Journal of Global Biosciences
ISSN 2320-1355
Volume 4, Number 7, 2015, pp. 2763-2775
Website: www.mutagens.co.in
E-mail: submit@mutagens.co.in
researchsubmission@hotmail.com

Research Paper

SOIL-TOPOSEQUENCE RELATIONSHIPS IN ALFISOL OF SOUTH WESTERN NIGERIA

Aruleba Joseph Olusegun

Department of Crop, Soil & Environmental Science
Faculty of Agricultural Science
Ekiti State University,
Ado-Ekiti, Nigeria.

Abstract

Soil-Toposequence relationship in Alfisol of South Western Nigeria were studied by comparing some morphological and chemical properties, texture down the profile and the distribution of Iron and Aluminum Oxides and Soil Classification of pedons at the upper, middle and valley positions along two toposequences. With morphological properties, clay and gravel content, three soil regions were delineated in each toposequence, upper slope, middle slope and valley bottom. The presence of diagnostic horizons (argillic (Bt)) also separate the two toposequences into upper slope, middle slope and valley bottom. Weathering intensity which is indicated as silt: clay ratio delineated the toposequences into three regions, the well-drained, moderately drained and poorly-drained with the upper locations being well-drained, middle location moderately drained and valley bottom poorly drained. There is little or no differences in Fe and Al oxides distribution among locations within a toposequence.The soils of the three regions were classified based on soil Taxonomy and FAO classification In toposequence A these were: upper slope- TypicKandiudalfs (Ferric Lixisols), Middle slope: AquicKandiudalf (GleyicLixisols), Valley bottom-PlinthicKandiaqualfs (EutricGleysols) while in toposequence B these were: upper slope – kanhapludalfs (Ferric Lixisols) Middle slope – TypicKandiudalfs(GleyicLixisols) Valley bottom – Typickandiaqualfs (EutricGleysols). This study to greater extent dictates the best management technical to which each region along the toposequences could be managed.

Key words: Soils, Toposequence, Classifications Soil regions and Alfisols.

INTRODUCTION

In a natural landscape, the kind of soil in a given location depends on the relative combination of the factors of soil formation (climate; living organisms, parent material topography and time). The relative impact of these factors on soil characterization varies from one environment to another. Thus in an undulating area the impact of topography on soil formation is expected to be more than in an area of flat or gently slope land.

Studies such as Ogunkunle 1989 Smyth and Montgomery 1962, Aruleba, 2011) have shown that the relationship between topography and geology are so interwoven that the impact of one cannot be clearly separated from that of the other.The importance of topography in soil formation has been realized from the inception of soil science and this is well documented

(Jenny 1941, 1946, Vine 1941, Gervard 1981, Greenwood, 1938 and Charter, 1949) Hence a farmer in this region finds himself cultivating the land in one of the various locations along the toposequence i.e. the upper slope, middle slope and valley bottom.

The differences between soils of a toposequence are generally related to the differences in their position and their drainage characteristics. Ogunkunle (1992) slated that slope steepness is about the most important factor that causes variation in moisture conditions along a toposequence. This is because steeper angle reduces the amount of water percolating through the soil and increases the removal through accelerated erosion of the upper portion of the soil profile.

More recent studies (Ogunkunle 1990 and Ogunkunle and Onasanya 1991) have also reported the occurrence of soils of different taxonomic classes from the crest to the valley bottom of these toposequences.

There is a lot still unknown on the inter relationship between topography and geology in terms of soil profile characteristics. The variation in land use along the toposequence may suggest a variation in the response to a given management. Although the previous studies (Boyd and Dermoert 1964, Ogumkunle and Brackatt 1987, Aruleba 2004) have established the vital role of management in crop performance and yield, the studies of the influence of the management at different portions of toposequence are not common. More studies are therefore needed as basis for choice of appropriate management and /or technology on farm plots at various locations along the toposequence in such areas. However the approach to understanding soil variation by the existence of different taxonomic pedons along the toposequence can only be very useful for broad land use decisions, decisions on special purpose land use etc. These will require more specific understanding of the point to point variations of some properties along the toposequence.

This study was therefore undertaken to examine the extent of soil properties variation along typical Alfisol toposequence with a view to knowing the extent of area requiring different management systems occurring on them. This will help farmers and other land users to choose appropriate technologies for the portion of the toposequence where they choose to operate.

MATERIALS AND METHODS

Study Site

The study was carried out at theteaching and research farm in Ekiti State University. Ado-Ekiti, capital city of Ekiti State. It lies approximately between longitudes $7^{o}31^{1}$ and latitudes $7^{o}49^{N}$. The location is in rainforest ecological zone.

