FACTORS INFLUENCING ADOPTION OF RECOMMENDED ENVIRONMENTAL MANAGEMENT PRACTICES BY CROP FARMERS IN SELECTED LOCAL GOVERNMENT AREAS OF JIGAWA STATE, NIGERIA

BY

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

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DECLARATION

I hereby declare that this dissertation titled "**Factors Influencing Adoption of Recommended Environmental Management Practices by Crop Farmers in Selected LGAs of Jigawa State, Nigeria"** has been written by me and it is a record of my research work. No part of this work has been presented in any previous application for another Degree or Diploma at any institution. All citations and sources of information are duly acknowledged by means of references.

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CERTIFICATION

This dissertation titled '**Factors Influencing Adoption Recommended Environmental Management Practices by Crop Farmers in Selected LGAs of Jigawa State, Nigeria',** by Suleiman SaboSAMBO meets the regulations governing the award of the Degree of Master of Science, Ahmadu Bello University, Zaria, and is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

This dissertationis dedicated to mylate Parents; Alhaji Muhammad Sabo Sambo (Jarman Hadejia) and Hajia Yelwawho have not live to witness this great achievement.

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Abstract

The studyevaluated factors influencing the adoption of recommended environmental management practices on agricultural production in three local governments of Jigawa State, Nigeria. Primary data were collected from 120 respondents using structured questionnaire. The statistical tools used to analyse the data were descriptive statistics, regression model. The result of the analysis shows that 37% of the respondents fall within the age range of 31-40years with an average of 42 years, 50% of the respondents had household size ranged from 1-5 people. The majority (76.7%) of the farmers are literate. About 43% of the farmers had farming experience range from 11-20 years. About 99% of the farmers finance their production through personal savings; majority (90%) of the farmers had land size ranging from 0.1-2.0 hectares. However, 94.2% of the farmers belong to one cooperative association or more while majority 57.5% of the crop farmers had no other source of income. The result of this study also shows that cumulative contributions of independent variables to the adoption of environmental management practices had coefficient of determination (R^2 Adjusted) value of 0.58. This implies that all the variables together, explained about 58 percent of the total variability in adoption of environmental management practices in the study area. The relationship between selected socioeconomic and institutional factors and adoption of environmental management practices show that out of seven variables included in the analysis, four had significant influence on adoption of technologies. These were education, membership of cooperatives, amount of credit borrowed and extension contact. The effect of adoption of environmental management practices on income shows that mulching and crop rotation had significant positive influences on income of the farmers. Finally, the most important constraint to the adoption of environmental management practices were: pest and diseases, bulkiness of the technology, labour shortage and inadequate capital. The study showed that the promoted environmental management technologies that farmers were mostly aware of mulching (95.8%), use of organic waste (91.7%) and crop rotation (75%) and the least adopted were pesticide use (18.3%) and farmyard manure (19.2%). Extension agent (74.2%) was the important source of information on the promoted technologies while least important was television (23.3%). It is recommended that farmers should join cooperative societies as this would facilitate access to vital information and credit provided mostly by financial institutions.

CHAPTER ONE

INTRODUCTION

1.1 Backgroundinformation

The world's population is currently estimated at seven billion people with an annual growth rate of 1.9% and it is projected to expand to about 9 billion people over the next forty years (Sajini, 2013). Consequently upon this, the demand for food and fuel is bound to rise tremendously while this growth rate will aggravate the situation of hunger and malnourishment (Efe, 2011). It implies therefore, that meeting the demand for food will require more intensive use of many natural resources especially agricultural land, forest, water and fisheries (Sajini, 2013). Against the backdrop of the increasing pressure to use the land resource for agricultural production there lies the need for farmers to update their knowledge on the possible soil management practices necessary to check soil overexploitation resulting from land use, other activities of man, and natural occurrences such as climate change . Thus,as farmers are conscious of increasing agricultural production such as crop farming, a concurrent effort is required to be put in place for continuous and proportionate soil conservation measures to sustain agricultural productivity.

According to Nuwagaba *et al* (2000), the position of farmers to maintain agricultural production greatly depends on their efforts towards maintaining soil productivity through proper management of the soil resource. Soil management is a major feature of land resource management ina country like Nigeria with large expanse of landwhich supports a rapidly growing population. However, the absence of committed efforts on the part of the farmers, government and other stakeholders to implement workable programs for sustainable use and management of land resource tends to predispose land to soil degradation as a result of over cultivation and accelerated soil erosion (Tumuhairwe *et. al*., 1999). This is because man's

quest to meet his basic needs of subsistence by increasing agricultural production, interact with the environment and often times create negative consequences for human survival some of which are explained as follows.

(i) Soil erosion is known to adversely affect over 80% of the land in Nigeria according to Miko, (2003), while Sajini (2011) remarked that farmers are compelled to continuous cultivation of same piece of land, using their traditional production techniques with the soil fertility and structure deteriorating rapidly where fallow periods are too short. Unfortunately, Nigeria's increase in agricultural production has essentially been in the area of opening up more land with several environmental implications such as deforestation and destruction of the ecosystem (Miko, 2003). As a result, farmers often contend with the challenges of land degradation, soil nutrients depletion general environmental unsustainability all of which culminates in low/poor yield and vicious cycle of poverty and socio-economic retardation.

In Jigawa State,realizing these environmental threats to mankind, various stakeholders have intervened in different capacities in promoting soil management practices in order to combat soil degradation. Consequently, farmers in this area have for a long time used both traditional and recommended soil management practices basing on both indigenous knowledge and other improved techniques by government extension staff and NGO's. In essence, Jigawa State Agricultural and Rural Development Authority (JARDA) have over the years been disseminating improved environmental management technologies to farmers for adoption. In realization of the poor environmental situation of the State in 2001 the State Government established several Ministries to tackle and improve the environmental situation of the State (JARDA, 2009). These Ministries in6xclude the Shelterbelts and Erosion Control; Rainwater Harvesting; Gum Arabic, Nature Conservation and Artifacts. Each of these Ministries has introduced a lot of innovations aimed at mitigating the problem of soil degradation resulting from erosion and problems ofsoil over exploitation.

To overcome declining output resulting from decreasing soil fertility and productivity, therefore, farmers need to improve their production techniques in order to put judicious use of land on a proper track and perspective. The decision to participate in new agricultural technologies depends on farmer's awareness, perception and other variableswhich are key determinants in influencing adoption of any technology (Adesina and Baidu-Forson, 1995). The need to know the factors which influences the adoption of therecommended environmental management practices in crop agriculture cannot be over emphasized. This is what the study is set to achieve.

1.2 Problem Statement

There is ample evidence from Jigawa State Agricultural and Rural Development Authority to conclude that the environment in Jigawa State is close to its limits of carrying capacity due to the unsustainable exploitation of the natural resources (JARDA, 2009). The report further stated clearly the fact that there is widespread case of land degradation which is attributed to rapid deforestation estimated to be 3.5% (JARDA, 2009). The exploitation of the environmental resources and farmers' interaction with the environment, especially agricultural practices can therefore be adjudged as unsustainable ,while the scope for further expansion of cropland has also drastically narrowed. Large areas of forest, wetlands, grazing reserves, river valleys have already been converted to farmlands on continuous basis while theaverage per capita arable land actually cultivated have declined withattendant lowproductivity JARDA, (2009).

Enormous money and efforts have been invested by Research Institutions in the areas of research on improved/recommended environmental management practices for farmer's usage. The Federal, States, Local Governments, Non-Governmental Organizations and Private Institutions have made several efforts through provision of resources, technologies, practices

so as to address the environmental problems, but their dreams are yet to be realized.It is based on this program that this study will attempt to ascertain the factors influencing adoption of recommended environmental management practices for crop farmers in Jigawa State, Nigeria.Since the role of agricultural extension is to facilitate the adoption of improved technologies or to influence the rate of diffusion and adoption by crop farmers, knowledge of the factors related to the adoption of such technologies which is hinged on the effective performance of farming system is imperative. A good number of recommended land and soil management practices/technologies have been transferred to the end users through various channels and sufficient studies have not been conducted to understand the peculiarities of the users of such technologies in terms of the social, economic, cultural, religious environmental and institutional characteristics of the farmers in relation to their adoption ofthe recommended technologies. There is therefore, the need to proffer answerthe following research questions:

i) What are the socio-economic characteristics of the farmers adopting the recommended environmental management practices in the study area?
ii) What is the level of awareness of the recommended environmental management practices in the study area?
iii) What are the perceptions of the respondents on the recommended environmental management practices in the study area?
iv) What are the rate of adoption of recommended environmental management practices in the study area?
v) What factors influences the adoption of recommended environmental management practices in the study are?
vi) What is the effect of adoption of recommended management practices on yield, income and living standard

vii) What are the constraints to the adoption of recommended environmental management practices?

1.3 Objectives of the study

The aim of this study is to provide an insight into factors influencing the adoption of recommended environmental management practices on agricultural production. The specific objectives were to:

(i) describe thesocio-economic characteristics of the farmers adopting recommended environmental management practices in the study area;

(ii) determine the level of awareness of the respondents on the environmental management practices in the study area;

(iii) determinethe perceptions of the respondents on environmental management practices in the study area;

(iv) assess the rate of adoption of environmental management practices in the study area;

(v) determinethe factors influencing the adoption of recommended environmental management practices in the area;

(vi) determinethe effects of adoption of recommended environmental management practices on yield, income and living standard in the area, and

(vii) describe the constraints to adoption of recommended environmental management practices.

1.4 Justification of the Study

According to Sajini (2011), hundreds of millions of poor farmers are suffering the cause of environmental degradation not only because they are injudiciously exploiting it, but because they simply do not have the skill, knowledge and resources to make simple investment to conserve, protect and replenish it. In order to avoid degrading the environment and understanding long term productivity, agriculture has to be built on ecological principles. But it also has to be possible for the farm family to be able to make long term investments in their farming systems. Only by taking such wider considerations into account can farming again become a basis for thriving rural communities.

