ASSESSING THE PHYSIOCHEMICAL PROPERTIES OF SOILS UNDER VARIOUS AGRICULTURAL LAND USES IN KWALI AND ITS ENVIRONS, FCT ABUJA

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ABSTRACT: This paper seeks to determine the soil changes under different Agricultural land uses in Kwali and its environs. This is necessary because of the level of population increase leading to urbanisation and increase in food production. Realizing the seriousness of the impact of different land uses on soil physical and chemical properties, this work investigates the influence of different land use types on soil physiochemical properties in Kwali town. The primary data for this research obtained from soil samples collected from Maize, Yam and Fallow lands which serves as control farm plots. In each plot of land a 15m x15m quadrant was marked out, where 12 soils samples were collected at (0-15cm and 15-30cm) respectively. A total of 36 soil samples were collected which were later compost to 6 soil samples. The soil samples were collected in back polythene and taken to the laboratory for analysis. The parameters investigated include: soil physical properties (soil organic matter, particle size distribution, bulk density,) and soil chemical properties (soil ph, soil nitrogen, soil phosphorous, soil carbon, cation exchange capacity). The results show that the mean range of the soils particles sizes is 10%, with a coefficient of variation (COV) of 6.52%, 19.6% and 12.1% for Sand, Silt, and Clay respectively. Generally, there is variation between and within the top soils and the sub soils across the various agricultural land uses. The percentage of sand content ranges between 54% and 62%. Results shows that fallow land has the highest percentage of soils followed by the two land uses that have little difference. The result of the hypotheses shows that there is no significant difference in the physiochemical properties of the soils from the different agricultural land uses in the study area, and when compared between the top soils and the sub soils, the results shows that there is significant difference in the physiochemical properties between the top soils and the sub soils of the different agricultural land uses in the study area. It is therefore recommended that, Farmers need to be informed about strengthening and expanding existing fertility management practices to sustain agriculture production. More also adequate soil nutrient analysis should be conducted to determine the soil suitability for a specific crop to be cultivated. The use of more organic manure in the soil is necessary so as to help in stabilizing soil pH level than inorganic or chemical fertilizer which has residual acidity effect on the soil.

Keywords: *Physiochemical Properties; Agricultural Land Uses; Soil Nutrients; Fertility Management*

INTRODUCTION

Land use defined as the arrangement, activities and inputs people undertake in a certain land cover type to produce, change or maintain it (Ayele, 2013). Changes of forests to rangeland and agriculture lands are one of the most concerns in environmental degradation and world climate change (Woldeamlak, 2007). Recently, due to population growth, forests lands are degraded and converted to agricultural lands. Land use changes such as deforestation, conversion rangeland to cropland and cultivation are known to result in changes in soil physic-chemical and biological properties (Shukla MK, 2006). Impact of these change and their magnitude is according to land cover and management (Chidumayo EN, 2003), land use changes and agricultural practices, especially cultivation of deforested land may rapidly diminish soil quality. Land use types affect soil physic-chemical and provide an opportunity to evaluate sustainability of land use systems and thus the basic process of soil degradation in relation to land use (Woldeamlak B, 2003). However, the information about the effect of land use changes on soil physic-chemical properties is essential in order to present recommendations for optimal and sustainable utilizations of land resources. Due to an increasing demand for firewood, timber, pasture, food, and residential dwelling, the hardwood forests are being degraded or converted to cropland at an alarming rate in most part of the country. Realizing the seriousness of the impact of different land uses on soil quality, the present investigation was initiated to evaluate the influence of different land use types on soil physiochemical properties in Kwali and its environs.

Intensive land use may cause important changes in soil physical and chemical characteristic and can affect soil fertility, increase soil erosion or cause soil compaction (Giessen, 2009). Land use changes through cultivation may rapidly diminish soil quality, as ecologically sensitive component of tropical soils are not able to buffer the effect of intensive agricultural practice (Islam and Weil, 2000). Kowal and Tinker (1959) found no decrease of chemical soil fertility during 16 years under oil palm (Elaeisguineensis) after secondary forest on a Nigerian Alfisol, except for losses of potassium (K) and magnesium (mg) which would have been replaced by fertilizer. In contrast Ollagnier *et al.* (1978) found decreases of total soil carbon (C) to 60% and of total nitrogen (N) to 75% of the levels under adjacent forest in out palm plantation of up to 14years age on an alfisol in the southern cote d ‘ivoire. Lal et al, (2011) measured differences in soil PH, organic matter, exchangeable calcium (CA), potassium (k) and phosphorous (p) between vegetation types on the same soils. Ogunkunle and Eghahhara (1992) also found differences in PH, K, and soil temperature and bulk density in different land use on the same soil type on an alfisol if such soil contrasts are statistically significant. This study was therefore carried out to assess the extent of different agricultural land use on soil properties.

This study is aimed at the assessment of soil properties changes under different agricultural land uses in Kwali, Kwali Area council in FCT Abuja. Sequel to this aim, the following set of objectives will be achieved; identify the major agricultural land use types, analyse the soils from the various agricultural land use types, to compare the soil condition of the various plots in order to ascertain the impact of various agricultural land uses on soil properties.

METHODOLOGY

This study is carried out in Kwali town and its environs. Kwali is one of the Six Area Councils in Federal Capital Territory (FCT). It has an area of 1, 206km^2, it is located between latitude 8^{o} 87'N and longitude 7^{o}01'E as in Figure 1, (Balogun, 2001). The study area is located in the middle belt of Nigeria. The climate of Kwali just like most climate in the tropics have a number of climatic elements in common, most especially the wet and dry season's characteristics. Recent data extrapolated from adjacent weather station as well as weather station within the study area revealed that long term mean temperature in the study area ranges from 30^{o}C- 37^{o}C yearly and mean total annual rainfall of approximately 1,650mm per annum (NIMET, 2017).

