PROPERTIES OF SOILS OF A FOREST-SAVANNA MOSAIC ON A RIDGE AT AFIKPO, SOUTHEASTERN NIGERIA

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ABSTRACT

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A stretching Ridge of about 1700m consists of forest vegetation on the south facing slope (SFS) (700m long) and savanna on the north facing slope (NFS) (600m long). A transect sampling technique was used on each slope orientation. Pedons were sunk on the crest, midslope and footslope of each toposequence at an interpeda distance of about 100m. All pedons were geo-referenced and routine laboratory analyses were conducted on selected soil properties. Soil properties variability was investigated as follow: Sand and pH displayed low variability (CV≤15%) while clay varied moderately (CV>15≤35%) in all slope positions investigated. The silt-clay ratio (SCR) varied highly (CV>35%) at the crest and midslope of SFS and NFS and moderately (CV>15≤35%) at the footslope of the South facing and North facing slopes. OM, TN and BS all varied highly (CV≥35%) in all slope positions except at the footslope of the NFS where it varied moderately. Soils were classified based on United States Soil Taxonomy Systems and correlated with FAO/UNESCO Soil Classification System as Typic Kandiustults (Plinthic Acrisols) for SFS Crest and Midslope and Footslope, NFS Crest, Midslope, while NFS footslope as Typic Kandiaquaults (Gleyic Luvisols).

Keywords: toposequence, soil properties, forest-savanna mosaic, ridge

INTRODUCTION

Soil properties exhibit a complex degree of variability in both time and space. Variability in soil properties is a function of prevailing soil forming factors. Vegetation is one of the biotic components of soil formation. Plants affect soil genesis through the addition of organic matter, the cycling of ions and the movement of water through the hydrologic cycle (Forth, 1984). Natural vegetation is broadly divided into forestland and grassland and it is assumed that their effects will differ in soils. Aweto (1981) noted that the effect of tree vegetation on soil organic matter and nutrients in forest zone of southwestern Nigeria is largely restricted to the top 10 cm of soil solum.

Buol *et al*. (1980) reported that soil colour of the root zone varied with tree type, stating that soil under oak trees were dark-brown while soils under beaches were reddish. These observations suggest that different organic compounds have been synthesized at different sites. Mutsaers *et al*. 1997) reported dominance of Alfisols (Ustalfs) in the forest savannah transition zone of Southwestern Nigeria. Ogunkunle (1993) observed variability in soil proportion on a toposequence due to variation in plant type and plant associations, and these affect management strategies (Oluwatosin *et al*. 200).

Native soil organic carbon varied considerably within a given landscape ranging from about 2 % on the crest positions to almost 4.5 % on north-facing footslopes (Rodman, 1988). Quideau (2002), confirmed that soil organic matter levels are higher on north-facing slopes of the Northern hemisphere and the other way around in the Southern hemisphere because temperatures are lower. Purakayastha *et al*. (2007) estimated that 50 to 70% of soil organic carbon had been lost from upland soils. Therefore, understanding how nutrient resources and soil properties vary across landscapes had become the focal point of much ecological research (Benning and Seastedt, 1995). Spatial variability and distribution of nutrients in relation to site characteristics such as land use and other variables are critical rate of ecosystem process (Schimel *et al*., 1991; Townsend *et al*., 1995).

Differences in soil properties occasioned by vegetation could be a result of variation in leaf type, root type, canopy size, decomposition rate of plant debris, as well as presence of decomposers, topography, slope orientation and land use. These affect organic matter content of soils (Stutter *et al*., 2004) and soil properties in space and time. This study however investigated soil properties in relation to slope position on a forest-savanna mosaic toposequence in Afikpo southeastern Nigeria for sustained soil use.