In Nigeria, it is clear that enforcement of environmental laws has been weak and ineffective.

The Nigerian agriculture, according to NEST (2004), is still plagued with declining soil fertility, low productivity, and meager income, and water shortage, rapid decrease of arable land and low savings. The semi-arid zone of Nigeria, which by its nature and characteristics is susceptible to desertification process, at the same time this region constitutes the largest grain producing area of the country, and, most of the livestock are concentrated in the area (Idrissa *et al*. 2008).

Sajini (2013) stated that it is now obvious that the environmental problems need to be addressed in a holistic manner in order to ensure human survivaland sustaining natural resources. Thus, the desire to boost agricultural production to meet ever, increasing population led to the introduction of several recommended environmental management practices designed to improve the environment (Olanina,2006). Unfortunately the adoption of recommend environmental practices has however encountered some obstacles (Akpoko, 2004).

This therefore, calls for research to finding possible factors that are impediments to the efforts being made and to use such information to formulate policies that can act as stimulus in motivating farmers to adopt these recommended environmental management practices in the study area and Nigeria at large.

Since the efficacy of any agricultural extension is judged by the level of mass adoption and spread of modern and scientific practices among farmers in the rural neighborhoods,this study will provide information on farmer's personal and socio-economic attributes, which can influence their decisions to adopt recommended environmental management practices. Understanding the factors influencing farmers decision will act as template (guide) for policy makers, researchers and extension agents in fashioning the best means of getting farmers to adopt recommended environmental management practices.

Change agents and policy makers may find the project and the document emanating from it a useful material for stimulating change in the socio-economic development of the country especially in terms of crop and agro forestry sub-sectors of agriculture and its contribution to the economy.

Finally the results obtained from this study will add to existing data and information for the purpose of academic discourse and comparison.

CHAPTER TWO

LITERATURE REVIEW

2.1 Characteristics of Farmers and Adoption of Recommended Practices

Many past studies have demonstrated that personal characteristics of farmers affects their decision on adoption and have largely been found to include age, farm size, family size, mental flexibility, farm ownership, other occupation, frequency of agents – farmer contact, social status, level of living, exposure to mass communication media and other socio-economic factors (Adesina *et al*., 2000; Ramji *et al*., 2002). Also Nambire *et al* (2006), found that socio-economic factors such as formal education, cosmopoliteness and community status were related to adoption.

Family size means the total number of people in the household who resides within the same family and eats from the same pot (Sale, 2006). Household size is the main source of farm labor in northern Nigeria. Labor constraints affect a farmer's choice of technology (Enyang *et al*., 1999) and can constrain the adoption of a labor demand technology (Onu,2006). According to Chianu and Tsuji (2004), larger family size are more likely to adopt some soil improvement technology due to sufficient labor.

The age of an individual as measured in years is believed to be capable of influencing the perception, views, interest and conduct of the person (Chianu and Tsuju, 2004). Young people are thought to be more receptive to modern ideas than older ones, that is negative, relationship between age and adoption (Nambire *et al* 2006). Ezekiel (2012) found that the probability of adoption of soil conservation practices was lower among older farmers because of their shorter planning horizon.

There is a universal assumption that formal education facilitates learning and as such those farmers who have attended schools would under normal circumstances have a more favorable attitude towards adoption of improved farming practices (Chianu and Tsuni,2004). Education improves human capital, farm management capacity and ability to understand and adopt new agricultural technologies (Bezuayehu *et al*., 2002). It is expected that better educated farmers are more likely to adopt technologies' than less educated (Chianu and Tsuji, 2004). Level of

education of an individual is usually indicated by number of years in formal schooling or by qualification certificate acquired.

Onu (2006), reported a positive relationship between farm size and adoption of improved agricultural technologies. However, Rutten (1977) noted that farm size is not a significant factor in explaining adoption. Similarly, Ogunfiditimi (1981), found negative relationship. The size of holding is not only surrogate for other more important factors such as improved technologies (Feder *et al*., 2001).

Farmers' diversity of knowledge has an influence on adoption of technology. Ezeaku (2013), found that there was no significant relationship between stubble mulching and reduced tillage on one hand and fertilizer use on the other. He found that soil conservation index correlated significantly with adoption of fertilizer. It was found that farmers' knowledge of improved practices such as chemical fertilizer application, planting, spacing made significant contribution to adoption of those groundnut production recommendation.

Arokoyo, (2005) recognized leadership structure in a community as a factor affecting adoption. He posited that the success of many programs depends on the approval of formal and informal leaders. Other researchers who found positive relationship between farmers' social status and adoption of farming innovations include Akpoko (2004) and, Yusuf *et al*., (2011) and many more.

Membership of social organization refers to social participation in organization which enhances interaction and exposes farmers to information about improved farm practices thereby high success rates when they work in groups (Iwuchukwu *et al* 2013). Credit is often used to promote adoption of agricultural innovations (Ahmed *et al*., 2002). Without credit, most farmers cannot afford recommended inputs because the income of small scale farmers is very low in Nigeria (Chianu and Tsuji, 2004). They also said that

there is positive relationship between access to credit and decision to adopt innovations. Anderson *et al*. (1986), found amount of credit received to be associated with higher degree of soil conservation. This suggests that individuals with low income and inability to obtain credit for conservation investments may not be willing to adopt soil conservation techniques.

One of the most important determinants of the outcome of the innovation-decision process is the adopters' perception of the attributes of innovations (Akpoko, 2004). Perception refers to respondents' view of the innovations (Idrissa *et al*., 2008). He went further to add that the perceived cost and compatibility of the technology are the determinants of adoption behavior in the innovation decision model. Ezeaku (2013), reported that if farmers knowledge in environmental management is increased they will likely adopt more of the practices.

2.2 Awareness of Technological Innovation

Awareness is the knowledge of existence of a phenomenon. To create awareness on government policies and programmes, public enlightenment organs such as the mass media, National Orientation Agency (NOA), Ministry of Information and Agricultural Extension Service were formed, funded and charged with the responsibility of information dissemination. Without awareness campaigns, knowledge and ideas may hardly reach those in need of it (Simon *et al.*2013).

The importance of awareness creation as a component of agricultural extension in introducing new ideas, technologies and practices has since been recognized and given premium. Awareness is the first step in the adoption process when considering new ideas or technology. At the level of awareness, mass media tools such as radio, newspaper, magazine, television, motion pictures, slide shows, exhibits and printed

materials are used to introduce new ideas and practices and alert people on emergencies such as the urgent need for the use of sustainable agricultural land management practices (Simon *et al* 2013).

Although the awareness stage gives little information about the idea it portrays, it serves as an appetizer, catalyst or stimulant that arouse clients' interest to seek additional information on the idea in the subsequent stages of the adoption process. The success or failure of the other stages of the adoption process which include interest, evaluation, and, trial depends on how the awareness stage is managed. (Simon *et al* 2013).

Awareness is the first stage in adoption process and involves the individual learning of the existence of technological innovation (Ekong, 2003). It is however observed that at this stage the farmer has limited knowledge about the technology. In this process the farmer might want to know more about the information after having heard it from other family members, friends, and neighbors, the mass media extension agents, researchers, sales promoters and local cooperative organization (Ekong, 2003). Exposure to information about new technologies significantly affects farmers' choices about it. Van den Ban and Hawkins, (1998) however posited that sometimes in adoption process interest may precede awareness especially in a situation where fish farmers may need to control a new and unknown fish disease or pest.

2.3 Farmers' perception of technologies

Farmers believe that technologies are good for them. They believe in technologies because they give good efficiency in terms of high yield, less pest, and more benefit. In soliciting respondents' subjective perceptions, researchers capture the qualitative

aspects that influence farmers' decisions probably because farmers' technology choices are based on their subjective probabilities. Farmers' perceptions are interpreted as perceived profitability of a technology and translate into more resources being devoted to it - hence adoption. Aphunu and Ajayi (2010) applied a five point Likert-type scale ranging from "undecided" (scale 1) to "strongly agree" (scale 5) were used to access the perception on adoption of environmental management practices. The level of knowledge and skills gained as a result of the training programme were measured on a four point Likert- type scale ranging from "poor" to "very good" and scaled 1 to 4 respectively. Respondents' perception of the constraints associated with the training programme was measured on a five point Likert type scale with response options ranging from "undecided" (scale 1) to "very serious" (scale 5). Responses of the 4-point and 5-point scales were categorized according to their mean scores. Responses on 5 point Likert-scale with mean scores of 3.50 or above were classified as good, while those with mean scores below 3.50 were classified as poor. On the other hand, responses on 4 point Likert-scale with mean scores of 2.50 or above were classified as good, while those with mean scores below 2.50 were classified as poor.

In a similar vein an earlier work of Ajayi(1998),used a 5-point Likert scale to compute the role perception of his respondents by analyzing a number of perception statements to obtain the perception index. This was later categorized into weak perception, strong perception and very strong perception depending on whether the value is less than 0.5, 0.5 or greater than 0.5.

2.4 The study of perception

Perception is defined as the process by which we receive information or stimuli from our environment and transform it to psychological awareness. It is a more or less permanent feelings, thoughts and pre-dispositions a person has about certain aspects of this environment. Like attitude it has three components: Knowledge, Feelings and inclination to act. It is an evaluative disposition towards some subject or object, which has consequences on how a person will act vis-à-vis the object being perceived (Van den Ban and Hawkins 1998) shows that an increase in knowledge will lead to change in perception, which in turn influences behavior. According to Van den Ban and Hawkins (1998) perceptions have some known general principles and these are:

(i) Relativity. Farmers' perceptions are relative rather than absolute as individual farmer is influenced by the environment in different ways, thus giving room to different interpretations.

