ANALYSIS OF INDIGENOUS KNOWLEDGE SYSTEM FOR SOIL FERTILITY MANAGEMENT AMONG FARMERS IN SELECTED LOCAL GOVERNMENT AREAS OF KADUNA STATE, NIGERIA

BY

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A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER IN SCIENCE DEGREE IN AGRICULTURAL EXTENSION AND RURAL SOCIOLOGY

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DECLARATION

I hereby declare that this dissertation titled "**Analysis of Indigenous Knowledge System for Soil Fertility Management among Farmers in Selected Local Government Areas of Kaduna State, Nigeria"** is a record of a research work undertaken by me. It has not been presented for any award in any previous application for another degree or any institution of higher learning. All consulted literature as sources of information were duly acknowledged by means of references.

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CERTIFICATION

This dissertation titled "Analysis of Indigenous Knowledge System for Soil Fertility Management among Farmers in Selected Local Government Areas in Kaduna State, Nigeria" by Zainab Abubakar USMAN meets the regulations governing the award of degree of Master in Science (M.Sc) in Agricultural Extension and Rural Sociology, Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

I dedicate this dissertation to my parents: Alhaji U. K. Abubakar and Hajiya Maryam Usman and siblings: Adamu, Aisha, Fauziyyah and Amina.

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ABSTRACT

The study was carried out to analyze the indigenous knowledge system for soil fertility management among maize farmers in selected Local Government areas of Kaduna State, Nigeria. The specific objectives were to: described the socio-economic characteristics and institutional factors of the farmers; identify the indicators for fertility decline and management practices employed by the farmers as well as the socio-economic characteristics influencing the adoption of indigenous knowledge system for soil fertility management. A multi-stage sampling technique was used to select 152 farmers for the study. Descriptive statistics were used to describe socioeconomic and institutional characteristics, indicators for fertility decline and management practices employed by the farmers. Logit regression analysis was employed to analyze the socio-economic characteristics influencing the adoption of indigenous knowledge system for soil fertility management. The results showed that the average age, farming experience and years spent on education of the farmers were 42, 13 and 12 years with an average household size of 12 persons. Mixed cropping, application of organic manure, supplementation of organic fertilizer with inorganic fertilizers and crop residues were the frequently used indigenous methods of maintaining soil fertility in the study area. The result also showed that age, education, farming experience and farm size were positive and significantly influencing the application of indigenous knowledge system for soil fertility management except education which was negatively influencing the application. The impact of indigenous knowledge system for soil fertility management on the farmers' yield was statistically significant at 1% level of probability. Inadequate labour, shortage and fragmentation of land and grazer's encroachment on farm lands were major constraints to indigenous methods of maintaining soil fertility by maize farmers. It was recommended that, indigenous knowledge system in soil fertility management should be encouraged particularly for subsistent maize farmers to improve soil fertility. Indigenous knowledge system in soil fertility management to be preserved and transmitted to the younger generation, it must be practiced and for it to be included in the education system it must be well documented and adapted to the current social system.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Soil fertility is the capacity to receive, store and transmit energy to support plant growth. These processes require healthy soils – living, self-organising systems with physical, chemical and biological components all functioning and in balance. Continuous use of acidic or salty synthetic fertilisers, insecticides, fungicides and herbicides disrupts this delicate balance (Stapper, 2004). Sustained agricultural production in most Sub-Saharan countries is under threat due to declining soil fertility and loss of topsoil through erosion (Hellin, 2003; Sanchez, 2002). The smallholder farmers in these countries are quite aware of the declining trends in soil fertility, the reasons for this and its impact on yields and household food security (Lyamchai and Mowo, 2000; Defoer and Budelman, 2000; Ouédraogo, 2004; Saidou*et al.*, 2004). Land degradation was a significant global issue during the 20th century and remains of high importance in the 21st century as it affects the environment, agronomic productivity, food security, and quality of life (Eswaran*et al., 2*001). Soil degradative processes include the loss of topsoil by the action of water or wind, chemical deterioration such as nutrient depletion, physical degradation such as compaction, and biological deterioration of natural resources including the reduction of soil biodiversity (Lal, 2001).

Admittedly, soil fertility management is highly complex given the myriad of interacting factors that dictate the extent to which farming households invest in the fertility of their soils. These interacting factors must be understood, as judicious soil fertility

management is of vital importance for sustaining food production in smallholder communities. On the other hand, the many endogenous and exogenous complicating factors, most of which are beyond the smallholder capability to handle, account for the continual trends in soil fertility decline (Van der Ploeg, 1993; Ondersteijn*et al.*, 2003) . The complexity of soil fertility management in smallholder farms calls for active participation of farmers and other stakeholders. As soil is the basic resource of farmers, it needs to be nurtured in order to improve, conserve and sustain its use.The main objective is to conserve soil resources in order to allow its future use: reduce soil loss, increase natural fertility and improve soil structure, leave the soil in same or improved condition to next generations. Crop yield is closely linked to soil productivity, which in turn highly depends on the management given. The following factors need to be in optimum state for good soil behaviour, and thus optimal plant growth: water retention capacity, soil density, soil porosity, structure and health. The premise of this work is that the wealth of indigenous knowledge coupled with the farmers comparative advantage of being familiar with their own environment should be exploited for better management of soil fertility for improved system productivity.

1.2 Problem Statement

The long recommended use of fertilizers, pesticides and other synthetic chemicals to address problems in agricultural production has been leading to poor soil health and resistance in insects, diseases and weeds (Stapper, 2004). More soluble nitrogen fertilizer makes plants more susceptible to diseases and insects, and increases weed problem.

The importance of indigenous knowledge has been realized in the design and implementation of sustainable development projects, however little has been done to incorporate this into formal soil fertility management strategies. Indigenous technical knowledge has been defined as institutionalized local knowledge that has been built upon and passed on from one generation to the other by word of mouth (Warren, 2002). It is the basis for local-level decision-making in many rural communities. It has value not only for the culture in which it evolves, but also for scientists and planners striving to improve conditions in rural localities (Swart, 2003).

Although research is gradually recognizing the importance of indigenous knowledge in developmental studies, the value of indigenous knowledge system in soil fertility management has received little attention. In order to understand the indigenous knowledge in soil fertility management among maize farmers, it is necessary to study farmer's knowledge system and learn more about the complex and diverse nature of the resources use in managing maize farming. Since soil fertility management practices are of substantial significance in agriculture, the inherent indigenous knowledge and values of the farmers must be considered to achieve sustainability in maize production.

In spite of these facts, there is no documentation of the farmers' indigenous knowledge in managing and using the local practices in Kaduna State. Therefore, analyzing factors influencing indigenous knowledge system in soil fertility management among maize farmers is critical in making policy recommendations for better management and sustainability in maize production.

In light of this background, this study investigatedthe factors influencing application of indigenous knowledge system for soil fertility management among selected maize farmers in Kaduna State. Hence this study provided answers to the following research questions:

i. What are the socio-economic characteristics and institutional factors of maize farmers in the study area?

ii. What are the famer's indicators for soil fertility decline in the study area?

iii. What are the indigenous knowledge systems for soil fertility management employed by the farmers?

iv. What are the socio-economic characteristics and institutional factors influencing the application of indigenous knowledge system for soil fertility management?

v. What is the impact of application of indigenous knowledge system on maize farmers yield?

vi. What are the constraints to the use of indigenous knowledge system for soil fertility management?

1.3 Objectives of the Study

The broad objective of the study was to analyze factors influencing application of indigenous knowledge system for soil fertility management among maize farmers in the study area, the specific objectives were to:

i. describe the socio-economic characteristics and institutional factors of maize farmers in the study area;

ii. identify famer's indicators for soil fertility decline in the study area;

iii. identify the indigenous knowledge system for soil fertility management employed by the farmers;

iv. determine the socio-economic characteristics and institutional factors influencing the application of indigenous knowledge system for soil fertility management;

v. determine the impact of the application of indigenous knowledge system on maize farmers yield;

vi. describe the constraints to the use of indigenous knowledge system for soil fertility management.

1.4 Justification of the Study

Indigenous knowledge need to be recorded and can be of good use to devise innovative research for agricultural researchers, extension workers, development practitioners, and environmentalists for sustainable agriculture development and management of soil fertility. Understanding Indigenous Knowledge in agriculture helps to ensure that farming practices will not cause so much plant genetic erosion and environmental erosion. In fact it should cater for sustainable food security and conservation of the variety and variability of animals, plants and very vital soil properties such as physical, biological and chemical properties. Soil fertility management depends on human beings and their interaction with the environment which is very much related to the Indigenous knowledge that has been communicated and passed down from generation to generation through family members and communities. Findings from this study have added to the existing knowledge in indigenous knowledge system for soil fertility management in the study area. The study will also serve as a baseline for further research in soil fertility management.

1.5 Research Hypotheses

The following null hypotheses were tested in this study:

H_{0i}: There is no significant relationship between socio-economic characteristics and institutional factors of maize farmers and application of indigenous knowledge system for soil fertility management;

H_{0ii}: There is no significant relationship between application of indigenous knowledge system for soil fertility management and farmers' crop yield.

CHAPTER TWO

LITERATURE REVIEW

2.1 Economic Importance of Maize

Maize (*Zea mays L.*) is a member of the grass family (gramineae). It originated from South and Central America. Maize is important in the feeding of human being and livestock because they have high starch (carbohydrate) content and varying amount of proteins and seeds can be dried to low moisture content. Fried maize is good in making popular refreshment called "guguru" or popcorn. This is eaten all over the world. Industrial use of maize includes the production of breakfast cereals like custard, cornflakes, corn oil, glucose, starch and alcohol (Komolafe and Adegbola, 1978). It started as a subsistence crop and has gradually become a more important crop. Maize has now risen to a commercial crop on which many agro-based industries depend for raw materials (Iken and Amusa, 2004).