MATERIALS AND METHODS

The study area

The study was conducted in Afikpo, southeastern Nigeria lying between latitudes 5° 50' and 5° 56' N and longitudes 7° 53' and 8° 54' E. The parent materials of the study area were identified to be an admixture of Nkporo shale and Afikpo sandstone. Hills and lowlands characterize the terrain. It is within the tropical rainforest zone of the southeastern Nigeria and experiences rainfall most of the months of the year with highest intensities occurring between June-August, it has a mean annual rainfall of 1800-2300 mm. while dry season duration is usually about three months from December – February. It has gently rolling toposequence with a characteristic physiographic differentiation of highly stepped slope. The study site is a ridge stretching about 1700 m with a south facing (700m) and north facing slope (600m). The south facing slope (SFS) (windward) has dense vegetation compared to its north facing slope (NFS) (leeward) counterpart which is only sparsely vegetated creating an alternation between the forest and the savanna on the toposequence. The prevalent plants available at the South facing slopes include the following; Gmelina (*Gmelina arborea),* Oil Palm (*Elaeis guineensis),* locust tree *(Robinia pseudocacia),* while at the north facing savanna were guinea grass *(Panicum maximum),* elephant grass *(Pennisetum purpureum),* giant star grass *(Cynodon nlemfuensis)*. Incessant grazing by the Hausa-Fulanis and other anthropogenic activities such as deforestation and bush burning on the toposequence has further encouraged the development of savanna vegetation. Also, population growth and farming activity have adversely impacted the original forest vegetation of the area leaving it with the present forest-savanna mosaic. The socioeconomic activities among most Afikpo people include quarrying, hunting and small scale farming due to land fragmentation encouraged by the land tenure system practiced in southeastern Nigeria. Common crops crown in the area include; rice *(Oryza sativa*), cassava *(Manihot spp),* yam *(Discorrhea spp),* maize *(Zea mays).*

Field work

A reconnaissance study was carried out and the study site identified on a toposequence some 10 kilometers away from Okposi road in Amasiri Afikpo, Southeastern Nigeria. The ridge stretches about 1700 m and has a forest vegetation on its South facing slope (SFS) and savanna vegetation on its North facing slope (NFS). A transect was cut across the toposequences on the ridge. Pedons were dug and described at the crest, midslope and footslope of the North and South facing slopes. Samples were collected from the pedons according to their horizons and carefully labeled in black polythene bags and transported to Soil Science laboratory of Federal University of Technology Owerri where they were analyzed. Soils were classified according to Soil Survey Staff (2003), FAO (1998). Handheld Global Positioning System (GPS) Receiver was used to geo-reference all pedons for the investigation.

Table 1: Description of study site

	Slope		SFS (Forest)	NFS (Savanna)
	F	S		
Crest	5.6	4.2	Undulating terrain, Tropical evergreen plants with dark brown top soils	Flat tops having abundant shrubs and grasses mostly giant star grass (*Cynodon nlemfuensis)*
Midslope	6.3	5.3	Undulating relief, tropical evergreen plants with broad leaves, dark brown to brown top soil.	Undulating and dominated with spear grass *(imperata cylindrical),*
Footslope	2.4	2.2	Gentle slope to nearly flat, thick forest with greyish brown soil	Dominated by elephant grass *(Pennisetum purpureum)* and spear grass *(imperata cylindrical),*

F- Forest, S- Savanna, SFS - South facing slope, NFS – North facing slope

Table 2: Geographical coordinates of the study site

	SFS (Forest)			NFS (Savanna)		
	Lat.	Long.	Elevation (m)	Lat.	Long.	Elevation (M)
Crest	N 5^o 56’ 01.3’’	E 7^o 53’ 22.4’’	49	N 5^o 55’ 57.7’’	E 7^o 53’ 13.5’’	49
Midslope	N 5^o56’ 01.3’’	E 7^o53’ 21.4’’	39	N 5^o 55’ 58.8’’	E 7^o53’ 13.4’’	38
Footslope	N 5^o 56’ 05.0’’	E 7^o 53’ 22.1’’	31	N 5^o 56’ 00.3’’	E 7^o 53’ 13.4’’	32

Lat- Latitude, Long- Longitude, SFS - South facing slope, NFS – North facing slope

