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ASSESSMENT OF SELECTED SOIL PROPERTIES UNDER DIFFERENT LAND USE IN THE DERIVED SAVANNAH OF IGBOORA

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ABSTRACT

Globally, efforts are being made to identify land use types that could potentially improve carbon sequestration to mitigate climate change and global warming and ensure sustainable agriculture. The study characterize the soils under different cultivations and assesses the effects of different land use systems on selected soil morphology and physicochemical properties in Igboora. Five land use systems (Cassava, Maize, Maize interplanted with cassava, fallow land and orchard plot) were identified. Twenty-five soil samples were collected from five profile at 0–20, 20 – 35, 35 – 65, 65 – 95, 95 – 125cm depth. Ten soil morphology, and physicochemical properties were measured.

Soil colour varied along soil depth, while soil consistence (wet) showed various grades of stickiness and plasticity, the soil reactions of the pedons were slightly acidic while soil total carbon, total nitrogen, and available phosphorous showed increasing trend with depth of pedon across the land uses, ranging from 0.23 – 5.4% suggesting that Organic Carbon, Total Nitrogen and Available Phosphorus and other properties were affected by the land uses.

Land use has detrimental effects on soil properties in Igboora, indicating that the conditions of cassava interplant with maize soils are becoming worse than other for land uses. Adopting integrated soil fertility, management, applying organic fertilizer should preserve the existing conditions and increase soil quality.

Keywords: Soil consistence, Land use, Soil quality, Climate change, Igboora.

INTRODUCTION

Across sub-Saharan Africa, natural resources remain central to rural people's livelihoods (Roe et al., 2009). Nonetheless, natural (rainfall and temperature) as well as anthropogenic (farming, grazing, burning) forces can exert pressure on these resources, thereby influencing spatial and temporal scale changes on a landscape. The dynamics of land use change associated with the anthropogenic activities are occurring rapidly in tropical landscapes. Valentine, et al., (2018). Several bad agricultural management practices have resulted in soil fertility decline and environmental degradation globally necessitating urgent attention to ensure sustainable agricultural production systems. Ayoubi, et al., (2011). Despite 37% of total land globally being used for agriculture with approximately 30% of land in Nigeria also being used for agriculture Chen, et al., (2018), and World Bank Group and World Bank (2006), the world still grapples with food production on a sustainable basis due to soil and land degradation, rising sea levels and climate change, and the rapid shrinking of the limited available agricultural lands amidst projected population growth by 9.8 ±1billion and 11.2±1billion by 2050 and 2100, respectively FAO (2016, Nations, U. 2018) and Trendou, S. (2019). This leaves us with no option than the adoption of sustainable agricultural intensification practices to achieve our food, fuel and fibre needs. Land use change involving the introduction of managed systems on natural ecosystems results in altering carbon balance Selassie, et al., (2015).Nations, et al; and Trendou, et al; noted that changes in land use caused 12 – 20% of human-induced emission of greenhouse gas (GHG) in the tropic and remains the second largest source of greenhouse gas emission going into the future. A whopping sixty per cent reduction in soil organic carbon pool was recorded in temperate soil and greater than seventy-five per cent was also recorded in tropical soils when pristine lands were converted for agricultural uses. Lal, (2004). As a result of increase erosion, decomposition, and leaching, converting natural land to agricultural use frequently causes a reduction in soil organic carbon Guo, L.B., Vandenbyart, (2003). The two major gases released as a result of human-induced soil cultivation practices that stimulate the rapid decomposition of soil-store carbon that accelerates global warming and climate change are methane and carbon(iv) oxide (CO_2). United State Environmental Protection Agency (2020).

It is estimated that fertilizer application, livestock manure deposition, and growing N. fixing plants, are known to contribute more than 75% of global nitrous oxide (N_2O) emissions. Despite these high emission, it is estimated that agricultural lands are capable of storing between 0.90 and 1.85Pgc annually, or 26% - 53% of the 4 per 1000" initiatives aim for soil carbon sequestration. Zomer, et al; (2017). Soil organic carbon in agricultural soils is lost through decomposition, above-grand biomass removal and erosion Berry, (2011).

The increasing population and its corresponding demand for food in the midst of change climate require the identification of land use types and management practices that can promote carbon sequestration and retention for agricultural sustainability and food security F.A.O. (2016), Okolo, (2019).

Despite these very important roles soil organic carbon plays in ensuring sustainable agriculture, environmental quality and climate change mitigation, uncertainties still exist in the Literature regarding how land use types affect soil organic carbon in addition to the dearth or knowledge about this in the Igboora content.

The need for sustainable land use ecosystems conjures the protection and enhancement of soil quality through designing efficient site specific actions to control soil erosion and restore soil quality, thereby improving the conditions and productivity of the soil at Ibarapa region. The objectives of the study include:

(1) to characterize the soils under different land use systems; and

(2) to assess the influence of land use change on selected soil properties in the Ibarapa.

MATERIALS AND METHODS

Description of the Study Area

The study was carried out in Oyo State College of Agriculture and Technology Teaching and Research Farm, Igboora in Ibarapa Central Local Government Area of Oyo State, Nigeria. It is located between 7°15' – 7°33' North, and 3°36' – 3°57' East.

Long time rainfall records (1990 – 2023) show a uni-modal pattern with the annual rainfall of 1278mm. The rainy season starts at the end of April and lasts in October with maximum rainfall in August. The mean annual maximum and minimum temperatures are 36.2 and 16.2°C respectively. The site cultivated for approximately 20 years with annual mechanized plow. The remaining part of the sites is open woodland (OWL) occupied by Sudan grass (*Sorghum bicolor subse drummondi*) with Acacia (*Acacia sp*) and Neem (*Azadirachta indica*) tress located at the northern part of the site. The field under cultivation has been cropped predominantly to maize (*Zea mays L.*), cassava (*Manihot spp.*).

