognizance of the Factors of Soil Formation, namely climate, organisms, parent material, topography, and time (Ogboghodo, 2017). Soil is a solid natural body that contains a mixture of minerals, organic matter, gases, liquid, and countless organisms (Christensen, 2001). It is characterized by one or both of the following: horizons and layers (Fierer *et al*., 2003).

Land Use

Land use is defined as the arrangements, activities, and inputs people undertake in a certain land cover type to produce, change, or maintain it (Ufot *et al*., 2016). Land use is the modification of the natural environment or wilderness (land) for use by humans, such as for settlements, semi-arable habitats, which include arable fields, pastures, and managed woods, industrial use, construction of transportation facilities, and recreational use, among others. Land use practices have a major impact on the soil (Ameztegui *et al*., 2016). The use of land is important and inevitable, especially with the exploding population, resulting in an increased demand for resources (Sunada *et al*., 2012). Land use can be defined as the human activities, arrangements, and inputs that apply to the use of land, such as industrial zones, residential zones, and agricultural fields, while land cover is the biophysical conditions that cover the ground surface, like crops, forests, and grassland (Di Gregorio & Jansen, 1998; F.A.O, 2000). Land-use change is the main component of environmental change in every region that alters biodiversity, soil properties, and water resources in terms of quality and quantity, and these, in combination, affect ecosystem functions and climate (Foley *et al*., 2005; Newbold *et al*., 2015).

Land-use change is due to the removal of forests and the conversion of grasslands to arable land use. The changes in forests to grazing land and agriculture lands are some of the most concerning in environmental degradation and climate change (Wali *et al*., 1999). Land use strongly influences soil properties, and unsuitable practices lead to the degradation of soil and environmental quality. Hence, understanding land-use history is essential to realizing the magnitude and trend of changes in soil properties (Kettle *et al*., 2000). Changes in land use type and soil management have influenced many soil physical and chemical properties (Lalisa *et al*., 2010; Tellen *et al*., 2018). Land use influences soil aggregation, aggregate stability, and overall soil health. It greatly influences many soil physical properties that affect the quality attributes and fertility of the soil. Land use changes affect many natural resources and ecological processes such as surface runoff and changes in soil resilience to environmental impacts (Ozdemir *et al*., 2007).

Macronutrients

Macronutrients are required by plants in adequate amounts, which are needed for plant growth. For example, nitrogen (N), phosphorus (P), and potassium (K) are required for plant growth and strengthening of reproductive parts, carbohydrate metabolism, and the activation of some enzymes. N and P are incorporated in the organic material and are not directly available to plants. K is present as elemental K, exchangeable K, or as part of mineral lattices. Under intensive agriculture, these components have to be added to the soil. Calcium (Ca), magnesium (Mg), and sulfur (S), besides their role as a plant nutrient, interfere in soil acidity and activate a number of plant enzyme systems. The deficiency of any of these elements has a pronounced retarding effect on plant growth (Willy, 2001).

Micronutrients

Micronutrients are essential elements required for plant growth and development at smaller amounts compared to macronutrients. Iron (Fe), copper (Cu), zinc (Zn), manganese (Mn), and molybdenum (Mo) are metal micronutrients that participate in various reactions in plant cells or contribute to protein structure. Boron (B) is a metalloid micronutrient that has structural roles in cell metabolism, whereas the non-metal chlorine (Cl) contributes to electrical and osmotic balance (Williams, 2015).

MATERIAL AND METHODS

Study Area

This study will be carried out at the University of Benin, Benin City in Edo State, Nigeria. The area lies from 6° 23' 53" - 6° 24' 40" N and 5° 37' 24" - 5° 37' 34" E. It is the segment of the coastal plain sand commonly referred to as acid sand of Nigeria (Ogeh and Ogwurike 2006). The soil type in this area is Ultisol (Rhodic paleudult). This region is within the rain forest zone of Nigeria. It has an annual average temperature of about 27°C and an annual rainfall of about 2000 mm. The study area experiences two major seasons namely the rainy season which lasts between March to October and the dry season lasts from November to February. The peak of rainfall is usually between July and September between which there is a brief drop in the month of August (Molindo *et al*., 2010).

Sample Collection

Soil sample were collected from four different land use types in the University of Benin, Benin City, Edo State. Which are: Arable, Fallow, Residential and Silviculture land. Three different sites were selected for each land use and the samples was collected in each of the selected land use type at two different depths (15 cm and 30 cm) using an auger (Wilding, 1985).