Rainfall in Kwali town like other parts of the FCT which also fall within the tropics experience the same nature of rainfall as well as the variability in the fringes of the settlement, rainfall play a vital role with respect to agricultural activities within the study area is highly dependent on rainfall. About 60% of the annual rainfall occurs between the month of July to September and it's during these period that flood occur (Adakayi, 2000; Balogun, 2001).

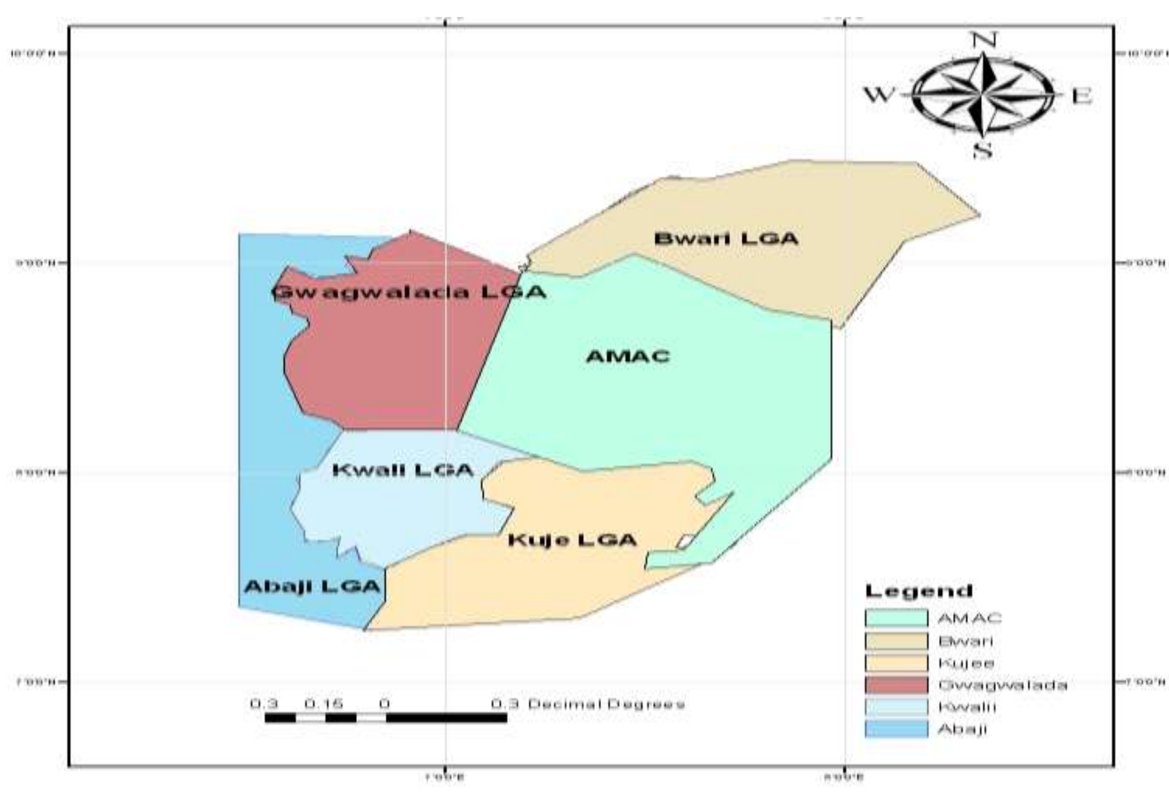

Figure 1: Federal Capital Territory showing Kwali Area Council Abuja

Source: Abuja Master Plan (1979)

The soils in Kwali are generally shallow and sandy in nature, especially on the major plains such as Iku-Gurara. The high sand content particularly son makes the soils to be highly erodible. The shallow depths is a reflection of the presence of stony lower horizons, which shows a high level of variability comprising mainly of sand, silt, clay and gravel. Alluvial soil cover very small part of Kwali town and the water table around the places where this type of soil is prominent is usually very high. It has well decomposed organic matter content in the surface layer, and its texture becomes heavier with depth, as the weathered parent material is approached, the materials are poorly sited because of the colluvial origin. These soils are products of down-wash from the hills and are generally the local sol developed on the foot plains located within the Iku-Gurara plains, (Balogun, 2001).

The vegetation type of Kwali is that of shrub savannah and the vegetation type also covers other areas which include Iku-Gurara plains, Usuma valley, and Chibiri. Gwako and also between Gwagwalada and Tunga Agunre (Balogun, 2001). The dominant indigenous groups are the Gwari which consist 61.7% and other groups includes Bassa 17.4%, Koro 6.1%, Gade 4.8%, Hausa 3.0%, Gwadnara 2.7%, Ebira 1.3% and others 3.0%, (Mundi 2000).

SOURCES OF DATA

The sources of data for this research are primary and secondary sources. The primary data for this research consist of soil samples from the cultivated and control farm plots, information regarding physical and chemical properties of soil from cultivated farm plots and the control plot being the fallow land. The secondary sources of data include unpublished thesis, journal articles, others from Food and Agriculture Organization (FAO), United Nations Environmental Programs (UNEP), Articles from the internet among others.

