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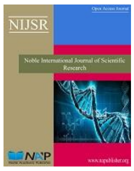

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Effects of Land Use Types on Soil Productivity Parameters: A Case Study of Ogbomoso Agricultural Zone, Southern Guinea Savanna Ecology of Nigeria

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Abstract: Soil properties and soil management are two important factors that determine crop yield, knowledge of soil characteristics is foremost in ascertaining the better way to which a soil may be used. Impact appertaining to varied land use types, namely: maize cropping and cassava cropping, tree plantations and secondary forests on soil carbon accretion and soil productiveness in Ogbomoso agro-ecological zones of Oyo State within Southern Guinea savanna vegetation zone of Nigeria was investigated. Top soils (0-20 cm) were sampled from 100 farms of diverse land use types. The location of the farms and forest reserve were also considered as treatment factors. The representative soil were processed and analysed for some selected chemical and physical attributes. Soil productivity diminished in the order of forest >plantation >cassava >maize. Land use types had significant (Lsd ≤ 0.05) impact on the soil carbon storage, Ca, Mg, K, ECEC, organic carbon, Fe, P, Mn, Zn and pH. The results revealed that for sustainable soil fertility and productivity, there must be careful choice of land that is appropriate for agricultural purposes. Though there is nutrient decline in all land use types, this would be necessary to reduce rapid soil nutrient depletion, and would enhance soil productivity.

Keywords: Soil Productivity; Soil Nutrient Depletion; Carbon Storage; Agricultural Zone.

1. Introduction

Soil is an important and dynamic component of the biophysical environment, its quality and management determines the productivity of all natural or managed ecosystem [1]. In a [1], noted that the sustainability of soil functions is dependent on soil properties, processes and management. Soil quality attributes such as physical, chemical and hydrological properties and characteristics were developed in consequence of the factors and processes of soil formation are the soil quality attributes affecting the sustainability of soil functions and use of the land. Several researchers have reported soil fertility decline as a problem in most tropical countries [2-6]. Soil nutrient loss is a tremendous threat to sufficiency in food production in the world [7] especially in Africa due to poverty constriants, growing land pressure and impact of climate change. [8], asserted that in sub-Saharan Africa, soil degradation leading to nutrient depletion has been considered a serious threat to agricultural productivity and vital causes of dwindled crop yields and per capital food production. The traditional methods of bush fallow and shifting cultivation for soil fertility maintenance are no longer sustainable due to population pressure and industrialization [9], therefore, the focus now is on alternatives to improve soil nutrient status for better crop yield in the sub-saharan Africa. Soil fertility depletion in the tropics is severe and ensue mainly from leaching and erosion of top soils due to intense rainfall. [10] reported that reduction in essential plant nutrient is due to inherent fragile characteristics of the tropical soil which have led to progressive decreases in the capacity of tropical soils to grow food and fiber. Furthermore, [11], asserted that decrease in soil productivity is due to depletion of large source of carbon based compounds (SOM) which is the reservoir of plant nutrients.

Depletion of the quantity of the carbon components of organic compounds emanates from land misuse and soil mismanagement, which results in immediate release of CO_2 and other greenhouse gas into the atmosphere. Organic matter directly affectes soil properties that define soil quality [12]. Increasing soil organic matter therefore leads to improvement of soil properties. [13] asserted that SOM is the repository of nutrients, particularly nitrogen (N), phosphorus (P), sulphur (S) and also function as a reservoir of nutrients to crops, enhances soil aggregation, facilitates nutrient exchange and helps to retain moisture. Similarly, soils organic matter helps in reducing surface crusting, increases water infiltration as well as water retention. It impacts the potential for herbicide residue for future crops and amount of lime necessary to raise the soil pH [14]. Soil carbon is generally high in virgin soils under grass or forest vegetation, lots of carbon is lost when forest land or grassland is converted to cropland and pastures [15].