For Arable Land

The Faculty of Agriculture Experimental Field and the Field Practical Training fields were sampled at two depths. The spots sampled are located within coordinates: Lat 6.40021, Long 5.62429, Lat 6.40019, Long 5.62408, and Lat 6.39972, Long 5.62420.

For Silvicultural Land

Forestry Arboretum, Faculty of Agriculture Garden (opposite Millennium) and beside Agriculture Orchard (Hall 4) having coordinates, Lat 6.40090, and Long 5.62380; Lat 6.40093, and Long 5.623801; and Lat 6.40118, and Long 5.62538 respectively.

For Fallow Land

Samples were taken from lawns/fallow lands beside Hall 4, Health Centre and Law having coordinates, Lat 6.39881, and Long 5.62250; Lat 6.40296, and Long 5.62388; and Lat 6.40103, and Long 5.62258 respectively.

For Residential Area

Samples were taken at Student Halls of residence (Hall 4, Hall 5 and Hall 6) were used, having coordinates, Lat 6.39718, and Long 5.62369; Lat 6.39786, and Long 5.62518; and Lat 6.39826, Long 5.62324 respectively.

The soil samples were air-dried, mixed well and passed through a 2 mm sieve for the analysis of selected soil physical and chemical properties. Global Positioning System (GPS) was used to obtain the coordinates of the sampling sites.

Soil Laboratory Analysis

The analysis of the soil physical and chemical properties was carried out at the Faculty of Agriculture main laboratory. Standard laboratory procedures were used in the analysis of the selected physiochemical characteristics selected in this study. The particle size distribution was determined by the hydrometer method (Boyoucos, 1951) as modified by Gee and Bauder (1986). The pH of the air-dried soil was determined using a glass electrode pH meter at a ratio 1:1 and (20g soil to 20ml distilled water) and in 1N KCl solution at a ratio of 1:2 soil to water suspension according to Mclean, (1982) method. Calcium and magnesium were determined volumetrically by the EDTA titration procedure, and Potassium was determined from the filtrate by flame photometry described by Black (1965). Organic carbon was determined by the chromic acid wet oxidation procedure of Walkley and Black as described by (Black 1965). The available phosphorus in the soil samples was determined using Bray and Kurtz (1945) solution. The total nitrogen in the filtrate was determined by the alkaline phenate procedure (Fiore and O'Brien,1962).

Analysis for Micro-Nutrients

1g of the prepared soil samples were weighed into a 100ml of conical flasks. 15ml of concentrated Nitric (HNO_3) acid was added and heated for 30 minutes. 5 ml of Perchloric ($HClO_4$) acid was added to the solution and heated further till samples become clear. The samples were cooled and 30ml of distilled water was added. These mixtures were filtered using Whatman No 45 filter Paper into 100ml volumetric flasks and were made up to 100ml mark. These samples were stored in 100ml plastic reagent bottle for instrumental analysis. These samples where read at recommended wavelength for different elements in an Atomic Absorption Spectrophotometer (AAS). The micronutrients read are: Boron (B), Chloride (Cl), Copper (Cu), Iron (Fe), Manganese (Mn), Molybdenum (Mo) and Zinc (Zn).

Statistical Analysis

Data obtained were subjected to analysis of variance using GENSTAT Version 8 (2012), while Duncan's Multiple Range Test was used to separate means, at 5% level of significance.

RESULTS AND DISCUSSION

Effect of Land Use Types on Soil Chemical Properties

The analysis of chemical properties and macronutrient contents of soils under different land uses in the University of Benin, Benin City, revealed significant ($P < 0.05$) variations among land use types, as represented in Table 1. The pH values did not differ significantly (at the 5% level of significance) in the four land uses (arable, fallow, residential, and silviculture) at the two depths (0-15 cm and 15-30 cm). However, pH in the top 15 cm ranged from very slightly acidic (5.70 and 6.20) in silviculture and arable land, moderately acidic (6.033) in fallow land, while residential land was neutral with values of 7.333. It was also observed that pH values decreased in the soils with depth, except for residential and silviculture land, which increased with depth. At the depth of 15-30 cm, Residential land recorded 7.40, while Silviculture land was 5.967. This is contrary to the findings of Michael *et al.* (2010), who reported that soils under silviculture have higher pH values than cultivated soils, and pH values decrease with depth in both cultivated and forest soils.

