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Effects Of Different Land Uses On Soil Quality And Degradation In Abeokuta, Ogun State, Nigeria

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ABSTRACT

A detailed soil survey was carried out at the Teaching and Research Farms of Federal University of Agriculture, Abeokuta. The study aimed to determine the effects of different land-use types on some soil quality indicators and to examine the relationship among the land use types, soil quality indicators, and land degradation. Surface (0-15cm) and sub-surface (15-30 cm) soil samples were taken from different land-use types: Arboretum, Cashew, Oil palm (OP) and Fallow. Modal profile pits were dug depending on the land and soil types encountered. Profiles were described and sampled following standard guidelines. Soil quality indicators were assessed using a selection of soil quality indices including the bulk density (BD), total nitrogen (TN), potassium (K), magnesium, sodium, phosphorus (P), organic carbon (OC) and calcium. The extent of degradation was assessed using the direct approach method. Data were subjected to Analysis of Variance and means were separated using Duncan's Multiple Range Test at 5% level of significance. The results showed that Arboretum, OP and Fallow unlike Cashew had no significant($p<0.05$) effect on BD, while TN was moderate in all the land uses. Phosphorus levels were low in all the land uses and not significantly different except in Cashew and OP. Direct observation showed that chemical deterioration was more severe than physical and biological degradation in all land use categories. In Arboretum, all the soils were minimally degraded with respect to BD and TN. All the soils were minimally degraded with respect to TN and 50% moderately degraded with respect to BD. In OP, 95% soils were only slightly degraded with respect to BD. However, in all the land use categories, the base saturation, potassium and phosphorus revealed high level of degradation. Land use, soil quality, and degradation.

Introduction

The success of any soil management technique in maintaining soil quality depends on an understanding of how soils respond to different land-use types under agricultural practices over time. Therefore, evaluating the soil quality helps not only in the production of food and fiber but also in the maintenance of global environmental quality ((Doran and Parkin, 1994). In the past, industrial, urban and/or agricultural development appeared to be undertaken as a matter of expediency in many countries and also as a result of availability of raw materials, rather than on the basis of any careful appraisal of the effect of the activities on the environment (Aminu *et al*., 2013). Where there are low population pressure and extensive land use, there is little or virtually no detrimental effect on the inherent characteristics of soil (Verheye, 1986). However, with increased competition for land, reserved of fertile areas are reducing at an alarming rate as new population needs are met by either encroaching on existing cropland or opening up new lands. Soil properties deteriorate with change in land use especially from forest to arable (Mbagwu *et al*., 2009). Cropping system, for instance, may lead to leaching or erosion of soil nutrients through continuous cropping of the land and the use of heavy machinery during cultivation, thereby hurting physical and chemical properties of the soil. Land-use change has a significant influence on many soil quality indicators, mostly through its effect on soil organic matter. Structural stability of soils as affected by land uses concerning arable cropping (tillage and harvest practices), which in turn is positively associated with total organic carbon content (Mojiri *et al*., 2011). Land-use changes may rapidly diminish soil quality, as ecologically sensitive components of the tropical forest ecosystem are not able to buffer the effect of agricultural practices especially cultivation of deforested land. As a result, several deteriorations in soil quality may lead to permanent degradation of land productivity (Islam and Weil, 2000). According to Mojiri *et al*. (2011), land-use changes cause a decrease in soil organic carbon, total nitrogen, available potassium, soil microbial respiration, and extractable iron.

In recent time, sustaining the ever-increasing human population is most challenging in developing countries because of the effects of land degradation on productive soil potential (Sanchez *et al*., 1997). In general, land degradation can either be as a result of natural hazards or due to inappropriate land use and improper land management practices (FAO, 1999). Available evidence leaves no doubt that land degradation caused by erosion, desertification, deforestation and poor agricultural practices vis-à-vis inappropriate land use is undermining the very resources on which African farmers and their families depend for their survival (FAO/UNESCO, 1999). The consequence of this problem is that the natural resource base of Africa is being degraded and destroyed at a rate which will soon make agricultural production unsustainable thereby leading to food insecurity.

Over the years, particularly in southern Nigeria, one common error made before establishing agricultural farmland is lack of land evaluation. Land use analysis helps in providing information about a particular land to know what precisely the land is suitable for. The study site cannot be exonerated from this error as most of the plantations before now were established without land evaluation and little or no information has been provided on the effects the soil quality indicators could be having on the crops and vice versa. To this effect, evaluating the land use effect on the soil quality indicators and degradation in this area is very relevant in optimizing and sustaining productive soil potential of the area, thereby ensuring healthy environmental quality.