Soil Profile Excavation

Based on the information obtained from free reconnaissance survey, transverse were cut and spaced at 50meter apart at each delineated unit and points of observation were fixed at the intersection of the perpendicularly running transects. After this, soils with similar characteristics were grouped together as same mapping unit. Soil profile pits were located and dug (1.5m x 1.5m x 2.0m) to represent each of the identified delineations on the farms. The selected units and their respective soil profiles are: pedon-1 (Cassava plot), pedon-2 (Maize plot), pedon-3 (Maize ipw Cassava), pedon-4 (Fallow) and pedon-5 (Orchard), in Teaching and Research farm, Igboora. Soil profiles pits were studied and described according to FAO guidelines for soil description (FAO, 2006). Collected soil samples were described for morphological characteristics, physical and chemical properties.

Soil Sampling

Sampled were taken from every identified horizon at fine land uses and five depths (0 – 20, 20 – 35, 35 – 65, 65 – 95, 95 – 125 cm) with hand trowel, cutlass and bucket. Altogether, a total of twenty-five samples were collected from the five profiles pits for laboratory determination of soil properties.

Laboratory Analysis

Soil samples for particle size data and chemical analysis were air-dried, crushed and sieved through a 2mm mesh sized sieve. Soil morphology was described in the field according to the guidelines for soil profile description (FAO, 2006). Soil physical and chemical properties were analysed using standard methodologies as specified below. Particle size analysis was determined by the Bouyoucos hydrometer method (Gee and Bauder, 1986), soil pH was determined in a 1:2.5, soil water suspension (Thomas, 1996). Organic carbon was determined by the diechromate wet oxidation method (Nelson and Sommers, 1996). Total Nitrogen was analyzed according to the Macro Kjeldahl digestion method (Brerunner, 1996), Avaialble phosphorus was extracted and determined by the Bray II Procedure (Kuo, 1996).

RESULTS AND DISCUSSION

Surface soil colour (moist) ranged from light brown (7.5YR3/3) to common, medium faint light brown (7.5YR5/2) lime mottles and lime coatings on pepples expect in the pedon of the fallow and orchard, where the colour (moist) of the subsurface horizons varied from very dark brown (7.5YR3/4) to grey brown (7.5YR5/3) with common distinct fine mottles of strong brown, (Table 1). The soil colour is due to organic matter (OM) which tends to coat minerals particles, darkening and masking the brighter colours of the mineral themselves, and water content which affects the oxidation state of iron and manganese, Munishi, (2010) - Table 1.

Pedon-1, 2 and 3 had light brown sandy clay top soil overlaying strong brown (7.5YR5/4) and graynish brown (10YR5/2) on ped faces, internally prominent medium mottles of reddish yellow (5YR6/6) and very dark brown (10YR2/2), grey (10YR5/1) along root channels (Table 1). The subsoil brown colour was attributed partially to the presence of goethite and/or hematite which was a function of moisture while the red colour was indicator to the presence of hematite (Fe_2O_3) (Allen *et al;* 1990). The soil colour (dry, moist) of the topsoil in the studied pedons were nominated by hue of 7.5YR, while the subsoil had a hue of 10YR and 5YR, (Table 1). The results showed that soil colour is highly influenced by soil organic matter, where the darkness in the A-horizon decreased with depth. Dark coloured surface horizons (values≤ 3) are often enriched with organic matter, offering many benefits to the soil.

Soils in cultivated area that were never saturated with water had reddish and brownish subsoil colour, which are indicatives of well drained and aerated conditions. Reddish colour is due to the presence of iron compounds in various states of oxidation and hydration (Foth, 1990) - Table 1. The horizons in the pedon at orchard varied in colour from others due to reduction reactions cause by water saturation. Pedons that collect water, and were poorly drained locations where soils are water saturated most of time, will tend to have grey coloured B-horizons (Foth, 1990).

The observed colour and prevalence of mottles from the topsoil to subsoil was attributed to the irregularly (episodic) drainage conditions. That is, while soils on the topsoil are usually well-drained ad some subsoils are not well drained or imperfectly drained respectively and experience oxidizing conditions, and therefore a lower hue and high chroma, soils in subsoil are under the influence of perennially high or seasonal, fluctuating water table, poorly drained in reducing state is therefore necessitating the higher hue and lower chroma in the matrix (Table 1).

Soil structure of surface horizons of pedons was generally crumb coarse with some variations in size of peds. Crumble grade of peds was observed at upper depths of Pedon-1 and 2 (Cassava and Maize plots) indicating structure deterioration attributed to prolonged cultivation that fragments soil aggregates. Pedon-3 was very angular coarse to crumble structure at top soil, while sub-soil had angular blocky structure. Pedon-4 had angular coarse throughout except Bhs horizon which had prismatic structure (Table 1). The crumble coarse structure in the top soil of the pedons could be attributed to the frequent cultivation.

The observed structure (crumb, angular blocky, columna) of the studied soils suggest no restrictions to root growth, and water movement will normally not be impeded. Accordingly, the crumb structure of the studied soils would promote drainage, aeration and root penetration. On the other hand, the crumb and loose structure of the soil indicates poor state of aggregation, fragility and susceptibility to erosion. This can be serious at the maize, cassava and cassava inter-planted with maize where the soil can easily loss cohesion and transport away from detached points (Table 1).

The moist consistence of the soils range from friable to extremely hard, whereas the wet consistence ranged from slightly stickly/slightly plastic to very stick/very plastic (Table 1). Despite high clay contents of up to 45% , the soil minerals were not extremely stickly (Table 1). Probably because of the type of clay mineral present. Many red coloured tropical soils have clay particles composed mainly of kaolinite and oxides of iron and aluminum, which have little capacity to develop stickness and to expand and contract on wetting and drying (Foth, 1990). The friable consistence observed in the surface soils at moist condition of the pedons (Table 1) could be attributed to the higher organic matter (OM) contents of the layers. Although consistence is an inherent soil characteristics, the presence of high organic matter in the surface horizon, changes its consistence (Wakene and Heluf, 2004).

Consistence (wet) showed various grades of stickness and plasticity along the profile depths, the characteristic which indicated the presence of Montmorilonite clay minerals in the pedon. This could be attributed to the presence of clay particles that might occur due to change in particle size distribution of soil (Table 1).

