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Effects of Plant Species on the Physico-chemical Properties of Soil in Falgore Game Reserve, Kano State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study was carried out to examine the effect of plant species on soil properties in the Falgore Game Reserve (FGR) in Kano State, Nigeria; with the aim to promote sustainable conservation and management of the game reserve and to encourage the use of multiple tree species on farmlands. Strata, systematic and random sampling techniques were employed in order to capture the variability of land cover. Composite samples of soil were randomly collected at a depth of 0-30cm from sample plots of 50 m × 50 m sizes at five points using soil auger. This experiment was replicated four times. The samples were thoroughly mixed and spread out on a dry floor to air dried under the roofed shade. The samples were packaged in polythene bags and taken to the biological science laboratory (Bayero University Kano, Nigeria) for preparation and analysis. The data collected were analyzed using descriptive statistics, ANOVA and Correlation at $p< 0.05$. Based on this finding, shrubs and tree species diversity were found to be inversely related to soil total Nitrogen, N, % O.C and soil p^H (H_2O). The nitrogen content of the soil sample was more stable compared with the carbon content across the strata in the study area. The results of this finding

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revealed that plants species diversity have different effects on soil properties of FGR. Thus, it is recommended that conservation and restoration of threatened plant species should be encouraged for soil amendment. For easy adoption of plant species on farmlands, farmers should be enlightened more on the effects and environmental functions of trees on farm land.

Keywords: Forest; sustainable; soil nutrients; conservation; land cover; soil property.

1. INTRODUCTION

Soil nutrients depletion as a result of environment degradations and rapid population growth [1]; is one of the most environmental problems affecting soil nutrients. Soil nutrients improvement play vital role for high growth and production of agricultural crops [2]. Nutrient availability depends on the general soil conditions, soil life and organic matter content [3]. Agricultural production in low input system in the tropics relies largely on nutrient recycling and maintenance of soil fertility through biological processes [2].

Intensive cultivation and past use of fire to clear vegetation have led to the degradation of lands in general; also, the degradation process is being accelerated by charcoal production. This turn led to a negative impact in the natural arrangement of the soil. The impact of charcoal production on the chemical and physical properties of soil in Nigeria can be traced to the heat generation during production and ash that always accompany the charcoal in the production site [4].

Consequently, research efforts have been geared towards organic farming with the use of trees on farmland intensified. The collective name for land-use systems in which trees are grown with agricultural crops and/or pasture and livestock on the same unit of land is known as agro-forestry [5]. Agroforestry offers a potential solution to the problem of land degradation and declining agricultural production in the tropics [6]. It is a viable option of obtaining farmers participation in tree planting [7]. There is no doubt that trees have played important role in soil conservation and management throughout the tropics. The choice of tree species for use in agroforestry is very important and to a large extent determines the success or failure of the system [1].

Soil and vegetation has a complex interrelationship; soil properties influence the vegetation and *vice versa*. Selective absorption of nutrients by different tree species and their capacity to return these to the soil brings about changes in the soil properties [8]. The destruction of vegetation through forest clearing for cropping purposes further reduces the vegetation cover thereby leading to erosion, especially in the sloppy area. Leaching of nutrients below the rooting zone of crops as a result of water logging, and the volatilization of nitrogen (N) and deficiency of phosphorus are common [1]. To improve soil nutrients for self-sufficiency in food production, this study aim at evaluating soil pyhsico-chemical properties in Falgore Game Reserve (FGR); and to determine the effect of plant species on the soil properties in order to make recommendation for improving soil fertility and boosting food production in the study area.

