



## Farmers' Perception on Soil Fertility and Management Under Small Holder Farming System in Kiyawa, Jigawa State, Nigeria



Adamu Ahmed<sup>1\*</sup> & Mansur Abdul Mohammed<sup>2</sup>

<sup>1,2</sup>Department of Geography, Bayero University Kano, Nigeria

\*Corresponding Author Email: [ahahmed.geog@buk.edu.ng](mailto:ahahmed.geog@buk.edu.ng)

### ABSTRACT

The study aimed at assessing local farmers' perception on soil fertility in which laboratory analyses of soil sample and Focus Group Discussion (FGD) were used as the source of data. Some selected soil properties and information on local methods used in assessing the fertility status of the farms and the perceive trend in soil fertility were assessed. The soils in the study area were classified into fertile and infertile farms using local criteria such as soil color, productivity, water holding capacity and proximity their settlement. Ten soil samples were collected using composite sampling methods and analysed for N, P, K, OC, pH and clay using standard laboratory procedures. The mean values of the chemical properties of soil were correlated between fertile and infertile land as classified by the farmers. The results shows that fertile land have highest mean values of organic carbon ( $0.27\% \pm 0.28$ ), electrical conductivity ( $0.33 \text{ ds/m}^3 \pm 0.41$ ), total N ( $0.17\% \pm 0.08$ ) and potassium ( $0.2 \text{ Cmol/kg} \pm 3.19$ ) while, the mean value of pH ( $7.1 \pm 0.12$ ), avail. P ( $4.14 \text{ ppm} \pm 13.4$ ) were found to be higher in infertile (bad) soil. Crop rotation, mixed cropping, fallow, use of crop residue and light tools were identified by respondents as ways of enhancing and improving the soil fertility in the area. It was conducted that local classification is in agreement with criteria used by researchers in assessing soil fertility. Researcher need to understand and utilize indigenous knowledge, complement their effort and ways of thinking. Therefore, it is recommended to use both researchers' (scientific) methods and farmer's perception in evaluation of soil fertility and management.

### Keywords:

Soil fertility,  
Soil,  
Perception and  
Management,  
Indigenous,  
Scientific knowledge

### INTRODUCTION

Soil is the vital resources that on human time scale is nonrenewable and it present the difference between survival and extinct for most terrestrial life. Thus, the live of all living things on the earth surface depend either directly or indirectly on the resources provided by soil and indeed the quality of soil rest upon its ability to supply nutrients essential to plant growth and provide a healthy environment to entire ecosystem (Yusuf, 2001). Until recently, farmers' knowledge of soil fertility has been largely ignored by soil researchers, but with increasing use of participatory research approaches, it is becoming clear that farmers have a well-developed ability to perceive differences in the level of fertility between and within fields on their farms (Kuldip *et al.*, 2011). Farmers see the actual fertility of a soil at any time as a function not only of these longer-term soil properties, but also of the current and past management regime. As such, they assess the fertility of the soil using a range of indicators which they can actually see or feel, including

crop yields, soil depth, drainage, moisture, manure requirements, water source, slope, and weed abundance. Compared to this 'holistic' perception, researchers generally take a more reductionist approach to soil fertility, often accounting only for the soil's nutrient status or physical characteristics. There is a strong need to compare the indicators used by farmers with those used by researchers. Soil properties under inappropriate management indicated an overall change towards the direction of loss soil fertility compared to the condition of the soil under appropriate management (Kuldip *et al.*, 2011). The ways by which farmers manage their cultivated land has a great impact on soil fertility indicators. In order to enhance sustainable soil quality and harmony, research activities must follow participatory and scientific approaches. Some agricultural researchers reported that there are low concern on indigenous knowledge systems of local farmers regarding soil classification, fertility and management.