The boundary separating the dark A_p from the B horizon was in a most cases gradual and smooth, while the boundary separating the B horizon from the under-laying Bt was largely clear and smooth, Table 1. The former condition indicates that the lower part of B horizons was still actively evolving through weathering processes.

Texture is the most stable physical property which influences other soil properties like

soil structure, consistence, soil moisture regime and infiltration rate, runoff rate, erodibility, workability, permeability, root penetrability and fertility of the soil (John et al; 2018).

The soil texture of the studied pedons varied from sandy clay loam to sandy loam in the surface horizon of all the pedons (Table 2), and become sandy at the pedon-1, (Cassava), pedon-2 (Maize), pedon-3 (Maize ipw Cassava), which may be due to removal of fine soil particles as a result of human influence which expose the soils to erosion while pedon-4 (Fallow) and Pedon-5 (Orchard) become silt as a result of accumulation of sediments from intensive used land.

According to Lawrence (1992), of the individual soil properties considered, silt and sand contents were the most highly correlated with erodibility. Result on the particle-size distribution of the pedons indicated that relative high sand content was recorded in pedon-3 (Cassava interplanted with Maize plot), pedon-1 (Cassava plot) and pedon-2 (Maize plot) followed by that of pedon-4 (Fallow) and pedon-5 (Orchard) fields in the topsoil (0 – 20cm) depth, whereas in the 0 to 20cm depth silt was found to be higher in Orchard soils (Table 2).

Accordingly, higher content of clay was recorded in 65 – 95cm depth of fallow farms. Although texture is inherent property, this might be attributed to accelerated weathering as a result of disturbance during continuous cultivation, as was also concluded by Boke (2004) from the result obtained from the Cassava site.

The soil texture of the different land use types and upper layers of the different horizons were found to be the same expect for that of orchard field soil (20 to 35cm depth), which was clay loam. This suggested that the different land use types did not have effect on the soil texture of the study area, since texture is an inherent soil property that not influence in short period of time.

The result shows that the clay content slightly increased from Ap to Bt and Bt2 horizon and then decreased with depth, while sand contents increased in all pedons (Table 2). Across the profile, the highest 55% and lowest 9.4% clay contents were recorded in pedon-5. Although the increase in clay content in the B_1-horizon of pedon-1, 2 and 3, agilliar (clay skins) were not found on the sides of pedon faces, implying that clay illuviation did not occur, and high clay content of Bt-horizon are due to in-situ weathering of parent material. This is line with observation of Yacob et al., (2014).

The silt/clay ratios of 1.0 to 2.0, 0.59 to 1.3, 0.54 to 2.08, 0.10 to 0.23 and 0.09 to 3.4 were observed in pedons-1, pedon-2, pedon-3, pedon-4 and pedon-5 respectively (Table 2). The subsoil silk/clay ratios of pedon-5 are lower than those of the other pedons indicating that pedon-5 is more weathered than the other pedons. The decrease of silt/clay ratio values with depth indicates that subsoils are more weathered than topsoils. Karuma et al., (2002) reported similar for soils of Busia country in Kenya.

The soils in the fallow fields had highest clay content (56%) while soil in the orchard fields had higher clay content (55%) when compare with the cultivated plots (Table 2), especially at two locations (maize and orchard). This is in line with the observation of Troech and Thompson (1993) who decided that good management strategies could slightly improve the clay content of the soil. However, this does not suggest that good management practices can alter the textural classes of soil within a long period of time.

Bulk density (BD) is an important parameter for the description of soil quality and ecosystem functions (John et al; 2018). Topsoil bulk densities of the studied soils ranged from 1.39 to 1.50mg/m-^{3} while subsoil bulk densities ranged from 1.40 to 1.57mg/m^{-3} profiles (Table 2). Generally, bulk density increased with depth in the studied pedons. The lower topsoil bulk density may be attributed to higher organic content. Accordingly, bulk density increases with depth since the subsoils are compacted, with less organic matter, aggregates and pore space, hence minimal numbers of roots compared to topsoils mainly the sand fraction, the dominant particle-size fraction. However, the values of soil density may not adversely affect plant root growth and function since the soils are generally friable, weakly structured and easily penetrable. The bulk densities of plough layers of pedon-1, 2, and 3 were higher than the "optimum" value (1.40 gcm^{-3}) for clayey soils (USDA, 2008). This could be attributed to soil compaction as a result of continuous and intensive cultivation with heavy farm machinery for many years.

The pattern of differences in total and macro porosity was similar to bulk density. Total pore space averaged 45% of the soil volume while water-free pore space averaged 51% of total pore space. The high total and air-filled porosities reflected the medium to coarse texture of the soils and may favour high rate of water transmission or internal drainage in the soils. The apparently high values of micropores may however favour water retention in the soils. Management practices such as mulching, may be adopted to conserve soil water against evaporative losses. The total porosity of soils in all pedons falls below the ideal porosity value (>50%) for healthy root growth (Lawrence, 1977) poor soil structure (less interped spaces), low soil organic matter and perhaps soil compaction associated with prolonged cultivation practices might have contributed to lower porosity of soils at cassava, maize, and maize ipw cassava plots as compared with orchard area. Bulk density is an indirect measure of pore space and is affected primarily by texture and structure showing that as soil space and clay content increase, bulk density decreases. Means of expressing soil weight is in term of density of the solid particles making up the soil. The particle density of the studied pedons range from 2.50 to 2.73 (Table 2). This range, usually make up the major portion of mineral soils of the study area. These results implying that the fitness of the particles of a given mineral and the arrangement of the soil solids have nothing to do with the particle density. Since organic constituent in a soil markedly affects the particle density. In all the pedons, surface soils usually possess lower particle densities than do subsoils.

Soil Reaction

Soil pH plays an important role in determining the solubility and reactivity of soil elements such as Aluminium (Al), Manganes (Mn) and Calcium (Cl). The results of soil reaction (pH) determined in a 1:25 soil to water and potassium chloride (KCl) suspension generally showed increasing trends pedon-1, pedon-2 and pedon-3 while inconsistently decreased with increasing depth of pedon-4 and 5, Table 4. On the other hand, change in pH, (pH H2O – pH KCl) values were positives in all pedons, ranging between 1.0 to 1.7 units.