(ii) Selectivity. A farmer tends to be selective and pay attention to only a selection of different stimuli being experienced by him or her.. Selective perception is influenced by attitude, past experiences and other physical and psychological factors.

(iii) Organization. Our perceptions are organized. A farmer tends to make meaning out of confused situation by structuring the sensory experiences into meaningful order.

(iv) Direction. Farmers perceive what they expect or are set to perceive. A technology, innovation or information must from the onset show direction for the user in order to give the right perception of the message it is meant for.

(v) Cognitive style. Farmers' perceptions will differ markedly from another's because of differences in tolerance to various cognitive styles. Individual mental processes work differently due to personality factors such as our tolerance for ambiguity, degree of

open and close-mindedness, authoritarianism, and other forms of communication errors.

Perceptions are made up of the beliefs that a person accumulates over his lifetime. Some beliefs are formed from direct experience some are from outside information and others are inferred or self- generated (Van den Ban and Hawkins 1998). The authors however affirmed that only a few of these belief, actually work and they are said to be immediate determinants of a person's attitude. An attitude is therefore a person's salient belief about whether the outcome of his/her action will be positive or negative. Three types of attitude change in social psychology. These include cognitive change, (new information from other media), affective change (experience) and behavioral change (force).

2.4.2 Farmer's perceptions of soil management practices

Farmer's perceptions of the different soil management practices determine the choice to utilize them. In addition farmers' decisions in land management are not separate from decisions on production, consumption and social control (Brookfield 1989). Farmers use various frames of reference in appraising the relevance and usefulness of research and development products accessible to them. In appraising interventions from various sources, farmers refer to the expected added value in respect to the farmers' objective functions, practicability of what is being proposed and its fit within the ongoingfarmers'practices (Opio-Odongo, 1999).

2.5 Previous Studies on Adoption and non-adoption of recommended environmental management practices

The wealth of Africa depends on her ability to conserve and manage her land resources. It is a well-known fact that soil degradation not only results in decreased food production but also in ecological imbalance and consequent degradation of the quality of life (Dimelu, 2013). In Africa the most conspicuous symptoms of the negative impacts of land degradation on food production are stagnating and declining yield and increasing levels of poverty (ICRISAT, 2012,). From these perspectives, desirable regulations/interventions should weigh two factors; the benefits associated with reduced environmental damage and the opportunity cost of the mitigation. In reality the extent and focus of government intervention shall also reflect national, political and institutional considerations. The demand for environmental quality should increase with income per capita. The state with high rural population density and heavy dependence on agriculture and forest extraction should be particularly concerned with agricultural water supply, soil erosion and deforestation.

Pedro *et al*. (1996), gave an elaborate negative impact of farming as crop productivity declines, nutrient depletion leading to less fodder for cattle, less fuel wood, small amount of crop residue, and less manure from livestock. These effect increase erosion losses because there is less plant cover to protect it.

Miko (2003) and FAO (2006), reported that there are also major negative side effects outside the farm. Erosion particularly in steep areas causes silting of reservoirs' and coastal areas and in some cases leads to eutrophication of rivers and lakes. Food shortage and famine become more acute during drought years. Land fragmentation due to local population growth rate that far exceed the national average, pushes people to abandoned farming and move into urban areas where many are unemployed. Rosnake (2006), reiterated that topsoil lost is not only a loss to the farmer alone, it also creates problems where it is deposited. He further said that on sloppy tilled land one heavy rain can remove equivalent of 50 tons of top soil per acre.

In just a matter of minutes, the work of hundred years of natural soil formation can be totally wiped out, which cannot be restored within the lifespan of anyone living at the time.

Nitrates in water can give rise to the condition mathaemoglobinaemia in infants and is a possible cause of cancer. Miko (2003) said that continuous use of artificial NPK fertilizers would lead to depletion of micronutrients that may influence plants and animal health. IITA (1996), indicated that organic manures improves the soil physical properties e.g. water retention but are not readily available.

In Nigeria, ignorance and lack of user protection have exacerbated the problems of pesticide hazard (FAO, 2003). The report went on to say that most rural farmers handle pesticide product without caution, endangering themselves and their families. Pesticides also has adverse effects on the environment which disrupts the natural balance between pests and antagonists (FAO, 2003).

FAO (2003), stated that as a result of restrictive bush burning, fire resistance and often undesirable species of trees such as Diniella divert, Butryospermum parkaii, terminalia glauscens, cassia and Acacia spp may now take over fields at the expense of ill adapted herbs and disruption and rapid loss of soil productivity.

ICRISAT(2012), estimates more than 90 percent of sub-Saharan energy is supplied by wood and afforestation result to increase in wood fuel, construction timber, check wind erosion, improve vegetation cover, reduce trees mortality and indirectly reduce mobility of human and livestock population.

In Africa, the only continent where per capita food-output growth has been declining, 321 million ha (14.4 % of the total vegetated land) have been degraded moderately or worse and another 174 million ha are lightly degraded (ICRISAT,2012). FAO (2003), stated that efficient soil water conservation will be efficient in regulating indiscriminate water application to the

fields, especially where drainage facilities are either absent or in efficient, resulting in checking rise in water table thereby avoiding water logging, pondering and absent of standing water which lowers productivity of the soils. Sanders *et al*. (1995), reaffirmed that poverty and environmental degradation have often been linked.

Backlog of the impact of improved environmental management technologies can be found in the works of IITA (1986), and Akpoko (2004). Highlights of the impacts are as follows:-

- Multiple cropping through inclusion of legumes and appropriate use of crop rotation principles. Multiple cropping ensures intensification of crops and optimum utilization of limited land resources.

  Conservation, tillage and adoption of minimum tillage. Conservation tillage involves less labor and resulting surface residue will reduce evaporation. Conservation tillage restricts tillage operation to a narrow strip and reduces damage to the soil structure.

- Savannah soils are very fragile and land preparation using heavy equipment such as tractor is a necessary evil in sustainable agriculture.
- The need to preserve fragile soil by using light farm tools such as ox drawn implements.

As farmers experience scarcity of land and increase population pressure, they will shift to more intensive production practices to increase land productivity if investments in the intensification are profitable e.g. conservation tillage, agroforestry etc (Ezeaku,2012). To further looked at the positive impact of the adoption of the environmental innovation, Bourlough and Dowswell (2002), stated that by increasing the productivity of land best suited for agriculture, world farmers have been able to leave untouched vast areas of land for other purposes. For example, had the global cereal yield of 1950 still prevailed in 1999, instead of 650 million ha that were used for production, we would have needed nearly 1.8 billion ha of land of the same quality to produce the current

global harvest. Obviously, such a surplus of land is not available. Moreover, had more environmentally fragile land been brought into agricultural production, the impact on soil erosion, loss of forest and grasses, biodervisity, and extinction of wild life species would have been enormous. Pretty (1995), however said that the alarming rate of deforestation in much of the tropics is the result of the failure to introduce high yielding technologies. Sanchez (2000), reported that as a result of afforestation (trees and shrubs), food crops and grasses trap large quantities of carbon in the process of photosynthesis. Thus, better management of croplands (forest) can counteract effects of climate changes. He comments that if 10 percent of the world's farmers adopted conservation tillage on existing crop lands, improved management of animals grazing areas, use low-impact forest harvesting techniques, 700 million tons of carbon will be trapped each year, that is 10 percent of what enters the atmosphere reducing environmental pollution and safer. Lastly, Leakey (1992), remarked that you have to be well fed to be a conservationist.

2.5.2 Recommendedenvironmentalmanagementpractices

Improved environmental management technologies are any activity (material inputs or agricultural practices) that is voluntarily performed by farmers to maintain or improve the productivity of the soil (Ezeaku, 2012; Akpoko, 2004).

Despite the fact indigenous system of soil,. Water conservation are wide spread, well adopted to local conditions, persistent for long period and are capable of supporting dense population, soil erosion continues to be a problem throughout the world (Dimelu,2012 and IPCC, 2001). Indigenous methods are insufficient alone to prevent agricultural land from continuing to loose productive soil because not all erosion arises from the farmland.

Organic manures include a wide range of materials such as cattle and poultry manure, urban waste, crop residues (Singh *et al*., 2001). Unlike inorganic fertilizers, the composition of these varies considerably (Briggs and Courtney, 1989).

Farm Yard Manure(FYM) has residual effects for at least two years and fertility build-up with time under continuous application and it is superior to mineral fertilizer at higher application rates (Abubakar *et al* 2002). Farm yard manure demonstrates superior restorative effects on degraded soils compared to mineral fertilizer (Ezaeku 2012). Dimelu (2013) reported that FYM is most preferred because it enhances productivity, high quality products, long term nutrient value, increase water infiltration, increases soil biological activities, increase soil aeration and also less environmental pollution.

According to Miko (2003), fertilizer that was highly subsidized to the tune of 80 percent in 1990 became scarce and expensive with reduction in Government subsidy and lower value of Nigerians currency Fertilizer recommendation has always been a blanket one for a whole climatic zone without much reference to soil types and soil testing (Miko, 2003). Nevertheless despite high cost of inorganic fertilizer and to some extent its unavailability at periods of dare need farmers still broadcast fertilizer on their fields instead of incorporation he added. Though this method of application is cheaper and faster, there are serious economic and environmental implications (Valencia and Breth, 1999). In some cases farmers apply higher doses/rates than recommended while in some cases farmers apply below recommended rates and on their field in anticipation of rainfall (Akpoko, 2004).

Highlights of recent advances in soil fertility management according to FAO (2008) and IITA (1986) include the following innovations: application of organic manure in combination with mineral fertilizer, side placement of fertilizer by burying and inorganic fertilizer use be based on soil test values to avoid fertilizer abuse and nutrient imbalance.