The area experiences a tropical climate with distinct wet and dry seasons.
Mean annual total rainfall is about 1367mm and the average rainfall days is about 112 per annum. Temperature is almost uniform throughout the year with very little deviation from the mean annual of 27^{o}C. February and March are the hottest months with the mean temperatures of 28^{o}C and 27^{o}C respectively.
The mean annual total number of sunshine hours is about 2,000 hours with mean daily sunshine of about 5 hours and means annual radiation is about 130kCal/cm^{3}/year.

The geology of Ado-Ekiti (study area) in dominated by crystalline rocks which form part of the Basement complex of South Western Nigeria. They are mostly granitic rock materials. The area attains a maximum elevation of about 730metres and relative relief of about 395m. The main vegetation of the area is forest mixed with various types of bush regrowth, grasses and creepers. Arable crops such as yam, cassava, rice, maize, vegetables and plantation crops like cocoa, oil palm and kola nut are very common.

The major soil types were identified following the soil survey manual/method (soil survey staff 2014). Field descriptions and sample collections were made during the dry season to ensure freedom from ground water disturbance.

Field Study

Two representative toposequences A and B at main gate and student dry season vegetable plots respectively were selected and demarcated into three land types positions (upper, middle and valley bottom). Profile pits were dug at the upper slope, middle slope and valley positions along each of them. The profile pits were described following the FAO guidelines (FAO 1977). Slope gradient (%) at each of the profile pit locations was measured with the abney level. The profile pits were sampled at different horizons and the samples were analyzed in the laboratory following established procedures.

Laboratory analysis

The soil samples were air-dried, ground and sieved to separate fine earth fraction (< 2mm) from coarser materials. Particle-size analysis was by the hydrometer method (Day 1953). Soil p^H was measured in water (1:1) and organic carbon was determined by the Walkley (1935) method. Exchangeable cations (Ca, Mg, Na and K) were extracted by NH_4) AC, Ca and Mg were determined on the atomic absorption spectrophotometer, while Na and K were determined on the flame photometer. Exchangeable acidity Al^{3+} was determined by titration of the soil solution extracted with 1.NKCl. Effective cation exchange capacity (ECEC) is the summation of the exchangeable bases and exchangeable acidity.

Dithionite extractable Fe and Al (Fe^{-d} and Al^{-d}) were determined by the method of Mchra and Jackson (1960) using the dithionite citrate system buffered with sodium bicarbonate. Fe and Al in the extracting solution were determined calorimetrically using potassium thiocyanate method of Jackson (1958) and the aluminum method of Hsu (1963) respectively,Ammonium oxalate Fe and Al (Fe-O and Al-O) were determined by the method of mckeaque and Day (1966). The Fe and Al in solution were determined as in the dithionite extraction.

RESULTS AND DISCUSSION

Morphological Characteristics

Tables 1 and 2 shows the data for the morphological properties of the three soil positions (upper slope, middle slope and valley bottom) that occur in the two toposequences studies in spite of their different gradients. The upper slope differs from the lower slope mainly in soil colour, drainage pattern (mottling), texture and structure. The valley bottom which is the third soil position along the toposequence is clearly different from the upper and lower slope in texture structure and soil colour. To compare the 2 toposequences some differences can be observed. At the upper slope, there is difference in soil colour both in value and chroma of the top soil (2 – 3/ 3 – 4 versus 4 – 5/1 – 2) and colour hue and value of sub soil 10YR / 6 versus 10YR/4 also concretions at the subsoil (lower slope) are much higher in toposequence A than B. Concretions are common mostly at the lower slope at the both sites. At the lower slope there are differences in the colour pattern while in toposequence A the colour ranges from 10YR4/6 to 10YR6/8 and in B 10YR 3/3 to 10YR6/6. Toposequence A shows better structural development and higher clay content in all the horizons except the surficialhorizons of the lower slope region. The toposequence at middleslope differs in depth ofB – horizon (17 – 69cm) vs. (18 – 130cm). The texture of the subsoil (A with higher clay content increasing down the profile than B) and sub soil structure (A better develop than B).

At the valley bottom there is difference in soil main colour similar to some extent to that of middle slope, the mottle colours are also differ to each other A (7.6YR 3/2 while B(2.5YR 4/6). Toposequence A has higher clay and better structural development. The factors responsible for most of these differences of similar locations on the two toposequences are slope gradient (%) and land use.

