IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 11, Issue 10 Ver. I (October 2018), PP 01-09
www.iosrjournals.org

Evaluation of Indigenous Soil Fertility Assessment of the Sudan Savannah Agro-Ecological Zone of Nigeria - A Paper Review

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Abstract: *A study was conducted to evaluate the indigenous knowledge by farmers toward their soil fertility assessment. More research has been deeply developed from the basically ideologies and ethno-scientific approaches generated by the locally farmers worldwide through their long-term experience in the farming system toward assessing the soil fertility using their commonly indigenous knowledge. The concept has received attention and gradually developing throughout the world and have been documented by numerous scientists in Latin America, South-East Asia and Africa (Nutnet, 2000).They formed the basis for many management practices such as attunement of cropping system to the agricultural capabilities of the site and adjusting soil conservation practices (Greb, 1983).This paper has paid attention on how farmers classified soil fertility using a commonly criteria such as soil color, depth, texture, structure and vegetation to maximize production. Farmers from three locations namely Dundaye, Kwalkwalawa and Gidan-Yaro were interviewed and soil samples were collected for a laboratory analysis.A total of eighteen (18) soil samples were collected at the depth of 20cm each, taken to the laboratory, air-dried, ground and sieved using 2mm sieve before the analysis. The samples were analysed for color determination, particle size analysis, pH, electrical conductivity (EC), total nitrogen (N), available phosphorus (P), organic carbon,and cation exchange capacity (CEC) using a standard methods. Results obtained showed that the soils are sandy-loam, sandy-clay-loam and loamy-sand. The soil pH is within the range of slightly-acidic, neutral and slightly-alkaline respectively. The total nitrogen and available phosphorus were very low in the soils with their values ranging from 0.02 to 0.06% and 0.17 to 0.45 mg/kg in Dundaye, 0.04-0.15% and 0.20 to 0.55 in Kwalkwalawa and 0.004 to 0.02% and 0.21 to 0.48 mg/kg in Gidan Yaro. The percentage organic matter content was found to be moderate to high while the exchangeable sites were found to be predominantly occupied by the bases thus indicating high percentage base saturation in mostly not-fertile soils. The percentage base saturation (PBS) values for Dundaye, Kwalkwalawa and Gidan-Yaro were 67.3%, 53.3% and 73.5% thus indicating a moderate to high mean values respectively. The cation exchange capacity (CEC) was low to moderate with mean values of 5.9 cmolkg^{-1}, 9.4 cmolkg^{-1} and 4.5cmolkg^{-1} for Dundaye, Kwakwalawa and Gidan-Yaro respectively. In conclusion, the results reported in the present study indicated that not-fertile soils were found to be coarser than fertile soils while the fertile soils are more characterized to dark colors and relatively higher in fertility parameters such as organic matter (OM), cation exchange capacity (CEC), % base saturation (PBS), total nitrogen (N) and available phosphorus (P). Based on this finding, there may be a room for accepting indigenous knowledge of assessing soil fertility in Dundaye district.*

Key Words: *Indigenous Assessment, Soil Fertility, Sudan Savannah*

Date of Submission: 28-09-2018 Date of acceptance: 15-10-2018

I. Introduction and General Overview

Considering the rapidly increased population and animal production all over the world,the demand for improved agriculture is necessitated to meet the consumption needs of the populace. It is therefore in search of high productivity in yield, the soil fertility is fundamental and must come to play (Nutnet, 2000).

Soil fertility is a valuable aspect for advancing food security and environmental sustainability in farming system henceforth requires an integrated soil fertility management approach that maximizes crop production while minimizing the mining of soil nutrient reserves. This can be achieved through the use of grain legumes, which enhance soil fertility through biological nitrogen fixation, and the application of both organic and mineral fertilizers.

1.1 *Different approaches to efficiently manage soil fertility*

An integrated soil fertility management aims at maximizing the efficiency of the agronomic use of nutrients and improving crop productivity by use of legume crops, manure and chemical fertilizers.

