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Sustainable Land Management Practices among Food Crop Farmers in the Northern Guinea Savanna of Agroecological Zone of Kaduna State, Nigeria

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Abstract
The study aimed to analyze various land management practices in selected rural areas in the northern guinea savanna of agro ecological zone of Kaduna State with a view to determining the most sustainable practice(s). Purposive sampling technique was employed in collecting data from three hundred and eighty (380) rural farmers with structured questionnaire administered. The data were analyzed using descriptive statistical techniques such as frequency tables, mean and percentages to summarize the data. Likert scale was also employed to determine the positive an negative effects of these land management practices and Principal Component Analysis (PCA) was adopted as a procedure for components reduction to determine the most sustainable land management practice. The study revealed that socio- economic characteristics such as educational status, farming experience, age had influence on the farmers' choice of practices being adopted. The study also discovered that the most common land management practices were mulching, irrigation, organic manure, fertilizer application, and agro-forestry, where 53% of the farmers adopted fertilizer application and 29% of total sample practiced organic manure application. The result from the likert scale 3-Points and above representing positive effects of land management practices are fertilizer application, organic manure, crop rotation, cover crop and irrigation, while agroforestry, mulching and bush fallow were perceived by farmers as negative effects on the environment in the study area. The result from the PCA revealed that Agroforestry and bush fallow were considered to be most sustainable land management practices because they appeared in the component one of the PCA. Therefore, the study concluded that the farming population is ageing and that is adversely affecting the choice of best practices due to lack of education and knowledge to adopt the best land management practice and also the choice of land management practices had great significant difference both negative and positive on farm productivity in this agro-ecological zone of Kaduna State. The study recommended that agricultural extension programmes should be encouraged to boost the famers' knowledge in adopting the most appropriate practices for different socio-economic and environmental problems.

Keywords: *Sustainable, Land Management, food crops, Northern Guinea Savanna, Agro-ecological zone.*

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I. Introduction

Poor land use and management practices affect human health directly and indirectly. It affects fauna and flora, contributes to local, regional, and global climate changes and is the primary source of soil, water and land degradation (Sala, *et al* 2005). Ecological Support Functions— i.e., the provisions people obtain from ecosystems (e.g., food, water), regulating services (e.g., predator-prey relationships, flood and disease control), cultural services (e.g., spiritual and recreational benefits), and support services (e.g., pollination, nutrient cycling, productivity)—that maintain the conditions for life on earth affect the ability of biological systems to support human needs (Vitousek,*et al* 1997). Alterations lead to large scale land degradation, changing the ecology of diseases that influence human health and making it more vulnerable to infections (Collins, 2001).

Moreover, poor incentives for natural resource conservation, among other socio-economic problems, have subjected the soils' nutrients to serious exploitation and depletion. Nigerian policy makers have now come to understand that sustainable management of land is a prerequisite for providing enabling environment for agricultural development, which is pivotal towards ensuring that the basic need of man (food) is adequately available, accessible and affordable for the growing populations (FGN, 2004).

Land is the major resource for the livelihood of rural dwellers. In Nigeria, a typical villager recognizes land in its entirety. According to Fabiyi (1990) land, to the farmer, is home and work place and shares it with the entire biotic complex. As important as land is to farmers' livelihood, Adekoya (1997) observed that subsistent farmers are faced with a lot of challenges in access and ownership of land resources. Dixon (1995) arranged problems of access and ownership of land resources under three headings; economic obstacles such as capital

need and financial incentives; social conditions which include land tenure, availability of infrastructures and educational level of farmers; and ecological consideration such as limited knowledge of inputs and sustainability of some systems.

Sustainable land management (SLM) has been defined as the adoption of appropriate land management practices that enable land users to maximize the economic and social benefits from the land while maintaining or enhancing the ecological support functions of the land resources (FAO, 2009). It is the key point for improving land resource resilience and productivity within the context of the potentially devastating effects of climate change in Sub-Saharan Africa, bridging the needs of agriculture and environment, with the twin objectives of maintaining long term productivity and ecosystem functions (land, water, biodiversity); and increasing productivity (quality, quantity and diversity) of goods and services (including safe and healthy food) (Durno, 1992; Woodfine, 2009).