Bush burning practices by a large proportion of farmers constitutes a technologically easy answer to the problems of clearing debris from the field prior to planting (Pretty, 1995). Early burning is less destructive than later burning in the dry season and also uncontrolled burning is highly discouraged. The use of light implements for land preparation or bush slashing and manual removal of the biomass to avoid soil compaction is acceptable (Akpoko,2004).

Crop rotation are a central component in the direction of resource conserving farming, with the maximum use made of crops that contributes to soil fertility and reduce pest damage (Pretty, 1995). According to Edwards (1993), other advantages are complimentary use of soil nutrients, the improvement of soil physical properties such as aggregates, water holding capacity and infiltration, soil conservation, organic matter restoration, Striga control in cereals. The approach is to restore non host crop in sequence. It is a practice that rarely has ecological or economic drawbacks and many farmers regard it as an essential component of prudent management.

Ridging is a common method of controlling soil erosion on farm in the savannah and also ridges across the slope is enough to check soil erosion (Antwi and Asiamah, 1993). In high rainfall areas ridges have the tendency to collect water and being able to serve as drainage, they are basically water conservation devices which have the advantage of providing a deep seed bed (Longtau and Gwalvangmin, 2000). Ridges and/or tied ridging had been evaluated as an improved soil and water management practices to alleviate moisture stress. In a study by ICRISAT (2012) shown significant yield increase of sorghum varying from 19 -80 percent over simple ridging. The study also assessed that manual construction of tied-ridges needs 15 man days per ha and at prevailing cost tied ridging gives a benefit cost ratio of 3.3:1 which is attractive for farmers to adopt.

According to Rosnake (2006), the single most important factor contributing to erosion of sloping land is tillage. As a result of clearing the land exposes the soil to the action of weather

and repeated tillage erosion. An alternative approach is to use conservation tillage in which the soil surface is disturbed as little as possible (Pretty, 1995). McCaber (2000), reported that conservation tillage is accepted worldwide. It is therefore a perfect replacement of shifting cultivation in Africa where expansion of crop land has resulted in rapid deforestation as existing crop land is abandoned due to loss of fertility, soil degradation and severe erosion. Bremer *et al*. (2001), reported that adoption of conservation tillage (CT) and cover crop system for erodible soil offers a practical means of preserving soil productivity.

Soil, water and nutrient conservation is also improved with the use of mulches or cover crops (Pretty, 1995). Similarly, organic or inorganic material is spread on the soil surface to provide a protective cover, the mulch, for the top soil protects it from soil erosion, desiccation and excessive heating. Cover crops consists of vegetation that is deliberately established after or inter cropped with a main crop, not necessarily with a view to harvest but to serve various regenerative and conserving functions (Pretty, 1995). The adoption of crop-residue mulching by small holders in the sub-humid/sub-tropics often require the creation of an enabling environment through technological or institutional change. One option to enhance the attractiveness of mulch is to link the mulch component to other technological changes that do generate a short term productivity boost such as improved varieties and fertilizers (Dimelu,2013).

Vertiver assist soil not to lose its fertility, minimize wind and water erosion and also farmers do not waste their inputs i.e. assist plant in making the best use of applied water and fertilizers (KNARDA, 2002). However, Pretty (1995) reported that for small scale farmers, vertiver should be planted on the farm boarder at 20 cm spacing while large scale farmers; it should be planted on contour i.e. across the slope.

Water harvesting system commonly includes a run-off producing and a run-off using area, water harvesting can be found in many parts of the world (UNEP, 1983; Reji, 1991). Rain water

run-offs can be collected and stored from different catchments areas such as ground surfaces, seasonal water courses, building roof, etc. It can be collected and stored in artificial water reservoirs, such as ponds, basins or tanks. From there, the water can be directed to a crop land for crop production, for supply to livestock, domestic consumption or other productive uses (Nega and Quinomes, 2004).

Longtau and Gwalvangonin,(2000) reported that irrigation agriculture requires optimum use of water management to attain maximum crop water efficiency with little or no damage to soil and environment in order to avoid poor irrigation schedule ,indiscriminate application of water should be avoided

King and Chandler (1978), defines agro-forestry as a sustainable land management system which has the potential for increasing the overall yield of the land; combines the production of trees (ligneous species) with crop simultaneously or sequentially on the same unit of land. This approach is the ration utilization of improved resources leading to improved ecosystem (ICRISAT,2012). Increase in population has forced people to open more land, colonize marginal lands with the attendant general environmental degradation problems (Miko, 2003). The desertification consensus as perceived by the then eleven northern governors at a meeting; is summarized in a report of the Consultative Committee on Desert Encroachment (CCDE, 1988), that deforestation for agricultural purposes and fuel wood is a commonly source for rural energy production system. The report also indicated that the causes of deforestation are hence many and include excessive use of wood fuel energy and destruction without reforestation, agricultural land expansion, even into grazing and forest reserves, over-grazing and bush burning. ICRISAT (2012) gave an outline of the afforestation innovations as avoid burning of farmland, regulate grazing, only aged and dead plants are cut down. Taah (2000) went further to add that selection of seeds/seedling, time and pattern of transplanting, fencing of seedlings, weeding and fertilizer application.

DeRouw (1988), reported that burning reduced the seed pool of the forest soil by 50 percent but advanced the germination of surviving seed by 2 weeks. He also said that planting of crops soon after burning was recommended to minimize the weed potential of those species whose germination was enhanced by burning. In a field study of control measures, fire killed seeds at the soil surface but enhanced germination of seeds buried to 5cm depth (Taah,2000).

Moreover, there has been an increase of livestock in this tsetse fly free zone, resulting in critical ratios of biomass to animal and consequently overgrazing, loss of vegetation and desertification (Longtau and Gwalvangmin, 2000). Besides overgrazing of the available pasture, branches, evergreen seedling are often lopped-off to provide fodder for livestock during the dry season. This practice result in further degeneration of the zone (Idirissa, 2008).

Wood cutting, commonly described as indiscriminate, reduces biomass and exports nutrients from the ecosystem. Its effects, however only become noticeable where off take exceeds the rate of natural regeneration of the specie concerned. The specie of the tree may be coppiced, pruned or pollarded. Some trees used in agro-forestry, such as Acacia angustissima, coppice after cutting at the end of the fallow phase and then grow during the subsequent cropping phase. The new growth of the trees is normally cut and mulched or incorporated at the beginning of each crop to reduce tree-crop competition and to cycle tree crop nutrient tree foliage to crop (Kwesiga *et al*., 1988).

Farm clearing is the principal cause of deforestation, although selected trees are normally protected on small holdings. A good number of shrubs should be maintained 12 – 15/ha, maintaining and protecting trees which are useful, including shade trees (ECA/FAO, 2000). During land clearing some species of trees where preserved and are generally not cut and use as a regular source of fuel wood or other timber products; they therefore form the common species on farmland and fallow land. They provide revenue and food product at the time of extreme food scarcity each year (Krani-Berisavijevia *et al*., 2000). In a study by Tahidu (1997),

on the percentage retention of indigenous trees on their farms, during land preparation, 100% shea trees were maintained followed by 85% of dawadawa, 75% neem trees and 65 percent mango.

Taah (2000), highlighted on the best way to manage agro forestry trees these are selecting and planting of good varieties of trees especially those that are fast growing, do not shade crops, drop litter, valuable, tolerate bush fires, serve as good wind breaks, response to fertilizer, thinning out trees according to a well laid out plan. Ideal time to transplant seedling is at the mid of raining season, avoid species with large dense crown or species with roots extending far beyond crown line or trees that use a lot of water in drier areas or species that gives off toxic chemicals as a defense against competing weeds, most preferably neem, Eucalyptus, Parkia, Acacia nilotica, A. albida (ECA/FAO, 2003). IITA (1996) reported that planting pattern of seedling in alternative rows of planting components; trees along boarders of fields, alternate strips or alley cropping and mixture of planting components.

2.5.3 Constraints to Adoption of recommended environmental management practices

Insecurity of land tenure particularly leasing arrangements, absentee ownership, small operating units and higher property taxes have been hypothesized to be institutionalized obstacles to adoption of recommended environmental management practices (Akpoko, 2004). Dimelu (2013), stated that the perceived cost and compatibility of innovations are key determinant in the adoption decision process model.. He further reported that when farmers find recommended farm innovations not to be technically feasible, economically viable and culturally compatible, they often reject such innovation. Mokonnen (1991), in a similar vein stated that farmers often reject innovation when innovations are inappropriate or unrelated to their needs and problems.

Akpoko, (2004), identifies other constraints to adoption are fear of risk and uncertainties, fear of the consequences, desire to preserve traditional ways and general unwillingness to change. FAO (2008), went further to add some constraints to adoption as, absence of the problem, inappropriate innovations, incorrect identification of adoption domain, local practices better and poor extension.

2.6: Theoretical frame work

This study will be guided by the theory of social change based on the adoption and infusionist perspective, and the perspectives on technology and impact assessment.

2.6.1: Social change theory

Donohor and Palmgreents (1976), defines theory as a set of inter-related constructs (concepts), definitions and propositions that present a systematic view of phenomena by specifying relations among variables with the purpose of explaining and predicting the phenomena. On the other hand, Moore (1963), defines social change as the significant alteration of social structures including consequents and manifestations of such structures embodied in norms, values and cultural products and symbols. Strauss (1959), stressed that essence of human life is change, development and growth. These three words; change, development and growth are often used interchangeably to associate the dynamics of society with progress. The change could be retrogressive which refers to change in an undesirable direction or progressive meaning in a desirable direction. However, Adekoye and Tologbonse (2005) stated that the only thing that is permanent is change because it is always taking place as everyone adjust to one thing or the other every time. They went further to add that change can be viewed as a state of dynamism, which precludes stagnation and if well managed and directed ways implies progress and development.