Laboratory analyses

Particle size distribution was determined by hydrometer method according the procedure of Gee and Or (2002). Bulk Density was measured by core method (Grossman and Reinsch, 2002). Soil pH was measured electrometrically in 1:2.5 soil/ water ratio (Hendershot *et al*., 1993). Organic Carbon was determined using method described by (Nelson and Sommers, 1982). Total nitrogen was determined using modified micro Kjeldahl method (Bremner and Milvaney, 1982). Total available phosphorus was determined using Bray II method (Olsen and Sommers, 1982). Exchangeable cations were extracted with 0.1M $BaCl_2$ method (Hendershot *et al*., 1993) and analyzed with atomic absorption spectrometer. Exchangeable acidity was determined by the KCl extraction method and the extractant was titrated against 0.05N NaOH. Effective cation exchangeable capacity (ECEC) was calculated as the summation of the exchangeable bases and KCl extractable Al and H of Juo *et al.* (1976). The percentage base saturation (BS) was the summation of total exchangeable bases expressed as a percentage of ECEC.

Data analyses

Coefficient of variation (C.V.) ranked as follow; Low variation ≤15%, Moderate variation >15≤35%, High variation >35% was used to estimate the degree of variability of soil properties (Wilding *et al.* 1994).

RESULTS AND DISCUSSION

Soil Colour: At the south facing slope (SFS), colour ranged from dark reddish brown (2.5 YR 3/2) moist to orange (7.5 YR 6/8) moist at the crest. At the midslope, colour graded from yellowish brown (10 YR 5/2) to light yellowish orange (10 YR 6/6) down the profile while the footslope was dark brown (10 YR 3/3) at the topmost horizon to yellowish brown (7.5 YR 5/8) at the lowest horizon of the profile. North facing slope (NFS) colours were as follow; crest was brown (7.5 YR 4/4) at the topmost horizon and orange (2.5 YR 6/8) at the lowest horizon of the profile. Midslope; dark brown (7.5 YR 3/3) to yellow orange (7.5 YR 8/8) while the footslope graded from grayish yellow brown (10 YR 6/6) to dull yellow orange (10 YR 6/4).

Generally, the colour indicated that virtually all the pedons show a sign of eluviation in which sesquioxides, carbonates, and or clay minerals have been leached out except at the foot of NFS where aquic condition was encountered. The grayish yellow brown colour suggests that the footslope is of less inherent productivity resulting from previous condition of restricted drainage (Ibanga, 2006). The crests and midslopes of SFS and NFS were all well drained. More litter availability at the SFS crest emanating from the relatively denser vegetation and material deposits at the North facing midslope may have encouraged higher organic matter contents at their surface horizons.

Soil Physical Properties: There was no particular trend in the distribution of sand down the profile at the SFS (Table 3). It decreased downwards at the crest (770 - 720gkg^{-1}) and footslope (790 - 760gkg^{-1}) and a slight increase at the midslope (760 - 770gkg^{-1}). The mean sand was highest at the footslope (805gkg^{-1}), followed by the crest (768gkg^{-1}) while the lowest occurred at the midslope (754gkg^{-1}) at the South facing slope. The NFS (Table 4) displayed sand distribution as follow; Crest ranged from 740 - 710gkg^{-1}, 780 - 760gkg^{-1} at the midslope and 760 - 790gkg^{-1} at the footslope. Mean sand followed the same pattern as SFS counterparts; the footslope was highest (773gkg^{-1}), followed by the crest (757gkg^{-1}) while the least occurred at the midslope (738gkg^{-1}).

Clay content however increased with depth in all physiographic positions at the SFS (Table 3). The crest recorded 140 – 220gkg^{-1}, midslope 140 – 190gkg^{-1} and footslope 110 – 120 gkg^{-1}. The mean clay content was highest at the midslope (164 gkg^{-1}), followed by the crest (154gkg^{-1}) while the footslope indicated 120gkg^{-1}.

