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Research Article

Assessing Impacts of Different Land Use Types on Soil Properties ın Asa and Moro Local Government Area, Kwara State, Nigeria

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Abstract

Successful agriculture requires the sustainable use of soil resource, because soil can easily lose its quality and quantity within a short period of time. Agricultural practices, therefore, needed basic knowledge of sustainable use of land. This research was conducted in Asa and Moro Local Government Areas of Kwara State to assess the impacts of different land use types on soil properties in the study area. Six villages noted for farming were randomly visited and in each village, three farms planted each with maize-cassava intercrop, cashew plantation and natural forest were sampled at 0-20 cm depth for laboratory analysis of particle size, pH, carbon, nitrogen, phosphorus, exchangeable cations and extractable micronutrients. The bulk density at 0-5 cm, 5-10 cm and 10-15 cm depths were determined. Soil properties were analysed using descriptive statistics. The soil texture was sandy loam with soil pH ranging from slightly acid to acid (6.4 to 5.1). Irrespective of the local government areas and land use, organic carbon (1.83 g kg^{-1}), Sodium (0.12 cmol kg^{-1}), Nitrogen (0.12 g kg^{-1}) and Phosphorus (6.15 mg kg^{-1}) were low while Fe (134.80 mg kg^{-1}), Mn (122.80 mg kg^{-1}) and Zn (19.22 mg kg^{-1}) were high. Across the local government areas, Potassium and Magnesium varied from medium to high while Calcium and Copper were low to medium. The bulk density range was medium to high (1.36 to 1.57 g cm^{-3}) for cashew plantations and maize-cassava intercrop while it was medium (1.40 to 1.47 g cm^{-3}) for natural forest. In conclusion, most of the cultivated soils were low in fertility, with low carbon stocks which is assumed to be due to emission losses arising from continuous cropping. The carbon sequestration status of land uses in the study area was very low. Management practices like composting, green manuring, use of organic fertilizer and residue retention is recommended.

Keywords
Land use; emission; natural forest; maize-cassava intercrop; cashew plantation

INTRODUCTION

Land use is defined as the arrangements, activities and inputs in a certain land cover types to produce change or maintain it (Ufot et al., 2016). 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 reasons like: intensive cultivation, leaching and soil erosion (Kiflu and Beyene, 2013). Agricultural practices, therefore, needed basic knowledge of sustainable use of the land (Takele et al., 2014). Success in soil management to maintain the soil quality depends on the understanding of how the soil responds to agricultural practices overtime (Duguma et al., 2010). However, the basis of this sustainable agricultural development is the quality of the soil, since maintenance of soil quality is an integral part of sustainable agriculture and the convenient witness to improve crop productivities (Liu et al., 2010). The productivity and sustainability of soil depends on dynamic equilibrium among its physical, chemical, and biological properties (Somasundaram et al., 2013). These properties are continuously influenced by land uses. Di et al., 2013, reported that agricultural management practices can largely influence the quality of the soil which in turn is intrinsically linked to the sustainability of agro ecosystem functions and productivity. Therefore, maintenance of soil health is essential for sustained food productivity, the decomposition of waste, storage of heat, sequestration of carbon, and the exchange of gases. Large hectares of arable land in Nigeria have been reported to be deficient in micro nutrients (Oguike and Mbagwu, 2009) and many of these deficiencies were caused by continuous use of inorganic fertilizers particularly N, P and K by farmers, limited use of organic manures as well as non-cycling of crop residues. These leads to rapid exhaustion of micronutrients in soil output (Onwudike et al., 2015). Intensive land use causes serious changes in soil physical, chemical and biological characteristics, and can rapidly diminish soil quality and soil fertility. Amana et al. (2012) reported that ecologically sensitive components of tropical soils are not able to buffer effect of intensive agricultural practices. Due to continuous cultivation, soils under particular land use system may affect physicochemical properties which may modify micronutrients content and their availability to plants. Many researches have been carried out to examine the influence of land use types on soil properties in different agro-ecological zones in Nigeria (Senjobi and Ogunkunle, 2011). Senjobi and Ogunkunle (2011) examined the effects of land use on land degradation and productivity in Ogun State, Nigeria. Soil properties vary from one land use type to another. Wasihun et al. (2015) also reported that changes in land use types and soil management have a marked effect on soil physical and chemical properties. Soil bulk density (BD) is an important parameter that changes over time depending on cultivation and field management operations. It is not an intrinsic soil property but depends on external conditions with changes associated with a variety of factors and with various natural and anthropogenic processes (Zeng et al., 2013). Analysis of various major land use conversion types on tropical mineral soils revealed an increase in bulk density values (5-23%) primarily associated with soil organic carbon changes in the surface 0-30 cm soil layers. As a rule of thumb, the coarser the texture, the higher is the bulk density value and the larger the soil organic carbon change, the larger is also the change in bulk density. Therefore, this present study was carried out to determine the effects of land use types on soil productivity parameters in the selected Local Government Areas.