Moreover, scientific developments are essential to increase soil fertility for food production, but they should be carefully built on the foundation of indigenous knowledge systems in order to successfully accomplish the mission of soil fertility enhancement and the preservation of natural resources for future generations. Yusuf (2002) examine the indigenous knowledge on soil fertility, classification and management using focus group discussion (FGD) and laboratory assessment of some soil fertility indicators. However, the study is limited in scope because the comparison of the indigenous soil fertility classification based on their local indicators with the scientific (laboratory results) was not included. Therefore, comparison of indigenous classification based on fertility status with the laboratory results of some fertility indicators is very pertinent in soil management for enhancing soil quality and productivity. Mohammed (2004) assessed the fertility status and classified the soil based fertility level using fertility ranking model, but failed to considered indigenous knowledge on the soil classification and their management. In order to have more insights about sustainable soil management, indigenous and scientific knowledge should be integrated which will enhance the

productive capacity of the soil. This study would generate, upgrade the data base on the indigenous knowledge on soil fertility classification and management which would be used for policy making with regard to the fertilizer production and fertilizer dose. The objectives of the research were to: identified the soil fertility indicators by the farmers, classified the soils into fertile and infertile based on the indigenous criteria and then compare the soil fertility indigenously classified with scientific knowledge.

## MATERIALS AND METHODS

### Site Description

The study was conducted in Makara Huta, Kiyawa town on August 2015 located between latitude  $11^{\circ} 45' N$  to  $11^{\circ} 58' N$  and  $9^{\circ} 36' E$  to  $9^{\circ} 59' E$  (Fig. 1). The climate of the area is wet and dry types with mean rainfall range from 450 - 600 mm and average annual rainfall in the region is 3180 mm and the area is surrounded by Sudan savanna vegetation type, mean annual temperature of  $26^{\circ}C$ . The soil of the area is ferrugeneous tropical soil. The main crops grown include millet, sorghum, cowpea and groundnut.