2.0 Materials and Methods

2.1 Description of the Study Area

The study was conducted at the Teaching and Research Farms, Federal University of Agriculture, Abeokuta (FUNAAB). The area is located between latitude 70 12' N and 70 18' N, Longitude 3o 20' E and 30 20' E. The vegetation is derived savanna, though this has been modified by various agricultural practices over time.

The climate of Abeokuta falls between the humid and subhumid tropics with a mean annual rainfall of about 1113 mm, two peaks distribution pattern, and five dry months in the year. Mean temperature ranges from 25oC-28oC.The soil temperature which is relatively higher than the air temperature is highest at the 5cm depth (340C to 350C) and decreasing with the depth from 10cm to 50cm from the surface, though still remaining above 300C. The relative humidity is highest in July, August, and September ranging from 86 % to 88 % and lowest in January and February at 66 % to 68 % in most years (Soil Science Society of Nigeria field guide for Abeokuta area, 2004).The study area has an undulating landscape underlain by crystalline basement complex producing very coarse grains with modification of colluvial and colluvial/alluvial sediments at the bottom of the valleys. The rocks show considerable variation in grain size and mineral composition, ranging from very coarse-grained pegmatite to fine-grained schist and from acid quartzite to underlying rocks consisting mainly of amphiboles (Smyth and Montgomery, 1962 and D'Hoore, 1964).Thedominant land-use types in the study area are Cashew, Oil palm, and Arboretum.

2.2 History of Land Use in the Study Area

Arboretum: The arboretum was established in 1990, basically for Teaching and Research purposes. The land is slightly sloppy and at latitude 30 N and longitude 70 E of the University. Common tree species planted in the area are *Gmelinaarborea, Enterelobiumspp, Tectoniagrandis* (Teak), *Chlorophyllumalbidum* and *Treculiaafricana*. Common weeds found growing together with the trees were *Chromolinaodorata*, *Panicummaximum*, *Teneferumconozoides* among others. The tree species are fully grown up and have formed canopy. The soil of the area is well-drained. The area of the land is approximately 10 ha, in which 4 ha was used for this study.

Fallow: This piece of land has been left fallow for 4 to 5 years. It was formerly used for research purposes with crops like soybean, maize previously cultivated on the land. The land is slightly sloppy. Grasses and some shrubs constitute the significant vegetation of the fallow land. It is located at latitude 30 N and longitude 70 E of the University. University cattle graze around this field sometimes, and the soil is well-drained.