SAMPLE SIZE AND SAMPLING PROCEDURE

Three (3) farm plots were identified of which two of them are under cultivation of Maize, and Yam and the third plot is Fallow which serves as a control. The choice of yam and Maize is based on the fact that, the two crops are the dominant crops grown on the study area, also yam being a tuber crop and maize, a cereal crop suits proper for the research. Each of these plots was measured, 15m by 15m, where samples were collected on each of the farm lands selected. Greed lines were superimposed at five (5) meters and 12 soil samples were collected randomly from each plot, 6 topsoil samples and 6 subsoil samples, making a total of 36 soil samples which later compost to 6 samples three for topsoil and three for subsoil respectively. The Soil samples were collected at (0-15) cm depth for topsoil, while (15-30) cm for the sub soils, a total of 32 soil samples were collected on each of continuously cultivated farm plot and control, the soil sampled were form into composite making a total of six soil (6) samples altogether. The soils were bagged and labeled in black polythene then transported to the Laboratory for analysis. The parameters investigated include soil organic matter, particle size distribution, bulk density and chemical properties such as soil pH, nitrogen, phosphorous, carbon, cation exchange capacity of the soil were all analyzed.

RESULTS AND DISCUSSIONS

Descriptive analysis

There are six samples comprises of both top soils and sub soils from the three deferent agricultural land use. Both their physical and chemical properties were analysed, and the results is presented in Table 1.

Table 1: Descriptive analysis of Soil properties

Parameter	No. of samples	Min	Max	Mean	Std dev.	COV
Sand (%)	6	52.0	62.0	55.17	3.60	6.52
Silt (%)	6	11.0	19.0	14.67	2.88	19.6
Clay(%)	6	21.0	29.0	24.17	2.93	12.1
Organic Carbon (%)	6	0.14	0.19	0.16	0.02	11.9
Total Nitrogen (%)	6	0.31	0.61	0.46	0.11	24.9
pH at 25^0C	6	5.3	7.10	6.23	0.70	10.4
Available Phosphorus (Mg/Kg)	6	22	28	25	2.68	10.7
Calcium (Cmol Kg^{-1})	6	4.23	5.33	4.84	0.40	8.3
Sodium (Cmol Kg^{-1})	6	1.64	1.83	1.76	0.08	4.6
Potassium (Cmol Kg^{-1})	6	1.61	1.73	1.69	0.05	2.7
Magnesium (Cmol Kg^{-1})	6	0.0	5.13	3.55	1.81	50.9
Bulk density (g/cm^{-3})	6	1.53	1.92	1.71	0.18	10.2
Organic Matter (g/kg)	6	14.0	19.0	16.17	1.94	12.0
Exchange Acidity (Cmol Kg^{-1})	6	0.73	74.0	13.01	29.88	229.7
ECEC (Cmol Kg^{-1})	6	12.1	14.74	13.19	0.87	6.6

Source: Field survey, (2018)

Table 1 presents a descriptive statistics of the results of soil analysis. The mean range of the soils particles sizes is 10%, with a coefficient of variation (COV) of 6.52%, 19.6% and 12.1% for Sand, Silt, and Clay respectively. Generally, there is insignificant variation within the top soils and the sub soils across the various agricultural land uses, except magnesium and exchange acidity that showed variation between the top soils and the sub soils. .

Comparison of Soil Particle Size properties across various agricultural land uses Analysis

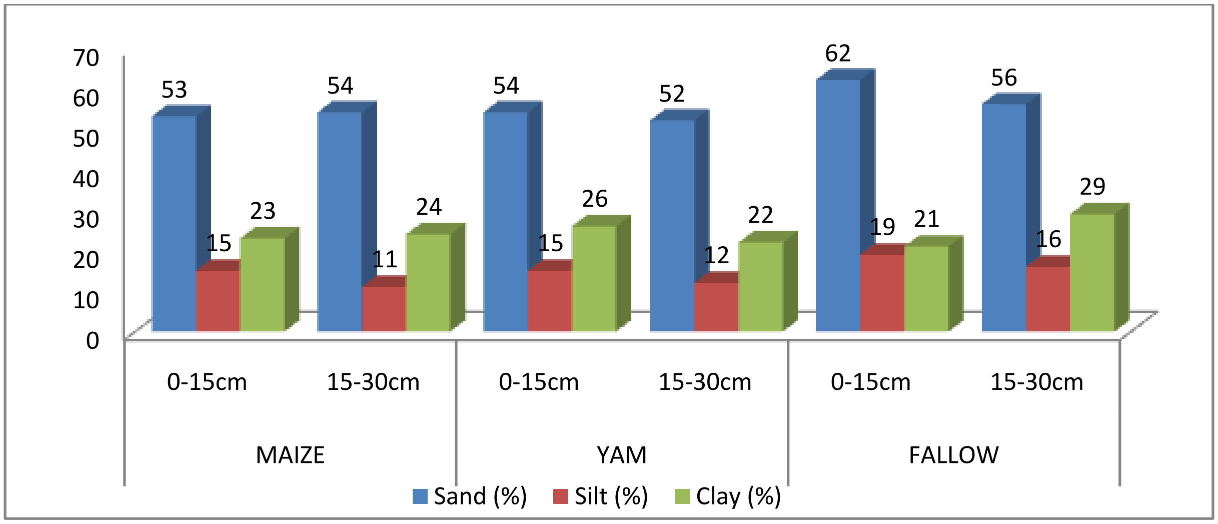

Figure 2: Soils Particulate size

Source: Field survey, (2018)

The percentage of sand content shows that fallow land has the 62% and 56% for top and sub soils, while that of maize and yam farms having 53%, 54% and 54%,52% for both top and sub soils respectively. This implies that the fallow land has the highest percentage of soils followed by the two land uses that have little difference. This could probably be due to the farming practices that exit in the study area, where the farmers alternate maize cultivation with yam after each season. It can also be observed that the particle decreases with dept. This is in agreement with Brandy, (2011), that said sand content decreases with increasing soil depth; this is probably because as the land is cultivated there is tendency that the soil would be mixed up with more of the sand from weathering activities. The percentage of Silt Particles shows it ranges between 19% and 11%. Fallow land being undisturbed with 19%, which is the highest.

