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Indigenous Knowledge of Integrated Soil Fertility Management in Kafanchan and its Environs, Jema'a Local Government, Kaduna State, Nigeria.

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Abstract

This paper is titled "Indigenous Knowledge of Integrated Soil Fertility Management (ISFM) in Kafanchan and its environs" it is aimed at investigating the demographic and socioeconomic characteristics of the respondents, indigenous ways of determining soil fertility and land suitability and soil fertility management. The Stratified and Random Sampling techniques were adopted in selecting the sampled respondents. A sample size of 313 was determined by applying the Krejcie & Morgan, (1970) formula for determination of sample size of a given population. Questionnaire and few oral interview were used in sourcing for the information. The collected data was analysed using the Statistical Package of Social Science. The Results show that 28.8% of the respondents are mainly farmers and the remaining 71.2% have one form of occupation or the other including farming. Virtually every body farms, hence the need for ISFM in the area. Results also show that farmers' soil classification was mainly based on soil colour and texture observation and slope position was used as the determining factor for land suitability. Crop yield, crop appearance, natural vegetation, soil *colour and texture were used to estimate soil fertility. The management strategies mostly adopted in the study area were crop rotation, application of organic and inorganic fertilizers. It is then concluded that Indigenous Knowledge of ISFM is rather subjective when compared with the commonly obtained scientific knowledge. This was evident in farmers' soil classification which only takes into account the soil colour and the way they perceived and assessed soil fertility. Farmers' fertility indicators and soil taxonomy are based only on visible soil and crop properties. The results show that only 32.3% of the respondents with a mean score response of 112.8, a standard deviation of 313.1 and coefficient of variation 277.6 attempted to integrate their soil fertility management. This implies that their knowledge of ISFM is very low, following the state of technology and the pressure on land resources. It is therefore recommended that, the Ministry of Agriculture in conjunction with Research Institutes should availed Agricultural Extension Officers to the field in order to educate the local farmers on the more scientific ways of integrated Soil Fertility Management for Sustainable Crop Production and Food Security.*

Introduction

There is no standard definition of indigenous knowledge. However, there is a general understanding of what it means. Some people define indigenous knowledge as the local knowledge that is unique to a given culture or society. Some have defined it simply as "local knowledge", while others have expressed it as "folk knowledge", "information base for a society", "traditional wisdom" or, when it applies to the physical environment, as "traditional ecological knowledge".

Indigenous knowledge is local knowledge that is unique to a given culture or society (Warren, 1987). Indigenous knowledge is the systematic body of knowledge acquired by local people through the accumulation of experiences, informal experiments, and intimate understanding of the environment in a given culture (Rajasekaran, 1993). According to Haverkort (1993), indigenous knowledge is the actual knowledge of a given population that reflects the experiences based on traditions and includes more recent experiences with modern technologies. Local people, including farmers, landless laborers, women, rural artisans, and cattle rearers, are the custodians of indigenous knowledge systems. Moreover, these people are well informed about their own situations, their resources, what works and doesn't work, and how one change impacts other parts of their system (Butler and Waud, 1990).

Indigenous knowledge is dynamic, changing through indigenous mechanisms of creativity and innovativeness as well as through contact with other local and international knowledge systems (Warren, 1991). These knowledge systems may appear simple to outsiders but they represent mechanisms to ensure minimal livelihoods for local people. Indigenous knowledge systems often are elaborate, and they are adapted to local cultural and environmental conditions (Warren, 1987). Indigenous knowledge systems are tuned to the needs of local people and the quality and quantity of available resources (Pretty and Sandbrook, 1991). They pertain to various cultural norms, social roles, or physical conditions. Their efficiency lies in the capacity to adapt to changing circumstances. According to Norgaard (1984):

Regardless of the definition, there is a consensus that various communities, cultures and societies have indigenous knowledge systems. We can define it as the "knowledge acquired over generations by communities as they interact with their environment". It mainly refers to a system of understanding one's environment in the broadest sense. Indigenous knowledge is the basis for local-level decision making in agriculture, health care, food preparation, education, natural-resource management, and a host of other activities in communities.

Traditional knowledge has been viewed as part of a romantic past, as the major obstacle to development, as a necessary starting point, and as a critical component of a cultural alternative to modernization. Only very rarely, however, is traditional knowledge treated as knowledge *per se* in the mainstream of the agricultural and development and environmental management literature, as knowledge that contributes to our understanding of agricultural production and the maintenance and use of environmental systems.