Oil palm Plantation: The Oil Palm plantation was estab-

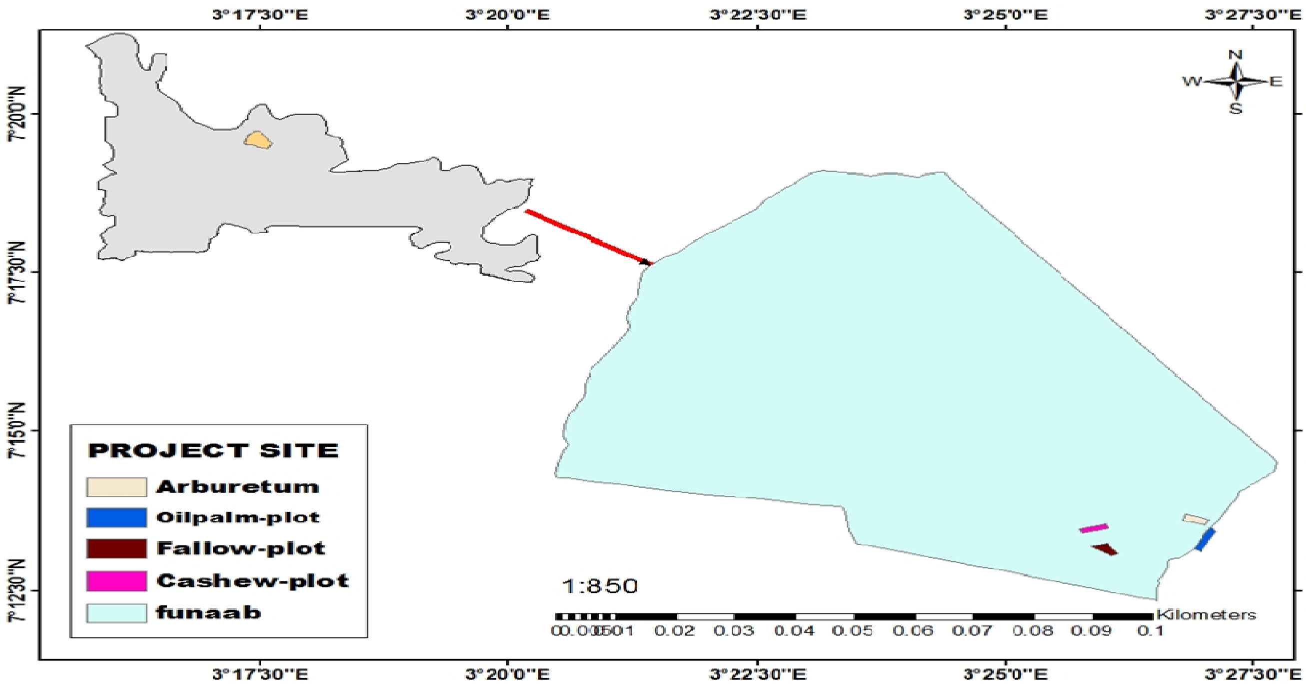

Figure 1: Map of the study area

lished 11years ago with *Tenera* species. The land is very sloppy and at latitude 30 N and longitude 70 E. The soil is well-drained, but down the slope, the soil remains poorly drained due to its closeness to a stream.

Cashew Plantation: The cashew plantation has been in existence for more than 10 years. Different species exist on the land, and it covers a land of approximately 15 ha. It is slightly sloppy with varying species of cashew planted

2.3 Field survey

Four different land-use types were considered for this study namely: Arboretum (land use 1), Cashew (land use 2), Oil palm (land use 3) and Fallow (land use 4). At each of the chosen land-use type, an area of 4ha was demarcated for the study. Surface (0-15 cm) and sub-surface(15-30 cm) soil samples were collected with the aid of soil auger at the intersections of traverses using Rigid Grid method at 100 m intervals for physical, chemical and biological analyses. Are presentative profile pit (2 x 1 x 2 m) was dug at each of the predominant land types, or slope segment and soil types/mapping units encountered at each of the chosen land-use types viz: crest, middle slope and valley bottom. The oil palm and the arboretum had 3 profile pits each dug based on the slope segments of the toposequence. Cashew and the Fallow had 2 profile pits each, based on the soil types encountered on the sites. The general site description such as climate, vegetation, land use, gradient of slope, drainage type, soil surface form, type and degree of erosion, field texture were determined. The profile pits were described morphologically after FAO, (2006) guidelines. They were sampled and placed in labeled bags and then processed in the laboratory after air-drying for at least 72hrs.Soilcolour was determined using Munsellcolour chart.

2.4 Laboratory Analysis

The soil samples were air-dried, ground and sieved with a 2 mm mesh sieve and some were further sieved with 0.5 mm sieve for the organic carbon and nitrogen determination. The Organic Carbon was determined using Walkley and Black method (1934)..Soil pH in both water and 0.01M potassium chloride solution(1:1) were determined with the use of a glass electrode pH meter (Mclean,1965).Exchangeable cations were extracted with 1M NH4OAC (pH7.0), sodium and potassium were determined using flame photometer and exchangeable Mg and calcium by Atomic Absorption Spectrometer (Spark,1965).Available P was extracted using Bray-1 extractant followed by Molybdenum blue colorimetric. Exchangeable acidity was determined by the KCl extraction method (Mclean, 1965).Percentage Base saturation was determined, and effective cation exchange capacity (ECEC) was calculated from the sum of all exchangeable cations. Total nitrogen was determined by the Macro-Kjeldahl digestion method of Jackson (1962). The bulk density was determined by core method. Soil porosity was estimated from the bulk density data at an assumed particle density of 2.65gcm-3.Particle size distribution analysis was determined by the Bouyoucos hydrometer (1951) method using Calgon as dispersing agent. Saturated hydraulic conductivity was determined using constant head method by Mbagwu(1984).

2.5Assessment of Soil Quality Indicator

Soil quality indicators were assessed using the direct method by matching the results of both physical and chemical properties of the soil quality indicators after analysis, with the Soil Quality Index (SQI) presented in Table 1.

2.6 Land Degradation Assessment

Land degradation was assessed through the Direct Approach of FAO (1979) and Snakinet a.1996). In this approach, pedons at each land-use site were placed in degradation classes by matching soil characteristics with land degradation indicators. The estimation of the degree of degradation was based on the physical, chemical and biological parameters of land use types. A broad classification of the seriousness of degradation was made to determine the degree of degradation. These are shown in Tables 2 – 4.

2.7 Statistical Analysis

The data were subjected to Analysis of Variance to assess the effect of different land-use types on the soil quality indices. Mean value were separated by Duncan's Multiple Range Test (DMRT) at $p<0.05$. Correlation analysis was used to assess the relationship between soil quality indices, land uses, and land degradation.