At the NFS (Table 4), the crest and midslope showed a consistent increase in clay content with depth, the footslope had irregular clay distribution. Clay distribution at the NFS ranged from 170-230gkg^{-1} at the crest, 150 - 190gkg^{-1} for midslope and 140 - 100gkg^{-1} at the footslope. The regular clay increase with depth was in agreement with Eshett (1996), that soils of the region are friable and underlain by clay enriched sub-soil (argillic horizon). The mean silt/clay ratio was generally low and increased down the slope in both the south and north facing slopes. The silt/clay ratio are as follow; crest (0.38), midslope (0.55) and footslope (0.84%) for south facing slope (SFS) and crest (0.37), midslope (0.51), footslope (1.05%) for north facing slope (NFS). The low silt/clay ratio, according to Nuga *et al*. (2008) indicated ferallitic pedogenesis. This however suggests that soils of the area were highly weathered. The relatively high value at the footslope of the NFS implies that the soils are younger and associated with low degree of weathering.

Soil Chemical Properties: The pH ranged from 4.56 – 4.75 for SFS and 4.65 – 4.83 for NFS. This pH results is an indication that the soils were strongly acidic which characterizes most tropical soils (Udo, 1980). The parent material which is an admixture of Nkporo shale and Afikpo sandstone created the acidic condition. Also the trend of pH on the toposequence indicated that acidity decreased from crest to valley bottom. Therefore, from the trend as seen in Tables 3 and 4, the acidic condition on the ridge may have resulted by the more presence of acidic cations like H^+ and Al^{3+} when compared to the exchangeable bases down the profile (Silver *et al.,* 1994).

The organic matter was generally low and showed a decrease down the horizon in all the physiographic position of the toposequence (Tables 3 and 4). Organic matter decreased down the horizon at the SFS but was highest at the crest (12.6g/kg) followed by the footslope (9.3g/kg) while the lowest occurred at the midslope (08.5g/kg). However, at the NFS mean OM increased from crest to valley bottom as follow; 7.3, 9.0 and 12.4g/kg for crest, midslope and footslope respectively. This situation can be attributed to differences in vegetation as SFS tend to add more organic compounds to the soil as well as prevent the direct impact of agents of erosion. The NFS may be more vulnerable to leaching, erosion and probably forest fires due to dominance of grassy vegetation. This situation encouraged leaching of materials from crest to the footslope thereby increasing their organic matter

Table 3: Soil Properties of South Facing Slope (SFS)