Crops remove nutrients from the soil through the agricultural produce (food, fibre, and wood) and crop residues. This may result in declining soil fertility if replenishment with inorganic fertilizers or manure is inadequate. A decline in soil fertility implies a decline in the levels of soil organic C, pH, CEC, and plant nutrients. Soil fertility decline includes nutrient depletion (larger removal than addition of nutrients), nutrient mining (large removal of nutrients and no inputs), acidification (decline in pH and/or an increase in exchangeable Al), the loss of organic matter, and an increase in toxic elements such as aluminum (Hartemink, 2003).

Soil fertility is declining in many parts of sub-Saharan Africa (SSA) (Stoorvogel et al., 1993). One of the major constraints to crop production faced by smallholder subsistence farmers is the inadequate supply of nutrients (Quinones et al., 1998; Shapiro and Sanders, 1998). Farmers are either entirely abandoning the traditional practice of using natural fallow to restore soil fertility, or are unable to leave land fallow for long enough for it to be effective. The use of mineral fertilisers is declining as they are increasingly beyond the means of most small-scale farmers (Larson and Frisvold, 1996). Erosion and severe run-off are further depleting existing soil nutrient reserves, while levels of soil organic matter are declining as land is subject to over-use.

Sustaining soil fertility has become a major issue for agricultural research and development in SSA (Smaling and Oenema, 1997). In the past, most research consisted of trials to determine the appropriate amount and type of fertiliser needed to obtain the best yields for particular soil types and specific agro-ecological locations. This approach emphasised the use of external inputs and expensive technologies, and often disregarded farmers' knowledge and the resources at their disposal. Since then, research has gradually shifted towards an approach based on Integrated Soil Fertility Management (ISFM), which combines various existing soil fertility management techniques. Integrated Soil Fertility Management (ISFM) is a set of soil fertility management practices that necessarily include the use of fertiliser, organic inputs, and improved germplasm combined with the knowledge on how to adapt these practices to local conditions, aiming at maximising agronomic use efficiency of the applied nutrients and improving crop productivity.

This approach is based on a thorough scientific understanding of the underlying biological processes of ISFM and aims to promote options that make the best use of locally available inputs, and that are tailored to suit local agro-ecological conditions, and farmers' resources and interests. Improving farmers' knowledge, and their capacity to observe and experiment, is an essential element in the development of ISFM technologies. It is also important to build on local systems of knowledge, as they relate to specific locations and are based on experience and understanding of local conditions of production. Such systems are a source of site-specific ecological information, and provide the key to understanding peoples' socio-cultural conditions (Pawluk et al., 1992, Deugd et al., 1998). Many development projects and policies have collapsed because of a failure to understand local knowledge, and how this influences the way farmers manage natural resources (Schoonmaker-Freudenberger, 1994).

Several studies have been undertaken to assess local knowledge about soils. Research in this area has predominantly focused on documenting how farmers classify their soils (Talawar and Rhoades, 1997). Less attention has been paid to studying and understanding how soil fertility is perceived and managed at farm level, and how various physical, economic and socio-cultural factors interact. The objective of this paper is to characterise and understand farmers' perceptions and technological knowledge of soil fertility in Kafanchan. The insights from this study should make it possible to develop more sustainable Integrated Soil Fertility Management (ISFM) research and development programmes, and to design more appropriate policies for maintaining and enhancing soil fertility in the study area.

As population increases, the pressure on agricultural land also increases while the soil fertility declines due to land fragmentation and continuous cropping. The present economy recession makes it difficult for the farmers to afford agricultural input especially the inorganic fertilizer and other forms of manure. It is against this background that this study set out to identify the demographic and Socio-economic characteristic of the respondents; investigate the Indigenous ways of determining soil fertility, land suitability and their soil fertility management strategies.

MATERIALS AND METHODS

STUDY AREA

Jema'a Local Government Area is located between latitude 9^0 10' and $9^0$30'N and longitude 8^0 0' and 8^0 30'E. The Local Government is bounded in the East by Kagoro in Kaura Local Government Area, in the North by Zonkwa and Ungwar Rimi District of Zangon-Kataf Local Government Area, in the West by

Jaba Local Government Area and in the South by Nassarawa State and in the South-East by Sanga Local Government Area. The study area has witnessed a tremendous growth in population in the last 30 years (Ishaya and Abaje, 2008).