Soil degradation is a common phenomenon in tropical soil systems and it is characterized by decline in quality and reduction in ecosystem goods and services, it is the main challenge to achieving the required rise in agricultural production systems [16]. Biomass burning, inadequate use of fertilizers and organic amendments, removal of leftover after crop has been harvested, low protection of soils against erosion and other factors are known to degrade soils. Most farmers do not apply chemical fertilizers due to high costs and their main means of maintaining soil fertility for both annual and perennial crop is through nutrient recycling. [17] also reported that in Southern Ghana, the most common tillage practices were slash and burn and hoe weeding, and that 32% of farmers applied inorganic fertilizer and only 5% applied animal manure to boost crop growth and yield. To design management system with enhanced nutrient recycling requires good understanding of soil dynamic processes under prevailing land-use systems. Therefore there is need for use of Available Sustainable Land Management (ASLM) techniques to effectively address the on-going land degradation in the country. Effective and efficient management of soil is essential for maintaining soil fertility and sustaining high yields. [18], asserted that conversion of natural vegetation to agricultural use led to significant changes in organic matter status in soils. Long fallow periods have been used by farmers but with increasing population and scarcity of land, fallow periods have been reduced considerably, while cultivation of marginal lands has increased [5, 8]. Furthermore, urban migration in a bid to get better living has increased pressure on the land. This is particularly manifested in places where farming is practiced extensively. This study was therefore carried out to ascertain the fertility of the soil and influence of varied land use types on soil productivity parameters in the survey area.

2. Materials and Methods

2.1. Description of Study Area

2.1.1. Study Sites

This research was conducted in Oyo State, located in the South West geopolitical zone of Nigeria. The location coordinates of Ogbomoso is Latitude 8^0 08'N and Longitude $4^0$14'E. Ogbomoso Agricultural zones, which comprise of five municipalities (Ogbomoso North, Ogbomoso South, Ogo-Oluwa, Surulere and Orire local government areas) were adopted as the study sites. The climate of the environment of Ogbomoso can be expressed as fairly hot, tropical and marked wet and dry seasons. There is usually a bit of harmattan between these seasons. The mean annual rainfall is about 1400 mm while the mean annual temperature is about 27^0C. The vegetation of the zone is classified as Southern Guinea savanna [19]. The respondents composed of all farmers registered with the State Agricultural Development Programme in the domain. A multistage random selection approach was employed to choose the farms that were sampled for the research. The first stage included deliberate selection of two out of the five local government areas with rural outlook. The two LGAs selected were Surulere and Ogo Oluwa. Second stage involved arbitrary selection of five villages in each local government area, making a total of ten villages. The selected villages are listed subsequently in Tables of results. The last stage involved random selection of ten farms of varying land use types from each village, making a total of one hundred farms. The tetrad land use types studied were maize farms, cassava farms, plantations and secondary forest. The maize, cassava and plantation farms were sampled in tripplicate from each village, and one forest sample was obtained from each village. The one hundred farms across the two local government areas were visited from April to May 2018 and soils were sampled from the depth of 0-20 cm from each land use type.

2.2. Soil Sampling and Analysis

Top soil (0-20 cm) samples were taken in triplicate with soil auger from each of the treatment at the study locations from April to May 2018, and brought to the laboratory for analysis. The mass of soil in a given volume of each sampled field was discovered using undisturbed soil core method [20]. Disturbed soil samples collected using the auger were air-dried, grounded and meshed by means of 2mm sieve for the determination of particle size, pH (H_2O), available P, extractable micronutrients and exchangeable cations. Soils sieved through 0.5 mm mesh were used for both the determination of total nitrogen (N) and organic carbon. Particle size analysis was carried out according to [21] hydrometer method using sodium hexametaphosphate as the dispersant. Soil pH was determined in

1:1 soil water ratio using the electrode MV88 Praitronic pH meter. Total N was extracted by the macro–Kjeldahl digestion method [22] followed by colorimetric determination using Technicon Auto analyser. Melich 3 (a multipurpose extractant) was used to extract available phosphorus, exchangeable cations (Ca, Mg, K and Na) and extractable micronutrients (Mn, Fe, Cu and Zn) [23]. Phosphorus was determined colorimetrically using the Technicon AAII Auto-analyser, while the concentration of (Calcium, Magnessium, copper, Zinc, Iron and Manganese) in the extract were determined by Atomic Absorption Spectrophotometer (AAS) (Model Buck 200A). Sodium (Na) and K were determined using Flame emission photometer. Exchangeable acidity was determined by KCl extraction method [24]. Effective cation exchange capacity (ECEC) was determined by summation of Exchangeable bases (Ca, Mg, K and Na) and Exchangeable acidity. Organic carbon was determined by chromic acid digestion method [25].