A close observation shows that in the three various land uses, the value of the silt particle deceases with depth. The results from the analysis show that the percentage of clay soil is highest in the fallow land (29% and 21% for sub soil and top soils respectively, compared to that of maize and Yam soils. The general trend of soils particles in the study area is Sand > Clay > Silts and that of Land use trend is as Fallow > Maize ≥ Yam.

SOIL CHEMICAL PROPERTIES

Soil pH

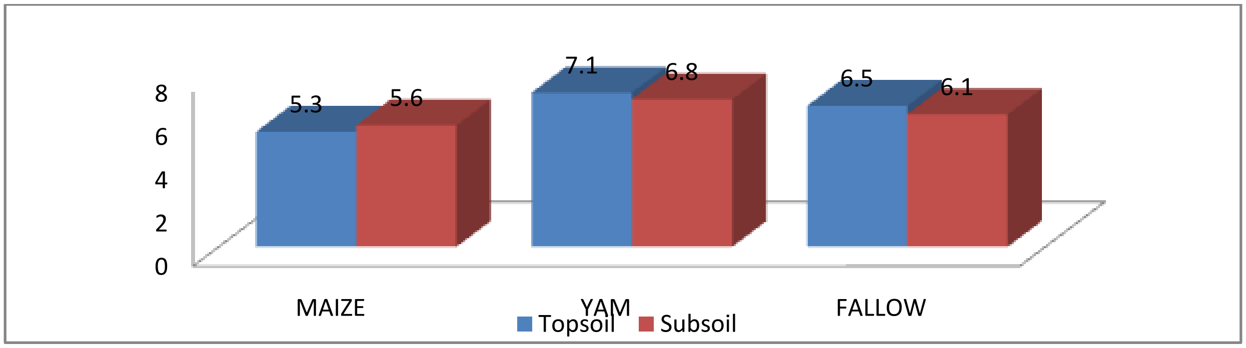

Figure 3: Soil pH

Source: Field survey, (2018)

Figure 3 shows the pH value of the soils. Results revealed that the top soil of Yam and Fallow land are higher than that of soils from Maize land. The pH of the soil from yam is 7.1 and 6.8 which is fairly neutral. Maize has a pH of 5.2 and 5.6 which are acidic in nature. The difference in pH between the topsoil and subsoil is very small. Continuous cropping might have influence but the use of fertilizers might also influence the pH. This range of soil pH according to Chude, (2013) is most suitable for solubility of plants nutrient in the soil, however strongly acidic soils encourage toxicity of micro nutrients in the soil.

Soil Bulk Density

Bulk density is an indirect measure of pore space and is affected primarily by texture and structure. As aggregation and clay content increase, bulk density decreases. Tillage operations do not affect texture, but they do alter structure (soil particle aggregation). Primary tillage operations, such as plowing, generally decrease bulk density and increase pore space, which is beneficial.

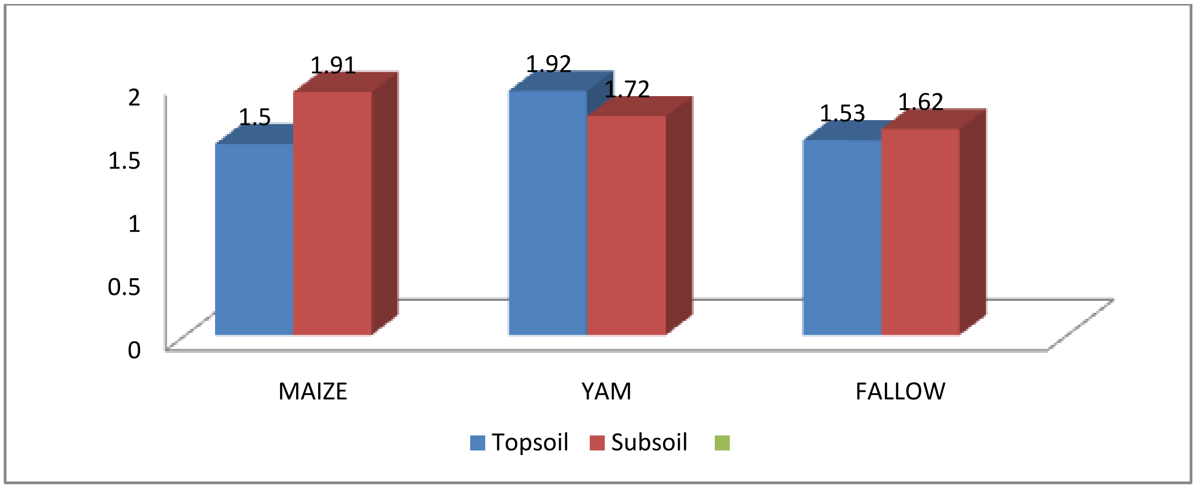

Figure 4: Soil Bulk Density

Source: Field survey, (2018)

Figure 4 presents the soil bulk density; the figure revealed that the soil bulk density of topsoil is 1.5 g/cm^{-3}, 1.92 g/cm^{-3} and 1.53 g/cm^{-3}; subsoil is 1.91 g/cm^{-3}, 1.72 g/cm^{-3} and 1.62 g/cm^{-3} for, Maize, Yam and Fallow lands respectively. It can be observed that the trend is this order Yam cultivated soils > Maize cultivated land > Fallow land. This is probably due to the fact that cultivation generally increases bulk density and decreases pore space. The compaction resulting from cultivation can be detrimental to plant growth. Cropped soils generally have higher bulk densities than un-cropped soils. Bulk density increases with compaction and tends to increase with depth; sandy soils are more prone to high bulk density (NLWRA 2001, Australian Agriculture Assessment 2001).