MATERIAL and METHODS

This research was carried out in Asa and Moro Local Government Areas of Kwara State, Nigeria as shown in Figure 1 and 2. Six (6) villages, Asa (Ajuwon, Ogele, Kajola) and Moro (Oniso, Budo-Apata, Eleshinnla) were selected for this study. The selection of these locations was primarily based on the predominance of farming occupation over other occupations in the local government areas. Kwara State has two climatic seasons, the wet and dry seasons with an intervening cold and dry harmattan from December to January. It is located on latitude 8° 30' and 8° 50' N and longitude 4° 20' and 4° 35' E. It is situated in the transitional zone inside the forest and the Southern Guinea Savanna Zone of Nigeria. It has extensive fertile soil suitable for agriculture. The state is divided into four main agro-ecological zones in consonance with the ecological characteristics, cultural practices and administrative convenience by the Kwara State Agricultural Development Project (KWADP, 2006) as given below: Zone A: Baruteen and Kaima; Zone B: Edu and Patigi; Zone C: Asa, Ilorin East, Ilorin South, Ilorin West and Moro; Zone D: Ekiti, Ifelodun, Irepodun, Isin, Offa, Oke-Ero and Oyun. The total land area was 32,500 square kilometres out of which 75.3% was cultivable (National Population Commission, 2010).

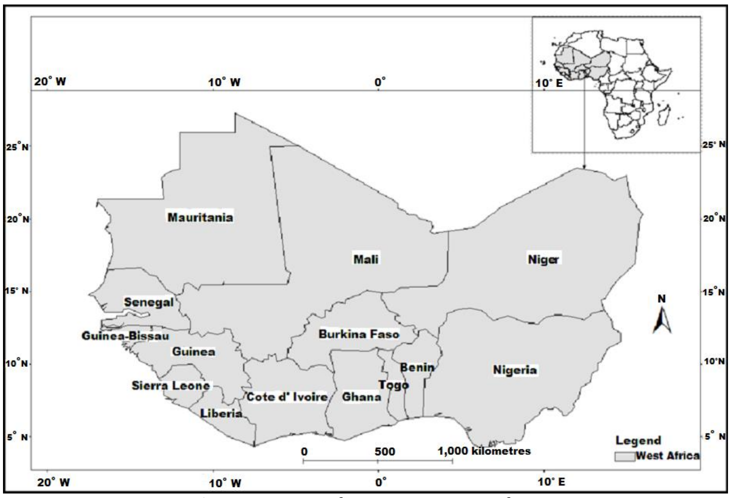

Figure 1. Map of Nigeria in West Africa

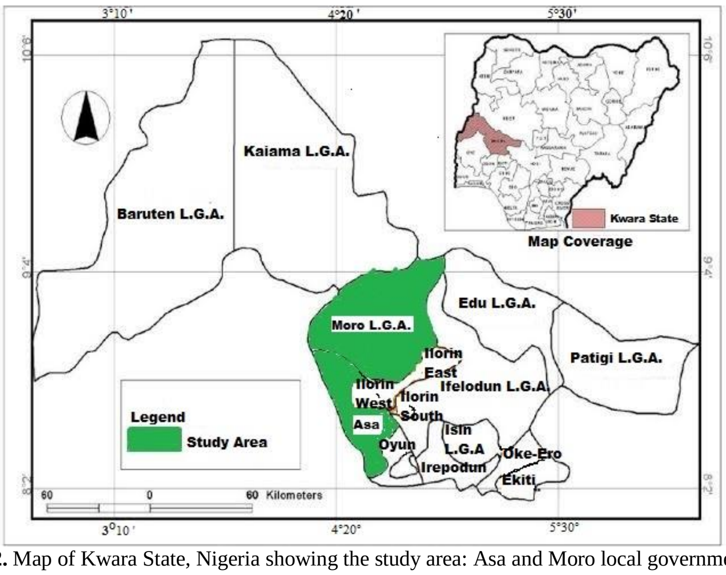

Figure 2. Map of Kwara State, Nigeria showing the study area: Asa and Moro local government area

The plant life covers were characterised through coexistence of trees (locust-bean tree, shea butter and baobab) and grasses (beard grass, bluestem grass and broom sedge). The annual rainfall ranged between 1000 and 1500 mm while average temperature levelled from 30 to 36 °C. Relative humidity in Ilorin within the wet season was between 75 and 80% even as within the dry season it was about 65%.