Maize can be classified according to the structure of the grain. We have sweet corn, flint corn, popcorn, dent corn, soft or flour corn and pod corn. Also there are different varieties like Western Yellow 1096BP6 (Yellow), NS – 1 (yellow), Tsolo (Yellow), N.S.5 (white), TZPB (White), TZB (white) e.t.c. Maize contains 80% carbohydrate, 10% protein, 3.5% fiber and 2% mineral. Iron and Vitamin B are also present in maize. Africans consume maize as a starchy base in a wide variety of porridges, pastes, grits and beer. Green maize (fresh on the cob) is eaten parched, baked, roasted or boiled and plays an important role in filling the hunger gap after the dry season (IITA, 2001).

Maize has a variety of uses. Its grain is a rich source of starch, vitamins, proteins and minerals. The starch extracted from maize grain is used in making confectionary and noodles. Corn syrup from maize contains high fructose and act as sweetener and retains moisture when added to certain foods. Edible oil is extracted from seeds, which is an all purpose culinary oil. Levulinc acid, a chemical derived from maize, is used as ingredient in antifreeze and is capable of replacing the toxic petroleum –based ingredients use. Plastic and fabrics are made from corn stocks. Ethanol obtained from maize can be used as a biomass fuel. Stigmas from female corn-flowers, known as corn silk, can be used as herbal supplements. Maize straw is a cheap source of energy and can be used in home-heating furnaces. Maize can be used as forage, feed for livestock and making silage after fermentation of corn stocks. Maize is used extensively as the main source of calories in animal feeding and feed formulation. Maize gives the highest conversion of dry substance to meat, milk and eggs compared with other cereal grains. Maize is a valuable feed grain, because it is among the highest in net energy content and lowest in protein and fibre content. Maize is a cereal plant that produces grains that can be cooked, roasted, fried, ground, pounded or crushed to prepare various food items like pap, 'tuwo' 'gwate', 'dokunnu' and host of others. All these food types are readily available in various parts of Nigeria among different ethnic groups, notably among which are Yorubas, Hausas, Ibos, Ibiras, Ishan, Binis, Efiks, Yalase.t.c. Preparation and uses of the maize grains varied from group to group, though at times with some similarities. Apart from food, maize is also useful as medicines and as raw materials for industries (Khawar*et al.,* 2007).

The oil present in corn (rich in embryo) is far and wide used for cooking and manufacture of soaps. Sticky gum contains dextrin used for sealing envelopes and

labels. Corn starch is well recognized for its uses in cosmetics and pharmaceutical industries as diluents. Corn seeds are functional in making alcohol and stem fibres for manufacture of paper (Dilip and Aditya, 2013).

2.2 Socio-economic and Institutional Characteristicsof Farmers

Some of the socio-economic and institutional characteristics of farmers include age of the farmer, years of experience, educational attainment, farm size, extension contact, and household size.

2.2.1 Age

Age is an important determinant of socio-economic status of a population since people wear in energy as they advance in age. Although experience is gained with age, farming needs not be dominated with aged populations in any region as this could have negative implications on the future of food production. Otitoju and Arene (2010) have stated that age of farming household heads have a direct relationship with soil fertility management. They argued that this was understandable since it was expected that as a farming household head becomes older, he/she tend to have higher Indigenous technical knowledge than the younger ones.

2.2.2 Educational status

Illiteracy is one of the factors militating against agricultural development in Nigeria. Educational status provides farmers with the ability to read and write, handle and interpret messages relating to farm operation in the instruction manuals on input and machinery uses, and also enable them to appreciate extension services. Sullumbe (2004)

opined that Education is a major determinant of the Nation's economy. He further argues that the level of formal education attained by an individual goes a long way in shaping his personality, attitude to life and adoption of new and improved practice

2.2.3 Family size

Although large family size can sometimes be an asset to the farmers in terms of available work force/labour, often time a farmer is faced with the challenges of providing social and welfare facilities such as feeding, education, sheltering, health care and other living expenses for such a large number of dependants. These expenses account for low saving at the end of every harvest season aside the fact that most farm produce are consumed by the large household members. In a related study, Achem*et al*. (2013) also found low overall output from cassava farmers as a result of large family size.

2.2.4 Farming experience

Experience is one of the determinants of management practices because it can inform farmers to adjust to changing economic conditions and adopt the most efficient cultural practice (Yusuf, 2007). Years of farming experience increase as the age of the farmer increases. Studies conducted in the humid forest and moist savannah agro-ecological zones of Nigeria showed that productivity was positively associated with more experience in farming (Ajibefun and Abdulkadri 2004; Ogunniyi and Ojedokun, 2012). Since experience is gained with age and farming being the major occupation of most of the population, years of farming experience can be linked with the age of the farmer. The older the farmer, the more experienced he is and the better his

understanding of farming practices.Farming experience can also determine farmers' awareness of and interest to a given technology and their ability to implement it.

2.2.5 Farm size

The larger the farms size the better for the farmer to practice ITK which leads to better soil fertility management and more productivity. However, crop rotation is negatively related to total land holdings by the household. This means that the more land that the farmer owns, the less likely that they will use crop rotation on their plot. This could be true because in addition to saying that crop rotation increased fertility and crop yields, farmers also said they used it due to inadequate land (Ajibefun and Abdulkadri, 2004).

2.2.6 Membership of associations

According to Onojah*et al*. (2013) naturally being members of associations afford farmers to benefit from financial institutions and/or lending agency since such requirement is the determinant factor. Members of a cooperative society have a positive influence on indigenous knowledge system of farmers. The more years farmers spend in cooperative societies,the more they access inputs and information on how to improve on farm management practices (Obare*et al.*, 2010; Nyagaka*et al.*, 2010).

2.2.7 Extension services

Mbanasor and Kalu (2008) found that the number of extension visits had a significant positive relationship with economic efficiency of commercial vegetable farmers in AkwaIbom State, Nigeria. Obare*et al.* (2010), Khan and Saeed (2011), found that

through extension visits, farmers become better informed about farm management, planning and new technologies, hence improving their efficiency.

2.3 Soil Fertility Management

Soil fertility decline in much of sub-Saharan Africa has been referred to as an ‘‘orthodoxy’’ where the existence, extent and cause of the problem are accepted without question (Roe, 1995; Leach and Mearns, 1996). Though many of the continent-wide studies indicate that soil fertility is declining, scholars are starting to question the underlying assumptions, evidence, methodologies and scale upon which studies and beliefs of soil fertility decline are based (Scoones, 1997; Scoones and Toulmin, 1999). This problem has often been attributed to the improper utilization and under management of natural resources by the traditional farmers. Due to increased population pressure, farmers are either entirely abandoning the traditional practice of using natural fallow to restore soil fertility, or unable to leave land fallow for long enough for it to be effective. The use of mineral fertilizers is declining as they are beyond the means of most small-scale farmers (Larson and Frisvold, 1996).

Soil fertility decline has become a major concern of policy makers worldwide. In sub-Saharan Africa, the issue has taken on a note of urgency as declining food production is linked to subsistence crises (Scoones and Toulmin, 1999). To respond to these concerns, many international organizations are proposing wide-reaching initiatives. The World Bank, for example, has recently adopted a Soil Fertility Initiative for sub-Saharan Africa. The presumption is that soil fertility decline relates to population growth, mismanagement of soil resources, and under-capitalization of farmers (Cleaver and Schreiber, 1994). Sustaining soil fertility therefore, has become a major issue for

agricultural research and development in Sub-Saharan Africa (SSA) (Smaling and Oenema, 1997). So far, most research activities concentrate on determining the appropriate amount and type of fertilizer needed to obtain the best yields. This approach emphasized the use of external inputs and expensive technologies and often disregarded the farmers' knowledge and the resources at their disposal (Corbeels*et al*., 2000). To maintain and improve soil fertility status organic agriculture uses a range of techniques such as mulching, use of farm yard manure (FYM), organic fertilizers, cover cropping, agro forestry, crop rotation, multiple cropping, planting of leguminous crops and agro forestry and incorporation of crop residues in the soil (GoK, 2007). In addition, organic farmers use dung and compost manures to provide nutrients and terracing or check-dams to prevent erosion and conserve groundwater (GoK, 2007). They also cover their soils with dead or living vegetation and therefore organic soil management practices have been found to restore degraded lands to fertility (Kilcher, 2007).

Local farmers have acquired knowledge from generations of experience and experimentation, as they had to adapt their agricultural systems using limited resources under harsh and insecure conditions (WinklerPrins and Sandore, 2003; Saito *et al*., 2006).

2.4 Soil Fertility Management and Maize Production

Maize production in the savannas is faced with several production constraints which limit productivity. Poor soil fertility, drought, and *Strigahermonthica* parasitism combined can reduce on-farm yield by over 70% even with the use of high-yielding varieties. Land-use intensification in the northern Guinea savanna has resulted in serious land degradation and nutrient depletion (Oikeh*et al.,* 2003). Nitrogen (N) is the

nutrient most deficient in the soils and it most often limits maize yield (Carsky and Iwuafor, 1995). Unfortunately, due to high cost and poor infrastructure, the availability of N fertilizers is limited.