2. MATERIALS AND METHODS

2.1 The Study Area

Falgore Game Reserve (FGR) was established in 1949 by the British colonial government; in 1969 the Kano State Government in Nigeria upgraded it into a game reserve. FGR (see Fig. 1) is located between Latitude $10^{o}50^{1}$ and 11^{o} 50^{1} N and Longitude $8^{o}35^{1}$ and $8^{0}45^{1}$ E. It has a mean length of 50km North to South and a width of 28 km East to West. The altitude of the study area ranges between 95-185 m, while the elevation above mean sea level ranges from 650 m at the northern margin to 1200 m at the southern tip. The highest peak within the FGR is about 1230 m above the sea level [9]. The present climate of the study area is tropical wet and dry type. Rainfall is about 1000 mm decreasing to about 800 mm around Kano metropolis. The temperature is warm to hot throughout the year, but very cool during the Harmattan period (between Novembers to February). The monthly mean values range between 21ºC in the coolest months (December-January) and 41ºC in the hottest months (April-May) [9].

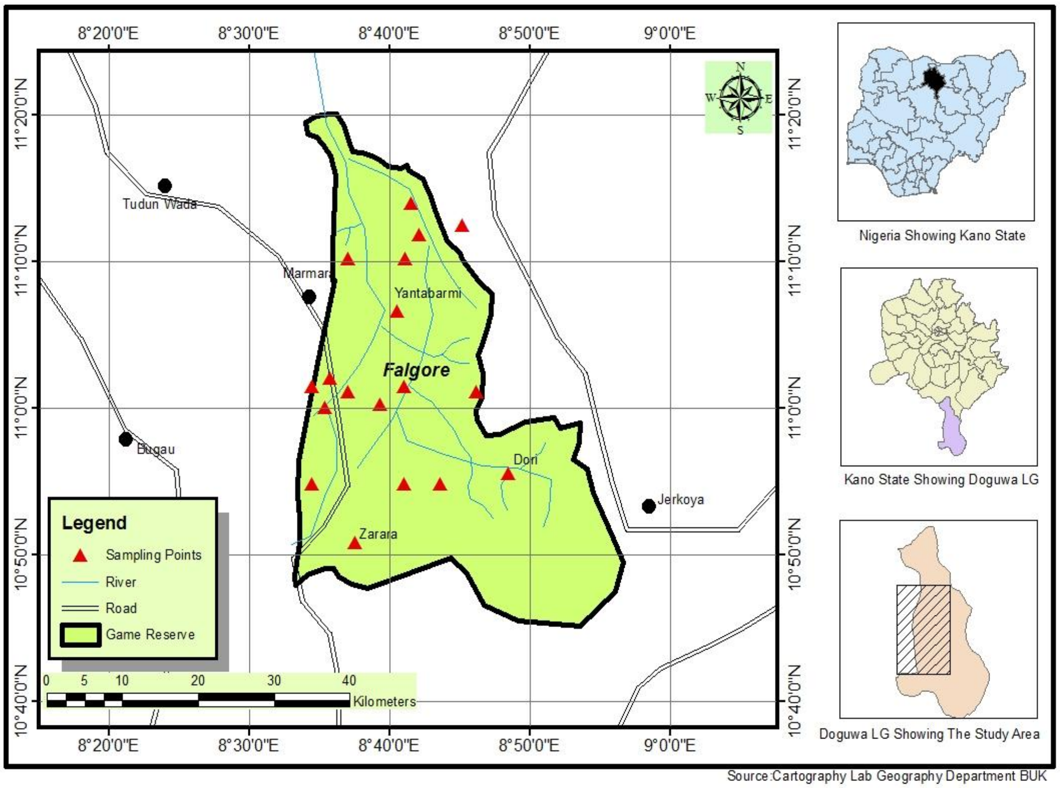

Fig. 1. Map of Falgore Game Reserve, showing the sampling plots
Source: Cartography lab. Geography department, Bayero University, Kano

2.2 Sampling Procedure and Soil Sample Collection

Stratified and systematic sampling techniques were employed in order to capture the variability of land cover. The study area was stratified into distinct topographic locations, namely: hill top, sloppy area, level ground and the riparian forest.