Depth	Sand	Clay (gkg^{-1})	Silt	TC	SCR	pH KCl	OM (gkg^{-1})	TN (gkg^{-1})	CNR	Av.P (mgkg-1)	Exchangeable Na	K	Ca	Mg	TEB ($Cmolkg^{-1}$)	Exchangeable H	Al	TEA	ECEC	BS (%)	Al Sat. (%)
Crest																					
0-13	770	140	90	LS	0.64	4.91	22.1	1.2	11.8	40.1	0.01	0.11	0.96	0.44	1.51	0.48	0.02	0.48	1.99	76	2
13-27	780	170	50	LS	0.29	4.62	19.7	0.9	12.9	36.2	0.02	0.09	0.22	0.04	0.37	0.75	0.95	1.71	2.08	18	46
27-50	790	190	20	S	0.11	4.52	8.6	0.4	12.8	26.8	0.01	0.06	0.21	0.04	0.31	0.93	1.21	2.13	2.44	13	49
50-70	770	200	30	SCL	0.15	4.41	6.9	0.3	15.4	24.1	0.02	0.09	0.22	0.31	0.63	1.79	2.15	3.95	4.58	14	47
70-150	720	220	50	SL	0.23	4.36	5.8	0.2	15.7	20.1	0.01	0.08	0.04	0.12	0.25	1.11	2.63	3.73	3.98	6	66
Mean	760.8	180.4	40		0.28	4.56	12.6	0.6	13.7	29.5	0.014	0.086	0.33	0.19	0.614	1.012	1.392	2.40	3.01	25.4	42
Mid slope																					
0-5	760	140	100	LS	0.71	4.76	15.8	0.8	12.4	32.3	0.02	0.08	0.56	0.46	1.12	0.05	0.41	0.45	1.57	71	26
05-20	800	110	90	SL	0.82	4.66	10.7	0.4	14.3	28.2	0.02	0.08	0.26	0.61	0.96	0.41	1.29	1.71	2.67	36	49
20-60	720	180	100	SL	0.55	4.57	7.9	0.3	16.8	22.1	0.02	0.08	0.42	0.04	0.56	0.81	2.01	2.81	3.37	17	60
60-90	720	200	80	SL	0.41	4.61	5.2	0.2	16.7	16.2	0.02	0.06	0.21	0.12	0.41	2.28	4.05	6.33	6.74	6	60
90-150	770	190	50	SL	0.26	4.65	2.8	0.1	15.8	14.4	0.02	0.07	0.21	0.04	0.33	2.32	4.18	6.48	6.81	5	61
Mean	750.4	160.4	80		0.55	4.65	8.5	0.36	15.2	22.6	0.02	0.074	0.332	0.254	0.676	1.174	2.388	3.56	4.24	27	51.2
Foot slope																					
0-14	790	110	100	LS	0.91	5.12	14.8	0.8	11.2	30.1	0.01	0.07	0.96	1.01	2.04	0.03	0.53	0.56	2.60	79	20
14-30	900	100	100	S	1	4.64	8.9	0.4	12.8	25.1	0.02	0.09	1.02	0.28	1.39	0.28	0.63	0.91	2.30	60	27
30-50	770	150	80	SL	0.53	4.65	8.6	0.4	12.9	24.1	0.01	0.05	0.86	0.68	1.61	0.68	1.13	1.81	3.42	47	33
50-95	760	120	110	LS	0.92	4.61	4.8	0.2	18.6	18.2	0.02	0.08	0.66	0.21	0.87	0.51	1.28	1.78	2.65	33	48
Mean	800.5	120	97		0.84	4.75	9.3	0.45	13.9	24.4	0.015	0.072	0.875	0.545	1.478	0.375	0.89	1.265	2.74	54.8	32

OM=Organic Matter, TN=Total Nitrogen, TC= Textural Class, SCR= Silt/Clay ratio, CNR= Carbon, Nitrogen ratio, Av. P= Available Phosphorus, TEB= Total exchangeable bases, TEA= Total exchangeable acidity, ECEC= Effective cation exchange capacity, BS= Base saturation, Al Sat.= Aluminum saturation

Table 4: Soil Properties of South Facing Slope (NFS)