The problem of poor soil fertility in the Guinea savanna is compounded by recurrent drought at various stages of crop growth. For maize, drought at the flowering and grain-filling stages can cause serious yield losses (Grant *et al.*, 1989). This indicates that farmers' fields are rarely characterized by only one biotic stress. It would, therefore, be desirable to increase the tolerance of crops to several stresses that occur in the target environment (Bañziger*et al.*, 1999).

Surveys in the northern Guinea and Sudan savannas of Nigeria showed that Striga has remained a serious problem, attacking millet, sorghum, maize, and upland rice (Showemimo*et al., 2*002). In northern Nigeria, over 85% of fields planted to maize and sorghum were found to be infested (Dugje*et al., 2*006). Grain yield losses ranged from 10 to 100% for these crops (Oikeh*et al., 1*996). In addition to the damage from parasitic weeds, significant losses occur in maize if other weeds (grassy and broadleaf) are left to compete freely with the crop.

To maintain a good crop and increase grain yield/unit area, agronomic best practices should be undertaken to address these constraints. Appropriate soil fertility management, drought adaptation, and proper weed management can help to close the yield gap for maize in the West African savannas

2.5 Indigenous Knowledge System

According to Warren (1991), the term local or indigenous knowledge (IK) is used to distinguish the knowledge developed by a given community from international knowledge systems or scientific knowledge. The latter, sometimes referred to as 'Western' knowledge systems (WKS), are generated by universities, government research centres and private industry. IK can also refer to the 'technical' insight or wisdom gained and developed by people in a particular locality, through years of careful observation and experimentation with the natural phenomena around them. In the view of Dewes (1993) the knowledge of local people is an enabling component of development. He compares indigenous knowledge to the feathers of a bird, since 'a bird can only fly if it has feathers'. The terms 'indigenous knowledge' and 'local knowledge' are synonymous. However, what development experts may object to is the use of traditional to qualify the knowledge peculiar to a people, since in some circles 'traditional' evokes 19th-century conceptions of 'simple, savage and static societies.' Western knowledge systems (WKS) and indigenous knowledge systems (IKS) are distinguished on contextual, substantive, and methodological grounds. First, Western knowledge systems are universal, due to the fact that Western education is entrenched in many world cultures. And second, they have long been noted for their rigorous observation, experimentation and validation procedures, all of which are carefully documented. The same cannot be said of indigenous knowledge systems, in particular when it comes to documentation.

Indigenous Technical Knowledge (ITK) is specifically concerned with actual application of the thinking of the local people in various operations of agriculture and allied areas. The Indigenous Technical Knowledge (ITK) system has been developed by

the people based on their experiences and continuous improvement through informal experimentation over centuries. These ITKs are interwoven and assimilated in the cultural life of the people (Ngatoluwa, 2007).

Levi-Strauss (2006) argued forcefully against such a distinction on the grounds that human societies could not, for example, possibly have acquired the skills to make water-tight pots without a genuinely scientific attitude and a desire for knowledge for its own sake. ITK, like scientific knowledge should, therefore, be regarded in the first instance as something which became possible as a result of a more general intellectual process of creating order out of disorder, and not simply as a response to 'practical' human needs such as sustenance and health. Some of the knowledge arising in this way would of course have direct practical applications, and equally new knowledge about the way in which the world worked might arise as the result of a process of inquiry triggered initially by the wish to solve a problem of a 'practical' kind. An appreciation of this underlying similarity between ITK and science is important if the full potential of ITK is to be realized.

An important difference between science and ITK lies in the way in which phenomena are observed and ordered. The scientific mode of thought is characterized by a greater ability to break down data presented to the senses and to reassemble it in different ways. The mode of ITK, on the other hand, is 'concrete' and relies almost exclusively on intuition and evidence directly available to the senses. A second distinction derives from the way practitioners of the two modes of thought represent to themselves the nature of the enterprise in which they are engaged. Science is an open system whose adherents are always aware of the possibility of alternative perspectives to those adopted at any

particular point of time. ITK, on the other hand, as a closed system, is characterized by a lack of awareness that there may be other ways of regarding the world. This is not to say that ITK does not change, but rather that those changes which occur are in nearly all instances comparable to the achievements of what Kihn (2002) termed 'normal science', or to the detailed working out of relatively minor 'puzzles' within an established 'paradigm' of thought. Science, in contrast, constantly carries with it the possibility of 'revolutionary change' in which one paradigm would be destroyed and replaced by another.

2.6 Indigenous Knowledge System used by Farmers for Soil Fertility Management

Getahun, (2013) in his study reveals a variety of indigenous soil fertility management techniques as practiced by farmers. Some of these include crop rotation, manuring, mixed cropping, fallowing, and planting legumes. Similarly, farmers apply different pest and disease control techniques. These include spraying animal urine, dusting the seed with ash and pepper, donkey waste, poisonous plant leaves and ash and spraying it on the crop-land where disease and pest occur; cutting and getting rid of infected plants; burning and smoking. Farmers in most cases tried to perform problem solving and adaptation experiments. The application of botanical pest control techniques, testing the productivity of different crops by applying commercial and non-commercial fertilizers, increasing and decreasing the frequency of fertilizer application on different crops and fields and finding the differences between the two were some of the local experiments conducted by farmers.

Increased use of organic and mineral fertilizers, together with diversification in cropping to include legumes grown in rotation is an important tool in restoring or sustaining soil fertility of the intensifying cropping systems of the dry savannas (Sangingaet *al., 2*003).

2.6.1 Crop residues: There are two types of agriculturalcrop residues. Field residues are materials left in an agricultural field or orchard after the crop has been harvested. These residues include stalks and stubble (stems), leaves, and seed pods. The residue is ploughed directly into the ground, or burned first. Good management of field residues can increase efficiency of irrigation and control of erosion. Process residues are materials left after the crop is processed into a usable resource. These residues include husks, seeds, bagasse, molasses and roots. They can be used as animal fodder and soil amendment, fertilizers and in manufacturing (Barrett *et al.,* 2002).

2.6.2 Green manures/cover crops: Crops that are incorporated into the soil while still green are referred to as green manures. Cover crops are similar to green manures, but are usually grown to protect soil from erosion during the non-growing season. Because topsoil is higher in organic matter and nutrient content than subsoil, controlling erosion is an important method of conserving soil nutrients. Green manures and cover crops are both used to supply N and increase soil organic matter. Legumes such as clover and alfalfa can fix between 100 and 200 lbs of N per acre in one year. The use of grasses such as rye or oats without a legume will not increase the N content of the soil. These crops are used for increasing soil organic matter content. They can also scavenge residual N from the previous crop and keep it from being lost by leaching. A mixture of both grasses and legumes can be used to obtain the advantages of each. Improved soil

tilth from added organic matter improves root growth, which increases the capacity of a crop to take up available soil nutrients.

Among the *Albizia* species, *A. lebbek* is the most commonly grown; it can be pruned continuously and provides green material even in the dry season (Whyte *et al.*, 1993). Many *Cassia* species are unpalatable and toxic, but some, e.g. *C. siamea*, are used for fodder in some tropical countries. *C. siamea* is commonly used as hedges in Nigeria and Zaire, and has also been recommended as a shade tree and for soil improvement in Rwanda (Behmel and Neumann, 2002). Yamoah (2005) observed that *C. siamea* suppressed weed growth and increase maize yields more than *Gliricidiasepium* and Flemingiacongesta in alley cropping with maize on an Alfisol.

2.6.3 Mulching: The major reason gardeners use mulch is to snuff out weed seeds by shading them. This allows the roots of desirable plants to access soil, water, and nutrients without undue competition. Mulches free of viable weed seeds—such as leaves, good compost, and wood chips—are best. Weed seedlings that sprout in any organic mulch are easily done in if you periodically fluff up and flip over the mulch with a pitchfork (Corbeels*et al.*, 2000).

The second reason to mulch your garden is to conserve water. Organic mulches soften the impact of raindrops so that water can effectively permeate the soil, and all mulches, organic or otherwise, limit evaporation of soil moisture. The benefits of mulch do not end with water and weeds. As organic mulches decompose, they promote healthy soil, which, in turn, helps fend off disease.

Mulches also regulate soil temperature, acting as insulation to prevent the alternating freezes and thaws that can heave plants out of the ground. Such ground-insulating mulches are especially useful in keeping the roots of newly planted trees and shrubs growing as long as possible into autumn, and keep the soil beneath evergreens unfrozen deeper and longer so that their roots can absorb moisture in winter (Corbeels*et al.*, 2000).

2.6.4 Wood ash: When clearing new land for cultivation, farmers make extensive use of burning and the ash produced is highly valued. Wood ash temporarily raises soil alkalinity making potassium and phosphate more available to the crop. Two main methods are used to clear new land and both leave a significant amount of ash. First, on second year and older land, crop residues and one-year-old coppiced tree and shrub growth are collected together into piles, left to dry and then burned. Sometimes this rubble is collected together towards the end of the growing season, left to dry and burned before the rains start. The ash area created in this way is then used to cultivate ecologically specialised crops. In this procedure, ash is deliberately generated and concentrated into one place (Kilcher, 2007).

Secondly, fire is used to kill large trees and remove fallen trunks that would otherwise hinder crop growth. Although smaller branches of trees may be broken off and used as household firewood, the trees themselves are set alight and left to burn slowly in the field for several days. The result is a concentrated area of wood ash which is subsequently used to cultivate ecologically specialized crops. In a fertile area such

concentrations of wood ash are avoided when sorghum is being planted for farmers know from experience that ash stimulates over-vigorous growth and lodging.