Soil Organic Carbon and Total Nitrogen

Soil organic carbon is the basis of soil fertility. It releases nutrients for plant growth, promotes the structure, biological and physical health of soil, and is a buffer against harmful substances. Total organic carbon is one of the most important constituents of the soil due to its capacity to affect plant growth as both as a source of energy and a trigger for nutrient active pool, it also tend to aggregate stability, nutrients and water holding capacity's. The results of the laboratory analysis of Organic carbon and Total Nitrogen are presented in Figure 5.

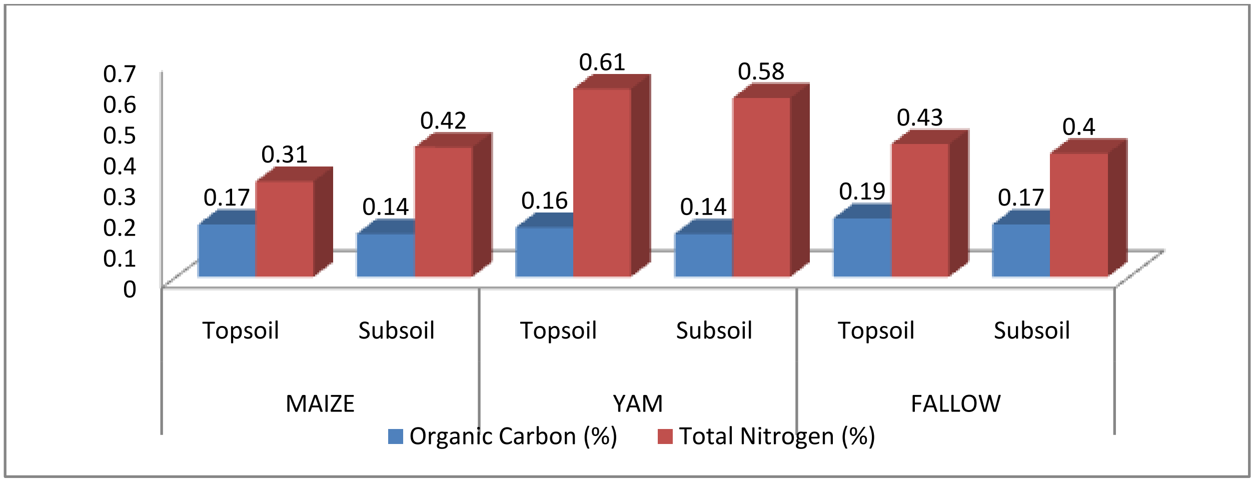

Figure 5: Soil Organic Carbon and total Nitrogen

Source: Field survey, (2018)

Figure 5 shows that soil organic carbon of topsoil is 0.15%, 0.17% and 0.19%; subsoil is 0.14%, 0.14% and 0.17% for Yam, Maize and Fallow lands respectively. It can be observed that the trend is this order Fallow land > Maize cultivated land > Yam cultivated soils. This is probably due to the fact that fallow land has more organic matter follows by Maize cultivated soils due to shallow nature of the cultivation coupled with the decay of the corn stalks. The total organic carbon (TOC) is the carbon stored in soil organic matter (SOM) which means the soil organic matter determines the value of soil organic carbon to a large extent.

The results show that the percentage of Nitrogen is highest in the Yam cultivated soils followed by the fallow land then the Maize cultivated land. The top soils have higher percentages except that of Maize plot where the sub soil was having the higher percentage of nitrogen. Generally, the nitrogen values range from 0.31% in Maize plot to 0.61% in the yam plot. Excess of nitrogen in the soil can result in rapid, lush growth and a diminish root system, however despite the role of Nitrogen in the soil , in extreme cases too much quick release of nitrogen into the soil can cause burning of leaf tissue and plant death (Anderson, 2000).

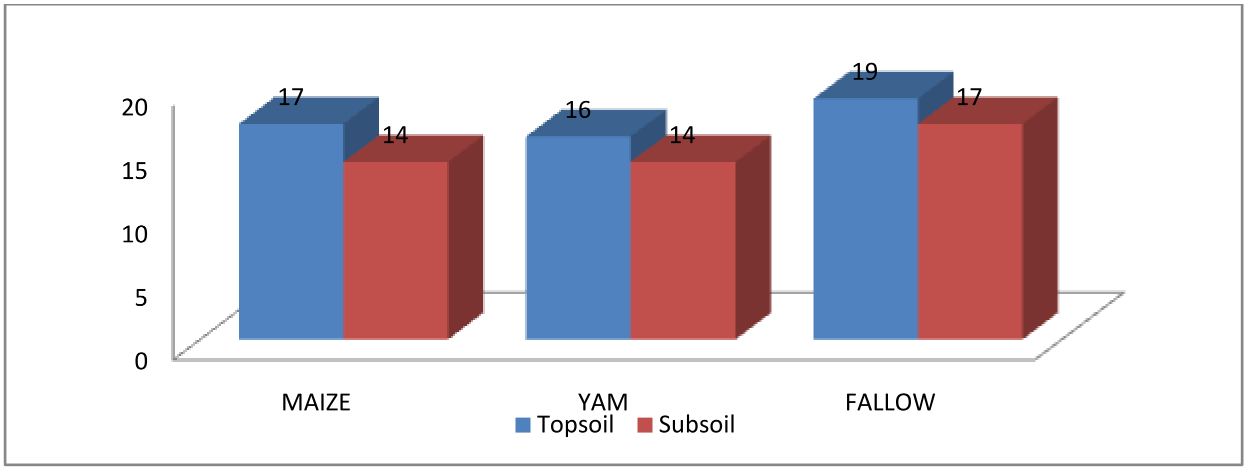

Figure 6: Soil Organic Matter

Source: Field survey, (2018)

Figure 6 shows that soil Organic Matter of topsoil is 17 g/kg, 16 g/kg and 19 g/kg; subsoil is 14 g/kg, 14 g/kg and 17% for Yam, Maize and Fallow lands respectively. It can be observed that the trend is this order Fallow land > Maize cultivated land > Yam cultivated soils. This is probably due to the fact that there are lots of dead plants and animals in fallow land and Maize cultivated soils, coupled with their decay.