Whether grown a pulses for grain, as green manure, as pastures or as the tree components of agro-forestry system, a key value of leguminous crops lies in their ability to fix atmospheric nitrogen, which helps reduce the use of commercial nitrogen fertilizers and enhances soil fertility.
Soil fertility can be further improved by incorporating cover crops that add organic matter to the soil, which leads to improved soil structure and promote a healthy fertile soils.

1.2 *The contribution of nuclear and isotopic techniques*

The isotopes of nitrogen-15 and phosphorus-32 are used to trace the movements of labeled nitrogen and phosphorus fertilizers in soils, crops and water, providing quantitative data on the efficiency of use, movement, residual effects and transformation of these fertilizers. Such information is valuable in the design of improved fertilize application strategies. The nitrogen-15 isotopic technique is also used to quantify the amount of nitrogen fixed from the atmosphere through biological nitrogen fixation by leguminous crops.

1.3 *Problem Statement and Justification*

Research on the use of indigenous knowledge system for agricultural development particularly in Nigeria is not elaborate and being largely ignored in search of the presently developmental programs. However, it has been partially recognized as a crucial national resource that facilitates progress in cost effectiveness, participatory and sustainable roadmap. Thus, this study was carried out to address the extent of knowledge shared by local farmers in assessing soil fertility.

1.4 *Aim and objectives of the research*

The main aim of this research is to find out how local farmers are able to identify fertile soil in Dundaye district of Sokoto State. The specific objectives include

1. To assess farmer’s knowledge on soil fertility evaluation
2. To identify soil characteristics and indicators used in soil fertility evaluation
3. To determine the physical and chemical properties of soil identified as fertile or not-fertile

1.5 *Scope of the study*

The present research was focused on the methods and different local ways through which local farmers adopted to evaluate the fertility status of the soil in Dundaye, Kwalkwalawa and Gidan-Yaro respectively. More emphasis was given to physical indicators such as color, texture and vegetation.

II. Soil Fertility

One of the central assumptions to fertility of the soil is related with the level of available nutrients it contains mostly resulting from large input of organic matter from leys and animal manure (Tinker, 2000). Fertility is actually enhanced when leys are incorporated to the soil, breaks down and lead to long term effect on the organic matter levels in the soil (Campbell et al., 1993). The fertility of the soil is determined by both physical properties and nutrients potentiality, most of the surface soils in the sudan savannah contains weak aggregates due to the low clay contentand so the predominance of kaolinite in clay fraction and free oxide as well as organic matter which are the major factors in the aggregation of the soils while erosion in the savannah regions removes greater amount of silt and clay than sand (Uriyo et al., 1979).

In savannah particularly cultivated soil free iron-oxides and percentage of clay correlated well with structural stability. Soil scientist made a distinction between soils derived from rocks low in iron (such as sand stones and granites) tend to be weakly structured and those high in iron (Basalt), the iron-oxides find soil particles in to stable crumbs.

Physical properties contributes to soil fertility determination where a number of which can be judged from the way soil looks or feels, are the first to be considered (Hauseen et al., 1978). The fertility status of soil determines to a large extent their productive capacity, the degree of aeration, moisture content and penetration depth which are directly related to the physical attributes of soil (Ochapa 1984) . Therefore, the soil physical properties are those agents responsible for the transport of air, heat, water and solutes through the soil to support fertility build-up.

2.1 Causes of fertility decline

Nutrient present in the soil give rise to fertility of a soil and exist in a varying quantities and the loss of one or the other may cause poor growth of crop plants (Eden, 1998). The decline or loss of nutrients from soil may be due to the following;

2.1.1 ***Leaching***

When raining, there is infiltrations of water in to the soil by a process called percolation, as the water passes down the soil, some nutrients are washed away off – the soil particle and move down deep to the soil where they may not be available for plant consumption (Dudal, 1973). Generally, soils from up - land leached more so they became less fertile than the soils in the lower level due to the water erodibility (Uriyo, et al., 1979). Leaching of soil nutrients also occur less in regions of lower rainfall such as northern states of west Africa than in the humid southern states (FAO, 1998).