The major goal of sustainable land management therefore is to develop economically viable agro-ecological system and to enhance the quality of the environment, so that farm lands will remain productive indefinitely. Since sustainable land management includes the maintenance over time of soil productivity, it therefore requires the combination of soil fertility treatment such as application of mineral and organic fertilizers with soil and water conservation measures including implementation of agronomic, soil management and physical measures, such as contour ridging, terracing, tied ridges or providing ground cover through mulching, use of plants and leaving crop residues (Durno, 1992; Woodfine, 2009).

This link between degradation (which is often caused by unsustainable land use practices) and its effect on land use is central to nearly all published definitions. The emphasis on land, rather than soil, broadens the focus to include natural resources, such as climate, water, landforms and vegetation (Woodfine, 2009).

Food and fiber productivity soared due to new technologies, mechanization, increased chemical use. Although these have had many positive effects and reduced many risks in farming, there have also been significant costs. Prominent among these are topsoil depletion, groundwater contamination, the decline of family farms, continued neglect of the living and working conditions for farm labourers, increasing costs of production, and the disintegration of economic and social conditions in rural communities (ASI, 2012).

Agricultural land in the northern guinea savanna zone, maintain their fertility due to tight cycling of nutrients between vegetation and soil; if this cycle is broken through forest destruction, nutrients are likely to be rapidly lost, which results in an impoverished soil (Hamilton and Bensted-Smith, 1989). Soil degradation is a major contributor to nutrient losses, because most of the scarce soil nutrients in the tropics are in the top 5-10 cm of the soil (Nkonya, Pender, Jagger, Kaizzi, and Ssali, 2004). The soils have a low water holding capacity due to a low content of small soil particles. High temperatures favour rapid decomposition of organic residues; thus organic inputs are needed to avoid erosion. Steep lands are more sensitive to rapid soil degradation through runoff (Hellin, 2006).

It is based on these observations that this study intends to analyze land management practices among food crop farmers in some selected rural areas in northern guinea savanna of agro-ecological zone of Kaduna state, Nigeria. With these specific objectives: describe the socio-economic characteristics of farmers, identify different land management practices, identify the effects of these land management on the environment and determine the most sustainable land management practices in the study area.

II. Methodology

Study Area

The study was conducted in Chikun Local Government Area which is one of the local government areas located in northern guinea savanna of agro-ecological zone of Kaduna state. It is geographically located between latitude 10^0 33'N to 10^0 37'N and Longitudes7^0 10' E to 7^0 14' E (see Figure 1). It is situated some 50km north west of Kaduna Township along Kaduna-Lagos express way. The area is bounded by Igabi Local Government Area to the east, Kaduna metropolis to the South east and north and Birnin- Gwari to the west. (Nwadelor, 2001). The area being located in the interior part of Nigeria experiences continental climate. It is characterized by wet and dry seasons orchestrated by the movement of the inter-tropical Convergence Zone. The dry season in the area begins in early November and lasts till April while the wet season starts from May and ends in September. The length of rainfall varies from 150 days to 190 days with an annual rainfall ranging between 1500mm and 2000mm. The temperature is high throughout the year with the peak in March and April (37^oc), while the mean annual temperature varies between 24^oc and 28^oc. Humidity is constantly high (above 60%) at mid-day and close to 100% at night during the rainy season, relative humidity is low ranging between 20% and 40% in January rising to between 60% and 80% in July (Ati, 2006).

The study area falls within the basement complex of central Nigeria and the soil type is derived from the weathering of the rocks. The area consists mainly of lateritic rocks, the soil of the area can be classified as ferruginous tropical soil (Nwadelor, 2001). The soils are typically red-brown to red-yellow tropical ferruginous soils. Some areas are richer in kaolinitic clay and organic matter, very heavy and poorly drained which are

characteristics of vertisols (Bello, 1993). The modified vegetation zone on the northern Guinea savannah, is a land described as wood land vegetation with relatively interspaced and short scattered trees within which are thick bushes and shrubs. The vegetation cover consist of the following native or indigenous species of *Isoberlina doka, Monotes kerotingu, Vapaca togoensis, Parimarie curratelli folia* etc. Some of the exotic species include; *Eucalyptus rudis, Mangifera Indica, Pinus cocara.* Some of these species serve as agroforerstry practices which is one of land management practices in the study area.