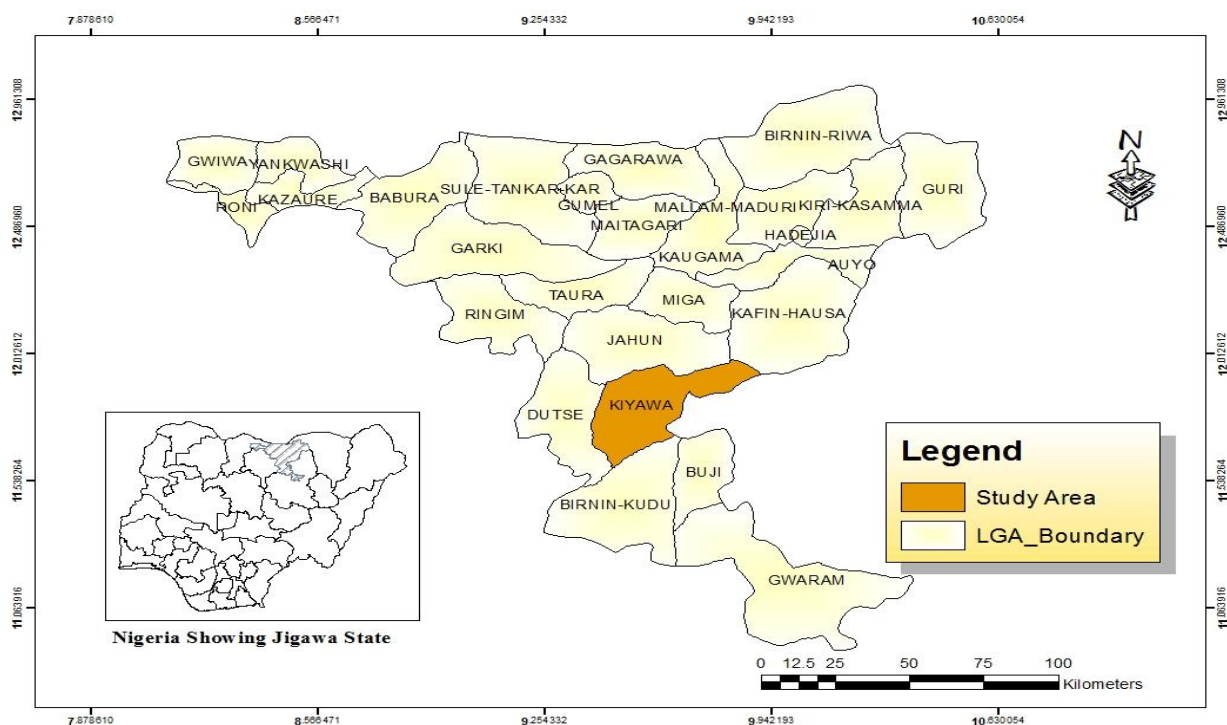


Fig. 1. Map of Jigawa showing Kiyawa Local Government Area

### Household Information

Information on farmer's perception of soil fertility and the indicators use to assess the fertility status of their fields were collected through focus group discussion (FGD) as shown in fig. 2 which took place in the district head's

house with the most experience farmers purposively selected in the area. The information received from the farmers included local methods used for assessing the fertility status of their farms, their perceive trends in soil fertility and soil fertility management practices.

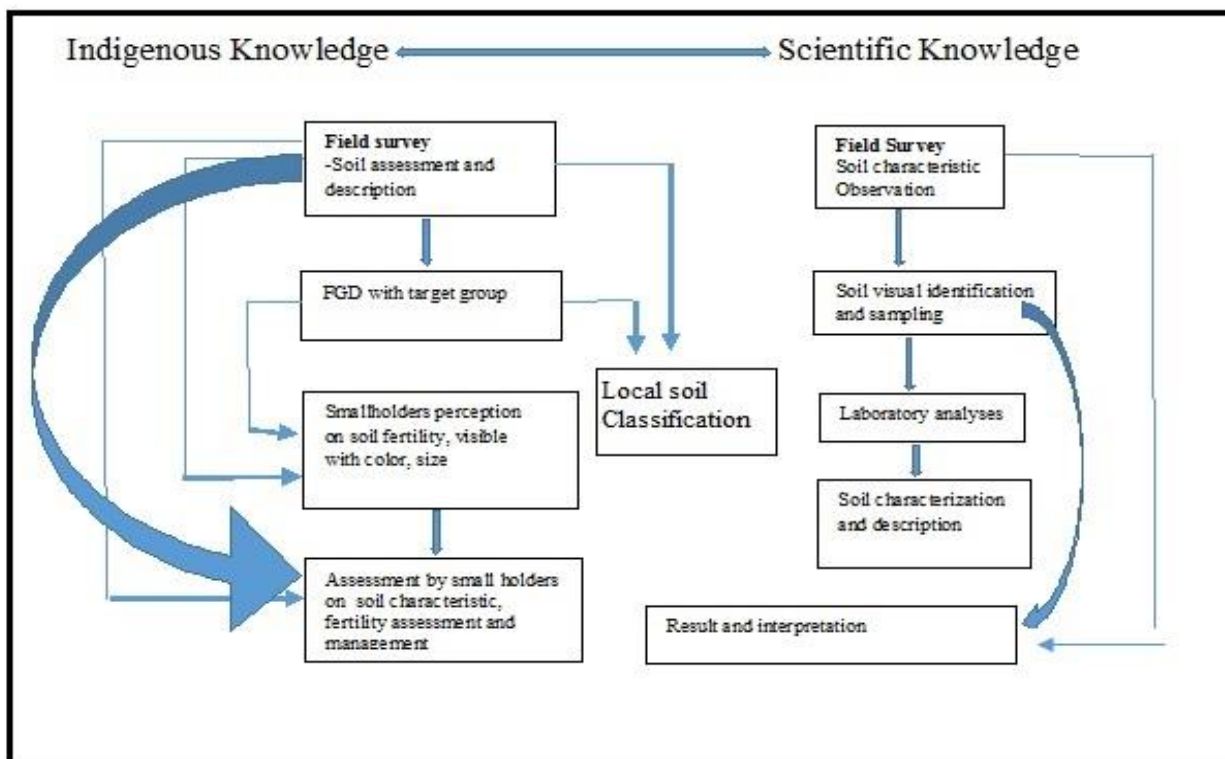


Fig. 2: Flow chart of an Overview of methodology relating to indigenous and scientific knowledge