The value for change pH can be positive, zero or negative, depending on the net surface change at the time of sampling, and positive change pH indicates presence of negative changed clay colloids (Soil Survey Staff, 2006); hence, higher change pH (1.4) for Bw horizon of pedon-5 indicates the presence of appreciable amount of negatively charged clay colloids. Following the soil pH change rating set by Jones (2003).

The pH of the studied soil varies slightly between and among profiles (Table 3). Tropical was rated as moderately acidic to slightly acidic pH whereas subsoil, was rated as strongly acidic to medium acidic ranging between 5.49 – 6.49 and 5.13 – 5.86, respectively Msanya et al., 2001). The acidity of the soils in the sites are mostly contributed by high amount of exchangeable acidity (ranging from 0.04 – 0.72cmol) (+)/kg, which can enter in the soil solution and hydrolysed to form hydroxyl Al compounds and free H^+ that make the soil acidic (Yatno and Zauyah, 2008).

All profiles in the study areas did not show any trend of either increasing or decreasing with depth but subsurface soils are more likely to be acidic than in topsoil. This might be caused by higher rainfall in the areas under study coupled with deep rooted perennial plants such as cypress, grevillea and mango observed in the field. Since in higher rainfall areas, deep rooted perennial plants reduce the risk of leaching as they are able to grow quickly after the 'august break' rains and capture soil water before leaching occur (McKenzie et al; 2004). Low pH in the study area is probably induced by acidifying nitrogen fertilizer, nitrate leaching, removal of the bases through crop harvests and the farming practices in the study area (McKenzie et al; 2004; Brady and Weil; 2008; and London, 1991). The strongly acid reaction values suggest possible low availability both the macro and micro plant nutrients for uptake by crops. Low soil pH values below pH<5.5 have potential to cause toxicity problems and deficiency of some essential plants nutrients as well as affect soil microbial activities (Adamchuk et al; 2005). It could also be cause dissolution aluminum and iron minerals which precipitates with phosphorus effectively causing its fixation and further lowering the soil pH (Brady and Weil, 2008). The comparison of pH_{kcl} with pH_{water} provides an assessment of the nature of the net charge on the colloidal system. The difference in pH result from displacement of OH^- icons by CL^{-1} ions. All profiles in the study areas had positive delta pH (pH water – pH KCL) values, indicating that the exchange complexes of the colloidal fractions of the soils are mostly negatively charged (Kebeney et al; 2015; Karuma et al; 2015).

The comparison of pH_{KCL} with pH_{H2O}provides an assessment of the nature of the net change on the colloidal system. The difference in pH results from displacement of OH^- ions by CL^- ions. Change in pH (ΔpH), (pH_{H2O} – pH_{KCL}) values were positive in all pedons ranging in between 1.1 and 1.7 units, (Table 4).

The value for change in pH can be positive, zero, or negative, depending on the net surface charge at the time of sampling, and a positive change in pH, indicates the presence of negatively changed clay colloidals (Soil Survey Staff, 2006); thus, higher change in pH value (1.7) for B horizon of pedon-1 indicates the presence of noticeable amount of negatively charged clay colloidals. All pedons in the study areas had positive delta pH (pH_{H2O} – pH_{KCL}) values, indicating that the exchange complex of the colloidal fractions of the soils are mostly negatively charged (Kebeney et al; 2015; Karuma et al; 2015). Following the soil pH ratting set by Jones (2003), the pH_{H2O} values throughout horizons of all pedons were within slightly acidic and neutral range.

Topsoil organic carbon (OC) contents of the studied pedons were higher in the fallow and orchard land could have been the result of accumulation of plant residues in (Khresat et al; 2008 and Saikeh et al; 1998). On the other hand, the decline in organic cultivation that aggravates organic matter oxidation and also insufficient inputs of organic substrates from the farming system due to residue removal and zero crop rotation (Eyayu et al; 2018). The presence of water erosion in the study area could also contributed to lower amount of organic carbon.

Accordingly, the low values of organic carbon may be attributed due to burning of crop residues which decrease amount of organic matter. Generally, the content of organic carbon could be rates as orchard < fallow < cultivated land in the study area, (Table 3). Generally, increase in organic carbon at surface soil of all studied pedons could be attributed that remain in the top surface soil compare to lower soil depth.

Content of the studied pedons were higher in fallow land and orchard field ranging from 0.06 – 0.24 and 0.12 to 0.29% respectively and lower cultivated land attributed due to rapid mineralization of soil organic matter following cultivation which disrupts soil aggregates and thereby increases aeration and microbial accessibility to soil organic matter. The study is in line with finding of Dawit Solomon et al; (2002). High rainfall that used to occur in the study area might be responsible for leaching loss of nitrate – N which in turn contributed to the decline of Total nitrogen in the cultivated areas. The low value of organic carbon in the cultivated area may also be attributed due to burning of crop residues, which decrease the amount of organic matter.

Accordingly, following the rating of total nitrogen by Landun (1991), the soils of the fallow and orchard field qualify for medium while cultivated land qualify for low status of Total nitrogen. This finding is in agreement with studies by Fantaw Yimer et al; (2007) and Fyayu Molla et al; (2009), they found a decreasing trend of Total Nitrogen with increasing soil depth and land use type in the eastern and northwestern highland of Ethiopia respectively.

The carbon nitrogen ration (C:N) of the studied pedons ranged from 3.6 to 10.3 and 9.0 to 10.9 on cultivated and uncultivated land respectively, (Table 3). Generally a C:N ratio less than 10 may indicate the incorporation of low levels of organic matter in the soils of these land use types (Sakih et al; 1998). In addition to this, aeration and increased temperature that enhance mineralization rates of organic carbon than organic nitrogen could probably be the causes for the lower level of C:N ratio in these land use types (Dawit Solomon et al; 2002).