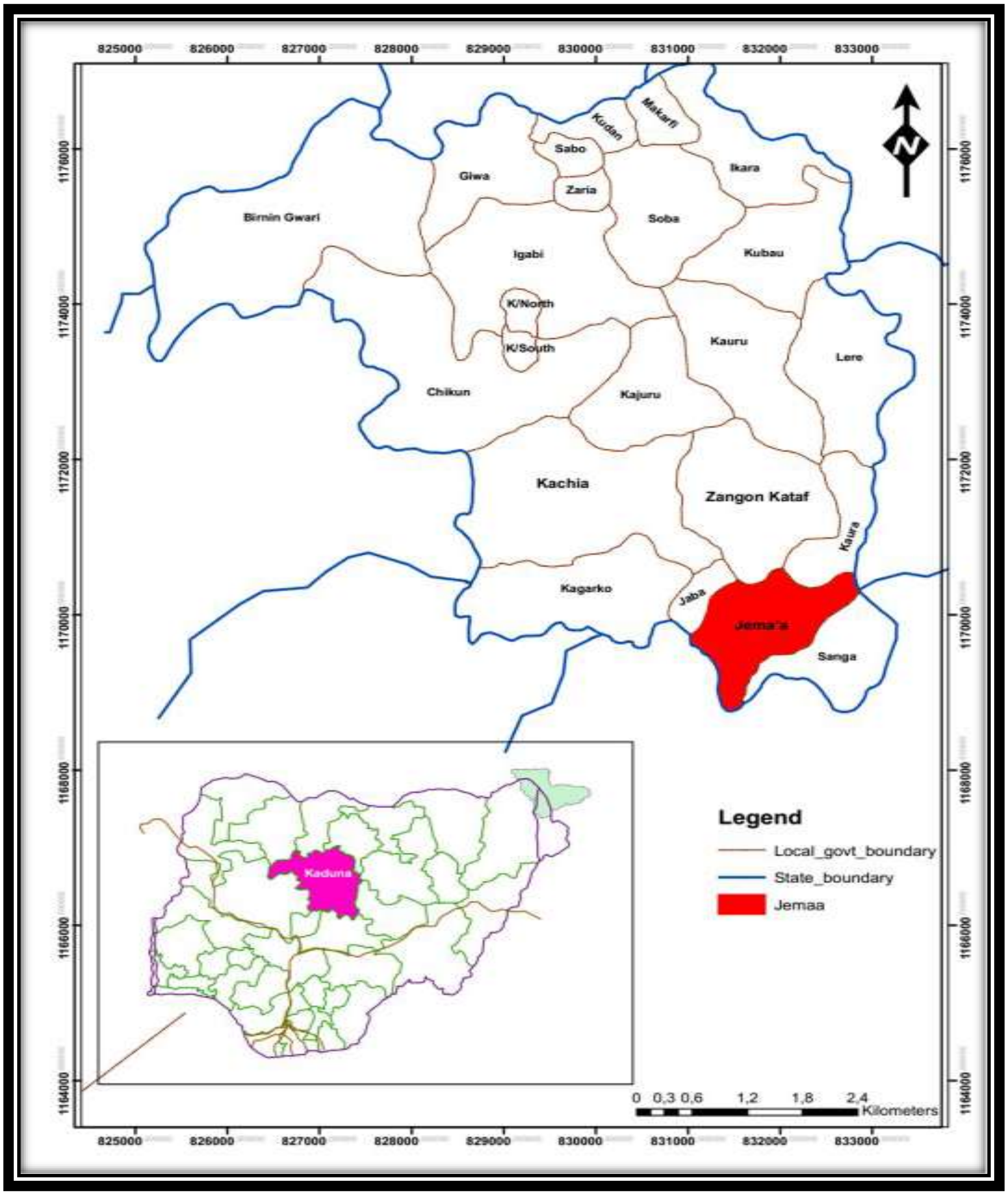

Figure 1: Map of Jema'a Local Government showing the study area.
Source: Adopted from Google Earth (2016).