At the upper slope with little difference in slope of (2 – 3%) differences in texture and structure were observed. At the middle slope the slope is 5% and is cultivated which may be more susceptible to erosion while on B (8%) the location received eroded materials from the cultivated upper slope. At the valley bottom both are on similar gradient of 1% but A received eroded material from the middle slope because of the cultivation at the middle slope.

Clay and Gravel Content

Fig. 1: Show the topsoil and subsoil clay content, along the toposequence A and B. In toposequence A the clay content increase consistently down the profile and the slope but the

clay content in B toposequence decreases consistently down the profile both at the upper and middle slope which is in accordance to (Smyth and Montgomery 1962) except the valley bottom which increases down the profile.

The clay content does not separate toposequence A very clearly into contiguous regions but separate toposequences B very clearly. There are clear differences in the clay content of the two toposequence at the upper regions.

Fig. 2 – shows the topsoil and subsoil gravel content along the toposequences A and B. In toposequence A and B the gravel content generally decreases down the slope in both toposequences. This is probably due to the effect of the erosional

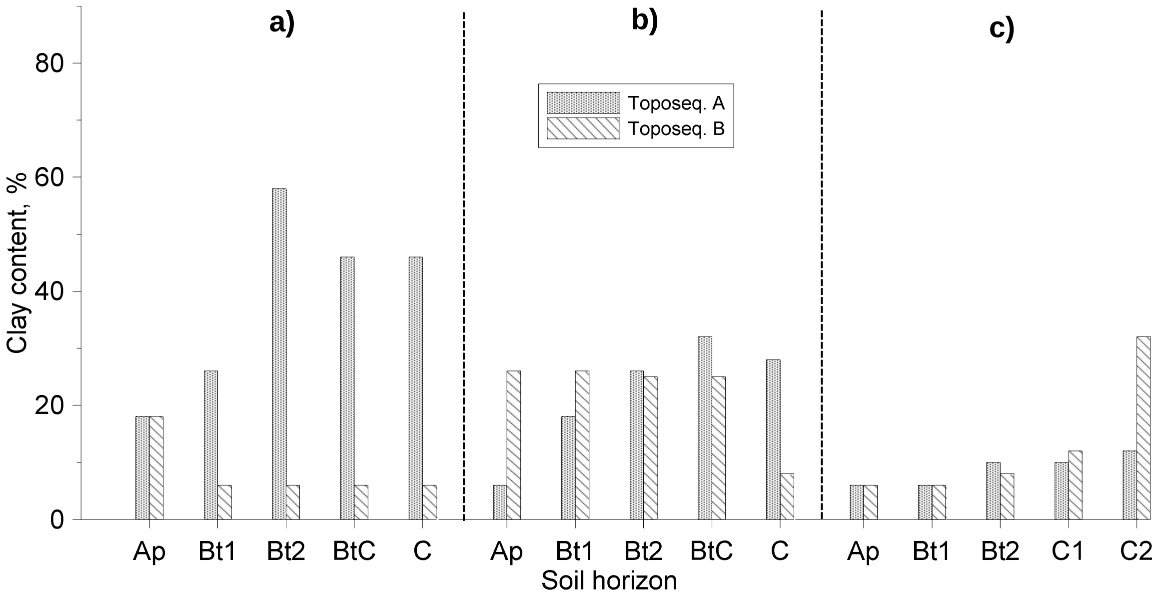

Fig. 1 Distribution of clay content in the different horizons of (a) upper, (b) middle and (c) lower slopes of the two toposequence.