Farmers also understand that ecologically specialized crops such as finger millet, maize, pumpkin, okra and spider flower (*Cleome spp*) as well as banana and papaya thrive where there are dead trees, rotting vegetation (bunds of last seasons' weeds, heaps of groundnut haulms) termite mounds and wood ash. This recognition shows that farmers understand their environment, but they do not know why these differences affect their crops.

2.6.5 Crop rotation: crop rotation is the practice of growing series of dissimilar/different types of crops in the same area in sequential seasons. Crop rotation gives various nutrients to the soil. A traditional element of crop rotation is the replenishment of nitrogen through the use of green manure in sequence with cereals and other crops. Crop rotation also mitigates the build-up of pathogens and pests that often occurs when one species is continuously cropped, and can also improve soil structure and fertility by alternating deep-rooted and shallow-rooted plants. Crop rotation is one component of polyculture.

2.7 Effects of Indigenous Knowledge on Soil Fertility Management

Problems of declining soil fertility are widespread in Studies in Sub-Saharan Africa (SSA), largely as a consequence of continued cultivation of crops with low levels of nutrient inputs. To counter growing food insecurity, there are renewed efforts to support the predominantly subsistence farmers to intensify crop production mainly by

increasing the use of fertilizers and improved crop varieties. Soil fertility varies considerably at the farm and landscape levels in many smallholder farming systems in Africa, leading to variable crop productivity and crop response to additions of fertilizer and organic nutrient resources (Zingore*et al*., 2007).

Palm *et al*. (1997) emphasized the effects of organic materials on nutrient availability and acquisition. According to these authors, organic inputs influence nutrient availability by the total nutrients added by controlling the net mineralization-immobilization patterns. Organic materials are also precursors to soil organic matter fractions that interact with soil minerals in complexing phosphorus (P) fixing cations thereby reducing P sorption capacity. Similarly, Negassa*et al* (2002 and 2003) demonstrated that the integrated use of farmyard manure (FYM), compost, and bone meal with low dose of NP fertilizers gave comparable maize grain when compared to the yield obtained under the recommended rate of NP fertilizers (110/20 kg ha-1) in Bako area. The sole application of either the organic fertilizer mentioned above doubled maize grain yield on relatively fertile soil as compared with the control treatment.

Organic inputs are often proposed as alternatives to mineral fertilizer. For instance, Palm (1997) reported that soil incorporation of calliandra and Leucaena green biomass with or without fertilizer increased soil nitrogen by 1% - 8% over a period of 4 years. During the same period, the total soil nitrogen declined by 2% - 4% when biomass was not applied. Palm (1998) reported that combination of mineral fertilizers with organic nutrient sources can be considered as better options for increasing fertilizer use efficiency as a result of improved synchronization of nutrient release and uptake by the crop (Negassa*et al.*, 2002). A judicious combination of organic and mineral sources of

nutrients may therefore be envisaged as it addresses both the problem of insufficient fertilizer supply and the large amounts of organic material required for nutrients supply.

On low and medium soil fertility conditions, combined application of N fertilizers and manure led to increased productivity above fertilizer treatments alone, and this is most pronounced on degraded soils. Many studies in Sub-Saharan Africa (SSA) have reported on the positive interaction between fertilizer and manure, with the benefits of manure increasing with decreasing soil fertility (Zingore*et al.*, 2008; Mtambanengwe and Mapfumo, 2005). Various legume-based technologies, such as rotations of cereal crops with grain legumes, improved fallows, alley-cropping, and green manures have been advocated as viable options for providing supplementary N to cereal crops through biological N fixation (Giller*et al.*, 1997). Within rotations, applying P to grain legumes has variable effects on the subsequent maize crop. The yield of maize following groundnut was greater than continuously fertilized maize, but soybean had no effect on maize productivity. Groundnuts can double the yields of the subsequent season maize crop without fertilizer, but gave more additional grain yield when fertilizer was used on the maize. Intercropping maize with grain legumes offers opportunities to improve overall productivity of both crops, and poorly-responsive fertile fields, responsive fields, and poorly responsive poor fields.

2.8 Problems Affecting Soil Fertility Management

Soil fertility management in semi-arid areas is mainly constrained by inadequate soil moisture and lack of resources for purchases of inputs (fertilizers). The problems of inadequate soil moisture are compounded by nutrient losses through plant uptake, leaching and erosion, and thus exacerbate the problem of soil fertility decline (Nyathi*et*

al., 2003). Soil fertility management has to; therefore, focus on supplying inputs from external sources.

Despite their strength, some indigenous knowledge systems (IKSs) and practices are, however, not free of limitations. The fertility management practices, such as manuring require large number of livestock population and green matter while fallowing needs large farm size. That is why these techniques are nowadays hardly practiced by most poor farmers. Although all indigenous practices need less money, they need more labour force and are hence labour intensive.Luka and Yahaya (2012) in their study of yam producers in Nasarawa State Nigeria reported that transportation problem, land ownership and the tedious nature of using indigenous soil management practices are considered by the respondents to be serious challenges encountered in using those management practices.

2.9 Theoretical Framework:

EthnomethodolgyTheory: This study wasbe based on the Ethnomethodolgy theory.Ethnomethodology is a method for understanding the social orders people use to make sense of the world through analysing their accounts and descriptions of their day-to-day experiences (Karamjit 1996). The term was originally coined in the mid-1960s by Harold Garfinkel to denote the study (ology) of people's (ethno) methods (method) of creating social order (Scott and Marshall, 2005). The term ethnomethodology can be broken down into three constituent parts: ethno - method - ology, for the purpose of explanation. Using an appropriate Southern California example: ***ethno*** refers to a particular socio-cultural group method refers to the methods and practices this particular group employs in its everyday activities and ***ology*** refers to the systematic description of

these methods and practices (Michael, 1993). Ethnomethodology is a descriptive discipline and does not engage in the explanation or evaluation of the particular social order undertaken as a topic of study as a method; it is used in ethnographic studies to describe people's methods that they use in everyday situations (Randall and Michael, 1978). The relevance of ethnomethodology theory in this study is seen on how maize farmers employ indigenous methods and practices for production and maintenance of social order. The study elicits and documents how maize farmers use their indigenous knowledge in soil fertility management.

2.10 Conceptual Framework and Model

Figure 1 is diagram of the conceptual model which identifies the factors influencing the use of indigenous knowledge systems in soil fertility management by maize farmers in the study area. A concept is a means by which social scientists seek to analyze social phenomena to classify the objects of the observed world, impact meaning through explanation to these phenomena and formulate higher level prepositions on the basis of these observations (Scott and Marshall, 2005). Ekong (2003) views conceptual model as a broad system of explanation which is founded not so much on prior research findings but largely on untested and unproved assumptions about social realities.

In the context of the study the independent variable in the model includes:

i. Socio-economic variables which comprise; age, level of education, household size, farming experience, farm size;

ii. And institutional variables which comprise; contact with extension agents and membership in cooperative societies. The dependent variable is the indigenous

knowledge technique in soil fertility management. Soil fertility management system considered are Organic manure application, Use of crop residues, Mulching(plant leaves), Use of plant roots, Crop rotation, Use of legumes cropping, Mixed cropping.

The model in figure 1 shows that independent variable (X) would influence the dependent variable (Y) which is the indigenous knowledge technique in soil fertility management. The observable effects of indigenous knowledge technique in soil fertility management are change in output, income and livelihood of the farmers.

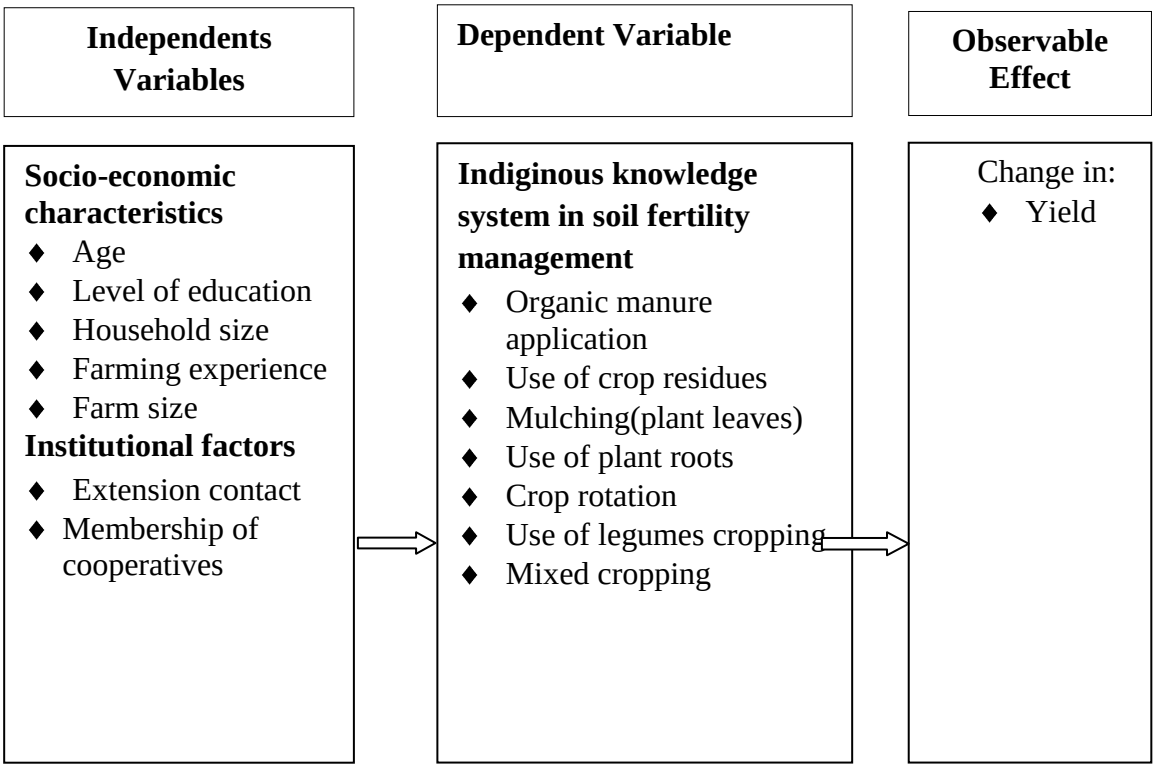


Figure 1: A conceptual model showing a priori expectation on the analysis of the application of Indigenous Knowledge System for soil fertility management among maize farmers in Kaduna state, Nigeria.