### Field Characteristics

Focus Group Discussion (FGD) was organized to interact with farmers selected, forty farmers were selected randomly and were asked to indicate their most fertile farm and the infertile farm and each of the identified farms and their surrounding environment were then characterized according to its distance from the household, stoniness, aspect of crops and hardness of the soil felt when sampling. Information on the soil characteristics and management of the farm were obtained from the respondents with the farmers on the fertility status, history, or particular problems of the field with particular reference to those indicators mentioned by farmers during the FGD session.

### Soil Sampling

From the plots identified by the respondents as fertile soil (Good) and infertile soil (Bad), ten soil samples were collected from each soil type and then homogenized and then sub-sample of each soil type was formed from the composite samples. The soils were air dried and then taken to the laboratory for the analyses of some nutrient elements.

### Laboratory Procedures

The air dried samples were crushed and passed through 2 mm sieve and then analysed for organic matter which was determined by wet digestion method using dichromate

method as described by Walkley and Black (1978), soil pH was determined by pH meter after extraction in 1N KCl from soil: water ratio of 1:1. Available phosphorous was determined using Bray no. 1 method, exchangeable potassium was determined by extraction method with 1M NH<sub>4</sub>OAC Buffered at pH 7 and the concentration of potassium was measured with Atomic Absorption Spectrophotometer. Total nitrogen was determined using Kjeldahl method as described by Sarkar and Haldar (2005).

### Data Analysis

The data generated from the laboratory analyses of the soil samples and FGD were analyzed using descriptive statistics such as mean to find the mean values of some selected soil properties and t-test was used to determine the significant difference in the soil properties among the soil types identified at  $P < 0.05$ .

## RESULTS AND DISCUSSION

Based on the information obtained from the FGD and laboratory analyses of soil samples the soils were classified into fertile (good) and infertile (bad). The parameters used by the farmers in classifying soil in relation to fertility status include drainage, proximity to settlement, color, soil depth, topography and soil texture. This soil classification is based on experience and

knowledge of the farmers to their fields as such farmers in the area classified their soils locally into four types as: *Tabo*, *Semo*, *Hancin kare* and *Kuresheshe* (Table 1) using their local language. The farmers used soil color, water holding capacity and texture as major criteria for soil fertility assessment and also mentioned that, they prepared heavy and black soil because of the high water retention capacity and release of nutrients to crops than coarse and sandy soil because of its high porosity which facilitate leaching of nutrients as such some nutrients are extremely limited.

The fertile soil (good soil) consist of *Tabo* and *Kuresheshe*, the *Tabo* mean sticky and black soil which is equivalent to vertisol based on USDA (1987) system of soil classification with characteristics of crack during dry season, high amount of organic matter content, high water holding capacity and abundant soil fauna such as millipedes and earthworms which make it more productive than other soil types identified. The respondents revealed that *Tabo* (vertisol) is normally found in depression (Table 1) with high fertility due to the washing away of organic materials from the upland farms and deposited into the depression. The *Kuresheshe* known indigenously as hard soil which can be equated to oxisol USDA (1987) system of soil classification. This soil type was identified in the interfluvial with reddish-brown color and moderate fertility (Table 1) with high accumulation of iron oxide. The respondents mentioned that *Marmara* known as concretion or hard fan were found scattered in the *Kuresheshe* soil type which is making it difficult to cultivate.