Soil organic matter consist of both plant and animal residues at various stage of decomposition, cells and tissue of soil organisms and substances synthesized by soil organic carbon these could be use to explain why there are high value of organic matter on the fallow land as there are more of plants and animal organisms undergoing the process of decomposition without been affected by human activities.

Available Phosphorus

Phosphorus (P) is an essential element classified as a macro nutrient because of the relatively large amount of (P) required by plants, phosphorus is one of the three nutrients generally added to soils in fertilizers, and one of the main role of role of (p) in living organisms is the transfer of energy.

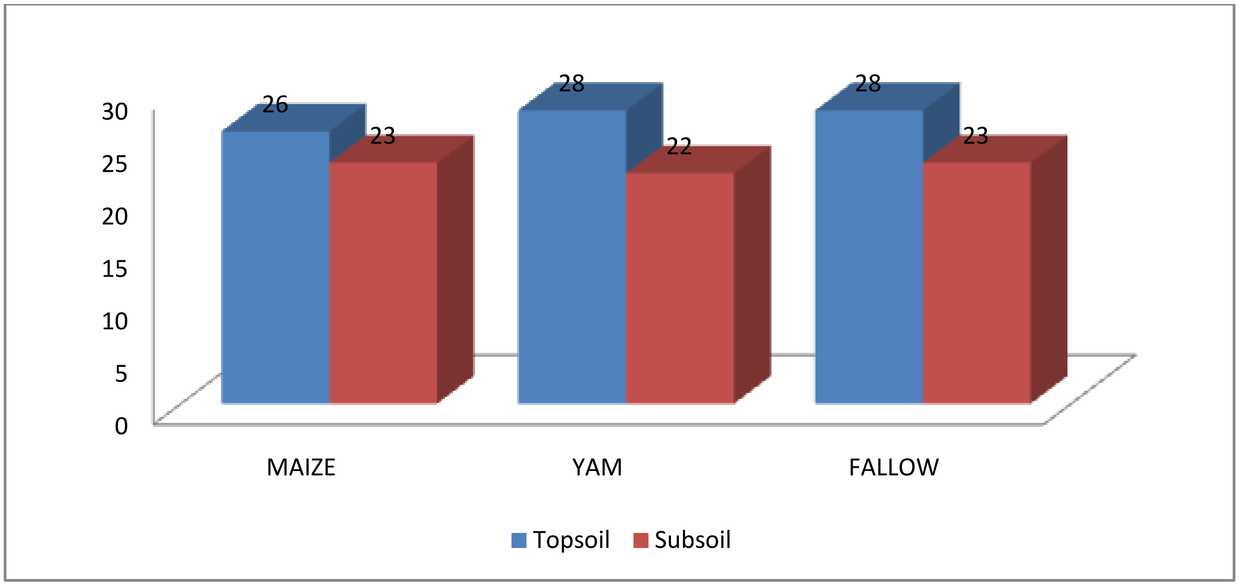

Figure 7: Available Phosphorus

Source: Field survey, (2018)

Figure 7 shows that Available Phosphorus of topsoil is 26 Mg/Kg , 28 Mg/Kg and 28 Mg/Kg; subsoil is 23 Mg/Kg, 22 Mg/Kg and 23 Mg/Kg for Maize, Yam and Fallow lands respectively. It can be observed that the trend is this order Fallow land ≥Yam cultivated soils >Maize cultivated land. The high amount of available phosphorus on the land uses could be due to the use of crop residues, similarly (silver, 1994) found a high correlation between litter fall and soil phosphorus, these explains the high amount of available phosphorus on the top soil of Maize land use which has more leaves residue than the yam land use.

Exchange Bases (Ca Na, K and Mg,)

Awotunde, (1981), rated Exchangeable Bases (Ca Na, K and Mg,) as shown in Table 2.

Table 2: Rating of Exchangeable Bases

Rating	Ca	Mg	K	Na
Very High	above 20	above 8	1-2	above 2.0
High	10 -20	3 – 8	0.6 – 1.2	0.7 – 2.0
Medium	5 – 10	1.5 – 3.0	0.3 – 0.6	0.3 – 0.7
Low	2 – 5	0.5 – 1.5	0.2 – 0.3	0.1 – 0.3
Very Low	below 2	below 0.5	below 0.2	Below 0.1

Source: Awotunde (1981)

The soil samples were analysed for Exchange Bases (Ca Na, K and Mg) and the results is presented on Figure 8.