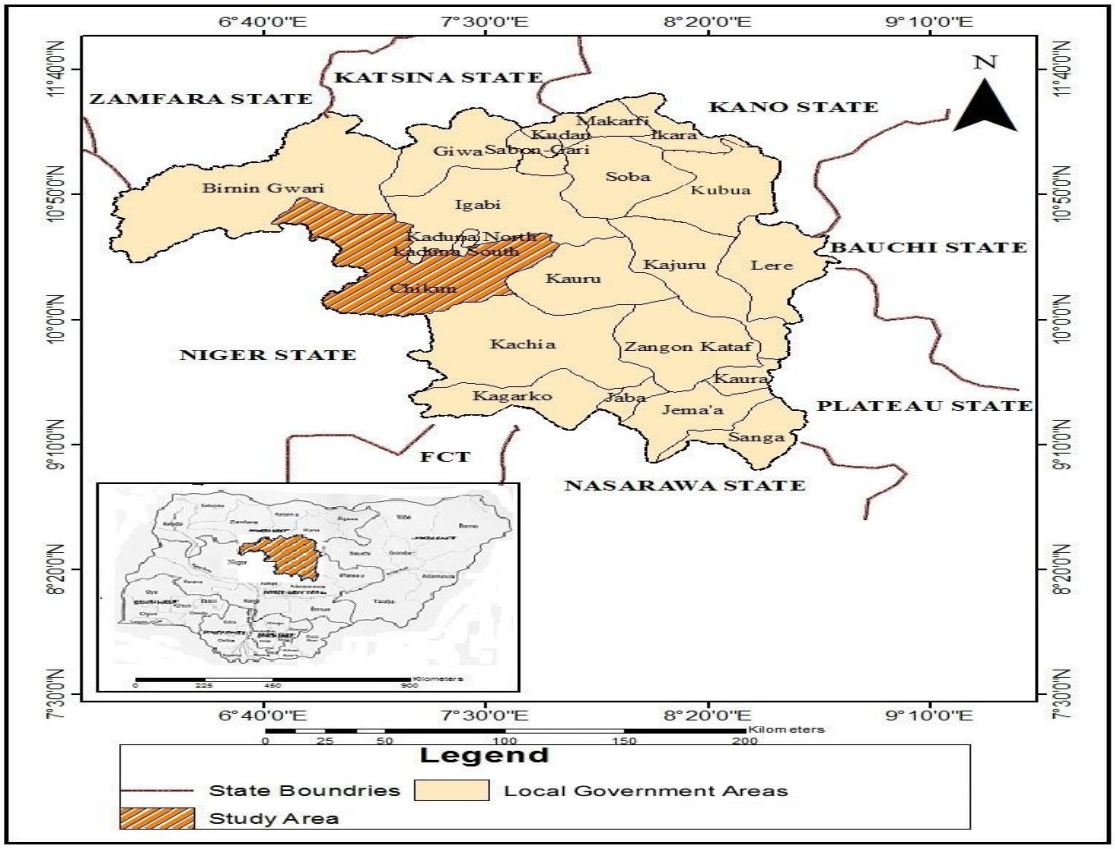

Figure 1: Map of Kaduna State showing the Study Area.

III. Methods of Data collection and Data Analysis

Reconnaissance survey was conducted to make enquiries from the farmers on the various land management practices in the study area. The farmlands were visited to identify different types of land management practices adopted by the farmers in the study area and also types of crops grown.

The study was carried out through field observation, personal contact with the rural farmers by means of questionnaire administration. This aided the study to acquire more information to achieve set objectives in the study area.

The study area is made up of seven (7) localities. The rural ares are Buruku Ung Majidadi, Buruku Ung Makama, Dandaladima, Ung Galadima, Buruku Gari, Ung Magaji, Buruku Afaka Afforestation. The population of the study area has been estimated to be seven thousand, four hundred and eighty-Nine, 7,489 (NPC, 1991) while the projected population to 2019 has been estimated to be fifteen thousand two hundred.

Purposive sampling was used to select the respondents from each of the seven localities in the study area for administration of questionnaire. Since the research study is purposely targeted at the farmers in the study area, the actual population of the farmers in Kaduna State has been given to be 47.2% of the total population, which would amount to 7175. This is according to Department of Research and Statistics in the Ministry of Economic Planning (NPC, 1991).

The data derived from the survey was statistically analyzed through the use of both descriptive and inferential statistical methods.