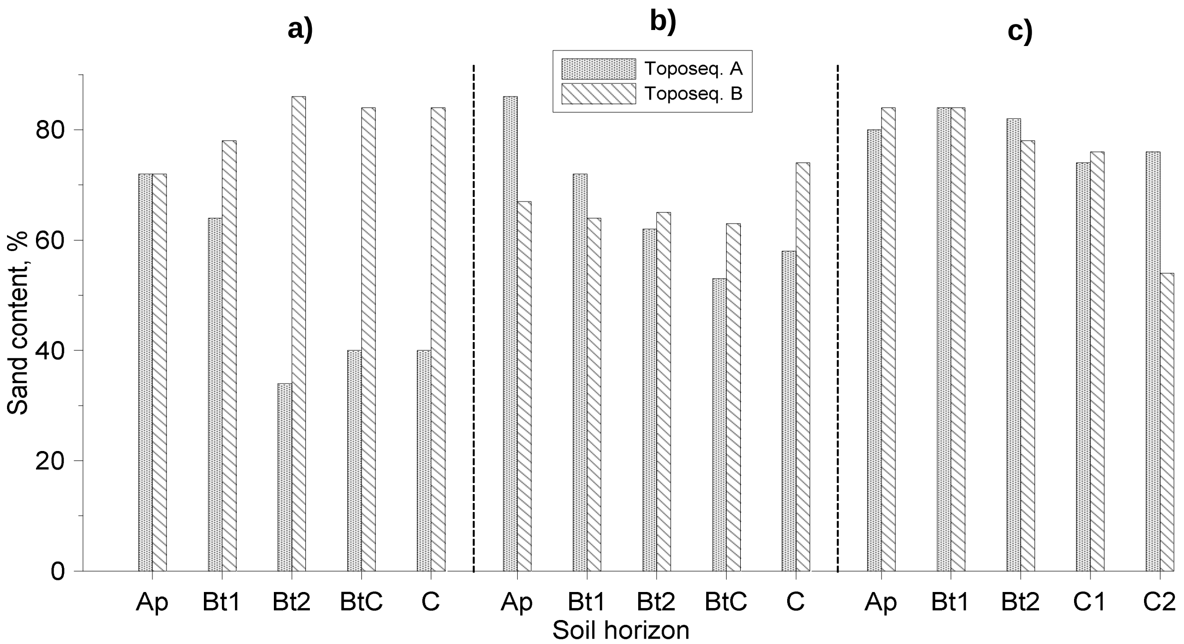

Fig.2. Distribution of sand content in the different horizons of (a) upper, (b) middle and (c) lower slopes of the two toposequence.

deposition giving rise to thick mantle of gravel free soil at locations down the slope. The removal of soil by erosion from high slope location make the sub soil close to the bedrock hence make the lower portions to be gravelly.
The topsoil of all the pedons is virtually free of gravel.

Iron and Aluminum Oxides
There are little or no differences in either Fe-d or Fe-o or Al-d or Al-o between any two pedons in their amount at different positions in each of toposequence. There are no difference in the ratio of Fe-o/Fe-d or Al-o/Al-d and Fe-d/clay. There are no clear-cut differences between similar locations on the two toposequences in all the pedons ofboth toposequences A & B, the distribution of the Fe and Al oxides are very erratic.

Diagnostic horizon and Weathering Intensity
The presence of a diagnostic horizon in a pedon is an indication of some degree of development. The presence of an argillic (Bt) horizon Table 3 & 4 in which the horizon in sandy or sandy-skeletal which is at least 15cm thick and evidence of clay alleviation of clay films on both vertical and horizontal surfaces of the peds i.e. (presence of clay skins could be established). This shows similarity among pedons at the upper, middle and valley regions in the toposequences A & B.
Silt/Clay ratio is an indicator or intensity of weathering. A ratio of <0.15 indicates low to moderate while a ratio of >0.15 indicates high intensity (Young 1976). Nearly all the pedons shows indications of high weathering intensity (Table 3 & 4).
The upper slope of toposequence A shows evidence of low weathering (0.030 – 0.36)while that of B shows very high weathering indication (0.56 – 2.67). At the middle slope toposequence A shows high weather indication (0.5 – 1.3) while B shows low weathering indication (0.30 – 0.4). At the valley region both toposequences show very high indications of weatherability.
The value of I_t (index of textural differentiation; Ogunkunle, 1990) is a measure of profile development separates the two toposequences into 2 regions. These regions are
1) Upper and mid-slope with It <0.2
2) Lower and valley with It >0.2

Soil Classification
On the basis of the criteria of the USDA. Soil Taxonomy (Soil Survey Staff, 2014) all the pedons clearly expressed argillic (Bt) horizon, a udic moisture regime, high base status, low ECEC (<12meq/100g clay) within the B horizons, and the fulfillment of the requirement of clay content increase with depth. The requirement of a regular decrease in organic carbon with increasing depth in also satisfied (Table 5), pedons at the upper, middle and valley on toposequence A and the middle slope in toposequence B were classified as first level as Alfisol because of their high base saturation (>35%). The prevalent udic moisture regime in the Alfisol necessitates their classification into the suborders udalf and as Kandiudalf. (Soil Survey Staff 2014) while the upper and valley slopes of toposequence B qualify for Kanhapludalfa and TypicKandiaqualfs respectively.
At the upper slope of toposequence A the soil was classified as TypicKandiudalfs while at toposequence B was classified as Kanhapludalfs. And at the middle slope toposequence A was classified as AquicArenicKandiadalf because it exihibit a Sandy particle size class throughout a layer extending from the mineral soil surface to the top of a kandic horizon at a depth of 50 to 100cm while at toposequence B was classified as TypicKandinotalf because of sandy particle size throughout the horizon. The valley pedons in both toposequences shows evidences of deposition but has diagnostic horizon development. They are aqualfts due to their moisture regime. Toposequent A was classified to plinthickandiaqualf because it has exhibited plinthite

in more horizon within 150cm of the mineral soil surface. The other on toposequence B qualifies as TypicKandiaqualfs.