The theory of social change seek to understand the social reality in which agricultural activities make use of natural resources (soil, water and air) and this have shaped the natural environment and landscape. Agricultural activities have both beneficial and harmful impacts on the environment through changing the quality or the quantity of locally available natural resources, which are also foundation of natural habitats, biodiversity and landscapes. The foregoing brief description of social change shows clearly how changes have occurred in soil, water and air as a result of mans effort in agricultural activities and efforts embark to mitigate the negative impacts.

2.6.2: Adoption and diffusion of innovation theory

Adoption, according to Rogers (2003) is a mental process, which an individual passes through in deciding to use an innovation. Also Ewuola (1988) noted that adoption is synonymous to transfer of technology.He defines transfer of technology as that which embraces all efforts to make sure that the farmers adopts new technology. He emphasized that for transfer of technology to take place, it must embraces input support, advice and other essential so that farmers will have no reasons for rejecting the technology. Before any technology is adopted according to Hoffmann, (2005) it must pass through a process of adoption, which involves, awareness, interest trials, evaluation and adoption. The success of the adoption process depends very much on effective instructor, by extension agents, which is determined by methods and techniques of instruction used.

Diffusion, according to Rogers (2003) is the process by which an innovation is adopted or gain acceptance by members of a community. Rogers (1995) defines diffusion as the process by which an innovation is communicated through certain channels over time among members of a social system. According to him a number of factors interact to influence the diffusion of innovation. These are the innovation itself, communication channels, time and the nature of the social system in which the innovation is being introduced, Adekoya and Tologborse (2005)

stated the process of diffusion is a precursor to adoption, although this does not necessarily always end in the latter. However, David and David (2000), reported that adoption and diffusion are the process governing the utilization of innovation.

In another study, Nda (2008) demonstrated that farmers followed an ordered, sequential process over time, and were likely to adopt practices in sets if they offered a means of arresting declining returns per production unit. Farmers made a rational decision not to adopt practices which do not have a socio-economic advantage to them.Traditional studies of innovation adoption behavior have asserted a modernity continuum from traditional to modern poles (Rogers, 2003), described reactive and pro-active forms of resources management.

2.6.3 Concept of technology

Ikoku (1981), defined technology as the embodiment of useful knowledge that has been effectively evolved and adapted to practical use and is available to be applied for the purpose of meeting man's immediate economic and social needs as determine by him. It entails all the new methods that increase agricultural production. Famoriyo (1982), also defined technology as the accumulation of scientific knowledge and its adoption to suit conditions of man's environment.

The adoption of improved practices/innovations and transfer of improved modern technologies to the predominantly farming populace of this country is one of the greatest challenges facing agricultural scientist and the extension services in Nigeria (Adekoya and Tologborse (2005). Many reached the farmers, few are adopted initially, and while very few are eventually adopted with many discontinued. The reason for this may not be far-fetched

from lack of adequate consideration of the factors influencing the adoption behavior of the target audience before introducing the improved practices to them (Onazi, 1973).

The relevance of the above discussions is that it will help in the understanding of the type of recommended environmental management technologies used by farmers in the study area.

2.6.4Conceptualframework/model

A model is a figurative representation of a perceived object used to guide one in the pursuit of knowledge (Adeniji, 2002). Theoretical model is meant by 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 (Ekong, 2003). The conceptual famework/model for this study is presented in Figure 1. The model for this study posits that the independent variable consisting of socio-economic characteristics of farmers, institutional variables and attributes of the recommended practices would influence dependent variables adoption of the recommended environmental management practices. Similarly, this model posits that adoption of recommended environmental management practices will lead to increase in yield and increase in income of the farmers.

Explanations of the Model of the study

In reference to this study, the model has four main aspects. These include independent variables, which constitute all the factors under investigation namely, the socio-economic variables, (personal and institutional characteristics of the farmers), awareness, perception, type of technology and production/adoption constraints; intervening variables, the dependent variable (adoption) and the impact variables.

The independent variables include farmer's age, education, experience in farming, farm size, household size, income level, exposure to other farms, access to market, extension contact, access to capital, source of information, social participation,, include farmers' awareness of technology, their perceptions, attributes of technology and farmers' production constraints.

The intervening variables include government policies, cultural/religious factors, and technology delivery mechanisms,technological change and market forces.

The dependent variable is the adoption of recommended environmental management practices,while the impact variables are the proposed effects of the influence of the dependent and intervening variables on technology adoption. These effects are knowledge acquisition, skill acquisition, farm production and increased yield,increased income,and level of living

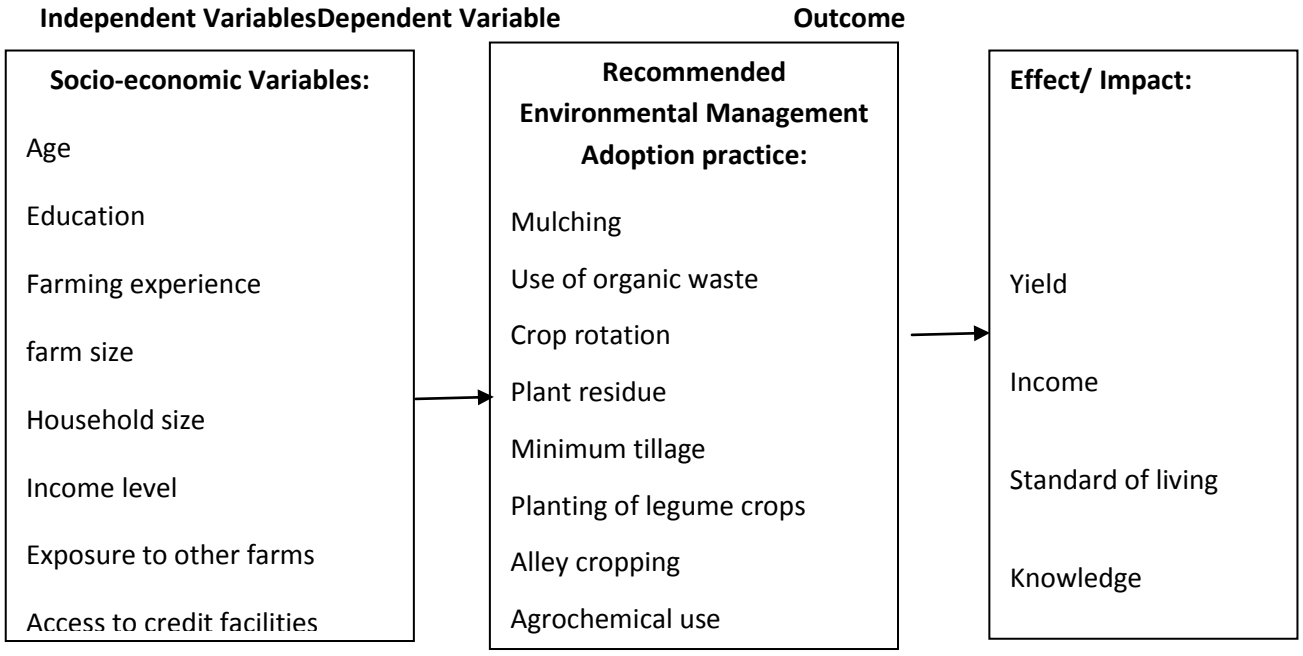


Figure 1: Conceptual framework of the study showing factors influencing adoption recommended environmental management practices by farmers

CHAPTERTHREE

METHODOLOGY

3.1 Study area

The study was conducted in Jigawa State. The State was carved out of the old Kano State in 1991 and it has twenty seven Local Government Areas (LGAs) with Dutse as the State capital. There are five Emirates namely: Hadejia, Gumel, Kazaure, Dutse and Ringim. Most of the land

in the State is classified as Sudan savannah, characterized by an annual rainfall of 300 – 600 mm during the rainfall period (May – September). However, the extreme northern part of the State is Sahel savannah, with an annual rainfall of less than 300 mm, with evidentsand dunes.

The State has history of severe droughts (Hassan, 1999). Soils in the region are classified as ferruginous tropical, brown and reddish brown, generally of poor structure and low fertility (Mortimore, 1989). The hot and dry climate in most of the dry land region causes bare unvegetated soils to easily heat up, especially during dry season, resulting in soil backing. Coupled with high evaporation rates, the soil becomes powdery and susceptible to wind and water erosion, crops suffer the stress effects of prolonged moisture deficiency (Hassan, 1999). Gully erosion is evident throughout the State.

Jigawa State occupies a land mass of about 24,410 Square km with a total population of about 4,348,679 million persons based on the 2006 census figures (NPC, 2006). The State is bounded on the north by Niger Republic, north east by Yobe State to the east by Bauchi and west by Kano State.Agriculture is the mainstay of the economy of the State (80% of the population are farmers). The predominant crops grown are millet, sorghum, cowpea, groundnut, rice, sesame, wheat and maize. The State is blessed with abundant livestock such as cattle, sheep, goats, chickens and fish.

3.2 Samplingproceduresandsamplesize

A multi stage sampling procedure was employed for this study. The first stage involved purposive selection of two agricultural zones (Gumel and Hadejia) out of the four (Birnin Kudu, Gumel, Hadejia and Kazaure) agricultural zones in the State, based on the fact that the two zones considered for the study are the zones that have received and conversant with the recommended environmental management practices for agricultural productions. In the second stage, two Block Extension Areas(BEAs) per zone were randomly selected from the total of 22 BEAs.Finally, a simple random sampling was employed in selecting farmers from

each of the villages. Ten percent (10%) of the sample frame (1203) was used as the sample size. In all, 120 farmers were randomly selected.

Table 3.1: population and sample size of farmers

LGA's	Villages	*Sample frame	Sample size (10%)
Zone 1	BEA 1	297	30
	BEA 2	309	30
	BEA 1	148	15
Zone 2	BEA 2	449	45
Total		1203	120

* Source: reconnaissance survey, 2014

3.3 Methodofdatacollection

Primary data were used for this study. These were collected with the aid of interviewed schedule. The information were collected on demographic information, institutional factors, attributes of recommended environmental practices, level of adoption, and constraints of adoption of recommended environmental management practices.