Land use systems, soil sampling and analysis

Three different land use types (natural forest, maize-cassava intercrop and cashew plantation) were selected for the study. Soil samples were collected in triplicate to reduce variability, with the aid of a soil auger. In each village, three farms planted each with maize-cassava intercrop, cashew plantations and natural forest were sampled. Soil samples were collected from the farmland randomly at the depth of 0-20 cm with the use of soil auger for physical and chemical analyses in the laboratory. The samples were bulked to form a composite and air-dried, crushed and sieved through 2 mm meshes for the determination of pH, particle size, P, exchangeable cations (K, Mg, Ca, Na) and extractable micronutrients (Mn, Fe, Cu, Zn) and through 0.5 mm meshes for the determination of C and N. The bulk density of each land use was taken at 0-5 cm, 5-10 cm and 10-15 cm with core samplers. Laboratory analysis was carried out at the International Institute of Tropical Agriculture (IITA), Ibadan. Particle size analysis was carried out with the aid of hydrometer using sodium hexametaphosphate as the dispersant (International Soil Research, 1993; AOAC, 1990). Soil pH was determined in 1:1 soil water ratio (Black, 1965). Total nitrogen (N) was extracted by the macro-Kjeldahl digestion method (Bremner, 1982) followed by colorimetric determination using Technicon Auto–analyser. Mehlich 3 (a multipurpose extractant) was used to extract available phosphorus, exchangeable cations (K, Mg, Ca and Na) and extractable micronutrients (Mn, Fe, Cu and Zn) (Mehlich, 1984). Phosphorus was determined colorimetrically while the concentration of (Calcium, magnesium, Copper, Zinc, Iron and Manganese) in the extract was determined by Atomic Absorption Spectrophotometer. Sodium (Na) and Potassium (K) were determined using Flame emission photometer. Exchangeable acidity was determined by KCl extraction. Organic carbon was determined by chromic acid digestion method (Heanes, 1984).

Determination of bulk density

The soil bulk density was evaluated using core method (Cresswell and Hamilton, 2003) as follows:

$$BD\ (g/cm^3) = \frac{\text{Weight of oven dry soil (g)}}{\text{Volume of Core } (cm^3)}$$

Where BD = bulk density (g/cm^3), Volume of core = πr^2 h

Where$\pi = 3.142$, h = height of the cylinder, r = internal radius of the cylinder

Experimental design and data analysis

The experimental design fitted into 3 x 3 x 2 factorial experiment. Data were subjected to analysis of variance (ANOVA) to test differences in soil properties, soil carbon and sequestration across soils of different land use types. Significant means were separated using Least Significant Difference (LSD) at 5% significance level.

RESULTS and DISCUSSION

Effects of land use on physical properties of soils from Kwara State, Nigeria

Bulk density

Effects of land use on soil textural class and bulk density are presented in Table 1. The textural class was sandy loam in all the locations. In Asa Local Government Area, bulk density ranged between 1.40 and 1.61 g cm^{-3}, while for Moro Local Government Area, bulk density ranged between 1.36 and 1.63 g cm^{-3}. The bulk densities for total soil depth 0-5 cm, 5-10 cm and 10-15 cm across the three land use increased from 1.36 g cm^{-3} (low) under cashew plantation to 1.63 g cm^{-3} (high) under maize-cassava intercrop.