3. Results and Discussion

3.1. Land Use Effects on Soil Physical Properties

3.1.1. Soil Texture

Across the two LGAS (Surulere and Ogo-Oluwa) the mean sand fraction ranged from 74-75%, 69-77%, 74-75%, 73-74% for forest, plantations, cassava and maize farm soils respectively as shown in Tables 1 and 2. Clay content was highest (18.35) in plantation farms across the two LGAs. The mean silt content was highest (12.72) in Plantation farms in Surulere LGA and lowest in the same plantation farms in Ogo Oluwa LGAs. The soil texture for farms of Ogo-Oluwa LGA ranged from sandy loam to loamy sand, and were sandy clay loam, sandy clay and clay for Surulere LGA soils.The high sand contents in the research area could be product of the parent materials (sandstone) from which the soil was formed. This was in agreement with some reports [26, 27], that parent materials influence texture. [28], also confirmed that soil texture is related to parent materials and topography and is influenced by land use type. [29], [30] also observed that particle size fractions were related to parent material than land use practices. Furthermore [31], reported that particle size is a major property of mineral soils which affects solute transport and other physical properties of soil. Therefore, majority of these soils in the two local government studied with low clay contents can be worked easily, though the soils would also have associated characteristics of weak gluing and traction forces which results in low aggragation potential of the soils, easily slaked, highly detachable and dispersible [28].

3.1.2. Bulk Density

Tables 1 and 2 also indicated significant ($P \leq 0.05$) differences in bulk density for the various land use and village farms studied. The bulk density obtained for forest (1.21 gcm^{-3}), and plantation (1.22gcm^{-3}) were low and high for cassava (1.51gcm^{-3}) and maize (1.54 gcm^{-3}) across the two LGAs. Results showed that bulk density values of soils collected from cultivated lands (Cassava, maize) were high compared with those taken from both forest and plantation farms. The bulk density values followed the trend Forest < Plantation < maize = cassava with the mean values of 1.22, 1.41, 1.51 and 1.54 gcm^{-3} respectively. Bulk density was much higher in the croplands (maize and cassava farms) compared to the secondary forest treatments (plantation and forest land use types) apparently due to effects of intensive agricultural practices frequently carried out on the croplands [32], The practice of ploughing the cultivated lands tend to lower the quantity of organic matter on surface soils due to the intense mixing, animal grazing, soil compaction due to effects of cultivation tools which eventually expose the soil surface to direct strike by rain drops [27]. This result is also in line with the result of [33, 34] who found the highest bulk density under cultivated land contrast to the adjacent grazing and forest at the surface soil depth of 0-20 cm. Furthermore, high-rise in bulk density as a consequence of conversion of forest to cultivated land would subject the land to more intense manipulation by cultivation, a process that could result in soil degradation [35]. High bulk density implies low porosity and higher level of soil compaction, which may cause restrictions to root growth and poor cappillary movement in soil [36]. Generally, the range of bulk density values recorded in this study were within the range expected (1.1 to 1.4 g cm^{-3}) in most mineral soils as reported by [37]. Since in the experimental area, bulk density was within the expected values, the aeration and water movement within the soil was conducive for plant growth and for the proliferation of a multivariousness of soil microbes that would stimulate good level of fertility and productivity of the soils.

3.2. Land Use Influence on Soil Chemical Properties

3.2.1. pH

The pH of soils of both LGAs, Ogo Oluwa and Surulere, are shown in Tables 3 and 4. The pH of soils in Surulere ranged from neutral to slightly alkaline (6.4-7.5) and for Ogo-Oluwa, pH values were slightly acid to neutral (5.7 -7.3). Maize farm in Opete village and forest in Otamokun village farms in Ogo-Oluwa were slightly acidic. Land use types and village and land use had significant effects on pH across the two LGAs, except in Ogo-Oluwa where pH values of the farms of the villages were not significantly different. The lower pH value of soil from lands that were cultivated might be emanated from the application of fertilizers containing ammonium (urea), which tends to reduce soil pH, since plant uptake of NH_4^+ is accompanied by release of hydrogen ion to the soil [38]. Other tenable reasons could be that the higher organic matter decomposition rate in cultivated lands, of much higher aeration conditions would have springed in the release of organic acids which

Table 1. Physical properties of Soil in Surulere Local Government Area, Ogbomoso.