IV. Results And Discussion

Socio-Economic Characteristics of the Respondents

Table 1 revealed that about 88% of the farmers are between 20 - 60 years of age, implying that they are in active age brackets. The mean age is 44 years and this has implication on the availability of family labour and productivity of the labour because age has a direct bearing on the availability of farm labour and the ease with which sustainable land management practices are adopted. This fact is in agreement with Raufu and Adetunji (2012), that age of farmers has direct bearing on the availability of farm labor and the ease with which improved sustainable land management practices are adopted.

The sex distribution of the farmers depicted more males (100%) than females. This result conforms with the cultural setting in the study area, an area which is predominantly Muslims and women are in Purdah (their religious beliefs make them to be indoors more often).

Most of the farmers (65%), have Quranic education. Those with primary and secondary education are 12% and 19% respectively. The remaining 4% have tertiary education. This is expected to have significant impact and ability of farmers to effectively adopt better land management practices.

Table 1: Socio-Economic characteristics of the respondents

Variable	Frequency	Percentage (%)
Age Group		
Below 20 Years	0	0
21 – 30 Years	53	14
31 - 40 Years	118	31
41 - 50 Years	95	25
51 – 60 Years	68	18
Above 60 Years	46	12
Total	**380**	**100**
Gender		
Male	380	100
Female	0	0
Total	**380**	**100**
Educational Level		
Primary	46	12
Secondary	72	19
Tertiary	15	4
Quranic	247	65
Total	**380**	**100**
Years of Farming Experience		
Less than 5 Years	8	2
6 - 10 Years	68	18
11 - 15 Years	34	9
16 – 20 Years	15	4
Above 20 Years	255	67
Total	**380**	**100**
Farm Land Size (Ha)		
Less than 2	23	6
2 – 4	166	44
5 – 7	65	17
8 – 10	65	17
Above 10	61	16
Total	**380**	**100**
Farmland Ownership		
Personally owned	182	48
Community	0	0
Hire	129	34
Rent	69	18
Total	**380**	**100**
Labour Supply		
Family Only	34	9
Hired Only	38	10
Family & Hired	308	81

Total	**380**	**100**

Source: Field Survey, 2019.

This result is in agreement with the findings of Abdulazeez *et al,* 2014 that, education influences the adoption land management practices positively.

Years of farming experience is one of major factors that contribute to the effective land management in this type of occupation. From Table 1, most of the farmers sampled have been in farming practice for more than 20 years, (67%). While 18% have between 6 – 10 years of farming knowledge, 9% have between 11 – 15 years of farming experience. Only 2% have just spent less than 5 years on the farm which indicated the mean farming experience to be 18.8 years.

The farm sizes of the respondents are fairly large. This is owing to near absence of farmland on plain terrain and bushes and forest undergrowth. Soil is also easy to work, as a result, wide expanse of land is put under cultivation. Majority of the respondents have farm sizes ranging between 2 and 7 hectares per farmer. A total of 44% of the respondents have farm size ranging between 2 and 4 hectares, while 17% of the people have farm size between 5 and 7 hectares. Seventeen percent (17%) have total farm land between 8 and 10 hectares, 16% have above 10 hectares and 6% of the farmers have below 2 hectares of land. This value gives a mean farmland size of respondents to be 5.9 ha of land per farmer. This corroborates with the findings of Abdulazeez *et al, (*2014) that this factor is necessary because the farmland size determines the types of land management practiced. Some land management practices such as fallowing are known to require more land area. Inadequate land area may therefore pose a problem in the adoption of such practices.

Land is the most important and vital resource for the productivity of the rural populace. Access to it is fundamental in rural system for the satisfaction of most of the basic needs. Table 1 shows the type of land ownership system among the respondents. About 48% of the farmers sampled personally owned the land while 34% hired the land, and only 18% of the farmers either rent the land or borrowed from the community head. The ownership structure conforms to the findings of Abdulazeez *et al,* (2014) which is important as farmers may not be willing to expend effort towards sustainable land management practices on land temporarily held by them. This group of people are those whose farmlands are not quite productive or those with large number of families, whose farmlands are not large enough to support their food requirement.

Sources of labour used by the respondents were also investigated during the field survey. Most farmers, 81%, depended on family and hired labour force. The use of hired labour is necessitated by two factors. Firstly, the land under cultivation has to be fairly large before adequate food to feed the family is ensured. Also, married women do not normally participate in farming activity and therefore more hands must be employed. However, 9% people depended solely on family labour. This group complained of having no money to hire labour for farm work, and only 10% could afford to hire labour for their farming activities, and this also has to do with the types of crop planted and farm size.

