

# THE STUDY OF SOIL PROFILE CHARACTERISTICS UNDER DIFFERENT LAND USE IN FUFURE LOCAL GOVERNMENT, ADAMAWA STATE, NIGERIA

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## ABSTRACT

*An assessment of soil Profile characteristics of Fufore, Fufore Local Government Area of Adamawa State was conducted. Two (2) profile pits were dug in each of the different land uses (Cultivated and Uncultivated) and samples were then taken from identified genetic horizons. The soils were described by their physical and chemical properties. All soil samples collected were analyzed in the laboratory using standard laboratory procedures. The results revealed that the soils were predominantly Sandy Loam in texture for both cultivated and uncultivated, the bulk density value for the cultivated and uncultivated sites ranged from 1.38-1.64 g/cm<sup>3</sup> and 1.47-1.74 g/cm<sup>3</sup> respectively. The soil pH was also slightly to moderately acidic for both land uses (pH range 5.5 – 6.6 cultivated and 5.6 – 6.3 uncultivated). The organic carbon, organic matter, total nitrogen and available phosphorus were generally found to be low for both cultivated and uncultivated land use. The TEB (Total exchangeable bases) for the cultivated site ranged from 5.19-20.19cmol (+)/kg, and termed low to medium, while that of the uncultivated was 3.62-9.78cmol (+)/kg, and termed low. It is recommended that, the incorporation of crop residue, addition of organic manures and provision of adequate drainage will improve the physical and chemical properties of the soils, which will enhance sustainable crop production.*

**Key words:** Characteristics, Cultivated and Uncultivated Land Use, Drainage, Profile.

## 1. INTRODUCTION

Given the central role of soil resources in subsistence crop production and the fact that soil as a resource in the human time scale, is a major aspect of sustainable agriculture [1]. The profile characteristics of soils have recently received more attention, as surface characteristics of tropical soils have failed to bring about detail information on soils; it has also become more apparent that the detail information on profile characteristics of soils can offer many insights about sustainable soil management

of agricultural soils. Natural resources including soils cannot be properly managed without proper understanding of their characteristics [2]. Effect of land use on soil physical and chemical properties especially soil nutrient quantity and quality varies. It has been reported that the conversion of forests into other land uses caused a decline in soil organic carbon [3]. This manifested as a depression in soil aggregation or structure [4] and other chemical and physical soil properties [5]. Land degradation has serious impact on soil physical and chemical properties especially the bulk density, organic matter, porosity and aggregate stability causing their compaction and erosion [6]. This has attendant implication on food insecurity, health and safety hazards and depressed viability of the earth for food production.

The major objective of this study therefore is to assess the profile characteristics of soils at Fufore in Fufore Local Government Area of Adamawa State, and suggest management practices for optimum and sustainable cropping systems.

## **2.0 MATERIALS AND METHODS**

### **2.1 The study area**

The study was conducted in Fufore, Fufore Local Government Area of Adamawa State. Fufore lies on latitude  $9^{\circ}14'$  North and longitude  $12^{\circ}38'$  East, at an altitude of 230m above sea level. The area is characterized by dry sub humid climate with a relatively dry environment. The mean annual rainfall is between 508mm to 1016mm, with a short growing season of between 4 to 5month (May-October) and maximum and minimum temperature range of  $45^{\circ}\text{C}$  and  $20^{\circ}\text{C}$  respectively.

### **2.2 Soil sampling and handling**

Two (2) profile pits each were randomly positioned and dug for both cultivated and uncultivated fields and soil samples were taken from identified genetic horizon using hand trowel. The collected Soil samples were then properly labeled in polythene bags and taken to the laboratory for analysis. In the laboratory, each sample was separately air dried ground and passed through a 2mm sieve for laboratory analysis as described by [7]. Particle size analysis, Bulk density, Soil pH, Electrical conductivity (EC), Organic carbon, Total nitrogen, Available Phosphorus, and Exchangeable Bases (Ca, Mg, Na and K) in the soil samples were all determined, while TEB was calculated by summing up the bases (Ca+Mg+Na+K).

### **2.3 Data analysis**

The Data generated from laboratory analysis were subjected to simple correlation and analyzed using SPSS (version 17).