It has a population of 278,735 (FRN, 2006), with an annual growth rate of 3% in the state (FRN, 2006), and a projected population of about 588, 887 people in 2016. Presently it has twelve wards, namely: Jagindi, Godogodo, Atuku, Gidan-Waya, Maigizo, Kaninkon, Kagoma, Asso, Kafanchan ‘A’, Kafanchan ‘B’, Bedde and Takau. The area is characterised with Koppen’s Aw climate with two distinct seasons, a wet season in summer and a dry season in winter. Rainfall occurs between the months of April to October with a peak in August. The mean annual rainfall is about 1800 mm, and the mean monthly temperature is 250C, while the relative humidity is about 62%. The relief effects of the Jos-Plateau and the Kagoro Hills have positive influence on the climate influencing rainfall, temperature and relative humidity. The main type of soil is the Ferruginous tropical soil which is related to the climate, vegetation, lithology and the topography of the area. The relief is relatively flat and undulating and it influences the drainage pattern of the area.

SOURCES OF DATA

The sources of data used for this study comprises of both Primary and Secondary sources of data. The Primary sources include the personal observation during reconnaissance and field survey using a designed questionnaire with little interview granted to the selected identified farmers. The secondary data source includes published and unpublished materials, journal articles, text books, thesis, paper presentation, internet, among others.

SAMPLE AND SAMPLING PROCEDURE

The target population of this study comprise of people who practice agriculture in one way or the other. The study area was stratified into twelve wards out of which 5 words were selected at random which includes:-Kaninkon, Kagoma, Takau Kafanchan A and Kafanchan B. The sample population was determined by adopting the Krejcie & Morgan, (1970) formula for determination of sample size for a given population, In each of these wards a list of all the identified households were compiled through their local village head offices compiled making a total of 1774 and the corresponding sample size of 313 determined(Table1). The required sampled respondents were systematically selected.

Table 1: Sample Frame

S/N	WARDS	NUMBER OF HOUSEHOLDS	SAMPLED HOUSEHOLDS
1	Kafanchan A	246	43
2	Kafanchan B	173	31

3	Kaninkon	439	77
4	Kagoma	331	55
5	Takau	585	103
TOTAL		1774	313

Source: Field survey, 2017

The first household was selected at random and the subsequent ones were selected systematically at an interval of 6 until the 313th number was obtained. The questionnaire was administered to 313 heads of the households and returned; the researcher therefore used them for analyses. Direct field observation was carried out to observe some of their farms and practices. The data was analysed with the aid of SPSS and the results is presented below.

RESULTS AND DISCUSSION

The results of this research are presented in this section and the discussions flowed**.**

Table 2: Demographic characteristics

SEX DISTRIBUTION OF THE RESPONDENTS

SEX	Frequency	Percent
MALE	238	76.0
FEMALE	75	24.0
TOTAL	313	100.0
AGE STRUCTURE OF THE RESPONDENTS		
AGE BRACKET	Frequency	Percent
(18-28) YRS.	92	29.4
(29-39) YRS.	173	55.3
(40-49) YRS.	32	10.2
50YRS. AND ABOVE	16	5.1
TOTAL	313	100.0
DISTRIBUTION OF MARITAL STATUS OF THE RESPONDENTS		
STATUS	Frequency	Percent
MARRIED	123	39.3
SINGLE	190	60.7
TOTAL	313	100.0
DISTRIBUTION OF THE RESPONDENTS ACCORDING TO FAMILY SIZE		

NO. OF PEOPLE PER HOUSEHOLD	Frequency	Percent
1-4 PERSONS	162	51.8
5-9 PERSONS	99	31.6
10 PERSONS AND ABOVE	52	16.6
TOTAL	313	100.0

Source: Field survey, 2018

Table 2 presents the sex composition of the respondents; analysis shows that male respondents were 238 representing 76%, while the females were 75, representing 24%. This composition does not mean that males are more than the female, rather farming activities and decision are majorly carried out by the men, so the stand a better chance to give the most desirable response.
The age distribution of the respondents show that 29.4% representing 92 respondents fall within the age bracket (18-28) yrs. , 55.3% representing 173 respondents are within (29-39)yrs. while 10.2% and 5.1 representing 32 and 16 respondents are within (40-49)yrs. and 50 and above years respectively. This analysis shows that about 70% of the respondents are within 29 years and above, which is a good composition of people who are into the farming business of different kind.
The marital status of the respondents was analysed and the results shows that 60.7% representing respondents are married, while 39.3% representing 123 respondents are singles. Determining their family sizes shows that 51.8% have family size of about 1-4 person, while 31.6 have 5-9 persons and 16.5% has ten and above persons. The implication of this distribution to this study is that, majority of the respondents are married people with large families, meaning more responsibilities apart from the requirements for Integrated Soil Fertility Management.