At each stratum, a baseline was established parallel to the edge of the forest. A one kilometer long line transects perpendicular to the baseline was laid in each of the four strata in the study area. On both sides of each transect, 50 m × 50 m sampling plots were systematically established at a predetermined interval of 200 m. This gave a total of ten sampling plots in each stratum, and a total of forty (40) plots for the study. Soil samples were collected systematically at a depth of 0-30 cm from each of the 50 m × 50 m sampling plots at five points using soil auger. The soil samples were mixed together to make a composite samples. The soil samples were thoroughly mixed and spread out on a dry floor to air dry under roofed shade; then packaged in polythene bags and taken to the biological science laboratory (Bayero University Kano, Nigeria) for preparation and analysis. In the laboratory the dried soils were grinded with a mortar and pestle and passed through a 2 mm sieve.

2.3 Laboratory Analysis of Soil Physico-Chemical

Soil particle distribution was determined using hydrometer method as described by Gee and Bauder [10], thus:

$$\% \text{ clay} = \frac{\text{corrected 2hr reading} - \text{blank}}{\text{weight of sample}} \times 100 \qquad \text{Equation [1]}$$

$$\% \text{ silt} = \frac{\text{corrected 40s reading} - \text{blank}}{\text{weight of sample}} \times 100 \qquad \text{Equation [2]}$$

$$\% \text{ sand} = 100 - (\% \text{ silt} + \% \text{ clay}) \qquad \text{Equation [3]}$$

The blank was run in distilled water and Calgon without the soil sample Soil pH was determined using glass electrode pH meter both in distilled water and 0.01 M $CaCl_2$ using 1:1 soil solution ratio.Soil organic carbon (O.C) was analyzed using wet oxidation method of Walkley and Black [11], thus:

$$\% \text{ O.C} = (\text{me } K_2C_20_7\text{-me } FeSO_4) \times 0.003 \times 100 \times (f) \qquad \text{Equation}[4]$$

Where

Correction factor, f = 1.33, and me = Normality of solution × ml of solution used.

Total Nitrogen was determined by macro-Kjeldahl digestion procedure as described by Nelson and Sommers [12]. Nitrogen was calculated as shown below:

$$\% \text{ N} = \frac{0.01\ 4 \times VD \times 1\ 00 \times N \times TV}{Weight of soil \times AD} \qquad \text{Equation [5]}$$

Where

VD = Volume of digest =100 ml, N = Normality of acid = 0.025N, AD = Aliquot of digest =10 ml, TV = Titre value.

Available Phosphorus was determined by Bray No 1 acid Fluoride method as outlined by Juo [13]. Exchangeable bases (Calcium, Ca, Potassium, K and Magnesium, Mg) were extracted in 1 N neutral ammonium acetate solution according to Chapman, as described by Anderson and Ingram [14].

2.4 Statistical Analyses

One-way ANOVA was used to test for significant differences in mean values of the soil samples.Pearson correlation was used to show the relationship between the vegetation types and soil nutrient statuses across the study area. The formula for Pearson Correlation is given as follows:

$$r = \frac{N\sum xy - (\sum x)(\sum y)}{\sqrt{[N\sum x^2 - (\sum x)^2][N\sum y^2 - (\sum y)^2]}} \ldots \qquad \text{Equation [6]}$$

Where

N = number of pair of scores, EXY = sum of the products of paired scores, EX = sum of X scores, Ey = sum of Y scores, EX^2 = sum of squared X scores, EY^2 = sum of squared Y scores.

3. RESULTS

3.1 Soil Physical Properties across the Land Use Types in Falgore Game Reserve

The mean textural value generally indicated higher sandy content in all the four locations of the study. Percentage sand ranged between 45.28% in the Level ground and 53.28% in the Sloppy area. Percentage sand was found to be 51.28% each for the Hill top and the Riparian forest. The highest percentage silt (38.56%) was recorded in the Riparian forest. This was followed by the Hill top which recorded a percentage silt 36.56%.Level ground and Sloppy area recorded 34.56% each. Level ground was found to have recorded the highest percentage clay (20.16%), while the least value of % Clay (10.16%) was obtained in the Riparian forest. From the textural triangle, the soil type in all the study sites is Loamy, except in the Sloppy area which was found to have a sandy – loam type of soil (Table 1).