3.4 Analytical Techniques

The analytical tools used were descriptive statistics and multiple regression model.

Descriptive statistics was used to achieve objectives (i), (ii), (iii), (iv) and (vii) of the study. It involves the use of measures of central tendency such as mean, frequency distribution and percentages.

Multiple regression model was used to achieve objectives (v) and (vi) of the study. The model for this study was specified as:

$Y = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \ldots \beta_7 X_7 + U$

Where:

Y = adoption

X_1 = Age (years)

X_2 = Level of education (years of schooling)

X_3 = Farming experience in crop farming (in years)

X_4 = Farm size (hectares)

X_5 = Family size (number of people in the household)

X_6 = Extension contact (number of visit in a year)

X_7 = Amount of credit obtained (naira)

U = Error term

β_o = Constant

β_1-β_{15} = regression coefficients

3.5.1 Operationalizationand Measurement of Variable

The variables for analysis in this study were age, level of education, farming experience, farm size, family size, extension contact, credit, and leadership status, farmer's knowledge of the innovation, social participation and land tenure.

3.5.2 Measurement of awareness, perception and constraints

Farmers' awareness,perceptions and constraints was measured in each case using a five point Likert-type scale ranging from "undecided" (scale 1) to "strongly agree" (scale 5). Respondents' perception of the constraints associated with the recommended environmental management practices was alsomeasured on a five point Likert type scale with response options ranging from "undecided" (scale 1) to "very serious" (scale 5). Responses of the4-point and 5-point scales werecategorized according to their mean scores. Responses on 5 point Likert-scale with mean scores of 3.50 or above were classified as good, while those with mean scores below 3.50 will be classified as poor. On the other hand, responses on 4 point Likert-scale with mean scores of 2.50 or above were classified as good, while those with mean scores below 2.50 were classified as poor.(Aphunu and Ajayi 2010).

Adopting Bagheri (2010) and Bagheri *et al*. (2008) perception analysis, the means for all indicators were then categorized as follows; the means 1.00-1.49= Strongly Disagree (SD), 1.50-2.49= Disagree (DA), 2.50-3.49= Undecided/Neutral (U/N), 3.50-4.49= Agree (AG) and 4.50-5.00 = Strongly Agree (SA). The respondents' perceptions were prioritized according to the mean on these statements. The perceptions on environmental management practice were calculated by obtaining a weighted mean on the farmers' responses.

In a similar vein according toAjayi(1998), a 5-point Likert scale could be used to analyze a number of perception statements to obtain the perception index. The result will later be categorized into weak perception, strong perception and very strong perception depending on weather the value is less than 0.5 or greater than 0.5.

Measurement of respondents perception will be achieved by the use of such computational tools as perception index adopted from Dimelu (2013) and represented as follows:

$$\text{Perception index} = \frac{\text{Sum of (X)}}{\text{N statements}}$$

Where (X) = Total perception scores

N = Total number of perception statement

If the computed index is less than the calculated mean score, the decision is weak or poor perception, if it is greater the decision is strong perception and if they are equal the decision is that the farmers are indifferent to the object of measurement.

3.5.3 Independentvariablesandtheirmeasurements

i. Age: Youthfulness is associated with adoption of innovation (Atala, 1988). The age of the farmer was determined by the number of years from birth, stated by the farmer at the time of survey.

ii. Level of education: The higher the level of education the better the chance to adopt innovation (Chianu and Tsuji, 2004). Level of education was determined by the formal education attained. Formal education was determined by total number of formal school years attained.

iii. Farming experience: The less the farming experience the less the ability to understand environmental problems (Roger, 2003). Farming experience was determined by the number of years engaged in farming.

iv. Farm size: Farmers with large farm sizes will easily adopt environmental innovations (Ezeaku, 2012). Farm size refers to the total number of hectares of farm land cultivated in the previous years.

v. Family size: Labor demanding technologies was easily adopted in a large family (Dimelu,2013). The total number of people eating from the same pot constitute the measurement.

vi. Extension contact: Farmers contact with agricultural extension agents has been reported to improve adoption of technologies (Hamidu *et al*,2006). This is defined as the frequency of contact of farmers with extension workers. It was measured by the total number of times a farmer received training orinformation on recommended environmental management practices.

vii. Credit: Credit support has been shown to influence adoption (Ahmed *et al*., 2002). Credit was determined the access to the institutional and non-institutional credit obtained in cash for the purpose of adopting recommended environmental management practices in the past years.

viii. Leadership status: Leadership structure in a community is a factor affecting adoption either positively or negatively (Williams *et al*., 1984). Was determined by any leadership position held in the community.

ix. Farmers knowledge of the innovation: Knowledge of an innovation has an influence on adoption (Iwuchuku *et al*,2013). Was determined by the use of perception index as adapted from the works of Likert which involves a lot of perception statements with

scores based on the expected responses from the respondents. Each response to the perception statement will be computed with a mean perception score.

x. Social participation: Social participation enhances interaction and exposes farmers to information about improved technologies leading to adoption (Yusuf, 2013). Refers to the number of associations the respondent belongs to.

xi. Land tenure: For land under lease/loan or share cropping hardly any environmental technology can be adopted in such farms (Akpoko, 2004). To be measured by determining methods of land acquisition with inheritance = 6, hire = 5, gift = 4, bought= 3, pledge =2, Government = 1.

xii. Compatibility Index: An important dimension of compatibility of an innovation is the degree to which the innovation meets the needs of the potential adopters. It is of course obvious that innovation with a high degree of compatibility as perceived by the respondents the higher the level of adoption (Hamidu *et al*,2006). The following questions determine the compatibility:

i. The recommended technologies are similar to the existing ones.
ii. The innovation meets my needs
iii. The recommended technologies gives me satisfaction
iv. The recommended technologies fit well into the existing farming systems.

One (1) was assigned to compatibility of the technology and zero (0) to non-compatibility of (No) the technology.

xiii. Complexity index: This variable determines how complex or easy to adopt the recommended innovations. For this study complexity would be measured by asking the following questions:

i. Training is required to correctly apply the recommended technology.

ii. It is difficult to use the recommended technologies correctly

iii. The recommended technologies are too technical

iv. The level of skill required to use the recommended technologies is too high.

One (1) was assigned to the complexity (Yes) of the technology and zero (0) to non-complexity (No) of the technology.

xiv. Relative advantage: For every advancement in technology, it is expected that such technology would have advantage over the existing ones (Olaniyan, 1998). It is conceived that the more a farmer perceive the practice as having relative advantage over the traditional practices, the higher the probability of its wide spread acceptance and use. This was measured by 3 points Likert scale.

(i) The skills required to use recommended technologies can be easily acquired

(a) Strongly agreed=5 (b)Agreed=4 (c) Undecided=3 (d)Disagree=2, Stronglydisagreed=1

(ii) The recommended technologies is cheap/economical to adopt

(a) Strongly agreed = 3 (b) Agreed = 2 (c) Undecided = 1 (d) Disagree = 0

(iii) The recommended technologies provide higher yield

(a) Strongly agreed = 3 (b) Agreed = 2 (c) Undecided = 1 (d) Disagree = 0

(iv) The recommended technologies provide higher income than the old ones

(a) Strongly agreed = 3 (b) Agreed = 2 (c) Undecided = 1 (d) Disagree = 0

(v) The recommended technologies make use of less inputs to give the same output as old practices

(a) Strongly agreed = 3 (b) Agreed = 2 (c) Undecided = 1 (d) Disagree = 0 (All these are questionnaire questions)

3.4.2 **DependentVariables**

Adoption of recommended environmental management practices were as follows:

i) Land clearing/bush burning – use of rake to clear all farm land highly discouraged because left over stalks, branches, leaves can decompose to increase organic matter content of the soil, indiscriminate burning of farmland is very bad only spot burning of unwanted debris is acceptable.

ii) Crop rotation: cereal-legume interchanging for soil fertility improvement, soil erosion control and suppression of weed. Continuous cropping of either cereal or legume is not advantageous.

iii) Inorganic fertilizer: Application of inorganic fertilizer to restore soil fertility. Best method is by spot application, dig and bury the fertilizer.

iv) Combine application of organic and inorganic fertilizer: for better soil fertility improvement use both organic and inorganic fertilizers.

v) Ridging: Ridging can be used to harvest rain, burying of plant debris to decompose faster and also cross-ties to check soil erosion.

vi) Conservation Tillage: Planting of crops with minimum soil disturbance, plant material are use as mulch which improves the physical and chemical properties of the soil.

vii) Use of light drawn implements: Such as ox-drawn plough for land preparation causing minimum soil disturbance.

viii) Vertiver grass: This is planted along the borders of farms, water ways to traps and check both wind and water erosion.

ix) Agro-forestry: Planting of economic trees and non-economic trees such as mango, Parkia, A. nilitico, A. senegalensis whose branches when cut, will ultimately be use to improve soil

fertility. Establishment of communal nurseries, care-maintenance of trees seedling such as watering, fertilizing, fencing, transplanting pattern (spacing), pruning.

x) Rain water harvesting: This is the harvesting or collecting of run-off waters in to reservoirs' built in the farm along the run-off sites. Rain water harvesting reservoirs can be used to grow crops all the year round, ecology of the surroundings have change thereby increase in plant biomass resulting to increase soil fertility.

xi) Safety use of pesticides: to determine if the safety procedures were observed when application of pesticides both in and off the field.

xii) Mulching: Mulching of crops reduces evaporation and drying off of farmland, reduces rain drop splashes, encourages water infiltration.