3.0 Results and Discussion

3.1 Soil quality indices as affected by Land Use Types

The result of the soil quality assessment is shown in Table 5.

In the arboretum, the total nitrogen was moderate in all the profiles, which showed that there was improvement in the total nitrogen. The phosphorus content was very low across all the profiles. This is an indication that tree crops utilize more phosphorus than it adds to the soil. The potassium content, however, was high. The Land-use had no adverse effect on bulk density. The value of the organic carbon recorded a possible deficiency at the top horizon while experiencing a moderately adequate level at the B horizon. Calcium, however, was very high and even increased with depth. The sodium content was moderate in all the horizons. Magnesium was at an adequate level needed for most plants.

In the cashew plantation, the total nitrogen also was moderate in all the profiles across the field. The phosphorus content was low. The potassium content was low. The bulk density recorded a possible adverse effect in all the horizons. The value of the organic carbon recorded a possible deficiency in all the horizons. Calcium was very high in its content. The high amount of calcium increased with depth. The sodium content was also moderate. Magnesium was low and could be deficient.

In the oil palm plantation, the total nitrogen was moderate in all the profiles. Phosphorus content and k were low. Magnesium was deficient. Sodium was also moderate. The value of calcium was very high just as seen in other land uses. However, Organic carbon was moderate at the A horizon and low at the remaining horizons.

In the fallow, the nitrogen content was moderate; the phosphorus content was low while the potassium content fluctuated in all the profile. The organic carbon was found to be low in A and B horizons but moderate in the C horizon. The sodium content, magnesium and the bulk density were moderate.

At the valley bottom, however, the value of the bulk density recorded a possible adverse effect on the fallow, but arboretum and oil palm had no adverse impact on the bulk density. The nitrogen content was moderate in all the land uses. Phosphorus was low in all the land uses while calcium content was very high. Sodium was moderate in all the land uses. Potassium was high in arboretum, moderate in fallow and low in cashew and oil palm. Magnesium was moderate in arboretum and fallow but deficient in cashew and oil palm. Organic carbon was low in arboretum but fluctuated in the rest of the land uses.

The results of degradation are presented in tables 6-9.

3.2 Physical Degradation

At LUT 1 (Arboretum), 100 % of the soils were none to slightly degraded for the bulk density. In LUT2 (Cashew), 50 % of the soils were none to slightly degraded, and 50 % of the soils were moderately degraded. In LUT 3 (Oil palm), 95 % of the soils were none to slightly degraded and 5 % were moderately degraded, and in LUT 4 (Fallow), 50% of the soil was none to slightly degraded, and 50 % were moderately degraded. This was for the bulk density. The hydraulic conductivity was 100 % none to slightly degraded.

3.3 Chemical Degradation

The Base saturation at all the locations in the land-use types was 100 % very highly degraded. In LUT 1, 100% of the soils were none to slightly degraded with respect to Nitrogen. In terms of the Phosphorus, 5 % of the soils were none to slightly degraded and 95% very highly degraded. For potassium, 100 % of the soils were very highly degraded.

In LUT 2, 100 % of the soils were none to slightly degraded in Nitrogen. 20 % none to slightly degraded, 10% highly degraded, and 70% very highly degraded for Phosphorus. For potassium, it was observed that 100 % of the soils were highly degraded.

In LUT 3, 80 % of the soils were none to slightly degraded, 15 % were moderately degraded, and 5 % of the soils were very highly degraded in nitrogen. In terms of phosphorus, 5 % of the soils were highly degraded, and 95 % were very highly degraded, and for potassium, 100 % of the soils were very highly degraded.

In LUT 4, 100 % of the soils were none to slightly degraded in nitrogen. 10% none to slightly degraded, 90 % of the soils were very highly degraded of phosphorus. Concerning potassium, 100 % of the soils were very highly degraded.

3.4 Biological Degradation

In LUT 1, 75 % of the soils were none to slightly degraded, 10 % of the soils were moderately degraded, and 15 % were highly degraded. In LUT 2, 20 % of the soils were none to slightly degraded, 15 % of the soils were moderately degraded, and 55% highly degraded, 10% very highly degraded. In LUT 3, 5% of the soils were none to slightly degraded, 30% moderately degraded, 60% highly degraded and 5% very highly degraded

In LUT 4, 15 % of the soils were none to slightly degraded, 10% moderately degraded, 50% highly degraded, 25% very highly degraded.

3.5 Relationship between soil quality and degradation

The results of the correlation between soil quality and degradation (physical, chemical, and biological) are presented in Tables 10-13 for all the Land Use Types in the study area.