2.1.2 ***Erosion***

Soil nutrients or organic matter present on the top soil can be easily washed away by either surface water run-off or wind and this eventually lead to a great loss of nutrients hence ause fertility decline (Foth, 1978).

2.1.3 ***Nutrient uptake and crop removal***

When root crops are harvested, there should be an appreciable removal of nutrients contain in the soil stick in the roots and when those roots are harvested lead to a certain level of fertility decline (Miller, 1962). Soil moisture level has pronounced effect on the uptake of plant nutrients. As a general rule, there is an increase in the uptake of cations and anions as soil moisture tension is decreased from the permanent wilting percentage to field capacity and when the pores become flooded with water, however roots respiration is affected and ions uptake is decreased (Brown, 1960).

2.1.4 ***Excessive irrigation***

Although irrigation schemes may be necessary to supplement insufficient rainfall, but if heavily irrigated lead to adverse leaching of the essential nutrients out of the root zone (Dudal, 1973). Excessive irrigation can also causes nutrient depletion, water logging and salt build-up (Abrol, 1962).

2.1.5 ***Drainage***

When land is waterlogged, it is necessary to remove the excess water out of the soil and this process lead to draining away of nutrients substantially together with the excess water (Thompson, 1957). In any soil profile especially with vegetation has a constant movement of salt which resulted from addition of solute and water at the surface losses at the lower boundary of the profile (Babcock, 1995). It is considered that the transport in horizontal direction hence distinguish three different concepts; movement of single band f salts, desalination of a profile by leaching and the balance set-up in a profile supplied with water containing dissolve salts (Hanks, 1969). These constituted drainage of fertilizers, soil nutrients and other added solutes especially in the irrigated lands due to excessive application of water.

2.1.6 ***Intensive cultivation***

Decomposition of organic matter and other nutrients in the soil is accelerated rapidly under the intensive cultivation practices because the nutrients improves the soil aggregation and aeration. The exposed soils reaches an ambient temperature and oxidation of the organic matter and other nutrients is increased, thus lead to cause a decline in organic and some inorganic nutrients (Ahn, 1979). More and intensified cultivation also encourages surface aeration and any further loss in top soils involves a substantial loss of organic matter and hence the fertility status of the soils is reduced (Aboukhaled, 1982).

2.2 Scientists and farmer's perceptions of soil fertility

2.2.1 ***Scientist's perceptions***

It is reported by the Nutrient Network Organization in the year 2000 that scientist perspection and understanding of soil fertility differed from that of farmers. Scientist often take account of soil nutrients status without considering its physical properties (Mengesha, 1996). Fertile land is defined as a land that is capable of producing consistently high yield in a wide range of crops (Nutnet, 2000). Scientific understanding of soil fertility is also perceived as the status of the soil n relation to the quantity and availability of required nutrients needed by crops to enhance their growth life (CDA, 1972).

2.2.2 ***Farmer's perceptions***

Farmers usually understands fertility in a given soils through their native understanding and long term experiences in a physical framework particularly color and texture as determinants (Pawluck, et al., 1992). Apart of color and texture, other important salient characteristics are rebirth such as organic residues content in the soil, moisture retention capacity, drainage, workability and friability (Williams, 1996). The farmers in tigray (Ethiopia) use a various observable indicators to assess soil fertility (Scoones, et al., 1998). One of the indicators used for fertility assessment in tigray include the appearance of specific weed species like Echinips hispidus and

Xanthium spinosum (Mengesha, 1996). Farmers also listed rocky outcrops and crops wilting at the end of rainy season as an indicator of declining of soil fertility (Deud, 1998). Alongside the successive decline of crop yields, poor soil moisture conservation.