The infertile soil (bad soil) identified by the respondents consists of *Semo* (light soil with coarse texture) and *Hancin kare* known as soil that is always wet or waterlogged. The *semo* soil type is equivalent to inceptisol based on which characterized by white color, low water holding capacity, desiccation which requires high manure fertilizer application and are normally found in the interfluvial. The low fertility nature of the *Semo* soil is probably due to the low water holding capacity which may affect the activities of soil organisms such as decomposition of organic materials and nitrogen fixation. Also their occurrence at the interfluvial make nutrients present vulnerable to wash down to the adjacent depression. The white color of the *Semo* soil is probably due to the high accumulation of calcium oxide and low organic matter content. The *Hancin Kare* which means the soil that is always wet which is equivalent to fluvisol USDA (1987) system of soil classification. The respondents revealed that, this type of soil is normally found in the depression and characterized by dark-brown color, water lodged, sticky when wet and hard when dry and have poor workability making it difficult for harrowing and any other form of tillage. The waterlogged nature of the *Hancin Kare* soil make the available nutrients in the soil to dissolve and leach down leaving the upper part of the soil with low fertility leading to poor structures and stunted growth. The reddish-brown appearance of *Hancin Kare* soil in the area is probably attributed to the high concentration of iron oxide (FeO) in the soil (Brady and Weil, 1999).

**Table 1:** Indigenous and USDA/UNESCO soil classifications and their perceived properties

Local soil classification	USDA/UNESCO equivalent	Occurrence	Color	Fertility	Manure demand
<i>Tabo</i>	Vertisol	Lowland	Black	high	Low
<i>Semo</i>	Inceptisol	Upland	White	Low	High
<i>Hancin Kare</i>	Fluvisol	Lowland	Dark-Brown	low	High
<i>Kuresheshe</i>	Oxisol	Upland	Reddish brown	moderate	High

Source: Field Survey, (2015)

### Relevance of Soil Fertility Indicators as Perceive by the Farmers

From the Focus Group Discussion (FGD), six major indicators were identified by farmers as common parameters used in assessing the fertility of their soils. The farmers mentioned the major soil properties as fertility indicators (Table 2). The farmers stated that, the major properties of the various soils as fertility and crop production indicators. 36.7% very important, 25.7% important, 18.25% less important, 8.85% not important and 6.55% undecided (Table 2). The result obtained contradicts the findings of Yeshaneh (2015) who reported

that farmers classified their soil very importantly based on their color rather than soil texture. The farmers used soil color, water holding capacity and texture as major indicators for soil fertility assessment and also mentioned that, they prepared heavy and black soil because of the high water retention capacity and release of nutrients to crops than coarse and sandy soil because of its high porosity which facilitate leaching of nutrients as such some nutrients are extremely limited.

The fertile soil (good soil) consist of *Tabo* and *Kuresheshe*, the *Tabo* mean sticky and black soil which is equivalent to vertisol based on USDA (1987) system

of soil classification with characteristics of crack during dry season, high amount of organic matter content, high water holding capacity and abundant soil fauna such as millipedes and earthworms which make it more productive than other soil types identified. The respondents revealed that *Tabo* (vertisol) is normally found in depression (Table 1) with high fertility due to the washing away of organic materials from the upland farms and deposited into the depression. The *Kuresheshe* known indigenously as hard soil which can be equated to oxisol USDA (1987) system of soil classification. This soil type was identified in the interfluvial with reddish-brown color and moderate fertility (Table 1) with high accumulation of iron oxide. The respondents mentioned that *Marmara* known as concretion or hard fan were found scattered in the *Kuresheshe* soil type which is making it difficult to cultivate.