### 3.0 RESULTS AND DISCUSSION

#### 3.1 Soil Physical Properties

Table 1, represent the physical properties of soils of the study area for cultivated (Pits1 and 2) and uncultivated (Pits 3 and 4) respectively. The results for particle size distribution presented in Table 1 showed the percentage (%) fraction of each horizon in Pit 1 to 4. The sand, clay and silt fractions of the cultivated field ranged from 54.8–86.8, 7.2–29.2 and 4.0–26.0% respectively, while for the uncultivated the values are 60.8–80.8, 3.2–17.2 and 12.0–30.0% respectively. In both fields sand fraction accounted for the highest percentage, with the uncultivated field having a higher mean sand values when compared to the values for cultivated field. The higher values of percentage sand content obtained for both Pits 1 and 2 could be attributed to the secondary products of weathering [8]. The mean clay content were also found to be higher in cultivated field than uncultivated, while the opposite was the case for silt as shown in Table 1. Generally the results revealed that the soils of both cultivated and uncultivated lands were similar in their particle size distribution and found to be predominantly Sandy loam in texture.

In Pits 1 and 2 (cultivated) the mean bulk density (Db) values are 1.52 and 1.51g/cm<sup>3</sup> respectively, while Pit 3 and 4 (uncultivated) recorded mean values of 1.65 and 1.62g/cm<sup>3</sup>, respectively. The soils investigated had almost equal distribution of bulk density values for both land uses. The values of bulk density obtained for this study are within the range reported in an earlier finding by [9], who recorded values of 1.50–1.80g/cm<sup>3</sup> while working on soils in Borno State. A good plant growth is best at bulk densities below 1.40g/cm<sup>3</sup> for clay, and 1.60g/cm<sup>3</sup> for sandy soils [10].

#### 3.2 Soil Chemical Properties

The chemical properties for soil samples from Pits 1, 2, 3 and 4 are shown in Table 2. The soil reaction (Table 2), indicated that the pH values obtained in this study ranged from 5.70 – 6.50 with a mean of 6.06 (Pit 1 cultivated), 5.50 – 6.60 with a mean of 5.94 (Pit 2 cultivated), 5.80–6.30 with a mean of 6.04 (Pit 3 uncultivated) and is 5.60 – 6.10 with a mean of 5.90 (Pit 4 uncultivated). This implies that the soil reactions of both the cultivated and uncultivated fields are almost similar, and can be classified as moderately to slightly acidic [11]. The result for electrical conductivity (EC) of the study area is presented in Table 2, the values ranged from 0.07–0.24dS/m with a mean of 0.24dS/m (Pit1 cultivated), 0.22 – 1.27dS/m with a mean of 0.46dS/m (Pit2 cultivated), 0.30 - 0.45dS/m with a mean of 0.35dS/m (Pit3 uncultivated) and 0.20 – 0.70dS/m with a mean of 0.39dS/m (Pit4 uncultivated).

Table 1: Pit Physical Properties Cultivated and Un-cultivated fields

Pit	Sample Name	Sand (%)	Clay (%)	Silt (%)	Textural Class	B.D (g/cm <sup>3</sup> )
1	Pit1 Cult 0-26	74.80	15.20	10.00	SL	1.51
	Pit1 Cult 26-55	78.80	11.20	10.00	SL	1.57
	Pit1 Cult 55-88	86.80	9.20	4.00	LS	1.61
	Pit1 Cult 88-98	54.80	29.20	16.00	SCL	1.38
	Pit1 Cult 88-un-limit	62.80	17.20	20.00	SL	1.47
	MEAN	71.60	16.40	12.00		1.51
2	Pit2 Cult 0-20	66.80	19.20	14.00	SL	1.46
	Pit2 Cult 20-34	80.80	7.20	12.00	LS	1.64
	Pit2 Cult 34-52	60.80	13.20	26.00	SL	1.51
	Pit2 Cult 52-68	58.80	29.20	12.00	SCL	1.39
	Pit2 Cult 28-39	78.80	10.20	11.00	SL	1.58
	MEAN	69.20	15.80	15.00		1.52
3	Pit3 Un Cult 0-27	74.80	3.20	22.00	LS	1.74
	Pit3 Un Cult 27-35	80.80	7.20	12.00	LS	1.64
	Pit3 Un Cult 35-44	70.80	7.20	22.00	SL	1.62
	Pit3 Un Cult 44-57	70.80	5.20	24.00	SL	1.66
	Pit3 Un Cult 57-76	66.80	8.20	25.00	SL	1.59
	MEAN	72.80	6.20	21.00		1.65
4	Pit4 Un Cult 0-25	60.80	17.20	22.00	SL	1.47
	Pit4 Un Cult 25-34	74.80	7.20	18.00	SL	1.62
	Pit4 Un Cult 34-44	70.80	4.20	25.00	SL	1.7
	Pit4 Un Cult 44-61	76.80	11.20	12.00	SL	1.56
	Pit4 Un Cult 61-89	60.80	9.20	30.00	SL	1.56
	MEAN	68.80	9.80	21.40		1.58