Depth (cm)	Sand	Clay (gkg-1)	Silt	TC	SC R	pH KCl	OM (gkg-1)	TN (gkg-1)	CN R	Av.P. mgkg-1	Exchangeable Na	K	Ca	Mg	TEB Cmolkg-1	Exchangeable H	Al	TEA	ECEC	BS (%)	Al Sat. (%)
Crest																					
0-20	740	170	90	LS	0.53	4.76	10.3	0.5	12.9	23.0	0.02	0.06	0.44	0.44	0.96	0.23	0.5	0.73	1.69	57	26
20-45	800	140	70	LS	0.51	4.71	7.9	0.4	12.0	20.0	0.01	0.06	0.52	0.44	1.03	0.82	0.75	1.57	2.60	40	28
45-75	780	190	30	LS	0.16	4.59	7.2	0.3	16.5	18.0	0.01	0.07	0.04	0.04	0.16	1.4	1.75	3.15	3.31	5	53
75-150	710	230	60	SCL	0.26	4.53	3.8	0.2	14.1	14.0	0.01	0.07	0.02	0.02	0.12	0.95	1.58	2.53	2.65	5	60
Mean	757.5	182.5	62.5		0.365	4.65	7.3	0.35	15.3	18.8	0.013	0.07	0.255	0.235	0.57	0.85	1.145	1.995	2.56	26.8	41.8
Mid slope																					
0-15	780	150	70	LS	0.47	4.98	24.1	1.3	10.8	45.1	0.02	0.09	0.68	0.44	1.23	0.21	0.03	0.24	1.47	86	5
15-35	750	150	100	LS	0.67	4.61	8.9	0.4	11.6	30.1	0.02	0.07	0.32	0.58	0.99	1.65	2.13	3.75	4.74	21	45
35-82	680	230	90	SCL	0.39	4.55	6.2	0.3	14.5	26.1	0.02	0.05	0.42	0.34	0.88	1.45	2.38	3.83	4.71	19	51
82-105	720	160	120	LS	0.75	4.52	3.1	0.1	16.2	16.8	0.02	0.07	0.44	0.71	1.23	0.7	1.75	2.45	3.68	33	48
105-165	760	190	50	LS	0.26	4.46	2.8	0.1	16.7	15.2	0.02	0.06	0.66	0.34	1.08	1.18	2.03	3.21	4.29	25	47
Mean	738	176.	86		0.508	4.62	9.0	0.44	13.9	26.7	0.02	0.068	0.504	0.482	1.08	1.038	1.664	2.696	3.77	36.8	39.2
Foot slope																					
0-17	760	140	100	LS	0.71	4.71	16.5	0.9	11.4	36.1	0.02	0.06	0.41	0.24	0.72	0.61	1.21	1.81	2.53	29	48
17-50	770	90	120	LS	1.33	4.79	16.2	0.8	12.1	31.1	0.02	0.07	0.36	0.04	0.49	0.05	1.01	1.05	1.54	31	65
50-75	790	100	110	LS	1.1	4.99	4.5	0.2	13.9	26.2	0.02	0.06	0.16	0.16	0.41	0.38	0.01	0.38	0.79	51	2
Mean	773	110	110		1.05	4.83	12.4	0.63	12.5	31.1	0.02	0.063	0.31	0.147	0.54	0.347	0.743	1.08	1.62	37	38.3

OM=Organic Matter, TN=Total Nitrogen, TC= Textural Class, SCR= Silt/Clay ratio, CNR= Carbon, Nitrogen ratio, Av. P= Available Phosphorus, TEB= Total exchangeable bases, TEA= Total exchangeable acidity, ECEC= Effective cation exchange capacity, BS= Base saturation, Al Sat.= Aluminum saturation content downslope. Therefore, SFS showed more organic matter, slightly above its NFS counterpart on the toposequence. This result agrees with (Rodman 1988, Quideau, 2002). Total nitrogen content was generally very low at both SFS and NFS, and the pattern of its distribution closely follows that of organic carbon as it decreases down the profiles (Tables 3and 4). The mean total nitrogen at the SFS, shows that highest occurred at the crest ($0.6gkg^{-1}$) followed by footslope ($0.45gkg^{-1}$) and then the midslope ($0.36gkg^{-1}$). North facing slope (NFS) recorded ($0.35gkg^{-1}$) for crest, ($0.44gkg^{-1}$) for midslope and ($0.65gkg^{-1}$) for footslope. However, at this slope position highest total nitrogen was obtained at footslope. Available P was also low and decreased down the profile at all physiographic positions of the toposequence as shown in Tables 3 and 4. At the SFS, highest occurred at the topslope ($29.5mgkg^{-1}$) followed by footslope ($24.4mgkg^{-1}$) while the lowest occurred at the midslope ($22.6mgkg^{-1}$). The NFS however showed a decrease down the slope as the lowest value occurred at the crest ($18.8mgkg^{-1}$), $26.7mgkg^{-1}$ for midslope and $31.1mgkg^{-1}$ for footslope. This can be explained to have occurred due to higher organic matter distribution at the footslope for NFS and at the crest for SFS.

The mean total exchangeable acidity was higher than the mean total exchangeable bases in all pedons investigated except in south facing footslope with higher mean total exchangeable bases (TEB) compared to total exchangeable acidity (TEA). This is because, the soil under study is highly acidic and its acidity increased with depth. There is however sufficient rainfall that may have leached out much of the base forming cations leaving the exchangeable complex dominated by H and Al ions (Donahue et al., 1990). In all pedons examined, base saturation decreased down the profile while Al saturation increased. This pattern only differs with footslope of the NFS where BS increased down the profile. The mean BS was generally low in all the profile and increased downslope. SFS mean BS were 25.4, 27, 54.75% for crest, midslope and footslope respectively while NFS were 26.8, 36.8 and 37% for crest, midslope and footslope respectively. The low BS and high Al concentration is an indication that soils were highly weathered, fragile and acidic likely ultisols which agrees with Eshett, (1996); Onweremadu *et al.,* (2007) and Obasi, (2010) who worked in soils of the same agro-ecology. BS was more concentrated on the epipedons of all the profile and higher on the SFS more than the NFS. The forest vegetation of SFS is a factor in the differential BS content.