The FAO (FAO 1986) equivalents of the classifications are as given in Table 5 & 6.

The soil taxonomy and the FAO classifications delineate the toposequences into the upper slope, middle slope and the valley bottom. Each of the region can be managed based on the characteristics existed by them such as structure, texture, concretion, drainage and others. Different crops that best scuted each region can be cultivated and managed as suggested by Aruleba (2004).

CONCLUSION

The results of soil classification in this study is a summary of the similarities and differences among the pedons since soil classification is a summary of the major characteristic of a pedon. The various regions existing on each toposequence require different management techniques for the same or different crops because of the basic differences in their characteristics. The difference observed between the two toposequence indicate that the management adopted at various position on onetoposequencecannot be transferred to similar positions on another toposequence on the same geology unless previous studies have shown that the two positions have similar characteristics.

Table 1: Some Morphological Characteristics of the Pedons along Toposequence A

Horizon Designation	Depth (Cm)	Colour Moist	Texture	Structure	Concretion (Fe-Mn)	Mottles	Drainage
			PEDON 1, UPPER SLOPE 2%				
AP	0 – 22	10YR2/3	SL	2.m.Cr/sb	A	A	IV
Bt_1	22 – 41	10YR2/3	SCL	3.m.sb/ab	A	A	IV
Bt_2	41– 65	10YR3/4	C	3.m.ab/sb	A	A	IV
Bt_c	65 – 96	10YR5/6	C	3.m.ab/sb	A	A	IV
C	96 – 150	10YR6/8	SCL	3.m.ab/sb	A	A	IV
			PEDON 2, MIDDLE SLOPE 5%				
AP	0 – 17	10YR4/6	LS	2.c.cr/ab	A	A	IV
Bt_1	17 – 32	10YR5/6	SL	2c.cr/Ab	A	A	IV
Bt_2	32 – 48	10YR6/8	SCL	3 f.ab	F	2.5 YR 4/8	III
Bt_c	48 – 69	10YR6/8	SCL	3 f.ab	F	2.5 YR 4/8	III
C	69 – 120	10YR6/8	SCL	3 f.ab	F	2.5 YR 4/9	III
			PEDON 3 VALLEY BOTTOM 1%				
AP	0 – 20	10YR2/2	LS	1.f.cr	A	A	II
Bt_1	20 – 75	10YR6/3	S	1 f.g	A	7.5 YR 3/2	II
Bt_2	75 – 84	10YR6/3	LS	1 f.g	A	7.5 YR 3/2	II
Bt_3	84 – 98	10YR6/3	SL	1 f.g	A	7.5 YR 3/2	II
Bt_C	98 – 150	10YR7/4	SL	1 f.g	A	7.5 YR 3/2	II

Table 2: Some Morphological Characteristics of the Pedon along Toposequence B

Depth (CM)	Horizon Designation	Colour (Moist)	Texture	Structure	Concretion (Fe – Mn)	Mottle	Drainage
			PEDON 1, UPPER SLOPE 3%				
AP	0 – 9	10YR4/1	SL	1.c.g/cr	A	A	IV
Bt_1	9 – 24	10YR5/2	LS	1.c.g/cr	A	A	IV
Bt_2	24– 48	10YR5/2	LS	1.c.g/cr	A	A	IV
$Bt_{c.1}$	48 – 82	10YR5/2	S	1.c.g/cr	A	A	IV
BtC_2	82 – 120	10YR6/2	S	1.c.g/cr	A	A	IV
			PEDON 2, LOWER SLOPE 8%				
AP	0 – 18	10YR3/3	SCL	1.c.g/cr	A	A	IV
Bt_1	18 – 42	10YR5/6	SCL	2.f cr	A	A	III
Bt_2	42 – 60	10YR5/6	SCL	1 f.cr	F	2.5 YR 3/2	III
Btc_1	60 – 82	10YR6/6	SCL	1 f.cr	F	2.5 YR 3/2	III
Btc_2	82 – 130	10YR6/6	SL	1 f.cr	A	2.5 YR 6/6	II
			PEDON 3, VALLEY BOTTOM 1%				
AP	0 – 21	10YR6/4	LS	1.f.cr	A	A	II
Bt_1	21 – 44	10YR6/4	LS	1.f.cr	A	2.5 YR 4/6	II
Bt_2	44 – 68	10YR6/4	LS	1 f.g	A	2.5 YR 4/6	II
Bt_3	68 – 90	10YR6/1	SL	1 f.g	A	2.5 YR 4/6	II
Bt_C	90 – 150	10YR6/1	SCL	1 f.g	A	2.5 YR 4/6	II