Table 3: Socio-economic characteristic of the respondents.

EDUCATIONAL ATTAINMENT

LEVEL OF EDUCATION	**Frequency**	**Percent**
NO FORMAL EDUCATION	53	16.9

QURANIC SCH.	34	10.9
PRIMARY	101	32.3
SECONDARY	100	31.9
TERTIARY	25	8.0
TOTAL	**313**	**100.0**
OCCUPATION	Frequency	Percent
FARMING	90	28.8
BUSINESS	103	32.9
CIVIL SERVANT	96	30.7
OTHERS (SPECIFY)	24	7.7
TOTAL	313	100.0
INCOME	Frequency	Percent
BELOW N18, 000	58	18.5
N18, 000-N25, 000	33	10.5
N26, 000-N35, 000	24	7.7
N36, 000-N50, 000	155	49.5
N51, 000 AND ABOVE	43	13.7
TOTAL	313	100.0

Source: Field survey, 2018

Table 3 presents the socio-economic characteristics of the respondents; analysis shows that 16.9% representing 53 respondents have no formal education, 10.9% representing 34 respondents have Quranic education, 32.3% representing 101 respondents have first school leaving certificates, 31.9% representing 100 respondents 8 % representing 25 respondents have tertiary education.

Their occupational distribution show that, 28.8%representing 90 respondents are farmers, 32.9% representing 103 respondents are businessmen, while 30.7% representing 96 respondents are civil servants and 7.7% do one form of work or the other.

Their income distribution shows that 18.5% representing 58 respondents earned below N18, 000.00, 10.5% representing 33 respondents earned N18, 000-N25, 000 , 7.7% representing 24 respondents earned between N26, 000-N35, 000 , while 49.5% representing 155 respondents and 13.7% representing 43 respondents earned between N36, 000-N50, 000 and N51, 000 and above respectively.

Table 4: Indigenous ways of determining soil Fertility

FERTILITY	FREQUENCY	PERCENT	MEAN	STANDARD DEV.	COV
CROP APPEARANCE	88	28.1	5.0	5.51	110.2
SOIL COLOUR	50	16.0			
SOIL TEXTURE	84	26.8			
CROP YIELD	67	21.4			
CROP APPEARANCE & SOIL COLOUR	16	5.1			
CROP APPEARANCE & CROP YIELD	8	2.6			
TOTAL	313	100.0			

Source: Field survey, 2018

The respondents were asked to identify the ways they identify fertile soils. Their responses show that 28.1% representing 88 respondents use crop appearance to detect fertile soil, 16% representing 50 respondents use soil colour, and 26.8% representing 84 respondents used soil texture 21.4% representing 67 respondents use crop yield to identify their soil fertility, 5.1% use both Crop appearance and soil colour in determining their soil fertility and 2.1 used both Crop appearance and crop yield. Analysis shows that their responses on their methods of identifying soil fertility has a mean score of 5.0 with standard deviation of 5.51 and a coefficient of variation of 110.2% implying that their responses were evenly distributed but having different perception of indicators of soil fertility.

Table 5: Indigenous ways of determining land suitability

NATURE OF LAND	FREQUENCY	PERCENT	MEAN	STANDARD DEV.	COV
SLOPE POSITION	32	10.2	8.17	20.8	254.3
MOUNTAIN FOOT	18	5.8			
VALLEY.	8	2.6			
FALLOW LAND	66	21.1			
SOIL TEXTURE.	157	50.2			
SLOPE POSITION AND FALLOW LAND	24	7.7			
SLOPE POSITION, VALLEY AND SOIL TEXTURE	8	2.6			
TOTAL	313	100.0			

Source: Field survey, 2018

The respondents were also asked to show how they choose a suitable land for cultivation; results show that they have different ways of identifying their suitable land for cultivation depending on the type of crops to plant. 50.2% use soil texture to determine the crops to be planted on the land, 21.1% said the years and nature of fallow determine the type of crops to be planted. 10.2% use slope position to determine land suitability, 5.8% and 2.6% identify mountain foot and valley respectively for suitability.