This finding was in-line with the observation of Abbasi et al; (2007) who found higher C:N rations in the soils of natural vegetation than that of arable lands. This indicating that oxidation and loss of organic matter is higher in soils under long term cultivation. However, topsoil carbon nitrogen C:N ratios of pedon-5 is exceptionally high (>10) indicating poor quality, which implies slowdown of decomposition rate by soil microbes; hence low nitrogen (N) content in the soil.

Accordingly, the deficiency of soil nitrogen is one of the factors constraining agricultural production in the area. Therefore, agronomic or soil management practices that increase soil nitrogen levels will improve the productivity capacity of the soil, crop performance and farmers income.

Available phosphorous in the studied pedons ranges from 2.3 to 30.0mgkg^{-1} with value decreasing as depth increases (Table 3). An increase in Available phosphorous content in the orchard field followed by fallow land could be as a result of relative higher organic matter content present in these soils Ap horizon, which strongly associated with soil organic matter. This indicates that variations in Available phosphorous among soils of different land uses were mostly a function of total soil organic matter dynamics that was affected by land use change (Eyayu Molla et al, 2009). It has been reported that the distribution and availability of available phosphorous in the soil is regulated by biochemical processes, since most of the phosphorous available in plants is derived from the soil organic matter (Dawit Solomon et al, 2002a). On the other hand, decreased in Ap horizon with increasing in soil depth, this could be attributed to the increase in clay content with depth that might have caused phosphorous fixation and also decline in soil organic matter with increasing in depth. This result is, therefore, in line with Ahmed Hussein (2002) who detected lower values of Ap with increasing soil depth at Mount Chilalo, Southwestern Ethiopia. Generally, the amount of Ap in the study area is high as per the ratings of Lando (1991) where the rated Ap less than 5mgkg^{-1} as low.

The value for most horizons of pedons were above “high” range (Olssen et al, 1954); hence, is not a limiting nutrient for crop production, since soil pH that ranges from 6.0 to 7.5 is ideal for phosphorous availability (Havin et al., 1999). High concentration of available phosphorous is a reflection of slightly acidic to neutral soil reaction. The critical limit for available phosphorus is 10mgkg^{-1} (Udo and Ogunkunle, 1986; Enweozor et al., 1989) for tropical soils. By this standard, available phosphorous is readily available in the agricultural fields of the study area. The high values observed in the study pedons could be attributed to the nature of soil parent material, which prevent the reaction of iron (Fe) and aluminium (Al) to take place, the condition that thereby encourage availability of phosphorous to plant.

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CONCLUSION

The characterization of soils as affected by different land use in Igboora area, Oyo State, revealed that surface soils were dominated with brown (7YR $^5/_8$) to grey brown (7.5YR $^5/_3$) with common distinct fine mottles of strong brown. The subsoil were overlaying strong brown (7.5YR $^5/_4$) and graynish brown (10YR $^5/_2$) on ped faces. The soil consistency were variable within the soil depth and land uses. Cutan were distant at last depth of all profiles studied. The silt clay ratio were very low, low indicating that soils of the area were highly leached and highly weathered which are characteristic of most soils in tropical regions according to USDA Soil Classification.

Soil reaction was slightly or moderately acidic. The organic carbon, total nitrogen, carbon nitrogen ratio were low. The available phosphorus show various levels of variability along the soil depth in all the land use studied. The land use of maize inter-planted with cassava, maize plot and cassava plot were more disintegrated with other two land use (fallow land and orchard).

Apart from parent material, climate and relief that influenced soil characteristic significantly, human activities such as land use deforestation and cultivation without proper land management practices also act as major determinant factors influenced the soils of Igboora. It have led to an increase in soil erosion, that disintegrate the soil quality.

For sustainable food security, organic matter should be maintained, soil acidity and fertility should be monitored. Sustainable cropping on the studied soils could be achieved with introduction of technologies suitable for rejuvenating soil fertility such as manuring, crop rotation, proper crop residue management, introduction of leguminous cover crops in the farming system and use of fertilizers couple with efficient placement, particularly non-acidifying type of fertilizers.

REFERENCES

Abbasi, M.K., Zafar, M. and Khan, S.R. (2007). Influence of different land-cover types on the changes of selected soil properties in the mountain region of Rawalakot Azad Jammu and Kashmir Nutrient. *Cycling in Agroecosystems* 78:97-110.

Adamchuck, V.I. and Mulliken, J. (2005). Precision Agriculture Site-specific of Soil pH (FAQ), extension paper 713, historical materials from University of Nebraska-Lincon. pp. 705.

Ahmed, H. (2002). Assessment of spatial variability of some physiochemical properties of soils under different elevations and land use systems in the western slopes of Mount Chilalo, Arsi, M.Sc Thesis, Alemaya University, Ethiopia.

Allen, D.G. and Jeffery, R.C. (1990). Methods for Analysis Phosphorus in Western Austrailian Soils. Report of Investigation. Agricultural Chemistry Laboratory Chemistry Centre of Wester Australia, Perth. 15pp.

Ayoubi, S., Khormali, F., Sahrawat, K.L. and De Lima, A.R. (2011). Assessing Impacts of Land Use Change on Soil Quality Indicators in a Loessial Soil in Golestan Province, Iran.

Berry, N., (2011). Whole Farm Carbon Accounting by Smallholder, Lesson from Plan Vivo Project Presentation at the Small-Scale Mitigation Whole Farm and Landscape Accounting Workshop, FAO vol. 27, 28th October, Rome, 2011.

Boke, S. (2004) Soil Phosphorus fractions as influenced by different cropping system in Andosols and Nitosols in Kembata-Tembaro and Wolayta zones, SNNPRS. M.Sc Thesis. Alemaya University (AU) pp.131

Brady, N.C. and Weil, R.R. (2008). The Nature and Properties of Soils. 14th edition Pearson Prentice Hall, Upper Saddle River, New Jersey. pp. 975.

Chen, B., Han, M.Y., Peng, K., Zhou, S.L., Shao, L., Wu, X.F., Wei, W.D., Liu, S.Y., Li, Z., Li, J.S. and Chen, G.Q. (2018). Global land-water nexus: agricultural land and freshwater use embodied in worldwide supply chains, Sci. Total Environ. 613 (2018) 931-943.