Touch is virtually involved I assessing soil texture where soils that causes itching is regarded as injurious not only to human but also to crop plant (Osunade, 1989). Taste is also considered for assessing soil fertility by detecting its levels of acidity and alkalinity in malaysia (Greb, 1983) as well as smell by Yoruba community in Nigeria (Osunade, 1989).

2.3 *Soil fertility management practices*

Soil fertility management simply refer to those techniques adopted by farmers to maintain soil fertility status and hence improving the physical, chemical and biological soil properties to enhancing the organic matter content, increasing the efficiency of nutrient by using closed nutrient cycles and by minimizing nutrient loss from the agro-ecological system (Conway, 1997). The most commonly management practices include fallowing, crop rotation, residues burning, manure application, weeding, terracing and tillage practices.

III. Materials and Methods

3.1 *Study area*

The present study covers three villages namely; Dundaye, Kwalkwalawa and Gidan-Yaro in Dundaye district of Wamakko local government area of Sokoto state.

3.2 *Soil sampling for fertility assessment*

Soil sampling and collection was carried out with well experience farmers from each of the villages using color, texture and vegetation as criteria. Some selected and well experienced farmers were interviewed individually on their native ways of understanding soil fertility for high yield in both the dry and wet cropping seasons. The interviewed farmers identified soil as fertile and not-fertile using the set criteria (color, texture and vegetation).

Soil samples were taken randomly at different spots at 0-30cm planting depth and composted in to single sample.

Table 1: Soil sampled using color as a criterion

Village	Fertile	Not-Fertile
Dundaye	Jan-Kasa	Fara-Fara
Kwalkwalawa	Bakar-Kasa	Farin-Kasa
Gidan-Yaro	Jan-Kasa	Ja-Ja

Table 2: Soil sampled using texture as a criterion

Village	Fertile	Not-Fertile
Dundaye	Allaka	Leba
Kwalkwalawa	Laka	Turda
Gidan-Yaro	Gurori	Yashi

Table 3: Soil sampled using vegetation as a criterion

Village	Plant found	Soil found
Dundaye	Dadadurus (*Physalis ungulate*)	Fertile
	Mallo (*Malvastrum cremendelianum*)	Not-Fertile
	Baban-More (*Ambrosia maritime*)	Fertile
	Tsirkiya (*Cynadon dactylon*)	Not-Fertile
Kwalkwalawa	Balasaya (*Commelina benghalenesis*)	Fertile
Gidan-Yaro	Alkamar-Kwaddi (*Eragrostis turgida*)	Not-Fertile

3.3 *Sample preparation*

Soil samples were taken to the soil laboratory of Usmanu Danfodiyo University, Sokoto, air dried, ground and sieved by 2mm sieving screen and kept in a well labeled polythene bags for a subsequent chemical analysis.

3.4 Soil analysis

3.4.1 *Particle size analysis*

Particle size analysis was conducted using the Bouyoucous hydrometer method (Soil survey staff, 1996).

3.4.2 *Soil pH*

The pH was determined by taking 10g of soil sample in the 50ml beaker and 10ml of distilled water was added. The suspension was well stirred and allowed to settle for 30 mins undisturbed. pH readings of the suspension was taken using pH meter (Bates, 1954).

3.4.3 *Cation exchange capacity*

The cation exchange capacity was determined using ammonium saturation method where 5g of soil was saturated with normal ammonium acetate solution after which it was leached in the filter paper. The filter paper was distilled in 30ml of distilled water, 15ml of sodium hydroxide and the distillate was received in 20ml of Boric acid and titrated against the standard hydrochloric acid solution (0.1N).

3.4.4 *Calcium and Magnesium determination*

Calcium and Magnesium were determined by the EDTA method where 19ml of the distilled water was added in a 1ml aliquot to make 20ml solution. 1ml of 10% sodium hydroxide (NAOH) and three drops of potassium cyanide, hydroxyl amine hydrochloride and triethanol amine reagents were added, this is followed by adding 2-3 drops of murexid indicator and finally titrated using EDTA where the solution changed from pink to purple for calcium determination. The other important element called magnesium was determined using 2-3 drops of Eriochrome Black T indicator in which the purple color changed to blue after titration.