Land use effect was significant ($p<0.05$) on bulk density. The effect of land use, village, interaction between land use and village, land use and local government area were highly significant ($p<0.01, 0.001$). Cashew plantations and maize-cassava intercrop had medium to high bulk density compared to natural forest with low to medium bulk density (Fagbami and Shogunle, 1995). This result could be due to the advanced soil organic matter from plant residue decomposition, effect of leaf litter and animal manure, as well as recycling of nutrients to upper horizons of soil. In keeping with the record of Anikwe et al. (2006) that the bulk densities except under continuously cultivated soil ranged from non-limiting to moderates values. Anikwe et al. (2006) and Mbah and Idike (2011) corroborated that continuous cropping increased soil compaction and hindered root proliferation which reduced soil productivity. The reduction in bulk density under forested land could be due to limited tillage intensity, which results in little pore space and absence of soil disturbance. Several researchers, (Islam and Weil, 2000; Michel et al., 2010; Yihenew and Getachew, 2013) reported that bulk density increased from natural forest to non-forested land. In line with the study of Halvorson et al. (2002) that decrease in bulk density under minimum or no tillage due to the lack of mechanical equipment used on the soil. The low to medium bulk density of forest soils may be a reflection of organic matter contents of the soils. Yihenew and Getachew (2013) opined that in forest soil, there has been distinctly excessive high organic matter contents making the soil loose, porous, properly aggregated thus minimizing bulk density.

Sand

In soils of the varying land use types, the percentage of sand ranged between 701.1 and 820.9 g kg^{-1} (Table 1). Highest percentage of sand was observed under maize-cassava intercrop which is significantly ($p<0.05$) higher than other land use types in other villages except in Kajola, Budo-Apata and Eleshinnla where highest percentage of sand was observed under cashew plantation which is significantly ($p<0.05$) higher than other land use types. The interaction effects of land use, village, land use and local government area and land use and village were highly significant ($p<0.001$), while interaction between land use and local government area were not significant ($p>$ 0.05).

Silt

Interaction between local government, land use and village were highly significant ($p<0.001$) on percentage of silt. From the result in Table 1, the percentage of silt varied from 69.4 and 148.4 g kg^{-1}. The highest percentage of silt (148.4 g kg^{-1}) were observed under maize-cassava intercrop in Kajola village which was significantly ($p<0.05$) higher than other land use types in other villages and cashew plantation recorded the lowest. Effect of land use on silt percentage was significant ($p<0.05$).

Clay

Across the different land use types, the percentage of clay varied from 112 g kg^{-1} and 144.3 g kg^{-1} (Table 1). The clay content for all soils were generally low. Highest clay content was observed under maize-cassava intercrop which was significantly ($p<0.05$) higher and also recorded the lowest in Ogele Village. The effects of land use, village, interaction between land use and village, land use and local government area were highly significant ($p<0.001$).

Table 1. Effects of land use on physical properties of soils from Kwara State, Nigeria

LGA	Villages	Land use	Bulk Density g cm^{-3}	Sand g kg^{-1}	Silt g kg^{-1}	Clay g kg^{-1}	Textural class
Asa	Ogele	Forest	1.47	765.6	87.2	137.8	Sandy Loam
		Cashew	1.52	805.3	82.8	113.9	,,
		Maize-Cassava	1.50	813.1	75.1	112	,,
	Ajuwon	Forest	1.40	748.9	110.6	127.8	,,
		Cashew	1.57	803.1	86.1	113.9	,,
		Maize-Cassava	1.61	820.9	71.8	114.3	,,
	Kajola	Forest	1.43	775.6	87.2	127.8	,,
		Cashew	1.40	789.7	87.2	125	,,
		Maize-Cassava	1.56	708.7	148.4	144.3	,,
Moro	Oniso	Forest	1.46	781.1	99.4	132.2	,,
		Cashew	1.36	767.5	110.6	125	,,
		Maize-Cassava	1.60	808.0	78.8	115.7	,,
	Budo-Apata	Forest	1.44	807.8	86.1	122.2	,,
		Cashew	1.55	812.5	69.4	121.7	,,
		Maize-Cassava	1.44	761.3	107.1	135.7	,,
	Eleshinnla	Forest	1.46	701.1	99.4	138.9	,,
		Cashew	1.46	818.1	76.1	106.1	,,
		Maize-Cassava	1.63	773.5	109.4	119.1	,,
	Land use LSD (0.05)		0.05	1.44	0.97	0.47	
	Village LSD (0.05)		0.67	2.04	1.37	0.67	
	Land use and Village LSD (0.05)		0.67	3.35	2.37	1.15	
	LGA LSD (0.05)		0.04	1.18	0.79	ns	
	Land use and LGA LSD (0.05)		0.67	ns	ns	0.67	

The textural class was sandy loam in all the various land use types. The high percentage of sand could be attributed to the geology of the area. (Akamigbo and Ukaegbu, 2003). Furthermore, high sand fractions could also be due to the parent material (coastal sand) considering the fact that the texture of a soil is highly influenced by the parent material and topography overtime (Oguike and Mbagwu, 2009). Similar report has been made by Udom and Ogunwole, (2015) and Nwite and Alu, (2017) that the dominance of sand fraction was recorded under different land uses in Nigeria.