Table 6: **Soil Fertility Management**

MANAGEMENT METHODS	FREQ.	PERCENT	MEAN	STANDARD DEV.	COV
SHIFTING CULTIVATION	83	26.5	112.8	313.1	277.6
CROP ROTATION	54	17.3			
APPLICATION OF CROP RESIDUES	8	2.6			
USE OF ANIMAL DUNG.	34	10.9			
USE OF COMPOST MANURE	1	0.3			
APPLICATION OF INORGANIC FERTILIZER	33	10.5			
SHIFTING CULTIVATION AND USE OF ANIMAL DUNG	8	2.6			
SHIFTING CULTIVATION AND USE OF COMPOST MANURE	8	2.6			
CROP ROTATION AND USE OF PLANTS RESIDUES	8	2.6			
CROP ROTATION AND COMPOST MANURE	20	6.4			
CROP ROTATION AND INORGANIC FERTILIZER	8	2.6			
SHIFTING CULTIVATION AND USE OF PLANT RESIDUE	8	2.6			
CROP ROTATION, ORGANIC FERTILIZER AND COMPOST MANURE	24	7.7			
SHIFTING CULTIVATION, CROP ROTATION, ANIMAL DUNG AND	8	2.6			
SHIFTING CULTIVATION, CROP ROTATION AND COMPOST MANURE	8	2.6			
TOTAL	313	100.0			

Source: Field survey, 2018

The core of this study is soil fertility management, the respondents were asked of how they manage their soil fertility with the view of identifying their Knowledge of ISFM. Their response show that, a good number (26.5%) still practice shifting cultivation only as a means of soils fertility management. This is followed by 17.3% who use crop rotation only to manage their fertility. 10.9% use animal dung only and 10.5% use inorganic fertilizer only. A few percentages apply crop residues only and compost manure only representing 2.6% and 0.3% respectively. Some sets of few respondents applied a combination of the methods in managing their soils; about 19.4% and 12.9% use two and three different methods respectively in their soil fertility management.

The summary of this table shows that only 32.3% of the respondents with a mean score response of 112.8, a standard deviation of 313.1 and coefficient of variation 277.6 attempted integrating their soil fertility management. This implies that their knowledge of ISFM is very low, following the state of technology and the pressure on land resources.

Farmers used a combination of indicators to rate the land as either 'good' or 'bad'. In scientific terms these lands will be either fertile or infertile, respectively. Soil colour and texture were used by 48% of farmers with dark soils indicating higher fertility than lighter soils. The abundance of mesofauna was used by 51% of farmers. Natural vegetation (18%), especially weed growth and diversity observed before planting, also gave a statement about soil fertility. However, the presence of weeds did not always reflect fertile soil conditions and led to errors by some farmers in their fertility assessment. Crop production factors are considered most reliable as they are said to clearly reflect soil fertility differences. These include crop colour and firmness (32%) during the establishment stages and crop yield (70%). This shows that crop yield forms a benchmark for soil quality in the indigenous approach (Gruver and Weil, 2006). It is clear that farmer fertility assessment is mainly concerned with food security which is highly dependent on land productivity.

DISCUSSION OF FINDINGS

The results revealed that about 70% of the respondents are within 29 years and above, which is a good composition of people who are into the farming business of different kind. The composition of the respondents falls within the active age group who can farm and produce the desired quantity of crop for the population other things being equal. Their marital status distribution shows that 60.7% of the respondents are married, while 39.3% are singles, with family sizes of 1-4 person representing 51.8% and 31.6% with 5-9 persons. This implies that majority of the respondents are married people with large families, meaning more responsibilities apart from the requirements for Integrated Soil Fertility Management. Even if they have the idea of ISFM, their resources might hinder them from practicing it.Analysis shows that about 40% of the respondents have secondary education and above. This distribution shows that there is need for sensitization in the area so as to educate the people on the modern methods of farming.

Results show that 28.8% of the respondents are mainly farmers and the remaining 71. 2% have one form of occupation or the other including farming. Virtually every body farms, hence the need for ISFM in the area. But this involves the combination of different methods which might require some financial implications, whereas their earning is very low, over 85% of the respondents earned below N50, 000 monthly. Their knowledge of soil fertile show that 28.1% use crop appearance to detect fertile soil, 16% use soil colour, and 26.8% used soil texture while 21.4% use crop yield to identify their soil. This implies that they are still lacking behind in the scientific concept of soil fertility, and need to be informed as such.