Types of Land Management Practice in the Study Area

The types of Land Management Practices in the area are presented in Table 2.

From Table 2, many farmers perceived use of organic manure, organic fertilizer as good because they increase crop yields and improve soil fertility. Based on this reasoning, majority of the farmers used these practices much more than others.

The most common land management practices used by farmers in the study area therefore are as follows: mulching, cover crops, crop rotation, irrigation, application of organic manure, inorganic fertilizer, bush fallow, agroforestry. From Table 2, it was revealed that 53% farmers adopted application of inorganic fertilizer, followed by 29% that practiced application of organic manure, irrigation was done by 4%, while mulching and agroforestry were adopted by 2% and 4% respectively. Cover crop was practiced by 6% of the farmers while crop rotation and bush fallow were adopted by very few farmers in the study area. This also conforms to findings of Abdulazeez *et al,* (2014), which concluded that while it is desirable to apply various management practices, the respondents who did not include both fertilizers and organic manure in the land management practices can be said not to apply sustainable land management practices in production. This is because application of both fertilizers and organic manure constitute what is generally termed integrated land management system.

Table 2: Basic Land Management Practices in the Study Area

Land Management	Frequency	Percentage
Mulching	9	1.6
Cover Crop	32	5.7
Crop Rotation	11	1.9
Irrigation	24	4.3

Organic Manure	164	29.2	
Inorganic Fertilizer	297	52.8	
Bush Fallow	5	0.9	
Agroforestry	20	3.6	
Total	**562***	**100**	

Sources: Field Survey (2019)
*Multiple Responses

Farmers' Perceptions on the Effects of Land Management Practices on the Environment

It was found that farmers perceived differently on the effects of land management practices on the environment Their perceptions on the effects on each of land management practices were scaled using five likert scales ranging from very poor to very good, a code was allocated to the scale from one to five accordingly while three is the midpoint of average scale point. Mean score of each of the land management practices was calculated, the mean score of any land management practice that falls below three has negative or poor effects on the environment while the mean point above three has good or positive effects on the environment. Farmer's Perception of the effects of farm management practices on the environment is given in Table 3.

It was discovered from Table 3 that the land management practice that had very good effects on the environment, with mean point of 4.8 as considered by the respondents is fertilizer application. This is the inorganic manure that is readily available to farmers and has been commonly and regularly applied to their farmland and has not noticed any negative effects on the environment for so many years. The next practice is organic manure with mean point of 3.9; this also had been considered to have good effects on the environment. Another land management practices that have been considered to have positive effects are crop rotation and cover crop with mean point of 3.5 and 3.3 respectively. These are also being practiced by some farmers and have been discovered to have positive effects on the environment. The last one in this category that has positive effect with mean point of 3.02 is irrigation practice. It was also discovered from Table 3 that agroforestry, mulching and bush fallow fell below 3 point with 2.3, 2.2 and 1.9 respectively; these were considered to have poor effects on the environment as observed by the respondents.

Table 3: Effects of Land Management Practices on the Environment

Land Management	**Frequency**	**Mean**	**Remarks**
Mulching	380	2.2	Poor
Cover Crop	380	3.3	Good
Crop Rotation	380	3.5	Good
Irrigation	380	3.02	Good
Organic Manure	380	3.9	Good
Fertilizer	380	4.8	Good
Bush Fallow	380	1.9	Poor
Agroforestry	380	2.3	Poor

Sources: Field Survey (2019)

MOST SUSTAINABLE LAND MANAGEMENT PRACTICE

A method adopted by this study to determine the sustainable land management is the use of Principal Component Analysis (PCA) through SPSS. Principal component analysis is found to be the most appropriate to obtain measures on a number of observed variables and also to develop a smaller number of artificial variables (called principal components) that will account for most of the variance in the observed variables. The principal components are used as predictors or criterion variables in this study to determine the most sustainable land management practices.

Sustainable Land Management Practice on Environment

From the data derived on the farmers' perception on the effect of land management practices on the environment, the PCA was calculated using SPSS to find out which practices had the greater effects on the environment and the result is presented in Table 4.