3.4.5 *Sodium and Potassium*

The filtrate solution from CEC determination was used to determine the concentration of sodium and potassium ions by flame photometer.

3.4.6 *Organic carbon*

Organic carbon was determined by Walkey-Black method (1934) where 10ml of 1N potassium dichromate ($K_2Cr_2O_7$) solution and 10ml of sulphuric acid (H_2SO_4) where pour in a conical flask containing a 1g of soil and was allowed to stand for 30 minutes after shaking. 50 ml of distilled water, 5ml of orthophosphoric acid and 1-3 drops o barium diphenyl indicaor were added differently in which the light brown colour of the solution turned to maroon after titration with ferric sulphate ($FeSO_4$) solution.

3.4.7 *Total Nitrogen*

A micro-Kjeldhal distillation method was used for Nitrogen determination where 2g of soil samples were taken into the digestion flask. One selenium catalyst tablet (Kjeldhal Catalyst) was added to 10ml of concentrated sulphuric acid (H_2SO_4). The flask was put in the digestion block for heating to about an hour and was allowed to cool. Distilled water was added to the digest and to make it 30ml, out of which 10ml was taken for distillation in Kjeldhal flask plus 15ml and 30ml of sodium hydroxide (NaOH) solution and distilled water respectively. The distillate was received in a 20ml of boric acid indicator. The distillate was titrated with 0.01N sulphuric acid (H_2SO_4).

3.4.8 *Available phosphorus*

A spectro-photometer with absorbance at 660α was used in determining the available phosphorus using Bray no 1 (0.03N NH_4F + 0.025 NH_4Cl) method where 5ml of Bray no 1 extract was added into a flat bottom flask containing of 2g of soil. 2ml of ammonium molybdate solution and 1ml of dilute standard chloride were added to the soil solution and shake vigorously in which it changed from colorless to light blue. Reading from the spectro-photometer was obtained (Bray and Kutz, 1945).

3.4.9 *Electrical conductivity*

Electrical conductivity of the samples was determined using conductivity meter method. 50ml of distilled water were added to 10g of soil sample in a beaker and shook up using hand. The reading values were obtained from the matter.

3.4.10 *Percentage base saturation* (PBS)

The PBS was computed using the formulae;
PBS = ∑EB/CEC x 100
Where ∑EB = Summation of the exchangeable bases

CEC = Cation exchange capacity

IV. Results and Discussion

The results of some physical properties of soils collected from Dundaye district, comprising of Dundaye, Kwalkwalawa and Gidan-Yaro are presented in table 4

Table 4: Physical properties of soils of Dundaye district

Location	Criteria	Local name	Color	PS: Sand	Silt	Clay	Texture
Dundaye	Colour	Jan-kasa	7.5 YR 5/8 (Strong brown)	91	07	02	S
"	"	Fara-fara	7.5 YR 8/4 (Pink)	77	13	10	SL
"	Texture	Allaka	10 YR 4/1 (Dark grey)	50	21	29	SCL
"	"	Leba	10 YR 5/8 (Very pale yellow)	79	19	02	LS
"	Vegetation	Mallo	5 YR 5/8 (Yellowish red)	91	07	02	S
"	"	Dadadurus	10 YR 4/6 (Dark yellowish brown)	99	00	01	S
Kwalkwalawa	Color	Bakar-kasa	10 YR 4/3 (Dark brown)	70	21	09	SL
"	"	Farin-kasa	7.5 YR 7/4 (Pink)	57	38	05	SL
"	Texture	Laka	10 YR 4/6 (Dark yellowish brown)	80	11	09	S
"	"	Turda	7.5 YR 5/8 (Strong brown)	96	03	01	S
"	Vegetation	Baban-more	10 YR 4/4 (Dark yellow brown)	84	11	05	SL
"	"	Tsirkiya	10 YR 8/6 (Yellow)	92	07	01	S
Gidan-yaro	Colour	Jan-kasa	5 YR 5/8 (Yellowish red)	91	05	04	S
"	"	Jaa-ja	5 YR 6/8 (Reddish yellow)	97	01	02	S
"	Texture	Gurori	5 YR 5/8 (Yellowish red)	91	05	04	LS
"	"	Yashi	5 YR 6/8 (Reddish yellow)	95	03	02	S
"	Vegetation	Balasaya	5 YR 5/8 (Yellowish red)	93	03	04	S
"	"	Alkamar-kwaddi	5YR 6/6 (Reddish yellow)	97	01	01	S