Village	Land use	Bulk density (gcm^{-3})	% Clay	% Sand	% Silt	Textural class
Adekunle	Forest	1.16	18.67	67	14.33	Sandy clay loam
Adekunle	Plantation	1.31	19.47	68	12.53	Clay
Adekunle	Cassava	1.51	14.13	77.33	8.53	Sandy clay
Adekunle	Maize	1.54	18.80	68	13.2	Clay
Alapata	Forest	1.41	18.13	67.33	14.53	Clay
Alapata	Plantation	1.24	17.47	70.67	11.87	Sandy clay
Alapata	Cassava	1.51	14.13	78	7.87	Sandy clay
Alapata	Maize	1.50	16.20	74.67	9.13	Sandy clay
Baba Egbe	Forest	1.02	16.80	80	3.20	Sandy clay
Baba Egbe	Plantation	1.21	16.53	73	10.13	Sandy clay
Baba Egbe	Cassava	1.49	14.13	61.33	24.57	Clay
Baba Egbe	Maize	1.48	13.13	79.33	7.53	Sandy clay
Balogun	Forest	1.14	11.87	81	7.13	Sandy clay
Balogun	Plantation	1.10	18.13	64.67	17.20	Clay
Balogun	Cassava	1.49	14.13	77.33	8.53	Sandy clay
Balogun	Maize	1.53	14.47	77.33	8.20	Sandy clay
Idi Opele	Forest	1.23	10.80	80	9.20	Sandy clay
Idi Opele	Plantation	1.28	20.13	68	11.87	Clay
Idi Opele	Cassava	1.50	14.47	76.33	9.20	Sandy clay
Idi Opele	Maize	1.56	17.47	65	17.53	Clay
Landuse LSD 0.05		0.057**	2.62*	2.99**	1.86**	
Village LSD 0.05		0.06**	2.93**	3.35*	2.08**	
Land use*village LSD 0.05		0.13**	5.85**	6.69*	4.16*	

Source: Author

Table 2. Physical properties of soils in Ogo Oluwa Local Government Area, Ogbomoso

Local government	Village	Land use	Bulk density (gcm^{-3})	% Clay	% Sand	% Silt	Textural Class
Ogo Oluwa	Alasunko	Forest	1.22	14.27	74.53	11.20	Sandy loam
		Plantation	1.12	12.60	77.87	9.53	Loamy sand
		Maize	1.56	14.60	75.87	9.53	Sandy loam
		Cassava	1.54	13.60	73.53	12.87	Sandy loam

	Idi Araba	Forest	1.14	14.27	74.53	11.20	Sandy loam
		Plantation	1.23	14.87	75.07	10.07	Sandy loam
		Maize	1.54	12.93	77.87	9.20	Loamy sand
		Cassava	1.51	14.27	77.20	8.53	Sandy loam
	Ladanu	Forest	1.42	14.27	74.53	11.20	Sandy loam
		Plantation	1.52	14.93	74.53	10.53	Sandy loam
		Maize	1.53	13.93	76.53	9.53	Loamy sand
		Cassava	1.54	13.93	78.87	7.20	Loamy sand
	Opete	Forest	1.19	14.27	74.53	11.20	Sandy loam
		Plantation	1.14	10.60	81.20	8.20	Loamy sand
		Maize	1.55	14.27	70.53	15.20	Sandy loam
		Cassava	1.50	12.60	75.20	12.20	Sandy loam
	Otamokun	Forest	1.14	14.27	74.53	11.20	Sandy loam
		Plantation	1.17	12.27	78.53	9.20	Loamy sand
		Maize	1.58	15.73	72.13	12.13	Sandy loam
		Cassava	1.52	13.60	71.53	14.87	Sandy loam
Land use Lsd (0.05)			0.10*	1.45^{ns}	3.61^{ns}	2.63*	
Village Lsd (0.05)			0.12*	1.62^{ns}	2.00^{ns}	2.94*	
Land use*Villages Lsd (0.05)			0.24**	3.23^{ns}	4.00^{ns}	5.88*	

Source: Author

Ultimately would have contribute to the acidic condition of the soil. [39] also reported lower soil pH values for cultivated farmlands.