The eigenvalue Table 4 shows that the first three components combined account for approximately 62% of the total variance (this variance value can be observed at the intersection of the row headed "Cumulative" and column headed "3"). According to the "percentage of variance accounted for" criterion, this suggests that it may be appropriate to retain three components (Table 4).

PRINCIPAL COMPONENT ANALYSIS (PCA) USING SPSS

Table 4: Descriptive Statistics

	Mean	Std. Deviation	Analysis N
Mulching	2.23	.737	380
Cover Crop	3.27	.679	380
Crop Rotation	3.53	.881	380
Irrigation	3.02	1.428	380
Organic Manure	3.87	.917	380
Fertilizer	4.79	.498	380
Bush Fallow	1.93	.671	380
Agroforestry	2.26	.630	380

The scree plot from this solution appears on the graph in Fig. 2

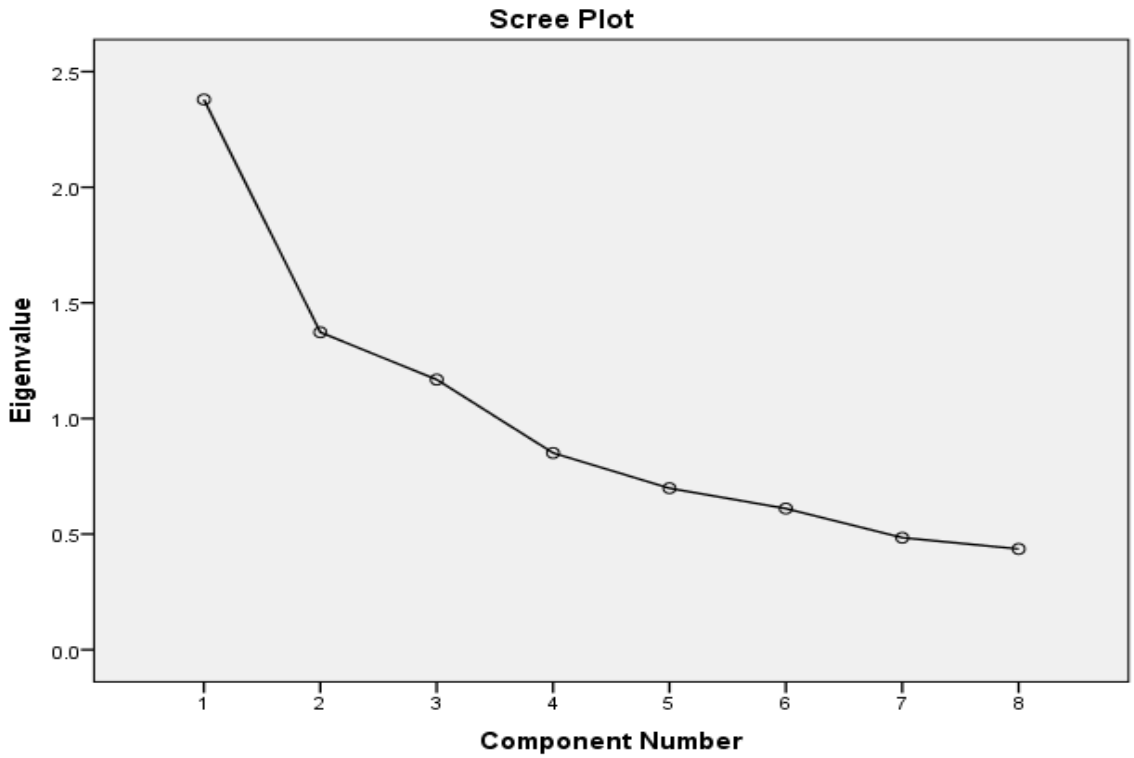

Figure 2 Principal Component Analysis Scree Plot

This scree plot shows that there are several breaks in the following three components number 1, 2 and 3 and are the components that fall above eigenvalue 1.0 and leads to the line beginning to flatten out, starting with component 4.

The last large break appears after component 3, suggesting that only components 1–3 account for meaningful variance (see Figure 2). This indicates that only these first three components should be retained and interpreted. So far, the results from the eigenvalue-one criterion, the variance accounted for criterion, and the scree plot have converged in suggesting that a three-component solution may be appropriate.

It is from these that the rotated component pattern is reviewed to see if such a solution is interpretable.