CHAPTER THREE

METHODOLOGY

3.1 Description of the Study Area

The study was conducted in Kaduna State which lies between latitude 9°N and 12°N of the equator and between longitude 6°E and 9°E of the prime meridian. Kaduna state shares boundaries with Katsina and Kano States to the north, Plateau state to the north east, Nasarawa and Abuja to the south, and Niger and Zamfara States to the west (Kaduna State Government, 2012).

The population of the State according to the 2006 census stands at 6,113,503, using 3.18% growth rate as allowed by the National population Commission, the projected population of the State stands at 7,474,369 (2014 projection) (Kaduna State Official Website, 2014). The population is spread across 23 Local Government Areas. Within the state there are a number of establishments ranging from companies, research institutes, higher institutions and colleges. The people of the state are engaged in agricultural production activities. Annual rainfall is between 942mm and 1000mm which last from may till October (NAERLS, 2001). The pattern of rainfall and temperature determine the types of crops, planning of farm operation, food and animal production.

The bulk of the food crops are grown during the wet season then followed by the dry season when agricultural production is at its peak in the Fadama areas where most dry season farming takes place from October to March. The farm economy of the area is characterized by small-sized and fragmented land holdings. The vegetation is influenced

by human activities such as clearing of land, cultivation (ploughing and ridging). The soils are poor and hard, it has poor water holding capacity, it cannot sustain intensive agriculture for a long period of time without the use of fertilizers. The major occupation is farming followed by trading and local rearing of animals with average farm size of 3.0 ha. The predominant crops grown are maize, yam, rice, millet, sorghum, cowpea, groundnut, soya bean and vegetables. The dominant rural population of the Local Government Areas consists of nomadic pastoral Fulani origin and crop farming population of both Hausa and Fulani origin and majority of the people are Muslims. According to Taiwo*et al.* (2010), in his study found that the average yield per hectare of hybrid maize was 2240.6kg and 1261.04kg for open pollinated maize respectively.

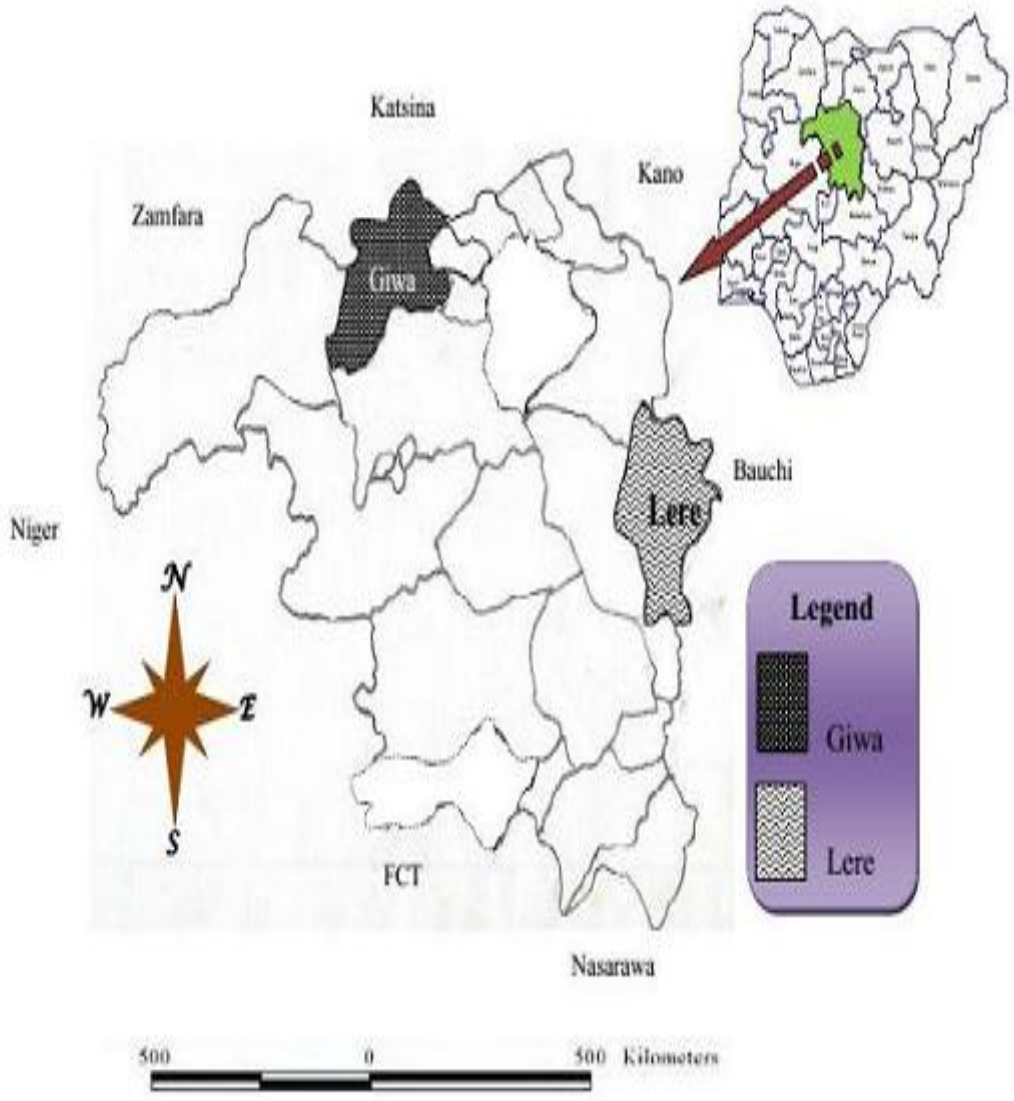


Figure 2: Map of Kaduna State

3.2 Sampling Technique

A multi-stage sampling technique was used in this study. Two Local Governments Areas were purposively selected based on their high involvement in maize production (Giwa and Lere). Two villages in each of the selected Local Government Areas:

Giwa(Yakawada and Kaya) and Lere: (Saminaka and 'Yarkasuwa) were also purposively selected based on high involvement of maize production, making a total of four villages. Finally, a random sampling was employed to select 20% from the sample frame (761) of maize farmers from each of the villages making a sample size of 152 maize farmers.

Table 3.1: Distribution of respondents of maize farmers in the study area

Local Government Areas.	Villages	Sample frame	Sample size (20%)
Giwa	Yakawada	131	26
	Kaya	220	44
Lere	Saminaka	118	24
	YarKasuwa	292	58
Total		**761**	**152**

Source: Reconnaissance survey 2015

3.3 Data Collection

Primary data were used for this study. Primary data were collected through interview method using structured questionnaire which was administered on the respondents. Information was collected on: farmer's socio-economic and institutional characteristics, perception of soil fertility management, indigenous knowledge system and constraints to the use of indigenous knowledge system.

3.4 Analytical Techniques

The analytical tools that were employed to achieve the objectives of the study include descriptive statistics, and logit regression analysis and T-test.

3.4.1 Descriptive statistics

The descriptive statistics such as frequency distribution, mean and percentage were used to achieve objectives i, ii, and v of the study.

3.4.2 Logit regression analysis

Logit regression analysis was used to achieve objective iii. Studies with a binary dependent variable (i.e. one or zero) can employ models, such as Linear Probability Model (LPM), Probit and Logit models to see the relationship between the dummy response variable and the explanatory variables.

Following Gujarati (2003), the logistic distribution function for the decision to use the farmers' indigenous knowledge can be specified as:

$$P^{(1)} = \frac{1}{1+ e^{-Z(1)}} \text{----------} 1$$

Where $P^{(1)}$is the probability of a household that practiced any form of indigenous knowledge in managing soil fertility at the time of the survey and Z(i) is a function of anexplanatory variables (Xi).

The explicit logit model is expressed as:

$$Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \beta_7 \ln X_7 + U \text{----------2}$$

Where:

Y = 1=applicators and 0=non applicators of any of the indigenous knowledge system identified for this study

X_1 = Age (years)

X_2 = Level of education (years spent in schooling)

X_3 = Household size (no. of people under the care of the household head)

X_4 = Farming experience (years spent in maize farming)

X_5 = Farm size (hectares of land for maize production)

X_6 = Extension contact (no. of visits either by extension agents or the farmers)

X_7 = Cooperative societies(of years spent in cooperative societies)

β_0 = Constant

$\beta_1 - \beta_7$ = the parameters to be estimated

U = Error term

Where β_0 is the intercept and β_1 is the slopes parameter in the model. The slopes tell how the log-odds of indigenous knowledge in managing soil fertility changes as the independent variables change by a unit. The stimulus index Zi also referred to as the log of the odds ratio in favor of a farmer that practiced any form of indigenous knowledge

in managing soil fertility at the time of the survey. The odds ratio is defined as the ratio of the probability that a farmer practiced any form of indigenous knowledge in managing soil fertility (P_i) to the probability that he/she is not ($1-P_i$).