The infertile soil (bad soil) identified by the respondents consists of *Semo* (light soil with coarse texture) and *Hancin kare* known as soil that is always wet or waterlogged. The *semo* soil type is equivalent to inceptisol and characterized by white color, low water holding capacity, desiccation which requires high manure fertilizer application and are normally found in the

interfluvial. The low fertility nature of the *Semo* soil is probably due to the low water holding capacity which may affect the activities of soil organisms such as decomposition of organic materials and nitrogen fixation. Also their occurrence at the interfluvial make nutrients present vulnerable to wash down to the adjacent depression. The white color of the *Semo* soil is probably due to the high accumulation of calcium oxide and low organic matter content. The *Hancin Kare* which means the soil that is always wet which is equivalent to fluvisol USDA (1987) system of soil classification. The respondents revealed that, this type of soil is normally found in the depression and characterized by dark-brown color, water lodged, sticky when wet and hard when dry and have poor workability making it difficult for harrowing and any other form of tillage. The waterlogged nature of the *Hancin Kare* soil make the available nutrients in the soil to dissolve and leach down leaving the upper part of the soil with low fertility leading to poor structures and stunted growth. The reddish-brown appearance of *Hancin Kare* soil in the area is probably attributed to the high concentration of iron oxide (FeO) in the soil (Brady and Weil, 1999).

Table 2: Relevance of indicators on fertility status and trend as perceive by the farmers in Makara Huta, Kiyawa					
Soil fertility					
Indicators	Very important	Important	Less important	Not important	Undecided
Soil drainage	7	6	10	10	7
distance from home	12	15	6	5	2
Soil color	24	10	8	3	1
Soil depth	7	8	20	2	3
Topography	13	12	8	2	5
Soil texture	20	10	5	4	1
Total	83	61	57	26	19
percentage rank	33.7	24.8	23.2	10.6	7.7
<b>Source: Field Survey (2015)</b>					
Table 3: Relevance of indicators on crop production as perceive by the farmers in Makara Huta, Kiyawa					
Soil drainage	18	12	8	1	1
distance from home	18	12	5	3	2
Soil color	14	6	10	5	5
Soil depth	20	12	2	4	2
Topography	18	20	1	1	0
Soil texture	22	6	6	3	3
Total	110	68	32	17	13
percentage rank	45.8	28.3	13.3	7.1	5.4

Mentioned by %	36.7%	25.7%	18.25%	8.85%	6.55%
<b>Source: Field Survey (2015)</b>					
<p>The soil fertility indicators identified by the respondents were ranked and presented in table 2, which shows that, the major indicators identified by farmers in the area are soil texture (0.52%), soil color (0.46%) and topography (0.38%) as very important and soil drainage is the least important than other indicators. Table 2, revealed that, soil texture is the best indicator for assessing the soil fertility followed by soil color. the respondents considered soil with fine particles as soil that retain water which is considered as productive soil, while black soil are considered by the respondents as soil with high level of manure. However, distance from home was not considered as the determinant factor of soil fertility and productivity. you discussed only fertility as perceived by the farmers (Table 2) what of the discussion of crop production as perceived by the farmers?</p> <p>Table 4: Ranking of indicators according to their importance for ..... is it for fertility or crop production or both please clarify?</p>					
<b>Rank Based on Farmers'</b>					
Indicators	Very important	Important	Less important	Not important	Undecided
Soil drainage	25/80 = 0.31%	18/80 = 0.22%	18/80 = 0.22%	11/80 = 0.13%	8/80 = 0.10%
distance from home	30/80 = 0.37%	27/80 = 0.33%	11/80 = 0.13%	8/80 = 0.10%	4/80 = 0.05%
Soil color	38/80 = 0.46% <sup>(2nd)</sup>	16/80 = 0.20%	22/80 = 0.22%	8/80 = 0.10%	6/80 = 0.07%
Soil depth	27/80 = 0.33%	20/80 = 0.25%	22/80 = 0.27%	6/80 = 0.07%	5/80 = 0.06%
Topography	31/80 = 0.38% <sup>(3rd)</sup>	32/80 = 0.40%	9/80 = 0.11%	3/80 = 0.03%	5/80 = 0.06%
Soil texture	42/80 = 0.52% <sup>(1st)</sup>	16/80 = 0.20%	11/80 = 0.13%	7/80 = 0.08%	4/80 = 0.06%
<b>Source: Field survey (2015)</b>					

### Comparison of Farmers Perceived fertility and Laboratory Results

From the laboratory analyses of soil samples, the mean values of some chemical properties of two soil types (fertile (good) and infertile (bad)) as classified by the respondents. indicated that the mean values of organic carbon (0.27%), electrical conductivity (0.33 ds/m<sup>3</sup>), total

N (0.17%) and potassium (0.2 Cmol/kg) were found to be higher in the fertile (good) soil, while higher mean value of pH (7.1) and available P (4.14 ppm) were found in the infertile (bad) soil. This indicates that there is an agreement between indigenous knowledge and scientific knowledge on soil fertility.