Dawit, S., Fritzsche, F., Tekalign, M., Lehmann, J., Zech, W. (2002a). Soil organic matter dynamics in the sub-humid Ethiopia highlands: Evidence from natural carbon abundance and particle size fractionation. *Soil Science Society of America Journal* 66:969-978.

Dawit, S., Fritzsche, F., Tekalign, M., Lehmann, J., Zech, W. (2002b). phosphorous forms and dynamics as influenced by land use changes in the sub-humid Ethiopia highlands. *Geoderma* 105:21-98.

Eyayu, M.F. and Mamo, Y.A. (2018). The effect of land use types and soil depth on soil properties of Agedit watershed, Northwest Ethiopia. *Ethiopia Journal or Science and Technology,* 1(11) 39-56.

F.A.O. Agriculture, Land-Use Challenges and Opportunities, State of the World's Forests, 2016, pp. 1545-2050.

Food and Agriculture Organization, (2006). Guidelines for Soil Description. 4th Ed. Food and Agriculture Organization of the United Nations. Rome. pp. 110, 2006.

Guo, L.B. and Gifford, R.M. (2002). Soil carbon stocks and land use change: a meta-analysis, Global Change Bio. 8(4), pp. 345 – 360.

Jones, J. (2003). Agronomic Handbook: management of crops, soils, and their fertility. CRC Press, Boca Raton, Florida, USA. p. 482.

Karuma, A.H., gachene, C.K., Msanya, B.M., Mtakwa, P.W., Nyambilila, A. and Gicheru, P.T. (2015). Soil Morphology, Physico-chemical properties and classification of typical soils of Mwala Districts, Kenya. *International Journal of Plant and Soil Science* 4(2): 156-170.

Khresat, S., Al-Bakri, J. and Al-Tahman, R. (2008). Impact of land use cover change of soil properties in the Mediterranean region of northwestern Jordan. *Land Degradation Development,* 19: 397-407.

Lal, R. (2004). Soil carbon sequestration impacts on global climate change and food security, Science 304 (5677), pp. 1623 – 1627.

Lawrence, G. (1977). Measurements of pore sizes in fine-textured soils: A review of existing techniques. *Journal of Soil Science,* 28:527-540. http:/dx.doi.org/10.1111j.1365-2389.1977.tb02261.

Lawrence, W.M. (1992). The variation of soil erodibility with slope position in a cultivated Canadian Prairie landscape. *Earth Surface Processes and Landforms,* 17(6): 543-556.

London, J. (1991). Booker tropical soil manual: A handbook for soil survey and agricultural land evaluation in the tropics and subtropics. Longman, NY.

McKenzie, N.J., Jacquier, D.J., Isbell, R.F. and Brown, K.L. (2004). Australian Soils and Landscapes: An Illustrated Compendium. CSIRO Publishing: Collingwood, Victoria. Handbook vol 436. United States Department of Agriculture, Natural Resources Conservation Service, Washington DC. 869pp.

Munishi, J.A. (2010). Pedological characterisation of soils and assessment of their agricultural potential in selected districts of Mbeya Region, Tanzania. Dissertation for Award of M.Sc Degree at Sokoine University of Agriculture, Morogoro, Tanazania. 135pp.

Ogunkunle, A.O. (1986). Spatial variability of some chemical properties in two ultisols mapping unit in Southern Nigeria. *Soil Survey and Land Use Evaluation.* 6(1):26-39.

Okolo, C.C., Gebresamuel, G., Retta, A.N., Zenebe, A. and Haile, M. (2019). Advances in quantifying soil organic carbon under different land uses in Ethiopia: a review and synthesis, Bull. Natl. Res. Cent. 43(1), pp. 1 – 24.

Roe, D., Nelson, F. and Sandbrook, C. (eds) (2009). Community Management of Natural Resources in Africa: impacts, experiences and future directions, natural Resource Issues No. 18, International Institute for Environment and Development, London.

Selassie, Y.G. and Ayanna, G. (2015). Effects of different land use systems on selected physic-chemical properties of soils in Northwestern Ethiopia, J. Agric. Sci. 5(4), pp. 112.

Soil Survey Staff (2006). Keys to Soil Taxonomy, 10th edition. USDA, NRCS. Washington DC, Untied States Govt Printing Olice. pp. 161-323.

Trendov, M., Varas, S. and Zeng, M. (2019). Digital Technologies in Agriculture and Rural Areas: Status Report. *Digital Technologies in Agriculture and Rural Areas: Status Report.*

U. Nations, Revision of World Urbanization Prospects, vol. 799, United Nations, New York, NY, USA, 2018.

Udo, E. and Ogunwale, J. (1986). Laboratory manual for the analysis of soil, plant and water samples (2nd Edition) Ibadan, pp. 111.

United States Department of Agriculture (2008). Bulk density, soil quality indicators. http://www.usda.gov/squ/publication/files.

United States, Environmental Protection Agency. Office of Policy, 1999. Inventory of US Greenhouse Gas Emission and Sinks: 1990-1997, United States Environmental Protection Agency, Washington, DC., USA, 2020.

VandenBygart, A.J., Gregorich, E.G. and Angers, D.A. (2003). Influence of agricultural management on soil organic carbon: a compendium and assessment of Canadian studies, Can. J. Soil Sci. 83(4), pp. 363 – 380.

Wakene, N. and Heluf, G. (2003). Influence of land management on morphological, physical and chemical properties of some soils of Bako, Western Ethiopia. *Agropedology* 13(2):1-9.

World Bank Group, Third Ghana Economic Update: Agriculture as an Engine of Growth and Jobs Creation, World Bank, (2018).

World Bank, Sustainable Land Management Project, Project Appraisal Document (PAD) (Report No. 42927-ET; Project I.D. P107139). Ethiopia, 2019 bank.org/external/projects/, http://www-wds.world (Accessed 14 February 2019).