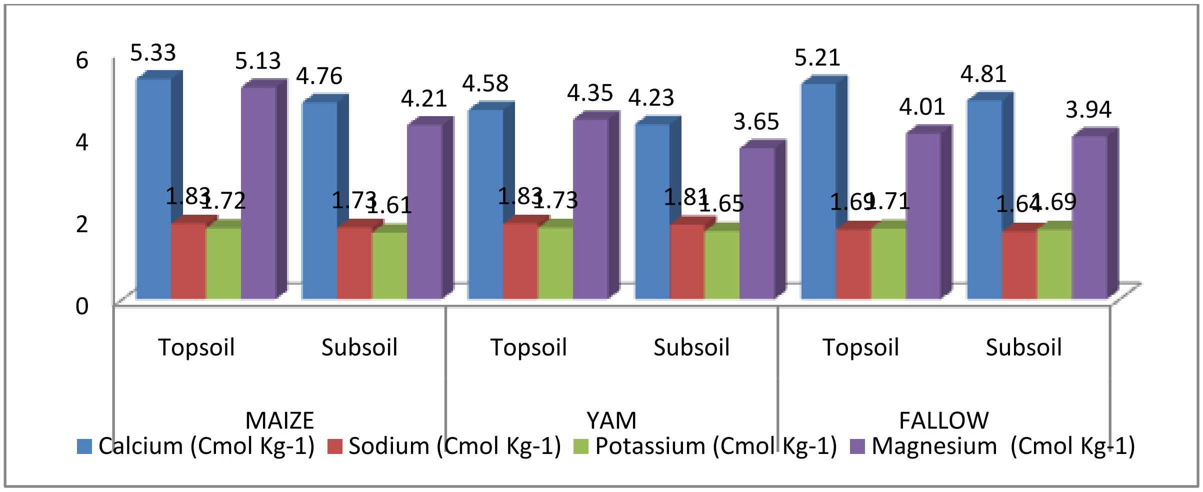

Figure 8: Exchange Bases (Na, Mg, K and Ca)

Source: Field survey, (2018)

Figure 8 shows that Calcium of topsoil is 5.33Cmol Kg^{-1}, 5.21Cmol Kg^{-1} and 4.58Cmol Kg^{-1}; subsoil is 4.81Cmol Kg^{-1}, 4.76Cmol Kg^{-1} and 4.23Cmol Kg^{-1} for Maize, Fallow lands and Yam land respectively. This means that the Maize land has the highest value of calcium while the yam land has the lowest value, relating it to soil fertility rating by Awotunde, 1981)) it implies that the yam land has medium value of soil calcium while the maize and the fallow land use has low value of soil calcium, these confirms that the yam has high effect on these element.

For Magnesium the value in topsoil is 5.13Cmol Kg^{-1}, 4.35Cmol Kg^{-1} and 4.01Cmol Kg^{-1}; subsoil is 4.21Cmol Kg^{-1}, 3.65Cmol Kg^{-1} and 3.94Cmol Kg^{-1} for Maize, Yam land and Fallow lands respectively, while for Sodium the value in topsoil is 1.83Cmol Kg^{-1}, 1.83Cmol Kg^{-1} and 1.69Cmol Kg^{-1} subsoil is 1.73Cmol Kg^{-1}, 1.81Cmol Kg^{-1} and 1.64Cmol Kg^{-1} for Maize, Yam land and Fallow lands respectively, and for Potassium, the value in topsoil is 1.73Cmol Kg^{-1}, 11.72Cmol Kg^{-1} and 1.71Cmol Kg^{-1}; subsoil is 1.65Cmol Kg^{-1}, 1.61Cmol Kg^{-1} and 1.69Cmol Kg^{-1} for Yam land, Maize land, and Fallow lands respectively, It can be observed that the trend is this order Maize cultivated land ≥ Fallow land ≥ Yam cultivated soils.

The high amount of magnesium content in the various land uses could be as a result of high pH in the soil as low soil pH decreases Mg availability and high soil pH soil Mg furthermore low CEC soils hold less Mg while high CEC soils hold abundant Mg, these could be the reason for high amount of Magnesium in the soil of the various land uses. Relating the results to the soil fertility rating the three land uses has high value of soil magnesium. Magnesium which is a component of several primary and secondary minerals in the soil which are essential insoluble for agricultural consideration, these minerals are the original sources of the soluble or available form of Mg.

According to Awotunde, soil fertility rating (1981) the soil sodium for all the land uses have high values, Zonn (1986) explains that sodium is one of the loosely held metallic ions which is readily lost in leaching water, leaching may be the reason why the fallow land use has the lowest value as the land is on a stepper slope. The implication for these findings is that sodium is available for plant uptake on both the yam and maize; however its availability could be injurious to plant which might cause sodicity effect on soil. Despite the importance of sodium nutrients in the soil, excessive increase in sodium nutrient could impair the growth of plant (Greeway and munns, 1980).

Exchange Acidity (Cmol Kg^{-1})

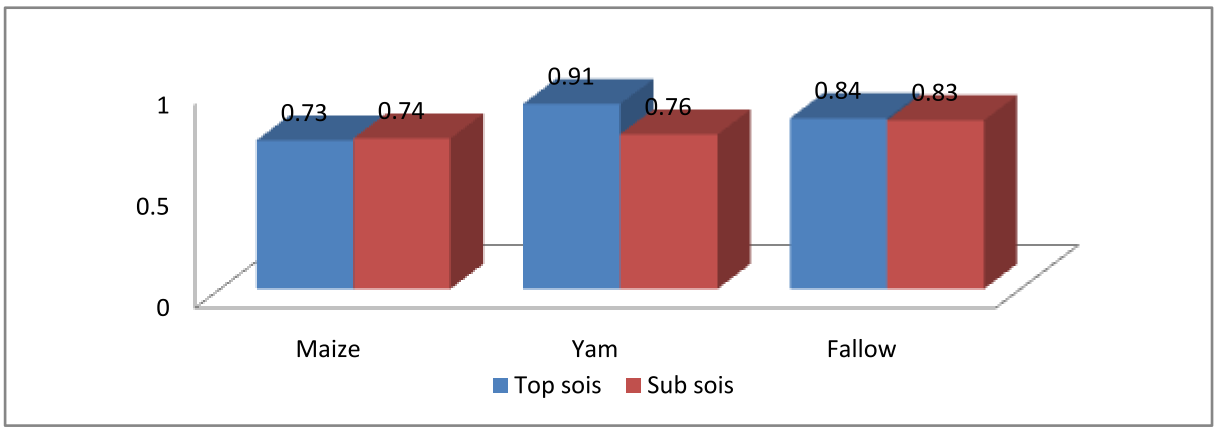

Figure 9: Exchange Acidity (Cmol Kg^{-1})