Table 5: Laboratory chemical characteristics of two soil types( fertile and infertile)

Soil classes	OC%	pH(Kcl)	EC(ds/m <sup>3</sup> )	N%	P(ppm)	K(Cmol/kg)
Fertile	0.27a	7.00a	0.34a	0.18a	28.33a	0.20a
infertile	0.11a	7.10b	0.29a	0.11b	41.43a	0.14b
LSD (0.05)	NS	0.001	NS	0.01	NS	0.04
The values with the same letters are not significant different at p<0.05, NS: No significant different						
Source: Field (2015)						

The mean values of N and P were ranked high based on the soil fertility assessment manual (Chude *et al.*, 2011). The student t-test analyses (table 5) shows that there is significant difference in the mean values of pH, N and K

between fertile and infertile soil at p<0.05 probability level, while no significant difference observed in the mean values of OC, EC and available P between fertile and infertile soil at p<0.05 probability level. The mean

values organic carbon and nitrogen obtained in this research were found to be lower than the mean values obtained by Yusuf and Yusuf (2008) from the same study area. This implies that there is gradual reduction in organic carbon and nitrogen in the soil of the area. This is probably attributed to over cultivation of crops and inadequate use of organic and inorganic manure. This is contained in Brady and Weil (1999) who explained that the organic manure is one of the major sources of soil nitrogen in the soil. Soil pH and phosphorus were found to have higher values in this research when compared to

the mean values reported by Yusuf and Yusuf (2008) which indicates that there is gradual increase in phosphorus and soil pH in the soil of the study area.

#### Soil Fertility Management Practice

The respondents (farmers) were asked to identify ways they normally enhance the fertility of their fields. The respondent mentioned crops residue, crop rotation, application of manure and use light tool (*Shasha*) for cultivation as soil fertility management (Table 6).

Fertility Management	Processes	Problem
crops rotation	Planting different types of crops in sequence from year to year because the crops may have different nutrient requirement and some can fix nitrogen	Not all Soils can be used for crop rotation because some soils are coarse and can only be good for cereals
use of crop residue	The crops residue are normally left after harvest so that the residue can decompose to form organic matter	The alternative uses of the residues limits its application in to farm but rather use as animal fodder and in building houses etc
Manuring (animal dungs and decomposed waste)	Application of decomposed waste and animal waste. Some applied it point by point called Zai pit	The alternative uses; the animal dung is use as source of fuel locally called <i>Kandilo</i>
<i>Shasha</i> (light tool)	Light tool use for tillage, the tool turn the soil slightly not deeply which conserve soil moisture	No problem was related to this.
Mixed cropping	Planting different type of crops in the same farm plot e.g. legumes and cereals	Not all Soils can be used for all crops
Fallow	Leaving the land without cultivation for some years in order to regain and improve the fertility through litter fall and decomposition of some organic materials	Population increase which increase the demand for the land to feed the populace limit this process to mere shifting cultivation.

The major soil fertility management practice adopted by farmers in the study location are: crops rotation between cereal and legumes, fallow system but due to high population pressure, long term fallow system is limited due to the inadequate farm land in the area and there is need to cultivate the available land to feed their timing population. The farmers mentioned that, they are aware on importance of leaving crop residues which decayed

and transform in to organic matter, while some respondents prefer alternative uses such as source of domestic fuel, fencing of houses and as animal feed (fodder), therefore these uses limit the use of crop residues for fertility management in the area.