Yacob, A., Heluf, G. and Sheleme, B. (2014). Pedologicala characteristics and classification of soils along landscapes at Abobo, Southwestern lowlands of Ethiopia. Soil and Water Research Section, Gambella Agricultural Research Centre, P.O. Box 62, Gambella, Ethiopia. *Journal of Soil Science and Environmental Management.*

Zomer, R.J., Bossio, D.A., Sommer, R. and Verchot, L.V. (2017). Sequestration potential of increased organic carbon in cropland soils, Sci. Rep. 7(1), pp. 1 – 8.

Table 1: Morphological characteristics of soil profile in the study

Depth (cm)	Horizon	Colour		Structure [1]	Consistency [2]		Concretion [3]	Cutan [4]	HB[5]	Mottles [6]
		Dry	Moist		Moist	Wet				
		Pedon -1: Cassava								
0 – 20	A_p	7.5YR 5/4	7.5YR 5/2	Cr Cs	Fr	SST-SPL	Ui F	Md	G-S	Ff
20 – 35	B	7.5YR 5/4	7.5YR 5/2	Cr Cs	Fr	SST-SPL	Ui F	Md	G-S	Cm
35 – 65	B_1	2.5YR 4/4	7.5YR 5/4	Cr Cs	Fr	SST-SPL	Ui F	Md	G-S	Ab
65 – 95	B_2	10YR 5/1	5YR 6/4	Cr Cs	Fr	SST-SPL	Fe mg	Mo	Cs	Ab
95 – 125	Bt_2	10YR 5/2	2.5YR 8/1	Ag BI M	Fm	SST-SPL	Fe mg	Di	Cs	Ab
		Pedon -2: Maize								
0 – 20	A_p	7.5YR 5/4	7.5YR 5/2	Cr Cs	Fr	SST-SPL	Ui F	Md	G-S	Ff
20 – 35	B	7.5YR 5/4	7.5YR 5/2	Cr Cs	Fr	SST-SPL	Ui F	Md	G-S	Cm
35 – 65	B_1	2.5YR 5/9	7.5YR 5/4	Cr Cs	Fr	SST-SPL	Ui F	Mo	G-S	Ab
65 – 95	B_2	10YR 6 /6	5YR 6/4	Cr Cs	Fr	SST-SPL	Fe mg	Md	Cs	Ab
95 – 125	Bt_2	10YR 6/6	2.5YR 8/1	Ag BI M	Fm	SST-SPL	Vr mg	Di	Cs	Ab
		Pendon -3: Miaze ipw Cassava								
0 – 20	A_p	7.5YR 5/2	7.5YR 3/3	Cr Cs	Fr	SST-SPL	Ui F	Md	G-S	Fr
20 – 35	B	7.5YR 6 /6	7.5YR 4/3	Cr	Fr	SST-SPL	Vr my	Md	G-S	Ff
35 – 65	B_1	2.5YR 5/7	10YR 6/6	Cr	Fm	SST-SPL	Fe mn	Mo	G-S	Ab
65 – 95	B_2	10YR 3/6	10YR 5/8	Ag BI	Fm	SST-SPL	Fe mn	Md	Cs	Ab
95 – 125	Bt_2	10YR 6/6	2.5YR 6/6	Pr	Fm	SST-SPL	Vr my	Di	Cs	Ab
		Pendon -4: Fallow land								
0 – 20	A_p	7.5YR 5/9	7.5YR 3/4	Cr Cs	Fr	SST-SPL	Ui F	Md	G-S	Ff
20 – 35	B	7.5YR 5/6	7.5YR 4/3	Ag BI	Ls	SST-SPL	Vr my	Md	G-S	Ff
35 – 65	B_1	7.5YR 5/7	5YR 5/3	Cs	Ex Hd	SST-SPL	Fe mn	Md	G-S	Md
65 – 95	B_2	10YR 6/4	5YR 5/6	Co Md	Sli Hd	SST-SPL	Fe mn	Md	Cs	Ab
95 – 125	Bt_2	10YR 5/2	5YR 7/6	Co Md	Sli Hd	SST-SPL	Vr my	Di	Cs	Ab
		Pendon -5: Orchard								
0 – 20	Ah	2.5YR 4/8	7.5YR 3/4	Cr	Fr	SST-SPL	Ui F	Md	b-d	Ab
20 – 35	B	2.5YR 2.5/3	7.5YR 5/3	Cr	Fr	SST-SPL	Ui F	Md	b-d	Ab
35 – 65	B1	7.5YR	5YR 6/8	Cr	Fm	SST-SPL	Ui F	Md	b-d	Cm
65 – 95	Bw	10YR 6/6	5YR 6/8	Cr	Fm	SST-SPL	Ui F	Md	b-d	Cm
95 – 125	Bhs	10YR	5YR 6/6	Pr	Fm	SST-SPL	Ui F	Di	b-d	Cm

1. Structure: Cr cs = crumb coarse; Ag Bl M = angular blocky medium; Gr Cs = angular coarse; Ag Bl = angular blocky; Pr = prismatic; Cr = cru Cs = coarse; Co Md = columna medium
2. Consistency: Fr = friable; Fm = firm; Ls = loose; Ex Hd = extreme hard; SS = swelling and shrinkage
3. Concretion (conc.): Ui F= unidentify few; Fe my = ferruginous many; Fe mn = Ferruginous manganese; Vr my = very many.
4. Cutan: Md = medium; di = distance; Mo = moderate.
5. Horizon boundary (HB): G-s = Gradual and smooth; Cs = clear and smooth.
6. Mottle: Ff = few fine; Cm = common medium; Md = medium; Ab = absence

Table 2: Physical properties of the studied pedons at cultivated, fallow and orchard