The Total Organic Carbon (C) showed no significant difference across depths and land use types, but the soils decreased with soil depth in all land use types. However, Residential Land at the topsoil (18.13 g/kg) had the highest Carbon (C), followed by Silviculture, and the lowest was observed in Arable land. This result disagrees with the findings of Lal (2002), which states that TOC storage and soil nutrient availability are greater in forested land than in the cropland and pastures that replace them. The Total Organic Carbon (C) increased in the following order: Residential Land > Silviculture land > Fallow Land > Arable Land.

Available Macronutrients

The total nitrogen content did not differ significantly in the four land uses at the 0-15 cm depth. At the 15-30 cm depth, arable land did not differ significantly from fallow land and silvicultural land but differed significantly from residential land at the 5% level of significance. However, the Total Nitrogen (N) in the soil increased with depth in all land use types for depth (0-15 cm), with the highest total nitrogen value (1.050 g/kg) obtained in the topsoil of Silviculture land and the lowest value (0.557 g/kg) obtained at Residential land at depth (15-30 cm). This disagrees with Nega (2006), who reported that total N content declined with a shift in land use from natural forest to cultivated land. In all land use types, the topsoil (15 cm) had a higher value of N when compared to 30 cm soil depths. Nitrogen Content decreased in the following order: Silviculture > Residential > Fallow > Arable Land. Available Phosphorus (P) showed significant differences in both depths; however, the highest P value was obtained in all topsoils with Silviculture Land (16.00 and 9.337 mg/kg), respectively, having the highest recorded values at both depths, and there were no significant differences among these depths. The relatively low P content across the soils may be due to fixation, while that of fallow land may be due to the impacts of fixation and erosion (Yeshanch, 2015).

Potassium was generally low across the four land use types studied at both depths. According to the ratings in Chude *et al.* (2011), the topsoils and subsoil were low, respectively. However, the highest was obtained in Residential at both depths, having identical figures (0.320), and this is followed by Arable Land (0.250 and 0.243) at both depths, respectively. According to Akinrinade and Obigbesan (2000), the relatively low K content could be a result of leaching effects, fixation, and erosion. The K contents observed no significant differences, but all the Land use samples decreased with depth in the following order: Fallow land > Arable Land > Silvicultural land > Residential Area.

Calcium (Ca) content observed a significant difference at depth 15–30 cm only and increased with depths in Residential land use types at both depths. However, the highest calcium value (1.017 cmol/kg) was obtained at the topsoil, while the lowest value (0.583 cmol/kg) was obtained at Silviculture at (15-30 cm) depth. Higher calcium content was recorded at the topsoil of the studied land use types than the subsoils, and the calcium content ranged from moderate (0.5 to 1.0) to high (>1.0) according to the ratings outlined by (Chude *et al.* 2011).

The highest Mg value (0.267 cmol/kg) was obtained in the Residential land, while the lowest value (0.147 cmol/kg) was obtained in the Fallow land at sub-soil; also Arable and Residential land had identical numbers at sub-soil with no significant difference among land use type and depths. However, when compared with the critical value of 0.2-0.4 cmol/kg, as reported by Akinrinade and Obigbesan (2000), this shows that Mg content is below the critical value in topsoil and subsoil of Silviculture land and also subsoil of Fallow land.

Sodium (Na) recorded no significant difference among land-use type and depths, but the highest value (0.167 and 0.157 cmol/kg) was obtained at the residential land for both top and subsoil, while the lowest value (0.117 and 0.107 cmol/kg) was obtained at the silviculture. The topsoil of all the land use types studied had the highest value of sodium, and this is similar to the findings of Gebeyaw (2007), who reported that depth significantly affected the distribution of soils under different land uses. The decrease occurred in the following order: Silviculture Land > Fallow Land > Arable land > Residential Land.

Sulfur (SO4) observed a significant difference at depth 15-30 cm, and the content decreased with depth in all the land use types. From the study, Silviculture land at both depths had the highest concentration of (9.940 and 4.873 mg/kg), respectively, while Arable land had the least concentration of (8.580 and 3.417 mg/kg), respectively. The low concentration of Sulfur in Arable land may be due to leaching, fixation, or crop removal according to (Yeshanch, 2015).