But $(1-P_i) = \frac{1}{1-e^{Z(1)}}$ ----------3

Therefore, $\left(\frac{P_1}{1-P_1}\right) = \frac{1+e^{Z(1)}}{1+e^{-Z(1)}}$ ----------4

And $\frac{P_1}{1-P_1} = \frac{1+e^{Z(1)}}{1+e^{-Z(1)}} == e^{\beta_0} + \sum_{i-1}^{n} \beta_i Y_i$----------5

Taking the natural logarithms of the odds ratio of equation (4) will result in what is known as the logit model as indicated below.

$\ln\left(\frac{P_1}{1-P_1}\right) = \ln\left[e^{\beta_0} + \sum_{i-1}^{n} \beta_i Y_i\right] = Z_{(i)}$ ----------6

If the disturbance term U_i is taken in to account, the logit model becomes:

$Z_{(i)} = \beta_0 + \sum_{i-1}^{n} \beta_i Y_i + U_i$ ----------7

3.4.3 T-test Statistic

T-statistic was employed to achieve objective iv of the study. T-test was carried out to evaluate the impact of indigenous knowledge systems for soil fertility management

among maize farmers to determine if there is real difference in their mean yields using a 0.05 level of significance.

T-test statistic for H_0: Yield of adopters = Yield of non adopters

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{(S_1^2/n_1) + (S_2^2/n_2)}} \text{ ----------8}$$

Where:

$\bar{x}_1$ = Mean of yield for applicators of indigenous knowledge system for soil fertility management.

$\bar{x}_2$ = Mean of yield for non applicators of indigenous knowledge system for soil fertility management

S_1^2 and S_2^2 = variance of yield for applicators and non applicators

n_1 = sample size of applicators

n_2 = sample size of non applicators

3.5 Definition and measurements of variables

Independent variables:

Age (years): It is a continuous independent variable indicating how old the respondent was. Many studies show that older farmers stick more to their indigenous knowledge

than the younger ones. This was measured in years, how old household head was at the time of data collection.

Level of education: This is a discrete variable indicating the educational status of the household head in terms of the number of years spent in schooling. As the level of education, increases, farmer's attitude and willingness to use the IK and practices decreases as education reinforces the negative attitude towards local knowledge.

Household size: This is a continuous independent variable;it measured the number of people who are living under the roof and dependent on the household head.

Farming experience (Years): this is the number of years spent by farmers in maize production.

Farm size (ha): This is the total land put into maize production. This was measured in hectares

Extension contact: this is the number of times extension agents visits the farmers or vice versa to provide non-formal education to the farmers or gets information from the extension agents respectively. It is measured by the number of times the contact is made within the production period.

Degree of participation in community organization:Refers to participation of the household in formal and informal organizations as a member and leader. Households

who have some involvement in organizations are more likely to be aware of the rewards of indigenous knowledge. This is measured by the total no of years the respondent has spent in cooperative society at the time of study.

Dependent variable

Application of indigenous knowledge: Indigenous knowledge refers to traditional and local knowledge, unique to a particular culture or society, existing within and developed around specific conditions of women and men indigenous to a particular geographic area in contrast with knowledge generated within the international system of universities, research institutes and private firms (Warren, 1991). According to Flavier*et al* (2003) Indigenous Knowledge is the basis upon which society communicate and make decisions. It is dynamic and continually influenced by internal creativity and experimentation as well as by contact with external systems.The indigenous knowledge systems are organic manure application, use of crop residues, crop rotation, mixed cropping and cow dung application

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socio-Economic and Institutional Characteristics of the farmers

Table 4.1 summarizes socio-economic characteristics and institutional variables of maize farmers in the study area.

4.1.1 Age distribution of maize farmers

The study revealed from Table 4.1 that the mean age of the farmers was 42 years which implies that the farmers are still in their economically active age that can make positive contribution to agricultural production. This supports the findings of Otitoju and Arene (2010) that age of farming household heads have a direct relationship with soil fertility management. They argued that this was understandable since it was expected that as a farming household head becomes older, he/she tend to have higher Indigenous technical knowledge than the younger ones. Age is an important determinant of social – economic status of a population since people wear in energy as they advance in age. Although experience is gained with age, farming needs not be dominated with aged populations in any region as this could have negative implications on the future of food production in such region (Onojah, Aduba and Oladunni 2013).

Table 4.1: Distribution of respondents according to socio-economic characteristics

Characteristics	Min.	Max.	Mean	Std
Age of the farmer (Years)	22.00	63.00	42.18	2.88
Education (Years)	3.00	18.00	11.86	4.13
Household size	4.00	17.00	12.00	5.45
Farming Experience (Years)	2.00	27.00	12.74	4.92
Farm Size (Ha)	1.00	3.00	1.82	0.38
Cooperative society (years)	1.00	18.00	7.30	7.04
Extension Contact	1.00	6.00	3.54	2.16

Source: field survey data, 2015

4.1.2 Educational status

The number of years spent on education by the household heads in the study area revealed that the minimum and maximum years spent on education were 3 and 18 years respectively. While the average years spent on education by the maize farmers was about 12 years from Table 4.1 which implies that they are literate enough to provide them with the ability to read, write, handle and interpret messages relating to their farm operations. Education enhances the adoption of innovations and thus increases efficiency. Their educational status as it is however is enough to provide them with the ability to read and write, handle and interpret messages relating to their farm operation in the instruction manuals on input and machinery uses, and also enable them to appreciate extension services. Sullumbe, (2004) opined that Education is a major determinant of the Nation's economy. He further argues that the level of formal education attained by an individual goes a long way in shaping his personality, attitude

to life and adoption of new and improved practice. In the same vein, Ogunniyi and Ojedokun (2012) have pointed out that education was a key to enhancing productivity among farming households in the humid forest, dry savannah, moist savannah and guinea savannah agro-ecological zones of Nigeria.

4.1.3 Household size

The distribution of household sizes of the respondents reveals that the smallest and largest household sizes were 4 and 17 persons per household with an average household size of12 persons in the study area. Although large family size can sometimes be an asset to the farmers in terms of available work force/labour, often time a farmer is faced with the challenges of providing social and welfare facilities such as feeding, education, sheltering, health care and other living expenses for such a large number of dependants. These expenses account for low saving at the end of every harvest season aside the fact that most farm produce are consumed by the large household members. In a related study, Achem, *et al*.(2013) also found low overall yield from cassava farmers as a result of large family size.

4.1.4 Farming experience of the respondents

The number of years spent on farming from Table 4.1 revealed that the minimum and maximum years spent on farming by the maize farmers were 2 and 27 years. The average farming experience of 13 years of the maize farmers implies that they are relatively experienced in maize farming. As a result, this couldinfluence the farmers' awareness of and interest to a given technology and their ability to implement it. This is

in line with the findings of Nkonya*et al*.(2008) who asserted in his study in Northern Tanzania that farming experience was the most important factor positively affecting the probability of adoption of improved maize seed.

4.1.5 Farm size

From the result, the size of farm allotted to maize production by the farmers in the study area (Table 4.1) revealed that the minimum and maximum farm sizes in hectare for maize production were 1 and 3 hectareswhile the average farm size was about 2 hectares. This indicates that the farmers were small-scale farmers.Farmers with larger farm sizes are expected to be more cost efficient owing to the advantage of economies of scale, as the unit cost of output decreases with increased production. Factors such high cost of land, high cost of labour and low income level could be responsible for this phenomenon. Farmers with larger farm sizes are expected to practice better land management practices. This is because when farmers have larger farm sizes, they can plan different management practices due to the large land holding size.

4.1.6 Cooperatives society

According to Obare*et al.*(2010), farmers who belong to cooperatives are better informed on resources use and farm planning which enables them to utilize resources more efficiently. The result in Table 4.1 revealed that the average number of years spent in cooperative societies was about 7 years with a minimum and maximum of 1 and 18 years in cooperative societies. From the foregoing, this implies that maize farmers in the study area could have benefitted in one form or the other from their respective groups or associations as members of cooperatives societies. This supports the findings of

Onojah*et al.* (2013) that naturally being members of associations afford farmers to benefit from financial institutions and /or ending agency since such requirement are the determinant factor.

4.1.7 Extension contact

Findings from the study (Table 4.1) revealed that the average contact with extension services by maize farmers per year in the study area was about 4 contacts per year while the minimum and maximum contacts were 1 and 6 contacts per year.This is relatively good because visit or contact with extension services provides opportunity for transfer of skills, knowledge and informations which facilitate adoption. This is in line with the findings of Demeke (2003), where farmers' pointed out that governments' extension service as the most important one. And they further disclosed that information about input supply and use, land management practices; improved cultural practices and soil conservation practices are among the aspects covered by the extension services.

4.2Indicators for Soil Fertility Decline in the Study Area

The most widely used indigenous indicators are decrease in crop yield,stunted growth, change in colour of crops, growth of unwanted plants (weeds),presence of small stones in the soil,decrease in depth of soils, and decrease in crop residues, (Table 4.2).