Adoption scores: will be calculated by summing up the number of practices the respondent reported as using on a continuous and large-scale basis. Each score practice will be assigned a score of 1 if the response was Yes and No = 0. The number of techniques reported adopted will constitute the total score for the individual respondent (All recos should be listed to form an index from which a farmer selects the one/s adopted this will give the adoption index as such the level of adoption)

Expected outcomes measurement

i. Yield : This was measured as total weight in kg/ha of the harvest of the major crops grown by the farmers.

ii. Income: This was the money realized from the sale of harvested products. Income was measured by the total estimated value of income in Naira terms as given by the respondents for each major crop.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socioeconomic Characteristics of Crop Farmer

4.1.1 Age distribution of crop farmers

The result in Table 4.1 shows that about 37% of crop farmers were within the age range of 31-40 years, with mean of 42 years. The average age of crop farmers was found to be approximately 42 years with minimum of 24 years and maximum of 70 years. The implication of this finding is that large proportion of the crop farmers in the study area were adults and can adequately be regarded as active, agile and physically disposed to farming activities. Age is expected to have negative influence on the respondent's participation in improved crop production that is why younger farmers are more active in the production of this crop. This agrees with the finding of Nwanko *et al.* (2009) and Institute for Agricultural Research (2001), who reported that the most active farmers' age group engaged in agricultural production is within 31- 50 years.

Table 4.1: Age distribution of crop farmers (n=120)

Age (years)	Frequency	Percentage	Mean
21-30	20	16.7	
31-40	44	36.7	
41-50	42	35.0	42
51-60	11	9.1	
61-70	3	2.5	

4.1.2 Family size of cropfarmers

The result in Table 4.2 shows the distribution of crop farmers by family size. Half (50%) of the crop farmers had household size that ranged from 1-5 persons in their family with an average family size of 7 persons. The maximum family size observed was 30 persons with a minimum of 1 person in the study area. This implies that the farmers in the study area might have advantage of family labour availability if many household members participate in farms. However, the implication of large family size is that it will increase household consumption expenditure which would compete with production for limited financial resources within the household. According to Okoruwa and Ogundele (2006) large family size does not necessarily translate to higher use of family labour because some of the young able bodied family member may prefer other jobs than farming. This finding is also in line with Solomon (2008) and Banmeke (2003), which indicates that large household size assist more on farm and other household activities.

Table 4.2: Distribution of crop farmers according to their family size (n =120)

Family size (number)	Frequency	Percentage	Mean
1-5	60	50.0	
6-10	32	26.7	
11-15	12	10.0	7
16-20	15	12.5	
>20	1	0.8	

4.1.3 Educational level of crop farmers

The result in Table 4.3 revealed that about 23.3% of crop farmers had no formal education while about 76.7% had one form of education or the other. However, about 78% of the farmers are literate. Literacy is believed to have a positive implication on efficient use of

productive resources and adoption of farm innovation. The level of farmers' education is believed to influence the use of improved technology in agriculture and, hence, farm productivity. The level of education determines the level of opportunities available to improve livelihood strategies, enhance food security, and reduce the level of poverty. It affects the level of exposure to new ideas and managerial capacity in production and the perception of the household members on how to adopt and integrate innovations into the household's survival strategies. This finding is in line with Amaza (2000), who reported that education has a positive and significant impact on farmers' efficiency in production. Thus, literacy level will greatly influence the decision making and adoption of innovation by farmers, which may bring about increase in productivity.

Table 4.3: Distribution of crop farmers according to their level of education (n =120)

Education (years)	**Frequency**	**Percentage**
No formal education	28	23.3
Quranic education	22	18.3
Primary education	17	14.2
Secondary education	39	32.5
Tertiary education	14	11.7
Total	120	100

4.1.4 Farming experience of crop farmers

The result presented in Table 4.4 shows that about 43% of crop farmers had 11-20 years of experience. The maximum farming experience observed was 40 years with a minimum of 3 year and average of 18 years of experience in crop productions. The farming experience shows that farmers will be able to make sound decisions as regards resources allocation and

management of their farms. This findings is in line with Ajani (2000) in his study on productivity in food farming in northern area of Oyo State where he revealed that year of farming experience increased agricultural productivity among farming households in Nigeria.

Table 4.4: Distribution of crop farmers according to farming experience (n =120)

Farming Experience	Frequency	Percentage	Mean
1-10	36	30.0	
11-20	51	42.5	18
21-30	27	22.5	
31-40	6	5.0	

4.1.5 Distribution of crop farmers according to farm size

The result in Table 4.5 shows that the majority (90%) have farm size ranging from 0.1 to 2 hectares. The maximum farm size observed was 7 hectares with a minimum of 0.3 hectares and average of 1.3 hectares in crop production. This show that majority of the farmers have small farm sizes and will not be able to enjoy economy of scale in production.Similarly, small farm sizes is an impedement to agricultural mechaniztion because using farm machineries like tractor will be difficuilt. Small farm sizes might be as a result of the fact that most of the farmers got their land through inheritance.

Table 4.5: Distribution of crop farmer according to their farm size(n =120)

Farm size (hectares)	Frequency	Percentage	Mean

0.1-2.0	108	90.0	
2.1-4.0	9	7.5	1
>4.1	3	2.5	

4.1.6 Credit obtain by crop farmers

The results in Tale 4.6 indicated that the majority 60% of farmers had access to credit to finance their crop production activities while about 40% had no access to credit. Adequate funding is required by farmers to finance all crop production activities. However, a large number of farmers had access to funds to finance their crop production activities, which in turn improves their level of production. This implies that the farmers have fund to purchase farm inputs and adopt farm innovation. Ekong (2003) asserts that credit is a very strong factor that is needed to acquire or develop any enterprise; its availability could determine the extent of production capacity.

Table 4.6: Distribution of crop farmers according to credit obtained.

Credit obtained (₦)	**Frequency**	**Percentage**
No access	48	40.0
Access to credit	72	60.0
Total	**120**	**100**

4.1.7 Membership of cooperative society

The result in Table 4.7 revealed that about (5.8%) of crop farmers do not participate in any cooperative association while those who were members of cooperative society constituted 94.2% of farmers. Membership of cooperatives influences the adoption of improved technologies resulting in higher productivity and poverty alleviation. This implies that farmers had opportunity of interacting with other farmers to enhance diffusion and adoption of innovations among the farmers. This finding is in line with Odebiyi (2010) that cooperative groups ensure that their members derive benefits from the groups such as they could not derive individually. According to Idiong *et al*. (2007), membership of cooperative affords the farmers opportunities of sharing information on modern crop practices.

Table 4.7: Distribution of crop farmers according to cooperative association (n =120)

Cooperative association	**Frequency**	**Percentage**
Non members	7	5.8
Members	113	94.2
Total	120	100

4.1.8 Distribution of farmers according to their income

The result in Table 4.8 shows that majority of farmers (57.5%) had no other sources of income. Those who had income from non-farm activities ranges between ₦1000 – ₦500,000 constituted only (26%) with minimum and maximum amount of ₦5,000 and ₦1,500,000, respectively. This means that farmers in these communities relied absolutely on farm business and must have acquired a lot of farming experience over time. This study is at variance FAO (1999), employment in non-farm activities is essential for diversification of the sources of farm

household's livelihood. It enables households to modernize their production by giving them an opportunity to apply the necessary inputs

Table 4.8: Distribution of crop farmers according to their income (n =120)

Income (₦)	Frequency	Percentage	Mean
Zero non-farm income	69	57.5	
1-500,000	31	25.8	340,000
500,001-1,000,000	18	15.0	
1,000,001-1,500,000	2	1.7	

4.2 Level of Awareness on Environmental Management Practices

Awareness is the first stage of adoption process and involves the farmers learning of the existence of an innovation of a programme. To determine the level of awareness of environmental management practices, there is need to know if the farmer is aware of the programme and sources of awareness.

4.2.1. Awareness of Environmental Management Practices (EMP)

The promoted technologies on environmental management practices by crop farmers were presented in Table 4.9. The result reveals that Majority (95.8%) of the respondents were most aware mulching, use of organic waste (91.7%), crop rotation (75%), and plant residue (71.7%). The technologies they were least aware of are pesticides usage (18.3%), farmyard manure (19.2%) and agrochemical usage (30%). This may be due to careless attitude of some farmers or voluntary withdrawal after being first nominated as participant. However, crop farmers were more aware of environmental management practices in the study area.

Table 4.9 Distribution of Respondents based on the Awareness of EMP

Awareness Recommended EMP	*Frequency	Percentages	Rank
Mulching	115	95.8	1st
Use of organic waste	110	91.7	2nd
Crop rotation	90	75.0	3rd
Plant residue	86	71.7	4th
Minimum tillage	57	47.5	5th
Planting of legume crops	47	39.2	6th
Alley cropping	45	37.5	7th
Agrochemical use	36	30.0	8th
Farm yard manure	23	19.2	9th
Pesticides overuse	22	18.3	10th

***** Multiple responses was allowed

4.2.2 Sources of information on environment management practices

The sources of information about environmental management practices are presented in Table 4.10. the result reveals that 74.2%, 53.3% and 42.5% of the crop farmers got to know of environmental management practices through extension agent, friends and relatives, and radio respectively while 35% and 23.3% of the crop farmers got to know of EMP through newspaper and television respectively. This implies that the extension agents are the major source through which information is disseminated to the people in the study area. However, iinformation obtained from friends about environmental management practices are often misleading as they contain a lot of misinformation, distortion, falsehood and misconceptions, and often times self centered. This finding is in consonance with reports obtained from Josaphat *et al*., (2006) who also ranked extension agent as the major source of information on environmental management practices among crop farmers.