Table 1: Chemical properties and Macronutrients of Soils under Different Land Use Types

Land-use	pH (1:1)	T.O.C.	T.N.	Av. P	K	Ca	Mg	Na	S-SO_4
	in H_2O	→ (g/kg) ←		(mg/kg)	→ (cmol/kg) ←				(mg/kg)
				0-15 cm	**Depth**				
Arable	6.200^a	16.93^a	0.773^a	11.94^{ab}	0.250^a	0.913^a	0.233^a	0.147^a	8.580^a
Fallow	6.033^a	17.33^a	0.837^a	11.23^b	0.237^a	0.812^a	0.200^a	0.137^a	8.657^a
Residence	7.333^a	18.13^a	0.960^a	14.03^{ab}	0.320^a	1.017^a	0.267^a	0.167^a	8.590^a
Silviculture	5.700^a	17.77^a	1.050^a	16.00^a	0.213^a	0.653^a	0.157^a	0.117^a	9.940^a
LSD	1.960	7.580	0.284	4.322	0.150	0.582	0.123	0.057	2.037
				15–30 cm	**Depth**				
Arable	5.967^a	8.807^a	0.630^a	7.833^{ab}	0.243^a	0.767^{ab}	0.253^a	0.133^a	3.417^b
Fallow	5.733^a	10.180^a	0.650^a	6.883^b	0.210^a	0.633^{ab}	0.147^a	0.110^a	3.863^{ab}
Residence	7.400^a	8.830^a	0.557^b	7.820^{ab}	0.320^a	0.933^a	0.253^a	0.157^a	3.900^{ab}
Silviculture	5.967^a	10.297^a	0.590^{ab}	9.337^a	0.227^a	0.583^b	0.153^a	0.107^a	4.873^a
LSD	1.739	3.016	0.068	2.037	0.134	0.327	0.104	0.059	1.126

LSD: Least Significant Difference

Available Micro-Nutrients

Table 2 shows the results of available micro-nutrients in each land use type and depth. Boron (B) content decreased with depth in the four land use types studied. The highest boron value (10.967 mg/kg) was obtained at silvicultural land, while the lowest value (5.647 mg/kg) was obtained at the fallow land in the topsoil (0-15 cm). At the subsoil (15-30 cm), the highest boron value (4.733 mg/kg) was obtained at the silvicultural land, while the lowest value (3.500 mg/kg) was obtained at the fallow land. The highest value of boron obtained from silvicultural land agrees with the report of Brady and Weil (2002), indicating that the solubility and availability of micronutrient cations (B) are higher under acidic conditions (pH of 5.00 to 6.60), which is the pH range of silvicultural land. At the 0-15 cm depth, silvicultural land did not differ significantly from arable land but differed significantly from both fallow land and residential land at the 5% level of significance. At the 15-30 cm depth, the four land uses (arable land, fallow land, residential land, and silvicultural land) did not differ significantly from each other at the 5% level of significance. The topsoil (0-15cm) of all the land use types studied had the highest value of boron.

Chloride (Cl) content decreased with depth in all the land use types. The chloride (Cl) content was highest in the residential land (6.753 mg/kg) and lowest at the silvicultural land (4.410 mg/kg) in the topsoil (0-15 cm). At the subsoil (15-30 cm), residential land had the highest (3.510 mg/kg), while silvicultural land had the lowest (2.500 mg/kg). This result does not agree with the findings of Oberg (2002), who stated that plants take up chlorine (Cl), and it is returned to the soil by litter fall. At the 0-15 cm depth, silvicultural land showed a significant difference from arable, fallow, and residential land, but arable and fallow land did not differ significantly from each other at the 5% level of significance. While at the 15-30 cm depth, all four land use types did not differ significantly from each other.

Manganese (Mn) content for the various land use types (Table 1) at the depth 0-15 cm recorded the highest nutrient value, while at depth 15-30 cm recorded the lowest nutrient value. Arable land had the highest manganese content (11.80 mg/kg), and silvicultural land had the lowest manganese content (6.77 mg/kg) in the topsoil. The lowest value on silvicultural land is not in consonance with the reports of Hodgson (1997), who stated that the presence of organic matter (plant litter) may promote the availability of certain elements such as manganese, iron, and zinc by supplying complexing agents that interfere with their fixation. At the subsoil, arable land had the highest manganese content (5.540 mg/kg), while residential land had the lowest manganese content (4.347mg/kg). At the 0-15 cm depth, arable land did not differ significantly from fallow and residential land but differed significantly from silvicultural land at the 5% level of significance. At the 15-30 cm depth, arable land did not differ significantly from fallow and silvicultural land but differed significantly from residential land at the 5% level of significance.