3.2.2. Nitrogen

There was significant difference in the N content of soils in Surulere LGA. The mean nitrogen content of soils in the two LGAs were low, except for forest soils in Ogo-Oluwa (0.21 g kg^{-1}) which was moderately high and plantation farms in Surulere (0.10g kg^{-1}) which was low. The order of increase in soil total nitrogen was Forest > Maize > Plantation > Cassava. The mean total N was same for plantation and cassava in Ogo-Oluwa LGA. [40] reported a significantly difference in total nitrogen between the forest and cultivated land due to differences organic matter content in soil, intensities of erosion and cultivation. The main cause of reduced contents of total nitrogen develop from biomass removal during crop harvest and inadequate replenishment through manure or fertilizers [41].

3.2.3. Phosphorus

Land use system had significant ($P\leq 0.05$) influence on the P content of the soil. The mean available P of the varying land use in the two LGAs were 7.57, 3.46, 8.15 and 4.65 mg kg^{-1} for forest, plantation, cassava and maize farms respectively. The outcome of the analysis revealed that P of the soils of each land use type were generally low and interaction between the land use and village were not significant. Plant uptake, erosion of top soil and fixation on soil particle surfaces account for much of the losses of available phosphorus from the soil system. The higher available P composition of forest soil might be ascribed to the higher quantity of litter fall in forest soils as compared to soils of both cultivated and grazing lands, as was reported by [42], who found a high correlation between litter fall and soil Available phosphorus content. However, the Available phosphorus content in the forestland soil was still lower than the optimum Available phosphorus required for optimum plant growth. Contrary to our present finding, [39] did not observe any significant effect of land use change on the soil available phosphorus content of soils. Compared with the remaining land use types studied, high available P value was recorded in the cultivated land next to the forest land. This might be resulted from the use of diammonium phosphate (DAP) fertilizers on the cultivated lands of the study area. As per the ratings of available P by [43], the available P of the soils under study were rated as very low in maize, cassava and plantation farms, whereas it was rated as low for the forest land. Several researches in the past have reported soil management, deforestation, topography, and continuous cultivation of tropical soils often result to decrease in nutrients and increase rate of erosion [44]. This result is in agreement with formal studies which found that long–term cultivation of crops with little or no fertilizer application reduced phosphorus contents in the soil [45]. Also [46] reported that in nations with tremendous fertilizer use, large amount of phosphorus is lost to leaching and run – off, bringing about eutrophication of both inland and coastal waters. Furthermore, the deficiency or low amounts of available P of the area of study could have been due to the high $CaCO_3$ content of the soil, since P can precipitate as calcium phosphate in calcareous soil [47]. [47] reported that in calcareous soil, the available P was low due to the precipitation of P in form of calcium phosphate. This is an indication that P fertilizer is needed on each of the land use systems across the agricultural zone for good growth and sustainable optimum seed production.

3.2.4. Organic Carbon

Organic carbon content was significantly influenced by land use, villages, and land use and villages in the study domain. The organic carbon in all land use types are 1.65, 0.93, 0.85 and 0.77 g kg^{-1} for forest, plantation, cassava and maize farms respectively with the trend: forest >plantation >cassava >maize. Results indicated that organic carbon contents of the forest land use type soil were significantly higher when compared with values for plantation and arable lands that were considered low.

With reference to rating by Soil Brief Cuba 8, the soil organic carbon content detected in this study for the forest soil was classified as medium (1.65%) whereas for both cultivated and plantations soils, were rated as low. Several studies showed that SOC content was reduced by intensive cultivation of land [48]. [49] reported that the SOC concentration rapidly declined after forest clearing and when maize crop residues were removed from the site, supporting the present findings. [50] also observed that SOC concentration declined in cultivated soils as compared to adjacent non-cultivated sites. The reason for the appreciable OM in soil of the forest land may have been due to consistent annual leaf fall over the years. Leaf litter and root debris would eventually decomposed to increase the OM present in the soil. The higher litter output and nitrogen fixation by nitrogen fixing trees species (leguminous trees) and higher microbial population in forestland facilitates decomposition of organic debris and thereby result in higher OM content of such soils. The higher amount of OM in forest soils also might have resulted from tree stems, barks, flowers, logs and fruits. Besides, microorganisms, roots and animals contribute to the build up of OM [51]. The highest value of soil OM on the surface layer of forest land was attributed to the excessively high amounts of plant residues and biomass that accumulate on the land. [52] reported that the aftermath of trees on qualities of soil occur mostly due to organic matter addition and the release of nutrients from it. The lower level of soil OM in lands that have been cultivated might have resulted from a combined effect of lower OM inputs addition to the soil system (less biomass due to poor crop residue management) and greater OM losses through crop residue burning and removal, accelerated top soil erosion and faster organic matter decomposition due to high soil aeration. In line with the present findings, [53] reported that forests contribute 40 to 60% of the OM to the soil as compared to cultivated lands. The lower OM percentage in lands cultivated in the study area could also be attributed to heavy livestock grazing and poor farming practices such as poor crop residue management. To corroborate these findings, [54], had reported that crop management practices and cropping systems that do not return crop residues to the soil would lead to critical reduction in SOC content. Comparably, improved aeration caused by tillage, enhances mineralization thus resulting in a decline in SOM content [48].