3.2 Soil Chemical Properties across the Four Land Uses in Falgore Game Reserve

The soil pH was tested in water and in calcium chloride (Table 2).There was no significant difference in pH (H_2O) values obtained in the Sloppy area (5.720) and the Riparian forest (5.79). Similar pattern was observed for soil pH

Table 1. Mean values of soil physical properties across the land use types in the study area

Soil properties	HT	LG	RF	SA	*P*-value
Sand (%)	51.790 ± 0.510^b	45.290 ± 0.010^c	51.295 ± 0.015^b	53.295 ± 0.030^a	<0.01
Silt (%)	36.540 ± 0.020^b	34.525 ± 0.035^c	38.495 ± 0.065^a	34.590 ± 0.030^c	<0.01
Clay (%)	12.175 ± 0.015^b	20.175 ± 0.015^a	10.195 ± 0.035^c	12.160 ± 0.000^b	<0.01
Tex. Class	Loam	Loam	Sandy loam	Loam	

Means on the same row with different superscript are statistically significant (p<0.05)
L.F = Life form, L.G =Level ground, H.T = Hilltop, S.A = Sloppy area, R.F = Riparian forest, F.G.R = Falgore game reserve, Tex. Class = Textural Class

in $CaCl_2$ with a high pH values of 5.09 and 4.89 recorded in the Hill top and the Riparian forest, respectively. The least pH value (4.17) in $CaCl_2$ was recorded in the Level ground (Table 2).

There was a significant difference in Percentage Organic carbon (O.C) recorded in the four study sites. O.C ranged between 0.814 in the Level ground and 1.398% in the Hill top. This indicates an increase of 0.575%. Similar values of O.C were recorded for the Sloppy area (1.309%) and 1.005% for the Riparian forest (Table 2).The ANOVA results indicated that there was no significant difference in the mean values of % Nitrogen for the four study sites. The Nitrogen (N) of the soils ranged between 0.1405% recorded in the Sloppy area and 0.105% recorded in the other three locations (L.G, H.T and R.F). A significant difference was observed in the Phosphorus (P) content of the Hill top and that of the other three locations.

The mean values of P ranged from 13.851 ppm in the Riparian forest to 26.935 ppm in the Hill top. This indicates an increase of 13.084 ppm between the highest and the lowest values. There were significant differences in the calcium (Ca) content of the soils in the four study sites. Highest Ca content (2.735 Cmol/kg) was recorded in the Level ground, while the lowest Ca value (2.156 Cmol/kg) was recorded in the Sloppy area.

Hill top and the Riparian forest recorded almost similar values of 2.616 Cmol/kg and 2.612 Cmol/kg respectively (Table 2). The highest mean value of Magnesium (Mg) (2.00 Cmol/kg) was recorded in the Riparian forest, while the least value (1.659 Cmol/kg) was recorded in the Level ground. Almost similar mg values of 1.927 Cmol/kg and1.982 Cmol/kg were recorded for the Sloppy area and Hill top sites respectively. The mean Potassium (K) content was found to be highest in the Level ground (0.316 Cmol/kg). This was followed by the Riparian forest and Sloppy area which recorded a K mean values of 0.268 Cmol/kg and 0.227 Cmol/kg respectively. The lowest mean value of K content (0.215 Cmol/kg) was recorded in the Hill top.