Copper (Cu) content also decreased with depth in the four land use types studied. In the topsoil (0-15 cm), the highest copper value (25.70 mg/kg) was obtained at residential land, while the lowest value (21.23 mg/kg) was obtained at the fallow land. At the subsoil (15-30 cm), the highest copper value (16.37 mg/kg) was obtained at the arable land, while the lowest value (13.50 mg/kg) was obtained at the silvicultural land. The lowest value of copper in the silvicultural land goes against the findings of Oberg (2002), who stated that plants take up copper and return it to the soil by litter fall and the decomposition process, which occurs in the soil. At the 0-15 cm depth, residential land did not differ significantly from silvicultural land but differed from both arable land and fallow land at the 5% level of significance. At the 15-30 cm depth, the four land use types did not differ from each other at the 5% level of significance. The topsoil (0-15cm) of all the land use types studied had the highest value of copper.

The iron (Fe) content at the depth 0-15 cm recorded the highest nutrient value, while at depth 15-30 cm recorded the lowest nutrient value. Residential land had the highest iron content (289.3 mg/kg), and the arable land had the lowest iron (258.7 mg/kg) in the topsoil. According to Samaranayke *et al.* (2012), the reduction of iron in arable land may be primarily due to the low solubility of the oxidized ferric form in aerobic environments. The residential land had the highest iron content (259.7 mg/kg), and the fallow land had the lowest iron content (242.7 mg/kg) at the subsoil. At 0-15 cm depth, residential land was significantly less than arable, fallow, and silvicultural land, but arable and fallow land did not differ significantly from each other at the 5% level of significance. At 15-30 cm depth, residential land did not differ significantly from arable and silvicultural land but differed significantly from fallow land at the 5% level of significance.

Zinc (Zn) content decreased with depth in the four land use types studied. The highest zinc value (20.93 mg/kg and 12.87 mg/kg) was obtained at residential land, while the lowest value (16.97 mg/kg and 9.36 mg/kg) was obtained at the silvicultural land at the 0-15 cm and 15-30 cm depth, respectively. The lowest value of zinc obtained from silvicultural land agrees with the report of Brady and Weil (2002), which indicated that the solubility, availability, and plant uptake of micronutrient cations (Zn) are higher under acidic conditions (pH of 5.00 to 6.60), which is the pH range of silvicultural land. The topsoil (0-15cm) of all the land use types studied had the highest value of zinc. At the 0-15 cm depth, residential land differed significantly from arable, fallow, and silvicultural land, but fallow and silvicultural land did not differ from each other at the 5% level of significance. At the 15-30 cm depth, arable land, fallow land, and residential land did not differ from each other but differed significantly from silvicultural land at the 5% level of significance. The zinc (Zn) decreased as follows in the various land use types in the following order: Residential land > Arable land >

Fallow land > Silvicultural Land.

Molybdenum (Mo) content decreased with depth in the four land use types studied. At 0-15 cm depth, the highest molybdenum value (0.9133 mg/kg) was obtained at arable land, while the lowest value (0.6667 mg/kg) was obtained at the fallow land. At the 15-30 cm depth, the highest molybdenum value (0.6100 mg/kg) was obtained at arable land, while the lowest value (0.3767 mg/kg) was obtained at silvicultural land. This result goes against the findings of Samaranayke *et al.* (2012), which indicated that the reduction of molybdenum in arable land (farm land) may be primarily due to the low solubility of the oxidized ferric form in aerobic environments, leaching, crop removal, and erosion. At the topsoil (0-15 cm), arable land was found to be significantly different from both fallow and silvicultural land but was not significantly different from residential land at the 5% level of significance. At the subsoil (15-30 cm), arable land was found to be significantly different from all other land uses (fallow, residential, and silvicultural land), residential land was not significantly different from fallow land but was significantly different from silvicultural land at the 5% level of significance. The topsoil (0-15cm) of all the land use types studied had the highest value of Molybdenum.

Table 2: Available Micronutrients of soils under different land uses

Land-use	**B**	**Cl**	**Cu**	**Fe (mg/kg)**	**Mn**	**Mo**	**Zn**
			0-15 cm	**Depth**			
Arable	9.660^{a}	5.430^{b}	22.80^{b}	258.7^{c}	11.80^{a}	0.9133^{a}	19.23^{b}
Fallow	5.647^{b}	5.013^{b}	21.23^{c}	263.0^{c}	11.33^{a}	0.6667^{b}	17.80^{c}
Residential	6.023^{b}	6.753^{a}	25.70^{a}	289.3^{a}	9.08^{ab}	0.8967^{a}	20.93^{a}
Silviculture	10.967^{a}	4.410^{c}	24.67^{a}	276.0^{b}	6.77^{c}	0.7000^{b}	16.97^{c}
LSD	3.187	0.5505	1.426	5.844	2.65	0.05442	1.097
			15-30 cm	**Depth**			
Arable	4.340^{a}	2.593^{a}	16.37^{a}	252.0^{ab}	5.540^{a}	0.610^{a}	12.33^{a}
Fallow	3.500^{a}	2.927^{a}	15.27^{a}	242.7^{b}	5.523^{a}	0.440^{bc}	11.90^{a}
Residential	3.713^{a}	3.510^{a}	15.27^{a}	259.7^{a}	4.347^{b}	0.5033^{b}	12.87^{a}
Silviculture	4.733^{a}	2.500^{a}	13.50^{a}	251.3^{ab}	5.087^{ab}	0.3767^{c}	9.36^{b}
LSD	1.330	1.128	3.043	9.40	1.106	0.0796	2.226