In Land Use Type 1 (arboretum), there was a negative correlation ($p<0.05$) between phosphorus and total nitrogen. There was a positive correlation ($p<0.01$) between organic carbon, land use, total nitrogen, and potassium. There was also a positive correlation ($p<0.01$) between the bulk density, land use, and organic carbon while a positive relationship existed ($p<0.05$) between the bulk density, total nitrogen, phosphorus, and potassium.

In Land Use Type 2 (cashew), there was a positive correlation ($p<0.01$) between phosphorus, organic carbon, and land use. The bulk density recorded a positive relationship ($p<0.01$) with phosphorus and a negative correlation ($p<0.01$) with organic carbon and land use type. There was also a positive correlation ($p<0.01$) between potassium, organic carbon, land use type, while a negative correlation ($p<0.05$) existed between potassium and bulk density.

In Land Use Type 3 (oil palm), there was a positive correlation ($p<0.01$) between bulk density, organic carbon, land use type, potassium, and phosphorus. A negative correlation ($p<0.05$) between total nitrogen and potassium existed.

In Land Use Type 4 (fallow), there was a positive correlation ($p<0.01$) between phosphorus and land use type while a negative relationship existed at the same probability between phosphorus and total nitrogen. A negative correlation ($p<0.01$) existed between potassium, land use types, and phosphorus. A positive correlation also existed ($p<0.01$) between organic carbon, land use types and phosphorus. Moreover, a positive correlation existed between bulk density, total nitrogen, potassium and organic carbon ($p<0.01$).

4.0 ***Discussion***

The high percentage of sand in all the land uses is a good indication of the observable high infiltration rate (Fagbemi and Udoh 1992; Senjobi 2007). The poor water holding capacity of the soils, which is as a result of coarse texture of the studied soil, enhanced erodibility of the soil which may have been exposed through cultivation and livestock grazing. The same trend was observed in land use 4 (Fallow). Bulk density >1.65g/cm3 may impede roots and inhibits development and water movement (Aminu *et al*., 2013). The increase in soil bulk density can be probably attributed to the loss of organic matters through tillage practices. It is anticipated that tillage operations and surface soil disturbance will reduce organic matter and bring about soil degradation. This conforms with Click (2005); Bahramie *et al*., (2010) who reported negative correlation between the bulk density and porosity. Ogunkunle *et al*., (2014) also supported that soils with bulk density values as recorded in almost all the land uses are indicative of compaction prone soils which will hinder root elongation, reduce aeration and impede water infiltration and movement within the root zone. The porosity was generally low (<60%). This could be as a result of the high bulk density (Aminu *et al*., 2013).

All the land use types observed moderate N content may be due to the accumulation of litter falls. This could be as a result of an imbalance in the accumulation of litter falls and the rate of decomposition by micro-organisms. This means that the rate of mineralization is on a reduction trend compared to the rate of accumulation.

Soil organic carbon is one of the principal components, and critical parameter of soil quality since soil organic carbon content correlates strongly with many soil properties and functions such as porosity, soil structural stability, and water holding capacity.

The organic carbon followed no definite pattern with depth for most of the pedons, and this is an indication of organic matter deposition at a regular interval. Organic carbon was also observed to be low in some pedons and high in others. This may be due to micro-organisms activities which aid decomposition of organic materials which are favoured by the high temperature and relative humidity and effect of previous land use (Agboola *et al*., 1976). Ahn, 1970 and Senjobi, 2007 reported that organic matter has a positive influence on the CEC, structure, pH, soil colour water holding capacity, buffering capacity and base saturation. Chew and Pushparajah(1996) reported that organic carbon increase was not noted in oil palm plantation due to the uneven redistribution of recycled fronds. This was also supported by Chen (1999).

).e. The level of organic carbon, nitrogen, calcium, magnesium, and phosphorus were similar under arboretum and cashew, suggesting that organic matter and nutrients cycles in a cashew plantation are similar to those in the tree plantation (Aweto and Ishola 1993). Aweto *et al*. (1993)also reported that organic carbon in teak plantation varied from 0.9 to 2.3 % while nitrogen varied from 0.21 % to 0.27 % and that soils of both teak and forest plantations were poor in phosphorus. Magnesium and Potassium were generally low but Ca was very high in all the pedons. The observed low values of magnesium and potassium may be as a result of leaching and weathering consequence.

In arboretum based land-use type, degradation ranges from moderate to very high for both chemical and biological degradation except for nitrogen which was mainly none to slight. This may be as a result of the high rate of utilization of potassium and phosphorus by the tree crops (Aweto *et al*., 1995). However, the bulk density, hydraulic conductivity, and nitrogen which are none to slight could be attributed to the ability of trees to stabilize the soils vis-à-vis the inherent feature of forest soils to accumulate dead leaves and rotten woods (Young, 1989).