3.3 Correlation Matrix of the Soil Properties in the Study Area

The correlation matrix of Soil properties is presented on Table 3. The results showed a highly significant relationship between % O.C and P,K and % sand ($P\leq 0.01$). The results also reveals a significant relationship between % O.C and pH ($CaCl_2$) ($P\leq 0.05$). There was no significant relationship between N and all the other chemical elements except with Ca ($p\leq0.01$). Phosphorus was found to be highly significantly related to pH (H_2O) ($p\leq 0.01$) while it was significantly related to K and pH ($CaCl_2$) ($p\leq 0.05$). It was also observed (Table 3) that Ca had no significant relationship with all the elements except with % Sand ($p\leq 0.05$.). Table 3 further reveals a negative but highly significant relationship Mg and % Clay($p\leq 0.01$).There was also a negative but highly significant relationship between K and % Sand ($p\leq 0.01$) based on the result on Table 3.

Correlation Matrix between Soil Properties and Density of Flora Life-form in the Study Area Results in Table 4, reveals a negative but highly significant relationship between O.C and the density of Shrubs and Trees in the study area. It shows no significant relationship between N and all the plant life-forms except Sapling ($p\leq 0.01$). Phosphorus was observed to have a negative

Table 2. Mean values of soil chemical properties across the four land uses in falgore game reserve

Soil properties	Land use				P-Value
	HT	LG	RF	SA	
OC (%)	1.399±0.010^a	0.817±0.003^d	1.002±0.002^c	1.304±0.004^b	<0.01
N (%)	0.107±0.002^b	0.107±0.002^b	0.107±0.002^b	0.150±0.100^a	0.01
P (ppm)	26.903±0.032^a	14.175±0.014^c	13.786±0.065^d	18.531±0.050^b	<0.01
Ca (Cmol/Kg)	2.673±0.057^{ab}	2.772±0.037^a	2.596±0.016^b	2.188±0.032^c	<0.01
Mg (Cmol/Kg)	1.916±0.066^a	1.624±0.034^b	2.050±0.050^a	1.928±0.001^a	0.01
K (Cmol/Kg)	0.222±0.007^c	0.318±0.002^a	0.269±0.001^b	0.228±0.001^c	<0.01
pH (H_2O)	6.535±0.035^a	5.920±0.020^b	5.760±0.030^c	5.705±0.015^c	<0.01
pH ($CaCl_2$)	5.105±0.015^a	4.180±0.010^b	4.495±0.395^{ab}	4.685±0.025^{ab}	0.04

Means on the same row with different superscript are statistically significant (p<0.05)
H.T = Hilltop, L.G = Level ground, R.F = Riparian forest, S.A = Sloppy area

Table 3. Correlation matrix of soil properties in the study area

	OC (%)	N (%)	P (ppm)	Ca (Cmol/Kg)	Mg (Cmol/Kg)	K (Cmol/Kg)	Sand (%)	Silt (%)	Clay (%)	pH (H_2O)	pH ($CaCl_2$)
OC (%)	-										
N (%)	0.41	-									
P (ppm)	0.85**	0.02	-								
Ca (Cmol/Kg)	-0.49	-0.88**	-0.03	-							
Mg (Cmol/Kg)	0.49	0.16	0.17	-0.46	-						
K (Cmol/Kg)	-0.97**	-0.44	-0.75*	0.59	0.66	-					
Sand (%)	0.83**	0.53	0.45	-0.70*	0.81*	-0.90**	-				
Silt (%)	0.02	-0.48	-0.02	0.24	0.70*	-0.15	0.32	-			
Clay (%)	-0.63	-0.22	-0.30	0.47	-0.95**	0.76*	-0.91**	-0.67	-		
pH (H_2O)	0.48	-0.47	0.85**	0.47	0.06	-0.35	0.01	0.10	-0.01	-	
pH ($CaCl_2$)	0.81*	0.08	0.80*	-0.16	0.35	-0.78*	0.63*	0.21	-0.54	0.61	-

*** Significant at 0.01; * significant at 0.05* but highly significant relationship with densities of Shrubs and Trees in the study area. The Table also indicates a significant negative relationship between Ca and density of Saplings ($p \leq 0.05$).