KEY:
Soil Texture: SCL = Sandy Clay Loam; C = Clay; S = Sand; SL = Sandy Loam; LS = Loamy Sand.
Structure: 1 = Weak; 2 = Moderate; 3 = Strong; F = Fine; c = coarse; cr = crumb; ab = angular blocky; Sb = sub angular; m = medium; g = granular
Concretion: A = Absent; F = Few
Drainage: IV = Well drained; III = Moderately drained
II = poorly drained.

Table 3: Selected properties of horizons at the B regions along toposequence A

Horizon	Depth Cm	-	Silt %	- Clay	Silt/ Clay	Citrate Fe-d	Al-d %	Dith Fe-o %	Ann. Al-o	Oxal Fe-d 102	Fe-O Al-d x10²	Al-o Clay	Fe-d ECEC meq/100g/Clay
						UPPER SLOPE (2%)							
AP	0 – 22	10	18	0.56	3.28		2.24	0.21	0.72	0.06	0.33	0.02	16.50
Bt_1	22 – 41	10	26	0.38	3.18		2.85	0.24	0.68	0.07	0.23	0.00	15.41
Bt_2	41 – 65	8	58	0.13	3.33		2.45	0.18	0.62	0.05	0.25	0.03	13.54
BtC	65 – 96	14	46	0.30	2.91		2.03	0.19	0.59	0.06	0.29	0.03	12.62
C	96 – 150	14	46	0.30	3.60		2.35	0.25	0.62	0.06	0.27	0.05	11.69
						MIDDLE SLOPE (5%)							
AP	0 –17	8	6	1.3	3.38		2.29	0.24	0.62	0.08	0.27	0.04	3.54
Bt_1	17 – 32	10	18	0.56	3.28		2.62	0.25	0.60	0.07	0.22	0.04	3.23
Bt_2	32 – 48	12	26	0.47	2.61		2.48	0.26	0.58	0.09	0.24	0.01	5.02
BtC	48 – 69	15	32	1.08	3.28		2.44	0.22	0.61	0.06	0.25	0.06	3.80
C	69 – 120	14	28	0.5	3.24		2.61	0.26	0.54	0.08	0.20	0.07	3.50
						VALLEY BOTTOM (1%)							
AP	0 – 20	14	6	1.75	3.26		2.32	0.26	0.71	0.07	0.30	0.03	37.0
Bt_1	20 – 75	10	6	1.67	2.27		2.28	0.36	0.62	0.15	0.28	0.06	27.32
Bt_2	75 – 84	8	10	0.8	3.34		2.41	0.54	0.68	0.17	0.28	0.06	27.60
C_1	84 – 98	16	10	1.6	3.28		2.53	0.29	0.59	0.08	0.24	0.02	21.89
C_2	98 – 150	12	12	1	2.59		2.29	0.39	0.63	0.15	0.27	0.04	14.70