Depth (cm)	Horizon	Particle size analysis %						Ps	pb	TP
		CF 32mm	Sand 2 - 0.02mm	Silt 0.02- 0.002mm	Clay <0.002mm	S$^{i}/_{c}$	Txs	(gcm3)		
	Pedon-1: Cassava plot									
0 – 20	Ap	60	70	20	10	2.0	SCL	2.50	1.20	42.70
20 – 35	B	62	48	26	26	1.0	SCL	2.46	1.25	40.20
35 – 65	B$_1$	63	52	22	21	1.05	C	2.40	1.24	40.18
65 – 95	B$_2$	39	54	26	20	1.3	SCL	2.40	1.23	40.22
95 – 125	Bt$_2$	65	58	24	18	1.3	SCL	2.70	1.26	40.21
	Pedon-2: Maize plot									
0 – 20	Ap	61	74.6	28.0	22.0	1.3	SCL	2.65	1.49	41.70
20 – 35	B	65	56.8	14.4	28.8	0.98	SCL	2.60	1.48	41.69
35 – 65	B$_1$	45	58.6	23.4	18.0	1.3	L	2.62	1.50	40.60
65 – 95	B$_2$	60	64.6	19.4	16.0	1.2	L	2.63	1.50	40.80
95 – 125	Bt$_2$	55	50.0	9.4	16.0	0.59	SCL	2.63	1.51	40.50
	Pedon-3: Maize ipw Cassava plot									
0 – 20	Ap	65	71.0	10.4	15.2	0.7	SCL	2.66	1.61	43.65
20 – 35	B	62	57.4	15.4	27.2	0.54	SCL	2.65	1.60	43.60
35 – 65	B$_1$	63	45.4	19.4	30.0	0.65	SCL	2.66	1.60	42.80
65 – 95	B$_2$	50	45.4	21.4	33.2	0.64	SCL	2.65	1.58	41.85
95 – 125	Bt$_2$	55	49.4	27.4	13.2	2.08	SCL	2.64	1.57	40.83
	Pedon-4: Fallow land									
0 – 20	Ap	60	63.4	25.4	11.2	2.3	SCL	2.68	1.18	40.65
20 – 35	B	62	46.0	26.0	28.0	0.93	SL	2.67	1.18	41.60
35 – 65	B$_1$	63	30.0	6.0	30.0	0.2	SCL	2.66	1.17	41.50
65 – 95	B$_2$	61	36.0	6.0	32.0	0.2	SCL	2.68	1.16	40.60
95 – 125	Bt$_2$	60	36.0	6.0	33.0	0.18	SCL	2.67	1.14	40.50
	Pedon-5: Orchard									
0 – 20	Ah	58	58.6	32.0	9.4	3.4	SL	2.65	1.13	38.40
20 – 35	B	55	39.4	19.4	31.0	0.63	CL	2.65	1.12	38.20
35 – 65	B$_1$	50	41.4	21.4	31.0	0.69	C	2.67	1.12	38.10
65 – 95	Bw	52	41.4	23.4	35.0	0.71	SCL	2.75	-	37.22
95 – 125	Bhs	50	45.4	21.4	34.0	0.63	SCL	2.65	-	36.23

Txs = Texture: SCL = Sandy, clay, loam; C = Clay; CL = Clay, loam, L = Loam; SL = Sandy, Loamy; L = Loam, - = Not determined

Moisture Content: FC = Field capacity; PWP = Permanent wilting point; AWC = Available water content, S$^{i}/_{c}$ = Silt clay ration.

Table 3: Soil reaction, change in p^H, organic carbon, total nitrogen, carbon nitrogen ratio and available phosphorus of soil profile

Depth (cm)	Horizon	pH H_2O 1:2.5	pH kcl 1:2	ΔpH	EC $d^s m^{-1}$	OC (%)	TN (%)	C/N	AV.P Mg kg^{-1}
Pedon-1: Cassava plot									
0 – 20	AP	7.0	6.0	1.0	0.03	0.85	0.09	9.4	19.8
35 – 65	B	6.9	5.2	1.7	0.03	0.85	0.09	9.4	8.3
65 – 95	Bt	6.8	5.4	1.4	0.03	0.41	0.04	10.3	5.0
95 – 125	Bt_2	6.6	5.3	1.3	0.03	0.95	0.11	8.6	30.0
Pedon-2: Maize plot									
0 – 20	AP	6.2	6.0	1.1	0.16	0.75	0.21	3.6	12.0
20 – 35	A	6.2	5.5	1.2	0.02	0.82	0.09	9.1	12.0
35 – 65	B	5.9	5.2	1.1	0.02	0.54	0.06	9.0	3.1
65 – 95	Bt	5.7	5.4	1.1	0.02	0.62	0.14	4.4	11.0
95 – 125	Bt_2	5.6	5.3	1.5	0.11	0.44	0.05	8.8	23.0
Pedon-3: Maize ipw Cassava plot									
0 – 29	AP	6.4	5.1	1.3	0.10	0.68	0.18	3.8	27.0
29 – 40	A	6.4	5.2	1.2	0.10	0.48	0.05	9.6	9.0
40 – 80	B	6.0	5.0	1.0	0.08	0.34	0.04	8.5	4.1
80 – 140	Bt	5.6	4.5	1.1	0.08	0.17	0.02	8.5	4.4
140 – 180	Bt_2	5.5	4.3	1.2	0.07	0.51	0.05	10.2	7.0
Pedon-4: Fallow land									
0 – 29	AP	6.0	5.0	1.0	0.13	2.35	0.24	9.8	25.0
29 – 40	A	5.7	4.5	1.2	0.15	0.82	0.09	9.1	2.3
40 – 80	B	5.6	4.4	1.2	0.17	0.54	0.06	9.0	6.0
80 – 140	Bt	5.4	4.2	1.2	0.11	0.82	0.08	10.3	10.2
140 – 180	Bt_2	5.4	4.1	1.3	0.03	0.78	0.08	9.8	7.0
Pedon-5: Orchard									
0 – 29	A h	4.8	3.8	1.0	0.02	2.82	0.29	9.7	10.2
29 – 40	A	6.9	5.7	1.2	0.02	1.31	0.12	10.9	3.1
40 – 80	A 2	5.3	4.1	1.2	0.02	1.7	0.18	9.4	7.0
80 – 140	Bw	5.4	4.0	1.4	0.02	1.26	0.13	9.7	28.0
140 – 180	Bts	5.7	4.6	1.1	0.03	1.16	0.12	9.7	28.0

EC = electrical conductivity; ΔpH = change in pH; OC = organic carbon; T/N = total nitrogen; C/N = carbon nitrogen ration; AV = available phosphorous