No significant relationship was observed between Mg and any of the four life- forms (Table 4). Potassium had a positive and highly significant relationship with density of tree species in the study area ($p \leq 0.01$).The results also reveals a significant ($p \leq 0.05$) but negative relationship between % Sand and Tree density. Similarly, there was also a significant but negative relationship between % Silt and density of Saplings. There was no significant relationship between percent Clay and any of the Life – forms in the study area (Table 4). Furthermore a significant negative relationship exists between pH (H_2O) and density of Shrubs as well as a negative but highly significant relationship between pH ($CaCL_2$) and the densities of Shrubs and Trees.

3.4 Correlation of Plant Abundance with Soil Properties in the Study Area

The majority of the plant species (30 out of the 53) encountered in the study showed a negative relationship with % O.C, six plant species have a highly positive significant relationship with % O.C ($p< 0.01$) (Table 5). Two species, *Boswelliaafricana* and *Sterculiasetigera*have a positive relationship with % O.C ($p<0.05$).Thirty four plant species have shown a negative relationship with % N, six species showed a highly positive relationship ($p<0.01$) while two species show a positive relationship with % N ($P< 0.05$) (Table 5).Thirty nine plant species indicated a positive relationship with Phosphorus while three species show a highly significant positive relationship with Phosphorus ($p< 0.01$).Thirty four species show a positive but not significant relationship with Calcium while 15 species have a negative relationship with Calcium. The Results in Table 5 indicate a negative relationship between Magnesium (Mg) and the twenty four plant species in the study. Twenty three species show a positive but not significant relationship ($p<0.05$) while only one species (*Piliostigma thoningii*) recorded a highly positive relationship with Magnesium (Mg) ($p< 0.01$). Fifteen plant species show a highly positive significant relationship with Potassium (K) ($P<0.01$) while sixteen species have shown a negative correlation with Potassium (K).

4. DISCUSSION

According to Schmidt et al. [15], tree species diversity has no effect on plant-available N in the soil compared to each mono-species with mixed-species stands. Thus, this study indicates that shrubs and tree species diversity was found to be inversely related to soil total Nitrogen, N, % O.C and soil p^H (H_2O). These results agrees with the findings of Huston [16] who also found a decrease in tree species richness with increasing soil P^H and concentration levels of % O,C and total N in a tropical forest soil. Also, the result was in accord with the report of Nirmal et al. [17] and Fu et al. [18], who reported no positive relationship between tree species richness and two soil factors (O.C and total N). in a research conductedin a dry deciduous forest of western India,with low annual rainfall similar to what obtains in this research finding.

The increased of aboveground productivity and carbon stock is related to litter quantity and quality; that is, most intermediate diverse mixtures had higher litter yields than monocultures [19]. While, the belowground

Table 4. Correlation matrix of soil properties and density of flora life-form i in the study area

Soil properties	Plant types			
	Herbs	Saplings	Shrub	Trees
OC (%)	-0.70*	0.14	-0.87**	-0.94**
N (%)	0.44	0.88**	0.04	-0.13
P (ppm)	-0.76*	-0.17	-0.94**	-0.91**
Ca (Cmol/Kg)	0.32	-0.76*	0.05	0.24
Mg (Cmol/Kg)	0.21	-0.18	-0.44	-0.54
K (Cmol/Kg)	0.56	-0.13	0.82*	0.92**
Sand (%)	-0.26	0.21	-0.61	-0.75*
Silt (%)	0.64	-0.72*	-0.27	-0.25
Clay (%)	-0.09	0.12	0.55	0.66
pH (H_2O)	-0.50	-0.56	-0.79*	-0.66
pH ($CaCl_2$)	-0.50	-0.14	-0.84**	-0.85**

*** Significant at 0.01; * significant at 0.05*

Table 5. Correlation of plant abundance with soil properties in falgore game reserve