In the Oil palm and Cashew based land uses, degradation ranges from moderate to very high for chemical and biological degradation except for nitrogen, which was moderate to slight. This could be as a result of high utilization of potassium and phosphorus by Oil palm and Cashew (Aweto *et al*., 1995). The bulk density and the hydraulic conductivity were none to slightly degraded, attributable to heavy clay content presence coupled with the use of machinery in weed clearing (Aminu *et al*., 2013).

Table 1: Selected soil properties for Tropical Soil Quality Index (TSQI)

Parameters	Levels	Interpretation
Bulk density (g cm^{-3})	> 1.5	Possible adverse effects
Total nitrogen in mineral soils (%)	>0.5	High – excellent reserve of nitrogen.
	0.1-0.5	Moderate – adequate levels.
	<0.1	Low – could indicate loss of organic N.
Exchangeable Na (%)	>15	High – sodic soil with associated problems.
Exchangeable K ($cmolkg^{-1}$)	>1.28	High – excellent reserve.
	0.26-1.28	Moderate – adequate levels for most plants.
	<0.26	Low – possible deficiencies.
Exchangeable Mg (cmol kg^{-1})	>4.17	High – excellent reserve
	0.42-4.17	Moderate – adequate levels for most plants.
	<0.42	Low – possible deficiencies.
	>5.00	High – excellent reserve, probably calcareous soil.
Exchangeable Ca (cmol	0.51-5.00	Moderate – adequate levels for most plants.
Available P (mg kg^{-1})	15-30	Moderate – adequate levels for plant growth
Total carbon in mineral soils (%)	>5	High excellent buildup of organic C with all associated benefits.
	1-5	Moderate adequate levels.
	<1	Low – could indicate possible loss of organic C from erosion or other processes, particularly in temperate Countries.
Soil acidity	6.81-7.2	Near neutral – optimum for many plant species except those that prefer acid soils

Source: Modified from Amacher et al., 2007

Table 2: Indicators & Criteria of Physical degradation of soils

Indicator	Initial level	1	2	3	4
Soil bulk density	1.25-1.4	<1.5	1.5-2.5	2.5-5	>5
Hydraulic conductivity		<0.13	0.13-0.15	0.15-2.	2.0-6.3

Source: FAO, (1979)

Table 3: Indicators & Criteria of Chemical degradation of soil

Indicator	1	2	3	4
Content of Nitrogen	<0.13	0.10-0.13	0.08-0.10	<0.08
Content of Phosphorus	>8	7-8	6-7	<6
Content of Potassium	>0.16	0.14-0.16	0.12-0.14	<0.12
Content of Base Saturation	<2	2-3	3-5	>5

Source: FAO, (1979)

Table 4: Indicator & Criteria of Biological degradation of soil

Indicator	**1**	**2**	**3**	**4**
Content of organic matter in the soil	>2.5	2-2.5	-2.0	<1.0

Source: FAO, (1979)

Where 1= none to slightly degraded soils

2= moderately degraded soils

3= highly degraded soils

Table 5: Assessment of Soil Quality Indices under Different Land Uses.

Bulk density	**1**	**1.08NE**	**1.58PE**	**1.22NE**	**1.21NE**	**NE=Noeffect; PE=Possible effect**
	2	**1.12NE**	**1.60PE**	**0.00NE**	**1.23NE**	
	3	**N.D**	**N.D**	**N.D**	**N.D**	
T.N (%)	1	0.22M	0.17M	0.11M	0.16M	M= Moderate
	2	0.19M	0.14M	0.11M	0.17M	
	3	0.16M	0.14M	0.13M	0.11M	
Phosphorus	1	5.79L	2.40L	1.67L	1.98L	L= Low
	2	2.58L	3.55L	2.31L	2.00L	
	3	2.58L	4.83L	3.26L	4.69L	
Organic. C (%)	1	0.76L	0.28L	1.04M	0.83L	L= Low; M= Moderate
	2	1.23M	0.40L	0.68L	0.81L	
	3	0.58L	0.68L	0.44L	1.07M	
Ca (cmol/kg)	1	25.95VH	27.16VH	37.76VH	16.07VH	VH= Very high
	2	27.37VH	28.04VH	34.66VH	28.04VH	
	3	27.95VH	34.24VH	32.15VH	34.24VH	
Na (cmol/kg)	1	5.44NE	0.02NE	0.05NE	0.49NE	NE= No effect
	2	3.28NE	0.03NE	0.05NE	1.05NE	
	3	4.39NE	0.04NE	0.05NE	0.71NE	
Mg(cmol/kg)	1	1.76M	0.08L	0.11L	1.48M	L= Low; M= Moderate
	2	2.22M	0.11L	0.11L	2.18M	
	3	2.14M	0.12L	0.11L	2.15M	
Potassium (cmol/kg)	1	2.45H	0.01L	0.01L	0.23L	L= Low; M= Moderate
	2	2.65H	0.03L	0.01L	0.31M	
	3	3.50H	0.02L	0.01L	0.13L	