Table 4: Selected Properties of horizons at the 3 regions along toposequence B

Horizon	Depth (Cm)	- %	Silt -	Clay Clay	Silt/ Fe-d %	Citrate Al-d %	Dith Fe-o	Ann. Al-o (10^2)	Oxal Fe-d x10^2	Fe-O (10^2) Al-d	Al-o Clay	Fe-d ECEC meq/100g/Clay
					UPPER SLOPE (2%)							
AP	0 –9	10	18	0.56	3.08	2.91	0.26	0.38	0.08	0.13	0.05	2.52
Bt_1	9–24	16	6	2.67	3.52	2.02	0.34	0.45	0.09	0.14	0.05	1.66
Bt_2	24 – 48	8	6	1.34	2.61	2.52	0.28	0.61	0.10	0.24	0.04	2.16
BtC_1	48 – 82	10	6	1.67	2.59	2.50	0.29	0.62	0.12	0.24	0.04	4.19
BtC_2	82 – 120	10	6	1.67	3.02	2.82	0.52	0.64	0.18	0.22	0.08	4.4
					MIDDLE SLOPE (8%)							
AP	0 –18	8	26	0.30	3.61	2.89	0.32	0.62	0.08	0.21	0.03	9.34
Bt_1	18 –42	10	26	0.38	3.58	2.62	0.26	0.59	0.10	0.22	0.01	4.15
Bt_2	42 – 60	8	25	0.32	3.25	2.54	0.28	0.71	0.08	0.27	0.01	3.13
BtC_1	60 – 82	10	25	0.4	3.31	2.61	0.41	0.59	0.12	0.22	0.01	3.44
BtC_2	82 – 130	18	8	2.25	3.25	2.59	0.36	0.68	0.11	0.26	0.04	3.69
					VALLEY BOTTOM (1%)							
AP	0 –21	10	6	1.67	3.61	2.76	0.28	0.66	0.07	0.23	0.04	1.94
Bt_1	21 –44	10	6	1.67	3.54	2.86	0.28	0.71	0.07	0.24	0.04	0.50
Bt_2	44 – 68	14	8	1.75	2.28	2.91	0.41	0.62	0.12	0.24	0.05	1.90
Bt_3	68 – 90	12	12	1	3.14	2.68	0.23	0.49	0.08	0.18	0.01	1.90
C	90 – 150	14	32	0.43	3.05	2.59	0.39	0.69	0.12	0.26	0.02	2.40

Table 5: Selection Chemical Properties and Classification of the Pedons in Toposequence A

Horizon	Depth	pH	Org C	Exchangeable					ECEC	BS	Soil Classification
	(Cm)	(H_2O)	%	Ca	Mg	K	Na	Acidity	Meq/100gClay		
				UPPER SLOPE (2%)							
AP	0 – 22	5.9	3.51	3.01	1.18	0.03	0.05	0.03	11.50	88.52	Typic
Bt_1	22 – 41	5.8		1.89	0.87	0.50	0.05	0.02	15.41	95.67	Kandiudalfs
Bt_2	41 – 65	5.6		1.84	0.81	0.48	0.05	0.02	13.54	99.88	(USDA)
Bt_C	65 – 96	5.6		1.18	0.87	0.39	0.05	0.02	12.62	98.29	Ferric Lixisols
C	96 – 150	5.8		1.19	1.21	0.31	0.05	0.02	11.69	99.14	(FAO)
				MIDDLE SLOPE (5%)							
AP	0 – 17	5.9	3.75	1.69	0.57	0.12	0.06	0.06	3.54	71.79	AquicArenic
Bt_1	17 – 32	5.8		0.99	0.53	0.14	0.07	0.05	3.23	53.52	Kandiudalfs
Bt_2	32 – 48	5.6		1.59	1.78	0.11	0.05	0.06	5.02	70.12	(USDA)
Bt_C	48 – 69	5.4		1.69	0.93	0.10	0.04	0.06	3.80	73.68	GleyicLixisols
C	69 – 120	5.0		1.52	0.61	0.11	0.04	0.05	3.50	98.45	(FAO)
				VALLEY BOTTOM (1%)							
AP	0 – 20	5.8	2.20	3.49	1.01	0.09	0.05	0.02	37.0	98.21	Plinthic
Bt_1	20 – 75	5.9		2.56	0.68	0.07	0.05	0.00	27.32	88.40	Kandiaqalfs
Bt_2	75 – 84	5.8		2.32	0.95	0.07	0.05	0.01	27.60	99.00	(USDA)
C_1	84 – 98	5.6		1.79	0.79	0.07	0.04	0.01	21.69	78.29	EutricGleysols
C_2	98 – 150	5.6		1.10	0.44	0.05	0.04	0.00	14.70	88.49	(FAO)

Table 6: Selection Chemical Properties and Classification of the Pedons in Toposequence B