Plant species	Soil properties					
	O.C(%)	**N (%)**	**P (ppm)**	**Ca (Cmol.kg)**	**Mg (Cmol.kg)**	**K (Cmol.kg)**
Ficussycomorus	-0.77*	-0.77*	-0.45	0.55	-0.90**	0.87**
Ficusglumosa	-0.77*	-0.77*	-0.45	0.55	0.90**	0.87**
Combretummolle	-0.91**	-0.91**	-0.63	0.61	-0.78*	0.97**
Combretumghasalense	-0.77*	-0.77*	-0.45	0.55	-0.90**	0.87**
Combretumhypopilium	-0.77*	-0.91**	-0.45	0.55	-0.90**	0.87**
Terminaliamacroptera	-0.77*	-0.77*	-0.45	0.55	-0.90	0.87**
Anogeissusleucarpus	-0.33	-0.33	-0.51	0.10	0.59	0.16
Combretumnigerican	-0.51	-0.51	-0.63	0.23	0.42	0.35
Combretumcollinum	-0.31	-0.31	-0.49	0.09	0.61	0.14
Guerra senegalensis	-0.77	-0.77*	-0.45	0.55	-0.90**	0.87**
Diospyrousmespliformis	0.92**	0.71*	0.64	-0.77*	0.44	-0.91**
Gardenia aquala	-0.73*	-0.50	-0.76*	0.39	0.15	0.60
Naucleadiderrichii	-0.30	0.54	-0.37	-0.34	-0.63	0.35
Mitragynainermis	-0.31	-0.31	-0.49	0.09	0.60	0.14
Mitracarpusscaber	-0.57	0.18	-0.46	0.05	-0.84**	0.66
Borassusaethiopum	0.43	0.96**	0.02	-0.94**	0.17	-0.46
Strychnospinosa	0.43	0.96**	0.02	-0.94**	0.17	-0.46
Hymanocardiumacida	-0.31	-0.31	-0.49	0.09	0.60	0.14
Cassia tora	-0.59	-0.12	-0.30	0.37	-0.95**	0.72*
Annonasenegalensis	-0.87**	0.04	-0.93**	0.05	-0.46	0.83*
Sterculiasetigera	0.73*	0.29	0.86**	-0.18	-0.18	-0.58
Parkiabiglobosaa	0.60	0.92**	0.27	-0.89**	0.13	-0.59
Vitellariaparadoxa	0.09	0.72*	-0.02	-0.53	-0.48	-0.02
Ziziphusspina	0.04	0.21	0.35	-0.44	0.80*	-0.24
Ziziphus Mauritania	0.58	0.94**	-0.49	-0.93**	0.20	-0.60
Lanneaacida	-0.52	0.17	-0.11	0.06	-0.86**	0.62
Commiphoraafricana	0.43	0.96**	0.02	-0.94**	0.17	-0.46
BoswelliaAfricana	0.69*	0.90**	0.35	-0.89**	0.22	-0.69*
XemiaAmericana	-0.31	-0.31	-0.49	0.09	0.60	0.14
Tamarindusindica	-0.45	-0.91**	-0.11	0.89**	-0.04	0.45
Isorbelinadoka	-0.87**	-0.40	-0.56	0.59	-0.83**	0.94**
BurkeaAfricana	-0.96**	-0.44	-0.73*	0.58	-0.68	0.99**
Danielliaoliveri	-0.73*	-0.50	-0.76*	0.38	0.15	0.6
Cassia sieberana	-0.77*	-0.33	-0.45	0.55	-0.90**	0.87**
Eragrosticspp	-0.31	-0.31	-0.49	0.09	0.60	0.14
Dactylactenumaegyptium	-0.51	0.28	-0.44	-0.04	-0.80*	0.59
Eleusineindica	-0.77*	-0.33	-0.45	0.55	-0.90**	0.87**
Cynodondactylon	-0.31	-0.31	-0.49	0.09	0.60	0.14
Dioscoreabulbifera	0.18	-0.65	0.65	0.71*	-0.27	-0.04
Euphorbia hirta	0.66	-0.31	0.93**	0.29	0.12	-0.55
Jatrophacurcas	0.77	-0.28	0.47	-0.84**	0.24	-0.76*
Euphorbia lateriflora	0.66	-0.31	0.93**	0.29	0.12	-0.55
EntardaAfricana	-0.81*	-0.28	-0.53	0.50	-0.88**	0.90**
Alysicarpusvaginalis	-0.66	-0.16	-0.37	0.41	-0.94**	0.78*
Poliostigmathoningii	0.12	-0.14	-0.39	-0.10	0.75*	-0.06
Dalbergiasaxatilis	0.94**	0.55	-0.82**	-0.56	0.26	-0.88**
Poliostigmareticulatum	-0.77*	-0.33	-0.45	0.55	-0.90**	0.87**
Acacia seyel	-0.73*	-0.50	-0.76*	0.39	0.15	0.60
Detariummacrocarpum	-0.85**	-0.27	-0.60	0.47	-0.85**	0.92**
Strespermumkunthianum	-0.31	-0.31	-0.49	0.09	0.60	0.14
Pseudocedrelakoschyl	-0.31	-0.31	-0.49	0.09	0.60	0.14