Table 6: Scores for physical, chemical and biological degradation of LUT 1 (Arboretum)

Sampling point	Depth	Physical properties	Chemical properties					Biological O.M
		B.D	H.c	B.sat	N	P	K	Biological O.M
1	0-15	1	1	4	1	4	4	1
	15-30	1	1	4	1	4	4	1
2	0-15	1	1	4	1	4	4	1
	15-30	1	1	4	1	4	4	2
3	0-15	1	1	4	1	1	4	1
	15-30	1	1	4	1	4	4	1
4	0-15	1	1	4	1	4	4	1
	15-30	1	1	4	1	4	4	1
5	0-15	1	1	4	1	4	4	3
	15-30	1	1	4	1	4	4	1
6	0-15	1	1	4	1	4	4	2
	15-30	1	1	4	1	4	4	1
7	0-15	1	1	4	1	4	4	2
	15-30	1	1	4	1	4	4	1
8	0-15	1	1	4	1	4	4	1
	15-30	1	1	4	1	4	4	2
9	0-15	1	1	4	1	4	4	1
	15-30	1	1	4	1	4	4	1
10	0-15	1	1	4	1	4	4	1
	15-30	1	1	4	1	4	4	1

Table 7: Scores for physical, chemical and Biological Degradation of land use 2 (Cashew)

Land use	**Depth**	**Physical**	**Chemical**					**Biological O.M**
		B.D	H.c	B.sat	N	P	K	Biological O.M
1	0-15	2	1	4	1	4	4	1
	15-30	2	1	4	1	4	4	1
2	0-15	2	1	4	1	4	4	1
	15-30	1	1	4	1	4	4	2
3	0-15	1	1	4	1	1	4	1
	15-30	2	1	4	1	4	4	1
4	0-15	1	1	4	1	4	4	1
	15-30	2	1	4	1	4	4	1
5	0-15	1	1	4	1	4	4	3
	15-30	1	1	4	1	4	4	1
6	0-15	1	1	4	1	4	4	2
	15-30	2	3	4	1	4	4	1
7	0-15	2	3	4	1	4	4	2
	15-30	2	3	4	1	4	4	1
8	0-15	2	3	4	1	4	4	1
	15-30	2	3	4	1	4	4	2
9	0-15	1	1	4	1	4	4	1
	15-30	1	1	4	1	4	4	1
10	0-15	1	1	4	1	4	4	1
	15-30	1	1	4	1	4	4	1

Table 8: Scores for Physical, Chemical and Biological degradation of land use 3 (oil palm)

Land use	**Depth**	**Physical**	**Chemical**					**Biological O.M**
		B.D	H.c	B.sat	N	P	K	Biological O.M
1	0-15	1	1	4	1	4	4	3
	15-30	1	1	4	2	4	4	2
2	0-15	1	1	4	1	4	4	2
	15-30	1	1	4	1	4	4	3
3	0-15	1	1	4	1	3	4	3
	15-30	1	1	4	1	4	4	2
4	0-15	1	1	4	1	4	4	3
	15-30	1	1	4	2	4	4	2
5	0-15	1	1	4	4	4	4	4
	15-30	1	1	4	1	4	4	1
6	0-15	1	1	4	1	4	4	3
	15-30	2	1	4	2	4	4	3
7	0-15	1	1	4	1	4	4	3
	15-30	1	1	4	1	4	4	3
8	0-15	1	1	4	1	4	4	2
	15-30	1	1	4	1	4	4	2
9	0-15	1	1	4	1	4	4	3
	15-30	1	1	4	1	4	4	3
10	0-15	1	1	4	1	4	4	3
	15-30	1	1	4	1	4	4	3

Table 9: Scores for Physical, Chemical and Biological degradation of land use 4 (fallow)