S = sand, SC = sandy-clay, LS = loamy-sand, SCL = sandy-clay-loam and PS = particle size.

Table 5: Chemical characteristics of the soils of Dundaye

Criteria	pH	Ca Cmol Kg^{-1}	Mg Cmol Kg^{-1}	Na Cmol	K Cmol Kg^{-1}	CEC Cmol Kg^{-1}	PBS Cmol Kg^{-1}	N %	P % Kg^{-1}	OM $mgkg^{-1}$	EC %	dSm^{-1}
Jan-kasa	7.39	0.7	1.70	0.30	0.62	6.4	52	0.02	0.27	4.43	0.64	
Fara-fara	6.82	0.5	2.95	0.43	0.28	6.8	61	0.03	0.24	3.64	0.32	
Allaka	5.86	0.9	2.15	0.69	0.41	8.0	51	0.05	0.17	4.24	1.02	
Leba	6.79	0.83	1.15	0.52	0.36	4.0	72	0.02	0.27	4.64	0.17	
Dadadurus	7.13	0.83	2.10	0.61	1.38	6.4	77	0.06	0.28	4.11	1.31	
Mallo	6.55	0.85	1.30	0.61	0.72	3.8	91	0.03	0.45	4.89	0.46	

Table 6: Chemical characteristics of the soils of Kwalkalawa

Criteria Cmol Kg-1	pH	Ca Cmol Kg-1	Mg Cmol Kg-1	Na Cmol Kg-1	K Cmol Kg-1	CEC Cmol Kg-1	PBS %	N %	P $mgkg^{-1}$	OM %	EC dSm^{-1}
Bakar-kasa	8.07	1.70	1.55	0.52	1.33	15.4	33	0.04	0.26	3.71	1.09
Farin-kasa	7.33	0.70	1.35	0.30	0.54	4.4	65	0.03	0.21	4.04	0.56
Laka	8.42	1.35	1.20	0.35	1.10	10.4	38	0.03	0.29	3.57	1.07
Turda	7.73	0.85	1.30	0.30	0.49	4.4	66	0.02	0.55	4.30	0.24
Baban-more	7.78	1.25	2.05	0.39	2.44	18	34	0.11	0.20	2.79	1.47
Tsirkiya	6.45	0.65	2.10	0.22	0.41	4	84	0.15	0.24	1.79	0.18

Table 7: Chemical characteristics of the soils of Gidan-yaro

Criteria	pH	Ca	Mg	Na	K	CEC	PBS	N	P	OM	EC
Cmol	Cmol	Cmol Kg-1	Cmol kg-1	Cmol kg-1	Cmol kg-1	% kg-1	% kg-1	$mgkg^{-1}$	%	dSm^{-1}	
Jan-kasa	5.15	0.55	1.70	0.26	0.44	4.4	67	0.02	0.34	1.73	0.88
Jaa-ja	6.63	0.55	2.20	0.39	0.49	4.3	84	0.02	0.24	1.99	0.27
Gurori	5.82	0.55	1.55	0.39	0.38	3.2	89	0.02	0.48	1.40	0.14
Yashi	6.99	0.65	1.40	0.35	0.44	3.0	94	0.02	0.31	2.12	0.56
Balasaya	6.71	0.75	1.75	0.35	0.31	5.0	63	0.01	0.21	2.65	0.17
Alkamar-kwaddi	6.42	0.65	1.65	0.57	0.31	7.0	44	0.004	0.25	1.66	0.28