B.D (Bulk Density)

These soils are therefore considered to be non saline [12]. The organic carbon (OC) content of the soil in cultivated field (Table 2) has a mean value of 0.93 and 0.93g/kg for Pits 1 and 2 respectively, while the uncultivated area had a mean value of 0.92 and 0.72g/kg for Pits 3 and 4 respectively, which implies low organic carbon content [13]. Also the content of organic matter (OM) obtained in this study (Table 2) is almost similar to that of organic carbon (OC). This seemingly low level content of organic carbon is attributed to the prevailing dry conditions, where the biomass production is low and rate of mineralization high [14].

The results for total nitrogen (TN) obtained in this study (Table 2) indicated that the cultivated field has a mean value of 0.45 and 0.29g/kg for Pits 1 and 2 respectively, while the uncultivated area has a mean value of 0.25 and 0.28g/kg for Pits 3 and 4 respectively, which implies low TN [13]. This low levels of the total nitrogen obtained in soils of the study areas could be attributed to the rapid rate of organic matter decomposition, high rate of leaching, soil erosion, volatilization and de-nitrification among other factors [15]. The higher mean value of TN obtained in the cultivated field could also be attributed to the application of chemical fertilizer containing nitrogen. In Pits 1 and 2 (cultivated) mean Soils available phosphorus (AP) were found to be 4.95 and 5.39mg/kg respectively, while Pit 3 and 4 (uncultivated), recorded mean values of 5.43 and 5.05mg/kg respectively. The values of soil AP obtained in this study could be regarded as low [13]. This low level of AP obtained in this study could be attributed to the nature of the parent material and its propensity to sorption on mineral surface [16].

In Pits 1 and 2 (cultivated) shown in Table 2. The mean soils Ca, Mg, Na and K content were found to be 1.89 and 3.59 cmol (+)/kg, 5.01 and 6.59 cmol (+)/kg, 0.13 and 0.36 cmol (+)/kg and 1.29 and 0.96 cmol (+)/kg respectively, while Pits 3 and 4 (uncultivated) (Table 2), recorded mean values of 2.77 and 3.16 cmol (+)/kg, 2.24 and 3.69 cmol (+)/kg, 0.16 and 0.27 cmol (+)/kg, and 0.29 and 1.08 cmol (+)/kg respectively. Generally, these values of soil exchangeable bases obtained for both cultivated and uncultivated fields for Mg and K were high and low for Ca and Na [11]. This seemingly high value of Mg and K obtained in this study could be related to the nature of the parent material [16]. In Pits 1 and 2 (cultivated) mean TEB (Total Exchangeable Bases) were found to be 8.33 and 11.50 cmol (+)/kg respectively, while Pits 3 and 4 (uncultivated), recorded mean values of 5.45 and 8.20 cmol (+)/kg respectively. Irrespective of the higher mean values of TEB recorded in the cultivated field, generally the values of soil TEB obtained in this study could be regarded as low [11].

### 3.3 Correlation analysis

Correlation analysis was carried out to know the relationship that exist between the physico-chemical properties for pits samples under cultivated and un-cultivated fields. The

result (Tables 3,4), shows that for profile pits under cultivated, only EC and Mg, and Ca and Silt that was positively correlated at 5% level of significant, indicating that the dominant factor that is responsible for the EC is Mg, if Mg increases EC also increases, and the higher the silt, the higher the Ca in the soil complex. It was also observed that only Mg and TEB that are positively correlated at 1% level of significant. This shows that, the TEB in the soil of the study area is largely affected by Mg with a positive relationship. On the other hand, OC and K, Ca and TN, Ca and TEB, Ca and Silt, Na and Silt, and Sand and Silt are negatively correlated at 5% level of significant, while Na and TN, Sand and Clay, and Bulk density and Clay was negatively correlated at 1% level of significant. Under un-cultivated pits, pH and Mg, pH and Clay, OC and Na, and Ca and Clay showed a negative correlation at 5% level of significant while, pH and BD, Na and TEB are positively correlated at the same level of significant. It was also observed that, EC and OC, Sand and Silt, Clay and BD are negatively correlated at 1% level of significant, while Mg and TEB, Na and TEB are positively correlated at 1% level of significant.