LSD: Least Significant Difference

The Result of Soil Separates Under Different Land Use Types

The soil separates under different land use types are presented in Table 3. The results revealed that the texture of all land use types was predominantly sandy, with a sand fraction ranging from 887.7 to 870.3 g/kg, a silt fraction ranging from 74.33 to 68.33 g/kg, and a clay fraction ranging from 55.30 to 42.00 g/kg at the topsoil (0-15 cm). In the subsoil, the sand fraction ranged from 883.0 to 867.7 g/kg, the silt fraction ranged from 59.33 to 57.00 g/kg, and the clay fraction ranged from 74.67 to 58.33 g/kg. Sand content decreased with an increase in depth, while clay content increased with increased depth. The similarity in textural class could be attributed

Table 3: Particle Size Distribution of Soil

Land use	**Sand**	**Silt (g/kg)**	**Clay**	**Textural Class**
		0-15 cm		
Arable	885.7^{a}	68.33^{c}	51.00^{a}	LS
Fallow	879.0^{b}	70.67^{b}	50.33^{a}	LS
Residential	887.7^{a}	70.33^{b}	42.00^{b}	LS
Silviculture	870.3^{c}	74.33^{a}	55.30^{a}	LS
LSD	3.811	3.648	5.719	NS
		15-30 cm		
Arable	881.7^{ab}	59.33^{a}	58.33^{b}	LS
Fallow	876.7^{b}	58.33^{a}	65.00^{b}	LS
Residential	883.0^{a}	57.00^{a}	60.00^{b}	LS
Silviculture	867.7^{c}	57.67^{a}	74.67^{a}	LS
LSD	5.317	6.465	7.77	NS

Where LS = Loam Sand, NS = Not Significant, LSD: Least Significant Difference to the fact that soil texture is not readily influenced by soil management or land use types (Oyedele *et al.*, 2009). At the 0-15 cm depth, the sand content in arable land did not differ significantly from residential land but differed significantly from fallow land and silvicultural land at the 5% level of significance. At the 15-30 cm depth, the sand content in residential land did not differ significantly from arable land but differed significantly from fallow land and silvicultural land at the 5% level of significance.

At the 0-15 cm depth, the silt content in silvicultural land differed significantly from all other land use types (arable, fallow, and residential), but fallow land and residential land did not differ significantly from each other at the 5% level of significance. At the 15-30 cm depth, the silt content in all land use types did not show any significant difference from each other. At the 0-15 cm depth, the clay content in silvicultural land did not differ significantly from arable and fallow land but differed significantly from residential land at the 5% level of significance. At the 15-30 cm depth, the clay content in silvicultural land differed significantly from the other land use types (arable land, fallow land, and residential land), but the other land use types did not differ significantly from each other at the 5% level of significance.

CONCLUSION

In the 0-15 cm depth, residential area had the highest macro and micronutrient content, and this was closely followed by arable land, while fallow land had the least concentration of both macro and micronutrients. More so, in the 15-30 cm depth, residential land had the highest macronutrients and closely followed by arable land. There was differentiation in range values between fallow and silvicultural land with both having the highest Sulphur contents respectively when compared to others. While arable land had the highest micronutrient contents and this as closely followed by residential area and fallow land, while silvicultural land had the least micronutrient contents. Furthermore, application of fertilizer (both organic and inorganic) as well as allowing for longer fallow periods can improve the nutrient content of fallow land. Soil conservation system like shifting cultivation, cover cropping, mulching and crop rotation should be encouraged in arable land to replenish nutrient loss and additional input of organic or inorganic fertilizer can be used where required to improve soil fertility. However, for silvicultural land, it will naturally gain its own fertility over time through the action of fallen leaves and organic matter accumulation.

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