3.2.5. Exchangeable Bases

Land use pattern had significant effects on exchangeable magnessium. The mean value for Mg ranged from 0.66-1.38 and 0.73 - 2.18 cmol kg^{-1} (Medium) for Surulere and Ogo-Oluwa LGAs, with the mean values of 1.64, 1.05, 0.98, 0.76 cmol kg^{-1} for forest, plantation, cassava and maize farms respectively. The mean values were in the order: forest >plantation >cassava >maize. The highest value (1.64cmol kg^{-1}) was recorded under the forest land use type, while the lowest value, (0.76), was recorded on maize farm. Pattern of land use and villages had significant effect on soils K contents of Ogo-Oluwa LGA. Land use and village interaction was not significant with K content in soils of the two LGAs. Forest soils had highest potassium (0.36, 0.35cmol kg^{-1}) content for Surulere and Ogo-Oluwa LGAs respectively and low for maize cultivated farms in the LGAs of study. Exchangeable Na was high in all the land use pattern including LGAs. Interaction between land use type and village were also not significant with Na in both LGAs. Exchangeable Ca was medium in all the research area and land use types, except for maize farms (1.90cmol kg^{-1}) in Surulere, Plantation (1.54) farms in Ogo-Oluwa with low exchangeable Ca values.

The higher potassium in cultivated land can be linked to the kind of fertilizers used on the cultivated soils. Extensive use of fertilizer containing potassium, residue retention and use of inorganic manure in the study area. [55, 56]. The high sodium in all the land use may be attributed to erosion and leaching.

Table 3. Chemical properties of soils in Ogo Oluwa Local Government Area

Village	Land use	pH (H_2O)	OC	TSC	N	Avail P	Ca	Mg	K	Na	ECEC
			g kg^{-1}	Tons ha^{-1}	g kg^{-1}	mg kg^{-1}	cmolkg^{-1}				
Alasunko	Forest	7.33	2.25	54.9	0.29	6.28	6.64	2.33	0.42	0.08	9.46
	Plantation	6.67	0.65	22.2	0.06	2.41	1.23	0.66	0.10	0.07	2.06
	Maize	6.50	0.56	22.2	0.06	1.59	1.46	0.72	0.12	0.09	2.38
	Cassava	6.60	0.59	19.4	0.05	7.38	1.62	0.68	0.12	0.08	2.50
Idi Araba	Forest	6.43	0.81	31.2	0.06	10.31	2.20	1.40	0.25	0.08	3.92
	Plantation	6.83	0.60	18.5	0.06	3.36	0.87	0.51	0.10	0.09	1.56
	Maize	6.90	0.65	22.7	0.06	3.09	1.74	0.84	0.09	0.09	2.75
	Cassava	6.67	0.86	27.9	0.09	7.96	2.67	1.18	0.17	0.08	4.10
Ladanu	Forest	7.20	2.15	61.0	0.20	4.79	5.29	2.61	0.54	0.07	8.50
	Plantation	6.77	1.24	37.2	0.12	6.55	2.73	1.18	0.23	0.07	4.21
	Maize	7.27	1.02	37.5	0.10	18.74	3.66	0.84	0.23	0.08	4.82
	Cassava	6.93	0.64	23.3	0.06	14.14	2.24	0.56	0.13	0.07	2.99
Opete	Forest	6.60	2.10	66.8	0.23	1.81	4.96	2.48	0.26	0.09	7.79
	Plantation	6.20	0.60	21.3	0.05	1.48	0.98	0.44	0.11	0.08	1.62
	Maize	5.80	1.06	39.5	0.11	2.37	2.01	0.92	0.24	0.08	3.26
	Cassava	6.63	0.64	23.0	0.06	8.06	2.08	0.65	0.11	0.08	2.93
Otamokun	Forest	5.70	2.01	70.0	0.28	3.20	4.31	2.10	0.27	0.06	6.74
	Plantation	6.43	0.84	28.0	0.07	1.82	1.91	0.87	0.16	0.06	3.00
	Maize	6.77	0.87	27.5	0.08	7.63	1.33	0.98	0.14	0.07	2.52
	Cassava	6.60	0.89	29.2	0.08	17.74	2.62	0.80	0.15	0.09	3.66
Land use Lsd (0.05)		10.72**	0.27**	8.60**	0.24 ns	4.45*	10.72**	0.31**	0.07**	0.01 ns	1.13**
Village Lsd (0.05)		11.96 ns	0.31*	9.61*	0.27**	4.98*	11.96 ns	0.35ns	0.08*	0.01	1.26*
Land use *Village Lsd (0.05)		23.92*	0.61*	19.23 ns	0.55**	9.95 ns	23.92*	0.69 ns	0.17 ns	0.02 ns	2.53*