Most (74%) of the farmers use decrease in crop yield as indicator for soil fertility status, provided that there are enough rainfall and other requirements fulfilled. It is not only an end harvest that links yield with soil fertility status, prior to harvest the way the crop grew up in the field can also show soil fertility status. Stunted growth and change in

colour, were indicated by57% and 36% of the respondents accredited to soils that do not meet the minimum fertility requirements for proper crop development. The crop residues produced are also used as an indicator but farmers don't show much concern for crop residue when the main crops failed (Desta, 2003).

The presence of stones in the soil and the decrease in soil depth are also other indicators of soil fertility status. The topsoil is the most fertile and contains different nutrients required for crops growth. The thickness of the topsoil indicates that there are more organic materials that can help for crop growth. The removal of this will create unfavourable environment for the crops and good yield will not be obtained. This will also expose the soil at the bottom and small stones, which are not weathered. Thus, the decrease in thickness of the soil and the outcropping of small stones indicate that the soil has lost the fertility. There are also different plants, weeds, which can grow on less fertile soil and indicate that the soil is not fertile. However, according to (Stocking and Niamh, 2001) this is not good indicator of soil fertility because weed may come to the farm with crops and grow. The weeds can also adapt to the existing type of the soil. These mislead to say something regarding the soil fertility using weeds as an indicator according to farmers. In these ways, farmers generalize the soil fertility problem and can say in crude the fertility of the soil helped by the indigenous soil fertility indicators, however, this doesn't give which nutrients and to what extent the soil fertility is decreased (Stocking and Niamh, 2001).

Table 4.2: Indigenous soil fertility decline indicators identified by farmers

Indicators	Frequency	Percentage	Rank
Decrease in crop yield	113	74.34	1
Stunted growth	87	57.24	2
Change in colour and dry up of crops	54	35.53	3
Growth of unwanted plants	34	22.37	4
Presence of stones in soil	32	21.05	5
Decrease in soil depth	19	12.50	6
Decrease in crop residues	8	5.26	7

Source: survey data 2015

4.3 Indigenous Soil Fertility Management Practices Employed by the Farmers

Results in Table 4.3 shows that more than half (52%) of the respondents identified mixed cropping as one of the frequently used indigenous methods of maintaining soil fertility. Mixed cropping systems create favourable condition for the soil, water, nutrients and provide excellent environmental conservation and sustainability. Forty nine percent (49%) of the respondents identified organic manure to be a common practiced in maintaining soil fertility and improve on maize production. The practice of these activities helps to reduce the high costs of purchasing inorganic fertilizers. This was followed by about 32% of the respondents use green manure application in order to maintain and improve soil fertility as well as improve maize production. Farmers preferred mineral fertilizer because it is less laborious to apply compared to organic fertilizer. However, they appreciated the slow release of nutrients by organic fertilizer and its long-term benefits to soil fertility (Irene *et al.,* 2001). About 26% of the

respondents had to leave crop residues in their farms after harvesting for soil texture and nutrients preservation which also helps in soil erosion control as well as protect the soil from exposure to harsh environmental conditions. The result also revealed that 21% of the respondents have practiced crop rotation. This is because different crops are planted, tilled and harvested at different times and agricultural work is spread out more evenly over the year. In addition to providing ground cover and in the case of a legume fixing nitrogen, cover crops also help suppress weeds and reduce insects' pests and diseases. This is in line with the study of Saidou*et al.* (2004) in Benin that farmers rotate maize with cowpea, which has a growing period of about 60-70 days, because of its food value and marketability and to maintain the fertility of their farmlands. According to the farmers, maize grown after cowpea grows faster and yields higher even if inorganic fertilizer is not applied. They mentioned that the nodules formed on the roots contain energy, which is released for the growth of the maize when they decompose. Farmers also attribute the yield increase in maize after cowpea to an increase in fertility of the soil as a result of the decomposition of the cowpea foliage that is left on the land after harvest. However, they remarked that if the land is not immediately used for cropping after harvesting the cowpea the fertility of the land is lost since cowpea leaves decompose fast.

Table 4.3: Indigenous soil fertility management employed by farmers

Indigenous Knowledge System	Frequency	Percentage	Rank
Mixed cropping	79	51.97	1
Organic manure application	75	49.34	2
Green manure application	48	31.58	3
Crop residue management	41	26.97	4
Crop rotation	32	21.05	5
Cow dung application	31	20.39	6

Source: survey data, 2015

4.4 Socio-economic Characteristic and Institutional Factors Influencing the Application of Indigenous Knowledge System for Soil Fertility Management

From the result in Table 4.4, it was revealed that age, education, farming experience and farm sizes were significantly influencing the application of indigenous knowledge system for soil fertility management.

Age: The coefficient estimate for age (2.7444)had a positive influence on the application of indigenous knowledge system for soil fertility management at 10% probability level. This implies that older farmers had a higher probability of applying the indigenous knowledge system for soil fertility management than the younger farmers. Farmers' age has been found to increase as well as increase the probability of application. The positive influence of age on application in the current study is contradictory with the findings of Odera*et al*. (2000) in Kenya who found age to negatively influence application of soil fertility replenishment practices. An explanation

for the probability of application being higher among older farmers than young ones is that the young farmers have a tendency to be more conservative in terms of preserving, managing and caring for natural and cultural resources.

Educational level: Educational level of the farmers (-11.961) had a negative influence on farmers' decision to apply indigenous knowledge system for soil fertility management at 1% significant level. This implies that an increase in education level of the farmers by one year will decrease the probability of applying the indigenous knowledge system for soil fertility management. This may be due to the fact that farmers who involve more in off-farm employment have less commitment to the farm and hence, they do not view the economic impacts of soil fertility depletion as being large enough to justify undertaking soil conservation activities. This is contradictory to the findings of Luka *et al*. (2012) in NasarawaState, Nigeria that formal education can give an unparallel advantage to the people of an area in terms of quick understanding of scientific principles underlying the use of indigenous soil management practices.

Farming experience: The coefficient estimate of farming experience (0.5881) of the farmers positively influenced application of indigenous knowledge system in soil fertility management at 1% probability level. This implies that an increase in farming experience of the household head by one year will increase the probability of applying the indigenous knowledge system for soil fertility management. This is in agreement with the findings by Edeoghon's (2008), who reported that farmers usually are more involved in practices that they are more familiar with than other practices.

Farm size: Farm size had a positive and significant coefficient (1.0408) from the result which implies that an increase in farm size will lead to an increased probability to

applyindigenous knowledge system for soil fertility management. This was significant at 10% probability level. As expected, the positive coefficient of farm size implies that farmers with relatively larger holdings had higher probability of applying indigenous knowledge system for soil fertility management. This can be attributed to the fact that conservation structures occupy part of the scarce productive land and farmers with larger farm size can afford retaining structures compared to those with relatively lower farm size. This result is consistent with the findings of Okoye (1998) in Nigeria and Mbaga-Semgalawe and Folmer (2000) in Tanzania. In Okoye's (1998) comparative analysis of factors in the adoption of traditional and recommended conservation practices in Nigeria, recommended soil erosion controlling practices adoption responded to farm size positively and significantly. That means, application tend to increase as farm size increases.

Table 4.4: Socio-economic characteristics of the farmers influencing the application of indigenous knowledge systems for soil fertility management in the study area.

VARIABLE	B	Standard Error	T-Ratio
Age (X1)	2.7444*	1.3878	1.9775
Education (X2)	-11.9610***	3.3497	-3.5708
Household size (X3)	0.8239	1.2024	0.6852
Farming experience (X4)	0.5881***	0.2139	2.7494
Farm size (X5)	1.0408*	0.6108	1.7040
Extension contact (X6)	0.0263	0.0389	0.6761
cooperative societies (X7)	0.0489	0.0358	1.3659
Constant	17.686*	9.0377	1.9569
No. of observations	152		
L R test	77.6511		
Log-Likelihood Function	-38.060		

Source: survey data, 2015, S E = standard error
*, **, *** Significant at 10%, 5%, and 1% level of probability.

4.5 Impact of adoption of indigenous knowledge system for soil fertility management on farmers' crop yield

From the result (Table 4.5), the calculated t-Statistic (10.76) was statistically different from the tabulated t-statistic at 1% level of probability with a critical value of α = 1.9774. So, the null hypothesis which states that "There is no impact of the application of indigenous knowledge system for soil fertility management on farmers' yield" was rejected, and it has been proven that the mean yields of applicators and non-applicators are different. The effects of indigenous knowledge system for soil fertility management such as higher and more stable yields with lower input costs and a better adaptation to dangers of climate change clearly have a positive impact on farmers' livelihood.

Table 4.5: Impact of application of indigenous knowledge system for soil fertility management on farmers' yield

	Yield forApplicators	**Yield forNon- Applicators**
Mean	18130.7229	10220.1493
Variance	31254014.1052	10955534.8259
Observations	83.0000	67.0000
Hypothesized Mean	0.0000	
Difference		
Df	137.0000	
t Stat	10.7642	
P(T<=t) one-tail	0.0000	
t Critical one-tail	1.6561	
P(T<=t) two-tail	0.0000	
t Critical two-tail	1.9774	

4.6 Constraints to the use of Indigenous Knowledge System for Soil Fertility Management in the Study Area

There are various constraints that prevent farmers from practicing indigenous knowledge systems for soil fertility management. These problems differ from household to household depending on household characteristics and socio-economic situation. Inadequate labour power, shortage and fragmentation of land, grazer's encroachment and infestation of pests were some measures mentioned as the constraints in using indigenous soil fertility management (Table 4.7).