Effects of land use on chemical properties of soils from Kwara State, Nigeria

pH

In soils of the varying land use studied, the mean pH value ranged between 5.1 and 6.4 (acid, slightly acidic and neutral) (Table 2). Soils of maize-cassava intercrop cultivated land in Ogele Village had highest pH value of 6.4 (slightly acid) and the soil pH of forest in Ogele was 5.1 (acid). Soil pH under maize-cassava intercrop farm land ranged between 5.8 and 6.4 (slightly acidic and neutral). Soils under natural forest also ranged within pH of 5.1 and 6.2 (acidic, slightly acidic and neutral). Soils under cashew plantations recorded pH of 5.6 and 5.9 (slightly acidic). There was no significant ($p>0.05$) influence of village and local government area on soil pH. Interaction between land use and village as well as land use and local government area were highly significant ($p<0.05$) on soil pH of the area of study. Generally, the pH of the soils falls between acid and slightly acid according to the ratings of Fagbami and Shogunle (1995). The findings from the present study were in line with the study of Amare et al. (2013) and Abay et al. (2016) who showed that no extensive difference occurred in soil pH between conserved and non- conserved lands. Variations in soil pH of exchangeable bases, nitrogen fixation, and production of litter were high in organic acid content (Githae et al., 2011).

Organic carbon

Across the different land use types, the organic carbon (OC) content of the soils varied between 0.40 and 1.83 g kg^{-1} (Table 3). The soils under natural forest stored the highest OC (0.72 to 1.47 g kg^{-1}) which was significantly ($p<0.05$) higher than other land use types while maize-cassava intercrop had the lowest (0.40 to 0.64 g kg^{-1}). The effects of land use, village, interaction between land use and village as well as interaction between land use and local government area were highly significant ($p<0.001$) on OC. There were significant ($p<0.05$) influence of local government area on organic carbon content of the soil. According to the ratings of Fagbami and Shogunle (1995) the organic carbon is medium. The result confirmed that forest in all of the villages contained the highest proportion of organic carbon when compared to the other land use types. This result corroborate with the work of Zhou and Wang (2017) that the better quantity of carbon accumulation under forest land may be due to litter fall on the surface and through root deposition in deeper layers. Furthermore, the higher soil organic carbon in forest soils might be as a result of higher organic matter inputs from above and below ground litter (Materechera, 2010). Anderson-Teixeira et al. (2009) reported that conversion of uncultivated land for agricultural purpose results in significant soil organic carbon loss. During the whole cycle, forest species deposit a large quantity of residues into the soil because of the natural process of senescence. The high carbon input in these areas is associated with increase in soil carbon stocks in afforestation areas worldwide (Shi et al., 2015). This finding is supported by Anikwe (2015) who made similar observations and corroborated by Lal (2008) that trees trapped carbon dioxide of the atmosphere and sequestered it in plants' part and finally as soil carbon.