*** Significant at 0.01%; * significant at 0.05%*

carbon stock is related to the decomposition of litter and other organic substances, that is, higher belowground productivity in evenly dominant mixed-species forests than in single-species-dominated forests [20].

The nitrogen content of the soil sample wasmore stable compared with the carbon content across the strata in the study area. This result could be as the result of a higher nitrogen input than nitrogen leaching in hill top and riparian area where there was higher species diversity increases. Trees affect the forest ecosystem by manipulating its constituents prominent to changing future forest vegetation [21] and influence them both physical and chemical [22]. Soil stability also spawns a strong reaction on existing vegetation and affects the understory vegetation and tree species development [23].

On the contrary, most studies done in temperate forests and agro ecosystems showed positive relationships between tree species and soil properties such as soil fertility index and soil % O.C, N and K contents. The difference in pattern between temperate and tropical forests may be caused by the fact that they are completely different ecosystems in different regions of the world. Huston [16] further suggested that lower fertility soil generally favored higher tree species richness. In lower fertility soil, a naturally strong tree species competitor may lack resources (nutrients) in order to outcompete with the other, thereby causing higher tree species richness. Furthermore, many researchers demonstrated a decrease in species richness following soil fertilization which leads to higher soil fertility.

It is known that the effects of tree species on soil carbon stock are more apparent in the top 20-cm layer [24] and that the increase in tree species diversity enhances the soil ecosystem functions, including mineralization and decomposition [25], and changes the soil basal resources markedly [26]. The generalized results of the abovementioned studies suggest that higher species richness means higher carbon inputs. Most carbon inputs are distributed at different concentrations into the forest floor, and the enhanced soil ecosystem function may lead to a decrease in the carbon stock in soil layers. Additionally, forsome tree species, varying soil organic matter affects the quality, quantity [27], and distribution of roots [28]. The species interactions also increase the productivity through resource complementarily [29].

The results of this finding revealed that plants species diversity have different effects on soil properties. Each species stand may have its own influencing trait on soil properties [30].

5. CONCLUSION

The results of this finding showed slight variations in the soil nutrient content across the four study locations. This could be as a result of an uneven distribution of floral Life- forms (plant species) between the four study sites. Greater density of trees and herbs were recorded at the level ground and riparian forest whereas hill top and sloppy areas were largely shrubby with fewer and shorter trees. Findings of the study had showed that soil nutrients and land use patterns in association with anthropogenic and environmental factors have substantial influences on the density of plant species in FGR.Based on the findings of this study, it is recommended that conservation and restoration of threatened plant species should be encouraged especially among the rural communities and farmers. Also, if possible, the use of multipurpose tree species (especially legumes) in fallow system should be encouraged; for plant species significantly improve physical and chemical properties of soil. For easy adoption of plant species on farmlands, farmers should be enlightened more on the effects and environmental functions of trees on farm land.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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