Soil Properties Variability: Table 5 displayed soil variability as follow; Sand had low variability ($CV \leq 15\%$) while clay varied moderately ($CV > 15 \leq 35\%$) in all slope positions investigated. The silt-clay ratio (SCR) had high variability ($CV > 35\%$) at the crests and midslopes of SFS and NFS and moderate ($CV > 15 \leq 35\%$) at the footslopes of the south facing and north facing slopes. Soil pH had low variability ($CV \leq 15\%$) in all the slope positions of the toposequence. Organic matter (OM), total nitrogen (TN), and base saturation (BS) all varied highly ($CV > 35$) in all slope positions except at the footslope of NFS where it varied moderately.

This variability in soil properties agrees with Upchurch et al. (1988) that more permanent (stable) soil properties such as soil texture, mineralogy, soil thickness and colour are less variable while more dynamic and variable properties are; hydraulic conductivity, water content, exchangeable cations and organic matter. Also, properties which are measured and closely calibrated to a standard such as texture, colour, pH are less variable. The high variability of soil properties on the slope showed that the soil under investigation is a typical highly weathered soil of the tropical region in the southeastern Nigeria (Eshett, 1996, Onweremadu *et al.* 2007).

Table 5: Variability of Selected Soil Properties

Soil Properties	SFS (C. V. in %)	Ranking	NFS (C.V. in %)	Ranking
		Crest		
Sand	5.78	LV	5.83	LV
Clay	16.6	MV	20.7	MV
pH	7.83	LV	1.18	LV
OM	60.79	HV	36.77	HV
TN	71.68	HV	36.88	HV
BS	112.6	HV	97.4	HV
SCR	74.3	HV	50.3	HV
		Midslope		
Sand	4.55	LV	4.6	LV
Clay	23.4	MV	19.5	MV
pH	5.14	LV	7.02	LV
OM	59.5	HV	97.46	HV
TN	75.05	HV	113.18	HV

BS	102.13	HV	76.15	HV
SCR	40.87	HV	39.6	HV
		Footslope		
Sand	8.02	LV	2.0	LV
Clay	18.0	MV	24.5	MV
pH	2.09	LV	3.31	LV
OM	44.51	HV	55.19	HV
TN	55.93	HV	59.81	HV
BS	35.74	HV	32.88	MV
SCR	25.07	MV	29.9	MV

CV = Coefficient of Variation, LV= Low Variation, MV= Moderate Variation, HV= High Variation

Soils were classified based on United States Soil Taxonomy Systems (Soil Survey Staff, 2003) and correlated with FAO/UNESCO Soil Classification System (FAO, 1998) as Typic Kandiustults (Plinthic Acrisols) for SFS Crest and Midslope and Footslope, NFS Crest, Midslope, while NFS footslope as Typic Kandiaqualts (Gleyic Luvisols). The classification gives an organized knowledge on the properties of the soil when reference is made to a particular objective.

CONCLUSION

The forest-savanna mosaic nature of the ridge resulted due to many anthropogenic activities on soils. Soil properties have shown extensive variation. The differences in vegetation cover of the toposequence had invariably induced variability of soil properties. The bare and grassy vegetation of the savanna slope makes it vulnerable to hamattan fires compared to its forest slope counterpart. This ultimately endangers wildlife, causes volatilization of soil nutrients as well as soil erosion. Intensive reforestation should be embarked upon to preserve savanna soils while farmers should be well educated on best farming practices on the slope to avoid nutrient loss.

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