The clearer number of retained components could been seen from rotated component matrix pattern table, using the critical value of 62% of the land management practices that has value above 62% in each of the components which are three. (See Table 5 and Table 6). The solution is now cleaner, in the sense that two items now load on each of the three components. In this sense, the current results demonstrate a somewhat similar and simpler structure in land management practices. From the results, the following land management practices are agro-forestry and bush fallow in the component one, crop rotation and cover crop in the component two, while irrigation and organic manure are the land management practices in the last component. In conclusion, these land management practices are strongly believed to have very good effect on the environment has perceived by the respondents.

Table 5: Component Matrix[a]

	Component		
	1	2	3
Mulching	.714	.198	.002
Cover Crop	.287	.659	.254
Crop Rotation	.395	.684	.125
Irrigation	.280	-.171	.698
Organic Manure	.411	-.364	.562
Fertilizer	-.668	.368	.242
Bush Fallow	.654	.131	-.459
Agroforestry	.715	-.341	-.123

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

Table 6: Rotated Component Matrix[a]

	Component		
	1	2	3
Mulching	.557	.463	.157
Cover Crop	-.047	.758	.072
Crop Rotation	.094	.794	-.016
Irrigation	-.014	.118	.762
Organic Manure	.211	-.031	.756
Fertilizer	-.780	.113	-.138
Bush Fallow	.723	.276	-.239
Agroforestry	.761	-.044	.247

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

V. Conclusion And Recommendations

Farmers' adoption of land management practices is motivated by many factors. Socio-economic characteristics such as age distribution, sex distribution, educational status had bearing on the choice of land management practices adopted and sustainable land use. The study revealed that the farming population in the study area is ageing and that is adversely affecting sustainable land use because of lack of education. Educational status also had bearing on the choice of land management practices as 65% of the farmers only had informal education, which meant they did not have adequate information on the benefits and challenges of each of these land management practices. Ownership of land had influence on the choice of adopted practices as farmers may not be willing to expend effort towards sustainable land management practices on land temporarily held by them.

All the respondents were male, which conforms to the cultural setting in the study area, an area which is predominantly Muslims. The most practiced land management practices were application of inorganic fertilizer and organic manure. The study revealed that the farmers perceived fertilizer and organic manure as the best land management practices, which leads to increased farm productivities. But the farmers were faced with different environmental problems such as strong wind, pest and diseases, erosion which could be better controlled by different land management practices best suited to the problems. The farmers adopted the wrong

practice for some of these problems, with the knowledge of application of organic manure and inorganic fertilizer being their most common land management practices. Strong wind could be better curbed by agroforestry, pest and diseases could also be better controlled by crop rotation, rather than fertilizer being adopted by the farmers as seen in the results.

The perception of the farmers on the effects of land management practices on environment and revealed fertilizer and organic manure as the best choices. In theory, agro forestry and organic manure have better effect on the environment, compared to fertilizer application, which could have negative effect on the environment in the long term.

Based on the findings of this study, the following recommendations were made:

1. Agricultural extension programmes should be strengthened for more impact on sustainability of existing farming systems and farmers should be made to understand specific land management practices are best suited to different environmental problems.
2. The study revealed that the farming population in the study area is ageing and that is adversely affecting sustainable land use. Government needs to intensify efforts at integrating more young school leavers into agricultural production within the currently institutionalized poverty alleviation programmes. Such programmes, if designed will not only go a long way in ensuring that vibrant youths gradually replace the old farmers, it will ensure conservation of natural resources because of the higher level of education already attained by these youths. Educational attainments become an importance issue here because the study showed that it enhances farmers' ability to use their land in a much more sustainable manner.
3. There is need for government to subsidize or make available for free different tree seedlings to the famers to encourage practice of agroforestry, which is a very sustainable form of land management practices and also, has very good effects on the environment as a whole.
4. There is urgent need for agricultural extension officers to make farmers understand how important the conservation of land and its resources are important to their sustainable livelihood. Most of these believe that land is only the soil, on which they cultivate and grow crops.
5. Farmers should also be made to understand the emission of gases from unsustainable practices which contribute to greenhouses gases, which in turn leads to global warming and affects the livelihood of farmers and also affect beyond their farmlands.
6. Sustainable agricultural practices need to be stimulated by further emphasizing improved production and reduced costs. Production benefits are the primary interest of land users, and have direct consequences for livelihoods in small-scale subsistence farming.

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