Nitrogen

The various land use types recorded very low N (0.03 and 0.12 g kg^{-1}) in all the land use types (Table 4). Natural forest soil stored higher proportion of available N in Ajuwon Village and Eleshinnla respectively and maize-cassava intercrop stored the lowest in Ajuwon Village. The effects of land use, village, interaction between land use and village, local government area as well as interaction between land use and local government area were highly significant ($p<0.01$, $p<0.001$) on Nitrogen content of the soil. Low nitrogen (N) may be due to over cultivation, poor management, and crop residue removal. This can also arise due to high erosion, low organic and inorganic fertilizer application and crop residue removal within the cultivated land in comparison with other land use types (Bezabih et al., 2014; Jamala and Oke, 2013; Yitbarek et al., 2013). Low N content can also occur because of leaching and volatilization owning to its mobile nature (Igwe and Akamigbo, 2001). The low nitrogen content recorded might also be as a result of absence of crop rotation with leguminous crops. According to Okpara and Igwe (2014) reported that legume-cereal rotations gave higher soil nitrogen than continuous maize whether there was addition of residues or not. Smil (2000) reported that when N and P are in excess in soils, they may be misplaced through leaching and erosion (for example, globally, an estimated 15 million tons of P are lost annually from crop fields due to erosion, and an estimated 8 million tons of P are lost in runoff from arable land annually) (Cordell et al., 2009). Total soil nitrogen was highest under natural forest soils compare to maize-cassava cultivated land with lowest except in Kajola and Budo-Apata Villages only where maize-cassava intercrop had the highest. This can be related to the build-up of organic residue on the forest soils. Ayoubi et al. (2011) reported that forest soils possess more total nitrogen as compared to cultivated lands. According to Heluf and Wakene (2006) reported the greater overall total nitrogen on surface soil layers of virgin lands compared to research and farmer's fields. Galloway et al. (2004) reported that the main sources of nitrogen in the soil are mineralization of the accumulated soil organic matter to ammonia and fixed atmospheric nitrogen by nitrogen fixing bacteria which convert nitrogen to ammonia. It was also reported that total nitrogen in croplands was substantially lower than in forested land (Chen et al., 2016). Result obtained by Bahilu et al. (2014) that lower nitrogen under crop land was as a result of the removal of the above ground biomass by harvesting of crops and its residues. Evrendilek et al. (2004) suggested that cultivation decreased total soil porosity, soil respiration rate and nutrient-retention capacity. Oguike and Mbagwu (2009) reported similar result, indicating that non-stop cultivation of soils cause huge lack of nitrogen because of volatilization and leaching effect.

Phosphorus

The phosphorus content recorded was lowest in all the various land use types which ranged from 1.09 and 6.15 mg kg^{-1} (Table 5). Highest P content was observed under maize and cassava intercrop in Budo-Apata Village and the lowest was observed under cashew plantation in Ajuwon Village. The effects of land use, village and local government area were not significant ($p > 0.05$) on P content of soils in the study area. Interaction between land use and village as well as interaction between land use and local government area were highly significant ($p<0.001, p<0.01$) on phosphorus content of the soil. According to Esu (1991) ratings, the low phosphorus (P) content throughout the land use types could be due to leaching, burning and intensive cultivation with low application of phosphorus sources or unavailability. According to Bunemman et al. (2010) the phosphorus content of soils is not necessarily low, however a high proportion of this phosphorus is stored in plant unavailable forms such as organic P, or is bound/adsorbed as inorganic P to e.g. aluminium, iron oxides, and calcium minerals depending on the soil pH and mineral composition. Yang and Post (2011) reported that in tropical soils (e.g. oxisols) as the iron and aluminium content dominate soil mineralogy, leading to low phosphorus availability despite high total phosphorus content. The result is consistent with previous study which observed that long-term cultivation of vegetation without or little fertilizer application reduced phosphorus contents in the soil (Song et al., 2017). The present study was in line with McDonald et al. (2011) in countries with high fertilizer use, much phosphorus is lost to leaching and run-off, leading to the eutrophication of both inland and coastal waters. Research from the past have reported that soil management, deforestation, topography, and continuous cultivation of tropical soils regularly result to depletion of nutrients and high rate of soil erosion (Tilhun, 2015). According to Osman (2013) the cause of low available phosphorus might be resulted from high exchangeable acidity where phosphorus is combined with Al, Fe, and Mn (as their presence is predicted at the pH values of the soils of the study area) and becomes fixed.

Potassium

It was shown that the various land use type recorded very low K which varied from 0.19 to 0.48 cmol kg^{-1} (Table 6). In Ajuwon Village, forest soils had the highest K when compared to other land use. The effects of land use, village, interaction between land use and village, local government area as well as interaction between land use and local government area were highly significant ($p<0.001$) on potassium content of the soil in the study area. The rankings of Esu (1991), medium to high contents of potassium was observed across the land use types. Sabo and Odus (2008) reported that cultivated soils are exhausted because of extensive cultivation and inadequate application of replenishment measures to sustain their productivity. Laekermariam et al. (2016) found that the reduction of K could be associated with continuous cultivation, complete removal of crop residues from farmlands, absence of crop rotation, unbalanced fertilizer application and soil erosion under maize-cassava intercrop farmland. Furthermore, complete removal of crop residue, intensive cropping, extensive use of fertilizers (diammonium phosphate and urea) which include no potassium and non-use of mineral K fertilizer in soils of the study area might have led to the prevalence of K depletion (Hailu et al., 2015; Laekermariam et al., 2016; Wassie, 2019). This result support previous findings that shows intensive cultivation that use of acid forming inorganic fertilizers affect the distribution of potassium in the soil system and increase its depletion (Beyene, 2013). The lower available K in the crop land could also be due to soil degradation and losses by leaching (Moges et al., 2013).