4.6.1 Inadequate labour

Soil fertility management measures require human labour to carry out. Table 4.6 revealed that about 67% of the respondents tried to overcome the problem of inadequate labour in their efforts to manage soil fertility using indigenous knowledge. The extent of the labour requirement varies from one measure to another measure. Farming households who have less human labour abandons or uses less those measures that require much labour. Among indigenous soil fertility management measures the use of animal manure requires much labour. Thus, the number of farmers using those measures varies with the available labour requirement at household level or on the capacity to get some external labour force on hired or other way. During the interview farmers gave the extent of difficulty to implement both indigenous and introduced soil fertility management measures based on labour requirement.

4.6.2 Shortage and fragmentation of land

In the study area there is shortage and fragmentation of land. Sixty four percent (64%) of the respondent own farm land of two hectares and thus could be referred to as small scale farmers. The result showed that about 47% of the respondents were challenged with shortage and fragmentation of land in the study area. Shortage and fragmentation of land comes as a result of population increase, which has exerted pressure on land. The use of some of the indigenous and introduce soil fertility management measures are limited by fragmentation of land. In the study area farmer can never have fragmented lands next to each other, rather located in different places, at the same time the land are far from the household homestead. These become difficult for farmer to implement labour intensive measures like animal manure, compost manure, and liquid manure.

Moreover shortage of land has resulted in continuous cultivation that worn out the fertility of the soil soon. In general, all the soil fertility management measures are directly or indirectly affected by the shortage and fragmentation of the land.

4.6.3 Grazer's encroachment

Grazer's encroachment into farm lands that were left to fallow was one of the problems faced by about 21% of the respondents in the study area. When the land left for fallow, grazers encroach to the fallowed land and the soil fertility restoration is hardly possible. The land comes back to cultivation from grazing almost without resting.

Table 4.6: Constraints to the use of indigenous knowledge system for soil fertility management in the study area

Constraints	**Frequency**	**Percentage**
Encourage pests	19	12.50
Encroachment by grazers	32	21.05
Inadequate labour	101	66.45
Shortage and fragmentation of land	71	46.71

Source: survey data, 2015, Number (n) > 152 implies multiple responses

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The study was carried out to analyze the application of indigenous knowledge system for soil fertility management among maize farmers in selected Local Government Areas in Kaduna State, Nigeria. Results showed that the mean age of the farmers was 42 years which implies that they were in their economically active age which make positive contribution toagricultural production. The average years spent on education by the maize farmers was about 12 years with a mean household size of 12 persons. It was also revealed that the average farming experience of the farmers was about 13 years with a mean of 7 years spent in cooperative organization. Soil fertility decline indicators pointed out by the farmers were ranked as follows; decrease in crop yield,stunted growth, change in colour of crops, growth of unwanted plants (weeds),presence of small stones in the soil,decrease in depth of soils, and decrease in crop residues. Mixed cropping ranked first followed by application of organic manure, green manure and crop residues andcrop rotation as the frequently used indigenous methods of maintaining soil fertility.

The logit regression analysis shows that age, education, farming experience and farm size were significantly influencing the adoption of indigenous knowledge system for soil fertility management. Against *a priory* expectation, education had a negative influence on the adoption of indigenous knowledge system for soil fertility management. This may be due to the fact that farmers who involved more in off-farm employment has less commitment to the farm and hence, they do not view the economic

impacts of soil fertility depletion as being large enough to justify undertaking soil conservation activities.There was impact of the application of indigenous knowledge system for soil fertility management on maize farmers' yield. This implies that farmers who applied indigenous knowledge system for soil fertility management have higher yield than those who did not apply. Indigenous knowledge systems for soil fertility managementconstraints mentioned by the farmers include;inadequate labour, shortage and fragmentation of land, grazer's encroachment and incidents of pests by some measures such as the use of cow dung.

5.2 Conclusions

It is evident that rural farmers use indigenous methods for maintaining soil fertility which include; mixed cropping, organic manure application, organic and inorganic fertilizers, crop residue management, crop rotation and cow dung application. The analysis also showed that older farmers, the more experience farmers and farmers with relatively larger holdings had higher probability of applying indigenous knowledge system in soil fertility management. There was significant impact on maize farmers' yield with the application of indigenous knowledge system for soil fertility management. Despite the constraints hindering the effective application of indigenous knowledge systems for soil fertility management among maize farmers in the study area, majority of farmers applied the various techniques. This necessitates intensification of agricultural production through the provision of appropriate support services.

5.3 Recommendations

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

i. Indigenous knowledge system in soil fertility management such as the use of crop residues, crop rotation, mixed cropping and cow dung application should be encouraged particularly for subsistent maize farmersto improve soil fertility.

ii. For indigenous knowledge system in soil fertility management to be preserved and transmitted to the younger generation, it must be included in the education system and must be practiced. For it to be included in the education system it must be well documented and adapted to the current social system.

iii. There is no doubt that modern agriculture has not been successful in feeding the poor in Nigeria. Modern agriculture should complement rather than compete with indigenous agriculture.

iv. Indigenous farming practices must be promoted and not denigrated by agricultural extension workers. This may warrant training of agricultural extension workers to integrate indigenous knowledge system with the modern farming system.

v. The challenge remains to achieve integration between indigenous and scientific approaches at the local level to enable a better understanding of soil management systems as applied by small-scale farmers and to ensure the protection of topsoil to maintain sustainable soil quality. Such a hybrid approach could give direction to farmers and encourage them to play a major role in the future sustainability of their land.

5.4 Contribution of the Study to Knowledge

i. The study revealed that the average age of the farmers was 42 years with an average household size of 12 persons while theaverage farming experience of the farmers was 13 years in the study area.

ii. Majority (64%) of the farmers were applying indigenous knowledge systems for soil fertility management while 36% of the respondents were only using inorganic fertilizers to manage soil fertility in maize production.

iii. The analysis also showed that age, education, farming experience and farm size were significant and positively influencing the probability of applying indigenous knowledge system in soil fertility management except educational status of the farmers which was negative.

iv. The impact of the application of indigenous knowledge system in soil fertility management on farmers yield was affirmed from the calculated t-Statistic (10.76) which was statistically significant at 1% level of probability. The mean yield difference between applicators and non-applicators of indigenous knowledge system in soil fertility management in the study area was found to be 7910.57kg/ha.

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APPENDIX

DEPARTMENT OF AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY, AHMADU BELLO UNIVERSITY, ZARIA.

QUESTIONNAIRE FOR MAIZE FARMERS.

Dear sir/madam,

I am a post graduate student of the aforementioned department carrying out a research on the topic:ANALYSIS OF FACTORS INFLUENCING ADOPTION OF INDIGENOUS KNOWLEDGE SYSTEM FOR SOIL FERTILITY MANAGEMENT AMONG MAIZE FARMERS IN SELECTED LOCAL GOVERNMENT OF KADUNA STATE, NIGERIA.

Please answer the following questions to the best of your knowledge. Information provided will be treated confidentially.

State……. LGA……Village…….……

SECTION A. Socio-Economic Variables

1 Sex: (a) male (b) female

2 Age: ----------years

3 Highest level of education attained----------

4 Marital status (a) Married (b) single (c) Widowed (d) Divorced

5 Size of household at time of interview(excluding visitors)----------

6 Main occupation: (a) Farming (b) Trading (c)Formal employment (d) Casual work(e) Others (specify)----------

7 How many years farming experience do you have in maize?----------

8 How do you acquire your land? (a) Inheritance (b) Purchase (c) Rent (d) Borrow

9 Do you engage in off-farm occupation? (Indicate the type(s) of occupation)--------

SECTION B: Institutional Variables

10. Do you have contact with extension agent? Yes ( ) No ( )

11. If yes, how many times does the extension agent visit you in a year?----------

12. How many times have you visited the extension agent in a year----------

13. Provider of extension services (a) ADP ( ) or (b) NGO ( )

14. Are you a member of any cooperative association? Yes ( ) No ( )

15. If yes, for how long have you been a member?----------(years)

16. Is credit readily available to you? Yes ( ) No ( )

17. If yes, from where do you source your credit? (a) Banks ( ) (b) Money Lenders ( ) (c) Cooperatives ( ) (d) Friends and relatives ( ) (e) Others specify----------

SECTION C: Production Information on Maize

18. Size of plot devoted for maize production----------(ha)

19. Do you have access to inputs from government agencies Yes ( ) No ( )

20. How many litres/kg of herbicides did you purchase for your farm?--------(Litres)

21. How many kg of seeds did you purchase for your farm?----------(kg)

22. How many bags (kg) of fertilizer did you purchase for your farm?---------(kg)

23. What is the main source of labour for maize production? (a) Family labour (b) Hired labour

SECTION D: Indigenous Knowledge System for Soil Fertility Management

24. How do u identify soil fertility decline ……...?

25. What type of indigenous knowledge systems do you practice? (a) Organic manure (b) Mixed cropping (c) Crop rotation (d) crop residues (e) Mulching (f) Use of legumes (g) (Note: Choose as many as possible answers)

26. What type of cropping systems do you practice? (a) Sole cropping (b) Mixed cropping (c) Crop rotation (d) Bush fallowing (Note: Choose as many as possible answers)

27. Do you use crop residues for building, feeding of livestock, fencing and/or fuel? Yes( ) No ( )

28. Are crop residues and/or weeds burnt during land preparation? Yes ( ) No ( )

29. Are crop residues and/or weeds incorporated into the soil during land tillage?

Yes ( ) No ( )

SECTION E: Constraints in Indigenous Technical Knowledge for Soil Fertility Management

30. What are the major problems in soil fertility management

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31. What are the possible solution to the problems in soil fertility management

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Thank you