Land use	Depth	Physical		Chemical				Biological
		B.D	H.c	B.sat	N	P	K	O.M
1	0-15	1	1	4	1	1	4	3
	15-30	1	1	4	1	4	4	2
2	0-15	1	1	4	1	4	4	3
	15-30	1	1	4	1	4	4	3
3	0-15	1	1	4	1	3	4	3
	15-30	1	1	4	1	4	4	4
4	0-15	1	1	4	1	4	4	3
	15-30	1	1	4	1	4	4	1
5	0-15	1	1	4	1	4	4	4
	15-30	1	1	4	1	4	4	3
6	0-15	2	1	4	1	4	4	1
	15-30	2	1	4	1	1	4	3
7	0-15	2	1	4	1	4	4	2
	15-30	2	1	4	1	4	4	3
8	0-15	2	1	4	1	4	4	3
	15-30	2	1	4	1	4	4	4
9	0-15	2	1	4	1	4	4	4
	15-30	2	1	4	1	4	4	4
10	0-15	2	1	4	1	4	4	1
	15-30	2	1	4	1	4	4	3

Table 10: Relationship between soil quality and degradation in LUT 1 (arboretum)

	LUT	**T.N**	**P**	**K**	**O.C**	**B.D**
LUT	-					
TN	0.27	-				
P	-0.2428	-0.5682*	-			
K	-0.1178	0.0232	-0.1304	-		
OC	0.9998**	0.9278**	-0.2495	0.7407**	-	
B.D	0.7451**	0.4482*	0.4600*	0.4467*	0.6560**	-

**Correlation is significant at 5%*

***Correlation is significant at 1%*

Table 11: Relationship between soil quality and degradation in LUT 2 (Cashew)

	T.N	**OC**	**LUT**	**P**	**B.D**	**K**
T.N	-					
OC	0.1806	-				
LUT	0.3310	0.0322	-			
P	0.0979	0.9715**	0.9721**	-		
B.D	-0.3152	-0.7880**	-0.7895**	0.8542**	-	
K	-0.0870	0.6692**	0.6699**	-0.4395	-0.4570*	-

**Correlation is significant at 5%*

***Correlation is significant at 1%*

Table 12: Relationship between soil quality and degradation in LUT 3 (oil palm)

	OC	**LUT**	**P**	**B.D**	**K**	**T.N**
LUT	0.3557	-				
P	-0.0800	-0.0766	-			
B.D	0.9210**	0.9207**	-0.5534**	-		
K	-0.0190	-0.0170	-0.0115	0.6043**	-	
T.N	-0.3557	0.3563	0.2839	0.0867	-0.4570*	-

**Correlation is significant at 5%*

***Correlation is significant at 1%*

Table 13: Relationship between soil quality and degradation in LUT 4 (fallow)

	LUT	**T.N**	**P**	**K**	**O.C**	**B.D**
LUT	-					
TN	-0.0517	-				
P	0.6257**	-0.6624**	-			
K	-0.6864**	0.3339	-0.8550**	-		
OC	0.9999**	-0.3098	0.6205**	-0.0528	-	
B.D	-0.0588	0.7834**	-0.6155**	0.6669**	0.6522**	-

**Correlation is significant at 5%*

***Correlation is significant at 1%*

5.0 Conclusions

The study inferred from the assessment of the soil quality indicators concerning the physical, chemical and biological parameters under different land use that Arboretum improved the availability of sodium, potassium and total nitrogen. In the oil palm plantation, most of the nutrients were leached down the profile or probably held up in the clay content which was highly improved and compacted. Total nitrogen was moderate; sodium was enhanced. Cashew plantation did not improve the availability of organic carbon, magnesium, potassium, available phosphorus but improved the total nitrogen. The exchangeable bases have been used up or leached away, and this, on the other hand, left the soil to be slightly acidic. The pH of the soil confirmed this claim. In the physical parameter, however, the bulk density had a possible adverse effect. In Fallow land, sodium, total nitrogen, and magnesium were all moderate.

Concerning the degradation of the land, in Arboretum, potassium, and phosphorus were highly degraded but nitrogen remained undegraded. The physical parameters were also favoured even though some were adversely affected, but the adverse effect could be said to be very minimal and not significant in the process. In Oil palm, phosphorus, potassium, base saturation, and organic matter were degraded. In Cashew plantation, base saturation, potassium, phosphorus and percentage organic matter were degraded. In Fallow, potassium, phosphorus and base saturation were highly degraded while nitrogen was none to slightly degrade.

Recommendations

Based on the study, the following recommendations are made:

Proper land use and soil survey must be conducted to determine the actual suitability of the land before any land-use system is adopted.

Since there was a positive correlation between tree crops, nitrogen, and carbon, it is highly advisable to invest in tree crops to continually purify the environmental nitrogen and withholding soil carbon in the process.

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