Source: Field survey, (2018)

Figure 9 shows that Exchange Acidity of topsoil is 0.73Cmol Kg^{-1}, 0.91Cmol Kg^{-1} and 0.84Cmol Kg^{-1}; subsoil is 0.74Cmol Kg^{-1}, 0.76Cmol Kg^{-1} and 0.83Cmol Kg^{-1} for Maize, Yam and Fallow lands respectively. It can be observed that the trend is in this order:- Yam cultivated soils ≥ Fallow land >Maize cultivated land.

ECEC (Cmol Kg^{-1})

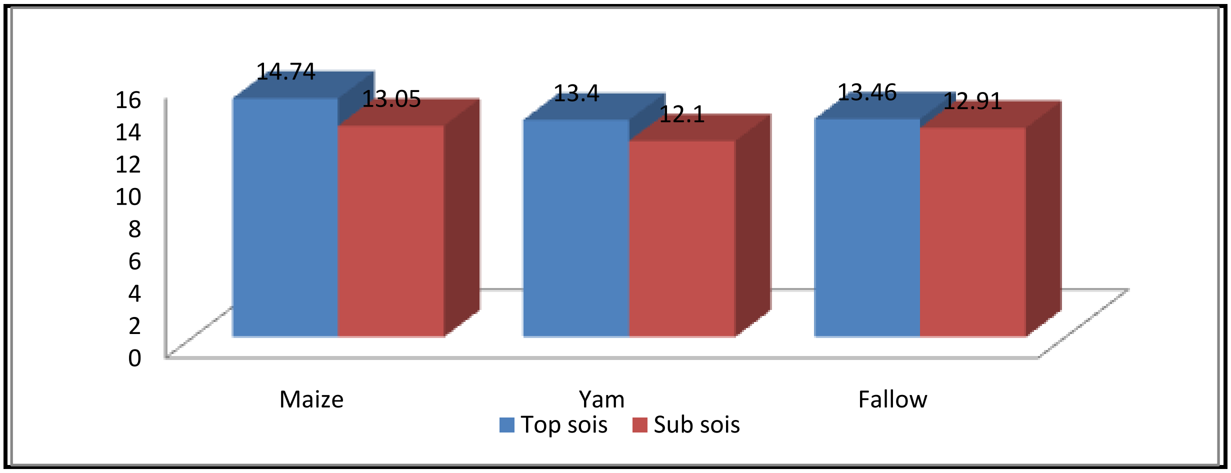

Figure 10: ECEC (Cmol Kg^{-1})

Source: Field survey, (2018)

Figure 10 shows that the ECEC of topsoil is 14.74Cmol Kg^{-1}, 13.4Cmol Kg^{-1} and 13.46Cmol Kg^{-1}; subsoil is 13.05Cmol Kg^{-1}, 12.1Cmol Kg^{-1} and 12.91Cmol Kg^{-1} for Maize land, Yam land and Fallow lands respectively. It can be observed in this trend; Maize cultivated land > Fallow land > Yam cultivated soils.

Result of Tested Hypotheses

The data is subjected to analysis of variance in order to verify if there is significant difference of the various agricultural land used on the Physiochemical properties of the soils. The result is as presented in Table 3.

Table 3: Results of One Way ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	9.092	2	4.546	0.021	0.980
Within Groups	9219.976	42	219.523		
Total	9229.068	44			

The result shows that the cal. F-ratio is 0.21 and the significance value is 0.98 at 95% confidence level. This implies that the hypothesis is accepted, we then conclude that there is no significant difference in the physiochemical properties of the soils from the different agricultural land uses in the study area. The implication of this is that the value of the agricultural land use result only has little variation which does not have great differences from the fallow land use.

Table 4: Results of Students t-test

Top soil vs Subsoil	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. dev.	Std. mean	Lower	Upper			
	0.894	2.208	0.3291	0.2308	1.557	2.717	44	0.009

The result shows that the t-cal. is 2.717 and the significance value is 0.009 at 95% confidence level. Since the calculated is greater than the significant level, the null hypothesis is therefore rejected and the alternative accepted. This implies that there is significant difference in the physiochemical properties between the top soils and the sub soils of the different agricultural land uses in the study area.

Conclusion and Recommendations

Based on the results of the analysis of the properties of soil of the various agricultural land uses, it can be concluded that the soil properties of the top soils varies significantly from those of the sub soils probably because of the different depths of cultivation and the types of crops produced in the farms. Yam is a tuber crop and do require cultivation of heaps or big and high ridges, thereby involving deep tillage as such influencing both the physical and chemical properties of the soils. Though there is no significant variation from the soils of the various agricultural land uses, it does not mean that difference does not exist but that it is not significant. Therefore there is need for soil conservation practices in order to manage the soil for sustainability.

It is therefore recommended that, Farmers need to be informed about strengthening and expanding existing fertility management practices to sustain agriculture production. More also adequate soil nutrient analysis should be conducted to determine the soil suitability for a specific crop to be cultivated. The use of more organic manure in the soil is necessary so as to help in stabilizing soil pH level than inorganic or chemical fertilizer which has residual acidity effect on the soil. The use of fertilizer and other farming techniques to best improve soil quality should be employed in the cassava and yam land uses. Lastly adequate and appropriate cropping system should be adopted particularly on low nutrient soil so as to increase the nutrient levels and prevent further nutrient loss.

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