Horizon	Depth (Cm)	pH (H_2O)	Org C %	Exchangeable Ca	Mg	K	Na	Acidity	ECEC Meq/100gClay	B.S %	Soil Classification
				UPPER SLOPE (3%)							
AP	0 –9	6.8	2.54	1.69	0.82	0.11	0.05	0.50	2.62	60.92	Kanha
Bt_1	9 –24	6.8		0.49	0.48	0.13	0.06	0.50	1.66	69.98	pludalfs
Bt_2	24 – 48	6.6		0.59	0.55	0.16	0.06	0.50	2.16	76.85	(USDA)
BtC_1	48 – 82	6.5		0.49	2.03	0.11	0.06	0.50	4.19	64.20	Ferric Lixisols
BtC_2	82 – 120	6.6		0.69	2.56	0.13	0.06	1.00	4.4	77.48	(FAO)
				MIDDLE SLOPE (8%)							
AP	0 – 18	6.8	3.10	6.48	2.04	0.25	0.07	0.50	9.34	94.64	Typic
Bt_1	18 – 42	6.9		1.69	1.77	0.14	0.05	0.05	4.15	87.95	Kandiudalfs
Bt_2	42 – 60	6.5		1.79	0.66	0.12	0.06	0.05	3.13	84.03	(USDA)
BtC_1	60 – 82	6.0		1.45	0.77	0.14	0.8	1.00	3.44	70.93	GleyicLixisols
BtC_2	82 – 130	6.5		1.29	0.72	0.12	0.06	1.50	3.69	70.76	(FAO)
				VALLEY BOTTOM (1%)							
AP	0 – 21	6.9	1.65	0.45	0.72	0.20	0.05	0.50	1.94	74.23	Typic
Bt_1	21 – 44	6.8		0.40	0.91	0.12	0.06	0.50	0.50	71.81	Kandiaqualfs
Bt_2	44 – 68	6.6		0.50	0.11	0.05	0.5	0.50	1.90	73.68	(USDA)
Bt_3	68 – 90	6.5		0.40	0.54	0.11	0.05	0.05	1.90	73.68	EutricGleysols
C	90 – 150	6.6		1.49	0.23	0.11	0.07	0.05	2.40	79.17	(FAO)

REFERENCES

Aruleba, J. O. (2004). Influence of Cropping System, land type and land suitability on land Degradation in South Western Nigeria. PLD Thesis submitted to the Department of Agronomy University of Ibadan 243pp.

Aruleba, J. O. (2011). Elements of Soil Science Gospel Press and publishing Company. Nigeria 157pp.

Boyd, D. A. and Dermott, T. W. (1964).Fertilizer experiment, on main crop potatoes, 1955 – 1901.J. Agric. Sci. Cambridge 63: 249 – 63.

Charter, C. F. (1949) The characteristics of cocoa soils proc. Coco cont. (London) 105.

Day P. R. (1953). Experimental Confirmation by hydrometer theory. Soil Science 75, 181 – 186.

Day; P. R. (1965). Particle Fractionation and Particle size analysis. Agron. Mon. 9, 1 Black C. A. (ed) 545 – 550.

FAO (1977).Guildlines for Soil profile dexcription. Soil Res. Dev. Conserv. Serv. Land Water Develop. Div. Food and Agriculture Organization of the United Nations Rome.

Gerravd, A. J. (1981). Soils and Landsforms.An integration of geomorphology and pedology, George Allen and UnwinBorton.

Greenwood, M. (1938).Some Gold Coart Soils. Third West African Agric. Conf. Papers pp 101 – 118.

HSN, P.H. (1963). Effect of Initial p^H, Phosphate & silicate on determination of Aluminium with Aluminon Soil Sci. vol. 96, pp 230 – 238.

Jackson, M. L. (1958). Soil Chemical Analysis (Eaglewood Cliffs New Jersey).

Jenry, H. (1946). Arrangements of Soil Series and types according to functions of Soil forming factors. Soil Science 61, 375 – 391.

Mehra, O. P. and M. I. Jackson (1960). Iron Oxide removal from soils and Clays by dithionite-citrate system buffered with sodium bicarbonate, clays and clay minerals 7. 317 – 327.

Ogunkunle, A. O. (1989). Topographic location, soil characteristics and classification in Three Bio-geological location in Mid Western Nigeria. Malaysian Journal of Tropical Geography 19 (1) 22 – 32pp.

Ogunkunle, A. O. and Beckett, PHT (1987).Comparative influence of Soil and Management on barley yield in the vale of Whitehorse, England J. Agric. Sci. Cambridge 108: 55 – 60.

Ogunkunle, A. O. and Onasanya O. S. (1992). Soil-Landscape relationships in a forest zone in South-Western Nigeria Samaru J. Agric. Res. 9 : 19 – 33.

Smyth, A. J. and R. F. Montgomery (1962).Soils and Land use in Central Western Nigeria. Government Printer, Ibadan.

Soil Survey Staff (2014).Keys to Soil Taxonomy, AID, USDA and SMSS.SMSS Technical Monograph No. 6 Cornall University.

Vine, H. (1941). A Soil Catena in Nigeria Cocoa belt. Farm and Forest 2, 139 – 141.

Walkley, A. (1935). An examination of methods for determining organic carbon and Nitrogen in Soils. Journal of Agricultural Science 25: 598 – 609.

Young A. (1976). Tropical Soils Survey. Cambridge University Press, pp 272 – 281.