Table 2. Effects of land use on soil pH from Kwara State, Nigeria

		Land use			
LGA	Village	Forest	Cashew	Maize-Cassava Intercrop	Village means
Asa	Ogele	5.1	5.7	6.4	5.7
	Ajuwon	6.2	5.8	5.9	6.0
	Kajola	6.1	5.7	5.8	5.9
Moro	Oniso	5.5	5.9	5.9	5.8
	Budo-Apata	5.7	5.7	6.1	5.8
	Eleshinnla	6.2	5.6	6.1	6.0
	Land use means	5.8	5.8	6.0	
	Land use LSD (0.05)	0.2			
	Village LSD (0.05)	ns			
	Land use x Village LSD	0.4 (0.05)			
	LGA LSD (0.05)	ns			
	Land use x LGA LSD	0.2 (0.05)			

Table 3. Effects of land use on OC (g kg^{-1}) of soils from Kwara State, Nigeria

		Land use			
LGA	Village	Forest	Cashew	Maize-Cassava Intercrop	Village means
Asa	Ogele	0.78	0.65	0.52	0.65
	Ajuwon	1.47	0.59	0.42	0.83
	Kajola	0.83	0.66	0.49	0.66
Moro	Oniso	0.72	0.68	0.49	0.63
	Budo-Apata	0.88	0.70	0.60	0.73
	Eleshinnla	1.33	0.63	0.40	0.78
	Land use means	0.91	0.59	0.64	
	Land use LSD (0.05)	0.07			
	Village LSD (0.05)	0.10			
	Land use x Village LSD (0.05)	0.17			
	LGA LSD (0.05)	0.06			
	Land use x LGA LSD (0.05)	0.10			

Table 4. Effects of land use on N (g kg^{-1}) of soils from Kwara State, Nigeria

		Land use			
LGA	Village	Forest	Cashew	Maize-Cassava Intercrop	Village means
Asa	Ogele	0.07	0.05	0.05	0.06
	Ajuwon	0.12	0.05	0.03	0.07
	Kajola	0.05	0.07	0.08	0.07
Moro	Oniso	0.07	0.06	0.04	0.06
	Budo-Apata	0.06	0.05	0.08	0.06
	Eleshinnla	0.12	0.06	0.04	0.07
	Land use means	0.08	0.06	0.06	
	Land use LSD (0.05)	0.01			
	Village LSD (0.05)	0.01			
	Land use x Village LSD (0.05)	0.02			
	LGA LSD (0.05)	0.01			
	Land use x LGA LSD (0.05)	0.01			

Table 5. Effects of land use on P (mg kg^{-1}) of soils from Kwara State, Nigeria

		Land use			
LGA	Village	Forest	Cashew	Maize-Cassava Intercrop	Village means
Asa	Ogele	1.47	2.88	2.98	2.45
	Ajuwon	4.48	1.09	2.56	2.71
	Kajola	1.31	5.05	4.91	3.75
Moro	Oniso	3.92	3.12	1.69	2.91
	Budo-Apata	1.24	2.00	6.15	3.13
	Eleshinnla	2.11	3.90	2.61	2.87
	Land use means	2.42	3.01	3.49	
	Land use LSD (0.05)	ns			
	Village LSD (0.05)	ns			
	Land use x Village LSD (0.05)	2.27			
	LGA LSD (0.05)	ns			
	Land use x LGA LSD (0.05)	1.31			

Table 6. Effects of land use on K (cmol kg^{-1}) of soils from Kwara State, Nigeria

		Land use			
LGA	Village	Forest	Cashew	Maize-Cassava Intercrop	Village means
Asa	Ogele	0.91	0.21	0.29	0.23
	Ajuwon	0.48	0.28	0.23	0.33
	Kajola	0.29	0.31	0.31	0.30
Moro	Oniso	0.33	0.24	0.23	0.27
	Budo-Apata	0.36	0.24	0.35	0.32
	Eleshinnla	0.28	0.32	0.25	0.28
	Land use means	0.32	0.27	0.28	
	Land use LSD (0.05)	0.03			
	Village LSD (0.05)	0.04			
	Land use x Village LSD (0.05)	0.07			
	LGA LSD (0.05)	0.02			
	Land use x LGA LSD (0.05)	0.04			