4.1 General Discussion

The fertility of a given soils is strongly related with the levels of available nutrients it contains largely resulting from the input of both organic matter and inorganic substances (Tinker, 2000). The fertility of a soil is the capacity of the soils in supplying the essential nutrients required for effective plant growth and development. The fertility of a particular soil can be determined by the laboratory analysis specifically on its physical and chemical properties that plays a vital role toward improving the degree of aeration, moisture content, roots penetration, soil depth and nutrient retention capacity.

The physical and chemical variables determined in the present study includes the conventional identification of color and texture while the laboratory analysis for the chemical composition was conducted which includes the pH, organic matter content (OM), total nitrogen (N), available phosphorus (P), electrical conductivity (EC), cation exchange capacity (CEC) and percentage base saturation (PBS) of the different levels of exchangeable bases such as calcium, magnesium, sodium and potassium using the color, texture and vegetation as criteria.

4.1.1 *Soil fertility assessment using color as a criterion*

Jan-kasa is the soils identified as fertile and *Fara-fara as* not-fertile soil respectively in Dundaye. The color of the fertile soils was 7.5 YR 5/8 (strong brown) and darker than 7.5 YR 8/4 (pink) which was regarded as not-fertile. This may be as a result of difference in their organic matter content which is usually higher in fertile soils (Taylor, 1991). The textural classes of the fertile and not-fertile soils were sand. The percentage base saturation (PBS) of the fertile soils was 52% and therefore less than in not-fertile soil. The total nitrogen (N) content of both fertile and not-fertile soils was 0.02% and is classified as low (Jones et al., 1975). The available phosphorus (P) of the fertile soil was 0.34mg/kg and slighter than not-fertile soil with 0.24mg/kg and therefore classified as low (Esu, 1991).

4.1.2 *Soil fertility assessment using texture as a criterion*

Allaka and *Leba* are the two soils identified in Dundaye as fertile and not-fertile respectively. The color of the fertile soil was 10YR 4/1 (Dark grey) and darker than not-fertile soil with 10YR 7/4 (very yellow). The textural classes of the fertile and not-fertile soils are sandy-clay-loam and loamy-sand. The cation exchange capacity (CEC) of the fertile soil was 8cm/kg and 4cm/kg for not-fertile soil. The organic matter (OM) content was slightly varied, the total nitrogen (N) was equally varied while the available phosphorus (P) was 0.17mg/kg and 0.27mg/kg respectively, thus regarded as low as reported by (Esu, 1991).

Laka and *Turda* are the two soils identified in Kwalkwalawa as fertile and not-fertile soils respectively. The color of the fertile soils are 10YR 4/6 (dark yellowish brown) and darker than not-fertile soil of 7.5YR 5/8 (strong brown). The textural classes of the fertile and not-fertile soils were clay and sand respectively. The cation exchange capacity (CEC) of fertile and not-fertile soils were 10.4cm/kg and 4.4cm/kg. The base saturation (PBS) of the fertile was 38% and 66% for the not-fertile soils. The organic matter (OM) content of the fertile and not-fertile soils were 3.5% and 4.3% respectively. The total nitrogen (N) and available phosphorus (P) content were 0.03% and 0.29mg/kg for fertile soil where 0.02% and 0.55mg/kg for not fertile soil respectively, thus indicated low values as reported by Esu, (1991).