*: significant at the 0.05 level **: at the 0.01 level ns: not significant at 0.05 level

Table 4. Chemical properties of soil in Surulere local government area, Ogbomoso.

Village	**Land use**	**pH (H_2O)**	**OC**	**TSC**	**N**	**P**	**Ca**	**Mg**	**K**	**Na**	**ECEC**
			g kg^{-1}	**Tons ha^{-1}**	**g kg^{-1}**	**mg kg^{-1}**	**cmol kg^{-1}**				
Adekunle	Forest	7.23	1.03	23.8	0.10	6.01	2.66	1.08	0.22	0.09	4.04
	Plantation	7.27	1.03	22.7	0.08	5.35	2.62	1.07	0.16	0.08	3.87
	Cassava	7.33	1.32	20.9	0.13	8.61	4.58	1.15	0.26	0.08	6.46
	Maize	6.6	0.98	16.2	0.07	1.19	1.94	1.54	0.08	0.07	2.76
Alapata	Forest	7.3	1.95	19.0	0.08	7.52	3.03	0.81	0.26	0.08	3.36
	Plantation	7.47	1.11	16.9	0.11	4.23	3.26	1.71	1.06	0.08	6.34
	Cassava	7.1	0.81	17.3	0.08	4.63	2.11	0.92	0.14	0.07	3.68
	Maize	7.1	0.57	15.6	0.06	2.98	1.97	0.50	0.10	0.08	2.63
Baba Egbe	Forest	7.5	1.65	27.0	0.05	6.36	3.88	1.13	0.20	0.07	5.29
	Plantation	7.5	1.04	25.0	0.11	5.35	3.4	1.55	0.24	0.07	5.26
	Cassava	7.23	0.83	24.8	0.09	6.06	2.96	1.10	0.16	0.07	4.29
	Maize	6.97	0.71	19.5	0.06	2.08	1.94	0.64	0.09	0.08	2.74
Balogun	Forest	7.27	1.13	25.9	0.06	5.66	2.04	1.52	0.19	0.07	3.83
	Plantation	7.17	1.02	23.2	0.08	1.99	2.83	1.15	0.17	0.08	4.05
	Cassava	7.2	0.94	20.1	0.10	7.49	3.04	1.36	0.18	0.08	4.66
	Maize	6.4	0.67	14.9	0.06	11.39	1.74	0.74	0.07	0.08	2.63
Idi Opele	Forest	7.4	0.47	28.4	0.04	175	1.59	0.55	0.10	0.08	2.32
	Plantation	7.53	1.18	24.8	0.10	4.50	3.29	1.44	0.19	0.08	5.01
	Cassava	7.40	0.95	15.2	0.08	10.44	3.31	1.23	0.19	0.08	4.81
	Maize	6.77	0.60	15.0	0.09	1.66	1.9	0.63	0.09	0.09	2.71
Land use (Lsd 0.05)		0.08**	0.18**	5.16*	0.02 *	2.81 ns	0.18**	0.32**	0.23 ns	0.01 ns	2.71
Village (Lsd 0.05)		0.09**	0.20**	5.78ns	0.06 ns	3.14 ns	0.20**	0.36 ns	0.26 ns	0.01 ns	1.27*
Land use *villages (Lsd 0.05)		0.19**	0.41**	11.57 ns	0.05 ns	6.29 ns	0.41**	0.71 ns	0.52 ns	0.01*	1.42 ns