Table 2: Chemical Properties Cultivated and Un-cultivated fields

SN	Sample Name	pH	EC (dS/m)	OC	OM (g/Kg)	TN	AP (mg/Kg)	Ca	Mg	Na	K	TEB
									(cmol(+)/Kg)			
1	Cult 0-26cm	5.70	0.24	0.95	2.67	0.30	5.20	4.37	7.91	0.17	1.44	13.89
	Cult 26-55cm	6.50	0.25	0.95	2.67	0.50	5.92	0.49	4.61	0.09	0.18	5.37
	Cult 55-88cm	6.10	0.41	0.91	2.60	0.45	4.63	1.21	8.57	0.09	1.79	11.67
	Cult 88-98cm	6.30	0.24	0.91	2.60	0.50	5.92	1.21	1.32	0.17	2.49	5.19
	Cult 88-un-limit	5.70	0.07	0.93	2.63	0.50	3.05	2.18	2.64	0.13	0.56	5.52
	<b>MEAN</b>	6.06	0.24	0.93	2.63	0.45	4.95	1.89	5.01	0.13	1.29	8.33
2	Cult 0-20cm	5.90	0.22	0.86	2.51	0.25	4.77	1.70	5.27	0.48	2.49	9.94
	Cult 20-34cm	6.60	0.27	0.92	2.61	0.20	4.49	3.64	1.32	0.30	0.23	5.49
	Cult 34-52cm	5.50	0.30	0.96	2.68	0.25	6.57	8.01	11.21	0.57	1.13	20.91
	Cult 52-68cm	6.20	1.27	0.97	2.70	0.35	6.28	2.43	13.18	0.17	0.18	15.96
	Cult 28-39cm	5.50	0.25	0.93	2.63	0.40	4.85	2.18	1.98	0.26	0.77	5.19
	<b>MEAN</b>	5.94	0.46	0.93	2.63	0.29	5.39	3.59	6.59	0.36	0.96	11.50
3	Un Cult 0-27	6.30	0.33	0.83	2.46	0.40	6.42	2.67	0.66	0.09	0.21	3.62
	Un Cult 27-35	6.00	0.30	0.96	2.68	0.30	5.20	1.46	1.98	0.17	0.56	4.17
	Un Cult 35-44	6.10	0.31	0.96	2.68	0.10	3.91	2.67	2.64	0.22	0.15	5.68
	Un Cult 44-57	6.00	0.36	0.94	2.65	0.20	6.06	4.37	4.61	0.17	0.15	9.31
	Un Cult 57-76	5.80	0.45	0.94	2.65	0.25	5.56	2.67	1.32	0.13	0.36	4.48
	<b>MEAN</b>	6.04	0.35	0.92	2.62	0.25	5.43	2.77	2.24	0.16	0.29	5.45
4	Un Cult 0-25	5.60	0.33	0.91	2.60	0.20	4.92	1.21	7.25	0.17	0.33	8.97
	Un Cult 25-34	5.70	0.70	0.15	1.29	0.30	4.13	4.37	4.61	0.39	0.41	9.78
	Un Cult 34-44	6.10	0.20	0.95	2.67	0.45	5.56	5.10	3.30	0.30	0.36	9.06
	Un Cult 44-61	6.00	0.46	0.75	2.32	0.35	4.70	2.18	1.98	0.26	1.79	6.22
	Un Cult 61-89	6.10	0.24	0.87	2.53	0.10	5.92	2.91	1.32	0.22	2.51	6.96
	<b>MEAN</b>	5.90	0.39	0.72	2.28	0.28	5.05	3.16	3.69	0.27	1.08	8.20