Gurori and *Yashi* are two soils identified in Gidan-yaro soil as fertile and not-fertile respectively. The color of the fertile soil was 5YR 5/8 (yellowish red) and slightly darker than not-fertile soil of hue color 5YR 6/8 (reddish yellow) respectively. The textural classes of the fertile and not-fertile soils are loamy-sand and sandy. The cation exchange capacity (CEC) of the fertile and not-fertile soils were 3.2cm/kg and 3cm/kg and both are classified as low (Wild et al., 1975). The percentage base saturation (PBS) of the fertile and not-fertile soils was 89% and 94% respectively. These showed that the soils have high PBS (Adepetu et al., 1979). The organic matter (OM) content of the fertile and not-fertile soils are 1.40% and 2.12%, thus classified as low (Wild et al., 1975). The total nitrogen (N) and available phosphorus (P) are 0.013% and 0.48mg/kg for the fertile soil. Thus, indicated low nitrogen and phosphorus content (Wild, et al., 1975).

4.1.3 *Soil fertility assessment using vegetation as a criterion*

Dadadurus and *Mallo* are vegetations identified to be growing in a fertile and not-fertile soils in Dundaye. The hue colors of the former and the latter are 5YR 5/8 (Yellowish red) and 10YR 4/6 (Dark yellowish brown) respectively. The textural classes of the both soils were sandy. The Cation exchange capacity (CEC) of the fertile and not-fertile soils were 6.4cm/kg and 3.8cm/kg and classified as moderate and low (Adepetu et al., 1979). The % base saturation of the fertile and not-fertile soils are 77% and 91% and are classified as high (Jones et al., 1975). The organic matter content of fertile and not-fertile soils were 4.11% and 4.89%, thus classified as high (Esu, 1987). The total nitrogen and available phosphorus content are 0.06% and 0.28mg/kg for fertile soil and 0.03% and 0.45mg/kg for not fertile soil respectively. These values showed both the fertile and not-fertile soils have low N and available P content(Esu, 1991).

Baban-more and *Tsirkiya* are vegetations identified to be growing in fertile and not-fertile soils in Kwalkwalawa. The colors of the soils are 10YR 4/4 (Dark yellowish brown) and 10YR 8/6 (Yellow) respectively. The textural classes of the soils are loamy-sand and sand. The cation exchange capacity (CEC) of the soils are 18cm/kg and 4cm/kg and were classified as high and low (Jones, et al., 1975). The organic matter (OM) content of the soils are 2.79% and 1.79% and were classified as low (Adepetu, et al., 1979). The total Nitrogen (N) and available phosphorus content were 0.11% and 0.20mg/kg for fertile soil and 0.15% and 0.24mg/kg for not fertile soils respectively. These values are classified as moderate accordingly (Jones et al., 1975).

Balasaya and *Alkamar-kwaddi* are vegetations found to be growing in fertile and not-fertile soils respectively. The colors of the fertile and not-fertile soils are 5YR 5/8 (Yellowish red) and 5YR 6/6 (Reddish yellow). The textural classes of the soils were both sands. The cation exchange capacity (CEC) of the soils were 5cm/kg and 7cm/kg and were classified as low and moderate (Adepetu, et al., 1979). The % base saturation of the soils were 63% and 44% and classified as high and low (Jones et al., 1975). The organic matter (OM) content of the soils are 2.65% and 1.66% and are classified as high and low. The total nitrogen (N) and available phosphorus (P) content were 0.01% and 0.21mg/kg for fertile soil and 0.004% and 0.25mg/kg for not-fertile soil respectively, thus classified as low and moderate (Esu, 1991).

V. Conclusions

The results reported here indicated that not-fertile soils were found to be coarser than fertile soils while the fertile soils are more characterized to dark colors and relatively higher in fertility parameters such as organic matter (OM), cation exchange capacity (CEC), % base saturation (PBS), total nitrogen (N) and available phosphorus (P).

Considering these findings, there may be a room for accepting indigenous knowledge of assessing soil fertility in Dundaye district. However, more research in this respect are necessitated to advance stages and to further accentuate in its reliability or otherwise.

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Umar, B. "Evaluation of Indigenous Soil Fertility Assessment of the Sudan Savannah Agro-Ecological Zone of Nigeria - A Paper Review." IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS) 11.10 (2018): 01-09.