Most of the farmers described that, it is very difficult to access the inorganic fertilizer due to high high cost in the

market, this made it necessary for them to use manure sources from decomposed house waste and some organic materials. The manure are normally taken to the farm using cart, donkey and small truck, during the dry season and then broadcasted to the farm, while some farmers use *zai* pit techniques which is an agricultural technique in dryland environment where rounded pits are made on soils and some quantity of organic manure is deposited during dry season where it (organic matter) can be completely decomposed, thereafter the crops can be planted directly in the pit where the organic manure is deposited so that crops can have access to the available nutrient contained in the organic matter and farmers believe that the pit system is an effective means of managing degraded soils thereby increase yield.

## CONCLUSION

The results of the finding indicated that there is good correlation between soil fertility assessment by farmers and scientific (laboratory) method of soil fertility assessment. However, the nomenclature of the soil by farmers is not exactly correlated with scientific classification this is because farmers classification and indicators depend on soil properties that can be practically experience by farmers. Both the scientists and farmers have common aim on fertility assessment and sustainable soil management in order to meet the demand of the users. Research scientists need to understand and utilize indigenous knowledge and also complement their effort and ways of thinking with indigenous knowledge rather than ignoring. Therefore it is very pertinent to use both researchers' (scientific) methods and farmers' perception in evaluation of soil fertility and management. Improving farmers' knowledge, and their capacity to observe and experiment, is an essential element in the development of intergraded soil fertility management technologies.

## Acknowledgement

The authors acknowledge the Geography Department Bayero University Kano for the assistance throughout the period of the research.

## REFERENCE

Brady, N.C and Weil, R.R (1999). The nature and properties of soils (12<sup>th</sup> Edition). Prentice-Hall Inc. Simon and Schuster A Viacon company, upper Saddle River, New Jersey

Kuldip, G., Dutta, A.A. and Kumar, P. (2011). Indigenous Knowledge of Soil fertility management in Humid

tropical Arunachal Pradesh, *Indian Journal of Traditional knowledge*, 10 (3): 508 – 511

Mohammed, M. A. (2004). Soil Fertility Assessment Between *Fadama* and Upland Soil in Dambatta Tomas dam, Kano state Nigeria, Unpublished B. Sc project, Department of Geography, Bayero University Kano, Nigeria, 21 – 39

Sarkar, D. and Haldar, A. (2005). *Physical and Chemical Methods in Soil Analysis: Fundamental Concepts of Analytical Chemistry and Instrumental Technique*, Newage International, Publishers, 4835/24, Ansari Road, Daryaganji, New Delhi-India

USDA (1987). United State Department of Agriculture, Soil Survey Staff, Key to Soil Taxonomy, Soil Management, USDA, Washington D.C

Yeshaneh, G. T. (2015). Assessment of farmers' perception about soil fertility with different management practices in small holders farms of Abuhoy catmint, Gidan district, North Wollo. *American journal of Environmental protection*. 3 (4): 137 – 144

Yusuf, M. A. (2002). An Overview of Causes and Control of Soil Pollution in Nigeria, In Yusuf, M. A., Lawan, M. M. and Ahmad G. (Eds), *Nigerian Politics, Society and the Environment*, A Publication of the Faculty of Social and Management Sciences, Bayero University, Kano-Nigeria, 212-229

Yusuf, M. A. (2001). Soil Assessment and Indigenous Soil Management Strategies in the Semi-arid Northeastern Nigeria, *Unpublished PhD. Thesis*, Department of Geography Bayero University Kano, Nigeria

Yusuf, A. A. and Yusuf, H. A. (2008). Evaluation of Strategies for Soil Fertility Improvement in Northern Nigeria and the Way Forward, *Journal of Agronomy*, 7: 15-24.

Walkley, A. and Black, C.A. (1934). An Examination of the Djetgareff Method for Determining Organic Matter and Proposed Modification of the Chromic Acid Titration Method, *Soil Sciences*, 37: 29–38