**TABLE 3: CORRELATION MATRIX FOR PHYSICO CHEMICAL PROPERTIES OF PROFILE UNDER CULTIVATED FIELD**

	<i>pH</i>	<i>EC</i>	<i>OC</i>	<i>TN</i>	<i>AVP</i>	<i>Ca</i>	<i>Mg</i>	<i>Na</i>	<i>K</i>	<i>TEB</i>	<i>Sand</i>	<i>Clay</i>	<i>Silt</i>	<i>B.D</i>
<i>pH</i>	1.000													
<i>EC</i>	0.220NS	1.000												
<i>OC</i>	-0.087NS	0.441NS	1.000											
<i>TN</i>	0.108NS	-0.108NS	0.081NS	1.000										
<i>AVP</i>	0.130NS	0.476NS	0.443NS	-0.148NS	1.000									
<i>Ca</i>	-0.489NS	-0.024NS	0.414NS	-0.647*	0.303NS	1.000								
<i>Mg</i>	-0.216NS	0.688*	0.487NS	-0.262NS	0.533NS	0.424NS	1.000							
<i>Na</i>	-0.393NS	-0.131NS	-0.218NS	-0.747**	0.250NS	0.677NS	0.167NS	1.000						
<i>K</i>	-0.188NS	-0.309NS	-0.690*	0.010NS	0.034NS	-0.106NS	-0.088NS	0.240NS	1.000					
<i>TEB</i>	-0.396NS	0.461NS	0.415NS	-0.472NS	0.537NS	0.715*	0.917**	0.459NS	0.060NS	1.000				
<i>Sand</i>	0.178NS	-0.241NS	-0.116NS	-0.054NS	-0.318NS	-0.220NS	-0.181NS	-0.286NS	-0.212NS	-0.266NS	1.000			
<i>Clay</i>	0.075NS	0.492NS	0.031NS	0.217NS	0.338NS	-0.182NS	0.216NS	-0.077NS	0.298NS	0.139NS	-0.843**	1.000		
<i>Silt</i>	-0.417NS	-0.200NS	0.170NS	-0.182NS	0.139NS	0.632*	0.048NS	0.616*	0.000NS	0.301NS	-0.720*	0.234NS	1.000	
<i>B.D</i>	0.116NS	-0.361NS	-0.031NS	-0.193NS	-0.296NS	0.058NS	-0.235NS	-0.044NS	-0.335NS	-0.211NS	0.914**	-0.967**	-0.405NS	1.00



Table 4: Correlation Matrix For Physico Chemical Properties of Profile Under Un-Cultivated Field

	<i>pH</i>	<i>EC</i>	<i>OC</i>	<i>TN</i>	<i>AVP</i>	<i>Ca</i>	<i>Mg</i>	<i>Na</i>	<i>K</i>	<i>TEB</i>	<i>Sand</i>	<i>Clay</i>	<i>Silt</i>	<i>B.D</i>
<i>pH</i>	1.000													
<i>EC</i>	-0.548NS	1.000												
<i>OC</i>	0.379NS	-0.856**	1.000											
<i>TN</i>	0.199NS	0.088NS	-0.175NS	1.000										
<i>AVP</i>	0.459NS	-0.468NS	0.429NS	0.231NS	1.000									
<i>Ca</i>	0.176NS	0.126NS	-0.314NS	0.272NS	0.130NS	1.000								
<i>Mg</i>	-0.713*	0.184NS	-0.200NS	-0.161NS	-0.342NS	0.062NS	1.000							
<i>Na</i>	-0.294NS	0.444NS	-0.690*	0.147NS	-0.598NS	0.534NS	0.313NS	1.000						
<i>K</i>	0.158NS	-0.117NS	-0.042NS	-0.230NS	0.094NS	-0.173NS	-0.351NS	0.168NS	1.000					
<i>TEB</i>	-0.477NS	0.204NS	-0.385NS	-0.064NS	-0.215NS	0.562NS	0.791**	0.659*	-0.048NS	1.000				
<i>Sand</i>	0.306NS	0.286NS	-0.244NS	0.562NS	-0.168NS	0.052NS	-0.322NS	0.151NS	-0.234NS	-0.325NS	1.000			
<i>Clay</i>	-0.693*	0.095NS	0.014NS	-0.382NS	-0.372NS	-0.632*	0.536NS	0.011NS	0.285NS	0.216NS	-0.494NS	1.000		
<i>Silt</i>	0.134NS	-0.392NS	0.268NS	-0.375NS	0.451NS	0.381NS	-0.006NS	-0.180NS	0.068NS	0.220NS	-0.795**	-0.134NS	1.000	
<i>B.D</i>	0.704*	-0.145NS	0.021NS	0.540NS	0.403NS	0.545NS	-0.457NS	-0.081NS	-0.398NS	-0.237NS	0.562NS	-0.961**	0.030NS	1.000

#### **4.0 CONCLUSION ANDRECOMMENDATIONS**

The result obtained from physical and chemical analysis of the soils of the study area indicated very little differences between the cultivated and uncultivated fields. Also the main limiting factors regarding soil productivity are low organic matter content, low total nitrogen, and low available phosphorus. An effective management practice is therefore very necessary for optimum agricultural productivity within the study areas. These management practices should include the provision of adequate drainages, incorporation of crop residue, addition of organic manures, and inorganic fertilizers containing especially N, P, Finally, proper and periodic monitoring of the physical and chemical properties of such soils is very necessary, so that appropriate preventive measures could be embarked upon as and when due, for optimum agricultural productivity.

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