Their mode of land suitability assessment is also very crude as 50.2% use soil texture to determine the crops to be planted and 21.1% used years and nature of land fallow to determine the type of crops to be planted and so on. Most of their techniques of soil fertility and land suitability are highly subjective.

The core of this study is soil fertility management, the respondents Knowledge of ISFM shows that 26.5% practice shifting cultivation only, 17.3% use crop rotation only 10.9% use animal dung only and 10.5% use inorganic fertilizer only. Just a few percentages applied a combination of two methods in managing their soils; about 19.4% and 12.9% use two and three different methods respectively in their soil fertility management. In a whole, only 32.3% of the respondents attempted integrating their soil fertility management. This implies that their knowledge of ISFM is very low, following the state of technology and the pressure on land resources.

CONCLUSION AND RECOMMENDATION

The need for Integrated Soil Fertility Management for food security can never be over emphasised. This study shows that crop yield forms a benchmark for soil quality assessment in the study area, and majority of the people don't practice the ISFM, probably due to lack of Knowledge. It is therefore recommended that field demonstration should be carried out in order to create awareness on the people, of the importance of ISFM in boosting the fertility of their soils.Government should help the farmers get more land to practice some techniques as land rotation and shifting cultivation.

REFERENCES

Butler, L. and J. Waud. (1990): "Strengthening Extension through the Concepts of Farming Systems Research and Extension (FSR/E) and Sustainability." *Journal of Farming Systems Research-Extension.* 1(1): 77-98.

Haverkort, B. (1993): "Agricultural Development with a Focus on Local Resources: ILEIA's View on Indigenous Knowledge." In D.M. Warren, D. Brokensha, and L.J. Slikkerveer, (Eds.), *Indigenous Knowledge Systems: The Cultural Dimensions of Development*. London: Kegan Paul International.

Larson, B.A., Frisvold, G.B., (1996): Fertilizers to support agricultural development in sub-Saharan Africa. What is needed and why? *Food Policy* 21: 509-525

Norgaard, R.B. (1984): "Traditional Agricultural Knowledge: Past Performance, Future Prospects, and Institutional Implications." *American Journal of Agricultural Economics* 66:874-878.

Pawluk, R.R., Sandor, J.A., Tabor, J.A., (1992): The role of indigenous soil knowledge in agricultural development. *J Soil Water Conserv* 47: 298-302.

Pretty, J. and R. Sandbrook, (1991): "Operationalising Sustainable Development at the Community Level: Primary Environmental Care." *Paper presented at the DAC Working Party on Development Assistance and the Environment*, London, October 1991.

Rajasekaran, B. (1993): A Framework for Incorporating Indigenous knowledge System into Agricultural Research and Extension Organizations for Sustainable Agricultural Development in India. *Unpublished Ph.D. Dissertation*, Iowa State University, Ames, Iowa.

Schoonmaker-Freudenberger, K., (1994): Challenges in the collection and use of information on livelihood strategies and natural resource management.

In: I Scoones &J Thompson (eds), *Beyond Farmer First*, pp 124-133. IIED. International Technology publications, Southampton Row, London, UK

Smaling, E.M.A., Oenema, O., (1997): Estimating nutrient balances in agro-ecosystems at different spatial scales. .) pp 229-252 in: R. Lal et al. (Eds.), Methods for assessment of soil degradation. *Advances in Soil Science*. CRC press.

Stoorvogel, J.J., Smaling, E.M.A., Janssen, B.H., (1993): Calculating soil nutrient balances in Africa at different scales. I. Supra-national scale. *Fertilizer Research* 35: 227-235.

Talawar, S., Rhoades, R.E., (1997): Scientific and local classification and management ofsoils. *Agric Human Values* 15: 3-14.

Ishaya, S. and Abaje, I. B. (2008): Indigenous people's perception on climate change and adaptation strategies in Jema'ah local government area of Kaduna State, Nigeria. *Journal of Geography and Regional Planning* Vol. 1(8), pp. 138-143, Available online at http://www.academicjournals.org/JGRP ISSN 2070-1845

Warren, D. M. (1987). "Editor's Notes." CIKARD News 1(1): 5.

Warren, D.M. 1991. Using Indigenous Knowledge in Agricultural Development. *World Bank Discussion Paper* No. 127. Washington, D.C. : The World Bank.