*: significant at the 0.05 level **: at the 0.01 level ns: not significant at 0.05 level

Table 5. Micronutrient properties of soils in Ogo Oluwa Local Government

Village	Land use	Mn	Zn	Cu	Fe
		mg kg^{-1}			
Alasunko	Forest	377.00	60.30	8.59	85.00
	Plantation	263.90	5.30	3.32	78.00
	Maize	249.40	3.00	2.93	76.00
	Cassava	240.80	4.80	3.71	71.50
Idi Araba	Forest	238.10	11.00	2.15	71.60
	Plantation	41.30	2.80	1.56	78.60
	Maize	208.70	4.20	2.54	68.20
	Cassava	311.60	15.90	6.25	75.60
Ladanu	Forest	302.20	55.50	4.30	83.30
	Plantation	262.80	9.50	3.71	75.50
	Maize	259.50	16.40	6.64	71.90
	Cassava	177.50	7.90	4.69	69.90
Opete	Forest	195.20	8.50	6.06	100.70
	Plantation	133.20	4.60	2.93	65.70
	Maize	46.70	4.80	3.32	146.80
	Cassava	211.90	11.90	4.88	77.30
Otamokun	Forest	259.30	40.80	7.42	88.90
	Plantation	178.90	6.80	2.74	73.00
	Maize	134.50	7.00	3.32	118.30
	Cassava	173.60	7.50	4.30	108.80
Land use (Lsd 0.05)		53.89*	10.70**	1.37*	12.98*
Village (Lsd 0.05)		60.23**	11.96 ^{ns}	1.53 ^{ns}	14.51*
Land use * Village (Lsd 0.05)		120.4*	23.96 *	3.07*	29.02*

*: significant at the 0.05 level **: at the 0.01 level ns: not significant at 0.05 level

Table 6. Micronutrient properties of soil in Surulere local government area, Ogbomoso.

Village	Land use	Cu	Zn	Fe	Mn
				mg kg^{-1}	
Adekunle	Forest	4.88	255	71.5	188.2
	Plantation	5.08	465	74.5	144.7
	Cassava	5.86	749	68.6	134.3
	Maize	2.35	8	57.8	147.1
Alapata	Forest	3.32	41	80.20	142.5
	Plantation	3.32	30	72.4	174
	Cassava	3.52	7	50.9	172.7
	Maize	2.93	7	63.9	165.3
Baba Egbe	Forest	4.3	41	81.4	188.2
	Plantation	2.93	40	73.5	155.5
	Cassava	2.35	9	62.1	134.3
	Maize	2.15	5	68.7	147.1
Balogun	Forest	3.52	12	62.6	190.3
	Plantation	3.71	47	71.7	132.7
	Cassava	4.1	21	64.2	180.8
	Maize	2.93	23	57.4	127
Idi Opele	Forest	2.35	4	50.7	223
	Plantation	2.93	54	72.2	144.4
	Cassava	3.13	14	53.1	181.4
	Maize	3.52	78	52	131.2
Land use (Lsd 0.05)		0.74*	181.1 ^{ns}	7.93*	28.34*
Village (Lsd 0.05)		0.83*	209.4*	8.86*	31.68^{ns}
Land use *villages (Lsd 0.05)		1.66*	418.8^{ns}	17.72^{ns}	63.37^{ns}

*: significant at the 0.05 level **: at the 0.01 level ns: not significant at 0.05 level

4. Conclusions

Knowledge of soil properties is important in knowing the best use to which a soil may be put. There were remarkable contrasts between the various land use studied. From this study, land use types had significant (Lsd ≤ 0.05) impact on the soil carbon storage, Ca, Mg, K, ECEC, organic carbon, Fe, P, Mn, Zn and pH. The results clearly demonstrated that the contrasting land use types had significant impacts on soil characteristics indicating that a change from forestland to another land use types could aggravate soil degradation, thereby resulting in soil productivity and fertility decline and hence reduction in crop production capacity. The results of this study showed that there must be careful choice of appropriate use of land since there is nutrient decline in all land use types, in order to reduce rapid soil nutrient depletion and to enhance soil productivity. Further research on conservation tillage involving the application of plant materials on the surface or ploughed into the soil and occassional fallow periods to replenish the organic matter make-up so as to bind the primary particles, stabilize soil structure and improve water infiltration and storage and soils nutrient content are needed.

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