Calcium

From the result in Table 7, it was shown that the mean content of Ca ranged between 0.84 and 4.85 cmol kg^{-1}. Soil under maize-cassava intercrop in Oniso Village recorded the highest Ca and forest under Ajuwon Village recorded the lowest. The effects of land use, interaction between land use and village were highly significant ($p<0.001, p<0.01$) on Ca and village was significant ($p<0.05$) on Ca. Local government area as well as interaction between land use and local government were not significant ($p>0.05$) on Calcium content of the soil. Low to medium content of calcium and medium or adequate content magnesium were generally observed throughout the land use types in keeping with the ratings of Fagbami and Shogunle (1995) which may be as a result of leaching, plant uptake from the floor of cultivated land, forested land and plantation. According to Grzebisz (2011), mobilization and leaching leads to lack of magnesium and calcium. Ayoubi et al. (2011) noted that several researchers have proven that deforestation and cultivation of virgin soils often leads to depletion of macronutrients and reducing soil quality. Banafshe et al. (2011) obtained lowest Mg in cultivated land which can be due to the high intensity of cultivation, abundant crop harvest with very little use of inputs and also leaching from forest or cultivated farm land.

Magnesium

In soils of varying land use types studied, the mean content of Mg ranged from 0.10 to 1.37 cmol kg^{-1} (Table 8). Forest in Eleshinnla Village stored the highest content of Mg which was significantly ($p<0.05$) higher than other land use types and forest in Ajuwon Village had the lowest. The effects of land use, village, interaction between land use and local government as well as interaction between land use and village were highly significant ($p<0.001$) on mg except local government area which differed significantly ($p>0.005$) on magnesium content of the soil.

Table 7. Effects of land use on Ca (cmol kg^{-1}) of soils from Kwara State, Nigeria

LGA	Village	Land use Forest	Cashew	Maize-Cassava Intercrop	Village means
Asa	Ogele	1.81	1.16	1.92	1.63
	Ajuwon	4.85	1.24	1.67	2.59
	Kajola	1.76	1.68	2.90	2.11
Moro	Oniso	2.67	1.44	0.84	1.65
	Budo-Apata	1.29	1.46	2.45	1.73
	Eleshinnla	4.46	1.20	3.19	2.95
	Land use means	2.81	1.36	2.16	
	Land use LSD (0.05)	0.69			
	Village LSD (0.05)	0.98			
	Land use x Village LSD (0.05)	1.70			
	LGA LSD (0.05)	ns			
	Land use x LGA LSD (0.05)	ns			

Table 8. Effects of land use on Mg (cmol kg^{-1}) of soils from Kwara State, Nigeria

LGA	Village	Land use Forest	Cashew	Maize-Cassava Intercrop	Village means
Asa	Ogele	0.67	0.51	0.65	0.61
	Ajuwon	0.10	0.51	0.39	0.96
	Kajola	0.43	0.60	0.86	0.63
Moro	Oniso	0.97	0.47	0.51	0.65
	Budo-Apata	0.74	0.57	1.09	0.80
	Eleshinnla	1.37	0.58	0.31	0.76
	Land use means	1.03	0.54	0.64	
	Land use LSD (0.05)	0.10			
	Village LSD (0.05)	0.14			
	Land use x Village LSD (0.05)	0.25			
	LGA LSD (0.05)	ns			
	Land use x LGA LSD (0.05)	0.14			

CONCLUSION and RECOMMANDATIONS

Current soil management systems are ineffective to enhance soil carbon and most of the cultivated soils were highly degraded which was assumed to be due to emission losses because of continuous cropping. Most of the soil productivity parameters like N and P were low, exchangeables and micronutrients were low to medium and some were high. Management practices like composting, green manuring, use of organic fertilizer and residue retention should be adopted. Efforts on land use management system strategies should be adopted for carbon sequestration, climate change and agricultural productivity. Therefore, reducing intensive cultivation, avoiding deforestation, bush burning, increased fallow period and multipurpose agroforestry trees should be more practiced in the study area. Management practices like composting, green manuring, use of organic fertilizer and residue retention is recommended.

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