Table 4.10: Distribution of farmers according to sources of information on environmental management practices

Information source	*Frequency	Percentage	Rank
Extension agent	89	74.2	1st
Friends and relatives	64	53.3	2nd
Radio	51	42.5	3rd
News paper	42	35.0	4th
Television	28	23.3	5th

***** Multiple responses was allowed

4.3. Perception of crop farmers on environmental management practices

There was no general consensus on the practices perceived to contribute to environmental management.

The result presented in Table 4.11 shows that there was a high perception that mulching ($\bar{x}$=4.7) may lead to pest harbouring. A study by Roling and Pretty (1997) contrast these results by indicating that farmers insisted on mulching as the easiest way to conserve soil against erosion and land degradation.

Table 4.11: Mean response of farmers on their perception of environmental management practices

s/no	Perception on Recommended practices	SA	A	U	D	SD	WS	MS
1	Mulching	75	14	25	7	39	559	4.7
2	Use of organic waste	13	13	26	10	98	313	2.6
3	Crop rotation	90	23	1	1	0	547	4.6

4	Plant residue	0	17	47	8	88	313	2.6
5	Minimum tillage	5	21	13	56	0	256	2.1
6	Planting of legume crops	47	28	12	12	11	418	3.5
7	Alley cropping	45	27	20	14	14	435	3.6
8	Agrochemical use	23	11	15	10	54	278	2.3
9	Farm yard manure	36	32	4	1	0	320	2.7
10	Pesticides overuse	88	25	3	2	4	557	4.6

Key: SA=strongly Agree, A= agree, U=undecided, D=disagree, SD= strongly disagree, WS= weighted score and MS= mean score

Crop rotation ($\bar{x}$=4.6) was strongly agreed as a practice that helps in weed control. Crop rotation makes rational use of the land, assures steady high yields and permits greater diversification. 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 finding agrees with those by Bagheri (2010) where potato farmers had a positive perception about the role of crop rotation in Ardabil Province of Iran.

There was a high perception that pesticide overuse may lead to pest resistance. A study by Roling and Pretty (1997) contrast these results by indicating that farmers insisted on insecticide application as the easiest way to combat pests, despite the awareness that insecticides are the major environment pollutants and their over-application makes insects resistant. Farmers strongly agreed that successive cultivation of a single crop increases pest invasion hence there is need to practice crop rotation as a way of reducing the build-up of pests. Agrochemical inputs were also perceived as environmental pollutants but only for

human and animal health. These results is in line with those of Roling and Pretty (1997) and Rahman (2003).

Cultivation of legume crops ($\bar{x}$=3.5) and application of alley crop ($\bar{x}$=3.6) was perceived by the respondents as practices which improve soil fertility, soil structure and help to suppress weed population. The results are consistent with those by Bagheri *et al*. (2008).

Despite the numerous emphases on retaining plant residues in the preservation of soil texture and nutrients, the respondents ($\bar{x}$=2.6) were not sure if this could increase weed population during the next growing season. At the same time, farmers were uncertain if plant residues would help in soil erosion control as well as protect the soil from exposure to harsh environmental conditions. This calls for the need for extension agents to train farmers on importance of plant residues in crop production.

The respondents were not sure if substituting chemical fertilizer use with organic fertilizer ($\bar{x}$=2.6) and farmyard manure ($\bar{x}$=2.7) would increase crop output in the long run. Contrary to these results, a study by Bagheri *et al*. (2008) indicated that most farmers perceived agrochemicals as the best means to increase production in the short run. Despite minimum utilization of external farm inputs under Organic Farming, the farmers were neutral on the argument that Organic Farming would reduce the cost of production. Perhaps this is because more labour is required in preparation and application of farm yard manure, compost manure which are the key sources of soil fertility under Organic Farming.

Farmers disagreed that minimum tillage operations ($\bar{x}$=2.1) decrease soil fertility. Instead, they recognized their over-cultivation destroys the soil structure. These results tally with those of Bagheri (2010). In addition, Rabiee *et al*. (2006) indicated that minimum tillage gives the best paddy residual management in regard to reduced costs and time, betterment of soil structure and drainage.

The respondents disagreed on agrochemical use ($\bar{x}$=2.3) as the major farm input and therefore chemical fertilizer alone cannot lead to the highest yields hence, they advocate for environmental management practices. Excess or uncontrolled use of chemical inputs can spoil the soil properties such as water holding capacity. It may also affect adversely the population of micro-organisms in addition to damaging water resources (Kang, 1993). Regarding the role of cover cropping, the respondents disagreed that this practice would lead to soil erosion. This is because cover crops protect soil from erosion, improves soil fertility by reducing nutrient leaching, improve soil structure and water holding capacity.

4.4 Rate of adoption of crop farmers on environmental management practices

The rate of farmer's adoption of environmental management practices is presented in Table 4.12. Adoption and diffusion of environmental management practices and information is likely to increase when high income expectations are projected. Total adoption of mulching as environmental management practices was (83.3%), organic waste (80%), plant residue (71.7%), planting of legume crop (81.7%), minimum tillage (71.7%), alley cropping (66.7%) and farm yard manure (83.3) is not surprising, because they all originate from indigenous practices hence their adoption. Adoption of organic waste (80%) could be due to decreasing yield resulting from shortened fallow length since fertility regeneration was by fallowing. Although, planted residue and liming are sound soil management technological packages, farmers are not confident hence low adoption in each of them. Adoption of crop rotation despite (80.5%) and adoption trial (6.7%) is possibly due to the rural setting of the study site; having relatively large expanse of farmland. Though, crop rotation makes rational use of the land, assures steady high yields and permits greater diversification. 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. These finding is in line with Bagheri (2010).

4.12: Distribution of respondents according to rate of adoption (n=120)

S/no	Recommended practices	Adoption (frequency)	%
1	Mulching	100	83.3
2	Use of organic waste	96	80.0
3	Crop rotation	82	80.5
4	Plant residue	5	4.2
5	Minimum tillage	86	71.7
6	Planting of legume crops	98	81.7
7	Alley cropping	80	66.7
8	Agrochemical use	19	15.8
9	Farm yard manure	100	83.3
10	Reduction in Pesticides overuse	85	70.8

4.5. Factors influencing adoption of environmental management practices

Multiple regression analysis was used to analyze the factors that influence the adoption of environmental management practices by farmers in the study area. The results of the analysis were presented in Table 4.13. Education (0.092) is positive and significantly related to the adoption of environmental management practices at 1% level of probability. The implication of this result is that farmers with more education would adopt more of the technologies than those with less education. The reason is that better educated farmers will be more ready to accept new techniques in agriculture to less educated farmers.

Table 4.13: Regression results of factors influencing adoption of environmental management practices.

Variables	Coefficient	Standard error	T-value
Constant	0.432	0.562	0.769
Age (years)	-0.241	0.482	-0.501 ^{NS}
Household size	0.324	0.217	1.493^{NS}
Educational level	0.092	0.012	7.667***
Membership of cooperatives	0.080	0.039	2.025**
Amount of money borrowed	0.360	0.210	1.714*
Extension contact	0.193	0.061	3.216***

***Significant at 1%, ** Significant at 5% level and * Significant at 10% level of probability

R^2=0.67

R^2 Adjusted = 0.58

Membership of cooperative association also had a positive and significant coefficient (0.080). This means that farmers who are members of social organizations adopted environmental management practices more than non-members. This is logical because membership to social organizations provides farmers with access to information on potential benefits of improved agricultural technologies. Thisis in agreement with Deji (2005) who observed that membership of cooperative societies positively and significantly influenced the adoption of agricultural innovation among farmers.

Table 4.13 further reveals that amount of loan received by the respondents had a positive and significant coefficient (0.360). This suggests that farmers who received credit adopted environmental management practices technology than those who did not received credit. It

also implies that availability of credit contributed significantly to technology adoption because credit is necessary for the purchase and use of new technologies by low capital base farmers. This is expected because availability to credit enhances farmer's ability to purchase necessary inputs such as improved seeds, fertilizers etc and pay for hired labour. This finding agree with Akpoko (2004) who reported that amount of credit received by farmers positively and significantly influenced the adoption of recommended soil management practices in Kaduna state.

Extension contact had positive and significant coefficient (0.193), indicating that adoption increased with increase in number of extension contacts offered to the famers. This is also in support of Saddiq (2012) and Agbamu (2006) who independently reported significant relationship between extension contact and adoption of recommended cotton production practices by farmers in Zamfara state. The result of this study also shows that cumulative contributions of independent variables to the adoption of environmental management practices had coefficient of determination (R^2 Adjusted) value of 0.58. This implies that all the variables together, explained about 58 percent of the total variability in adoption of environmental management practices in the study area. Ojo (2009) also reported the importance of socioeconomic factors in adoption of improved production technologies.

4.6. Effect of adoption of environmental management practices on farmer's income

Multiple regression analysis was used to analyze the effect of adoption of environmental management practices on farmer's income in the study area. The results of the analysis were presented in Table 4.14. The coefficient of mulching (0.590) is positive and significantly related to the income at 1% level of probability. This implies that adopting mulching as a technology on environmental management practices will increase the farmer's income by magnitude of 0.590.

The coefficient of crop rotation (0.237) is positive and significantly related to the income at 1% level of probability. Crop rotation makes rational use of the land, assures steady high yields and permits greater diversification. This is because different crops are planted, tilled and harvested at different times and agricultural work is spread out more evenly over the years which invariably result to increase on farmer's income. This implies that adopting mulching as a technology on environmental management practices will increase the farmer's income by magnitude of 0.237.

The coefficient of plant residue (0.194) is positive and significantly related to the income at 10% level of probability. This implies that a unit increase in plant residue will help in soil erosion control, preservation of soil texture and nutrients as well as protect the soil from exposure to harsh environmental conditions. This implies that adopting plant residue as a technology on environmental management practices will increase the farmer's income by magnitude of 0.194.

Farmyard manure and pesticide overuse was negatively related to profit and statistically significant at 10% and 5% respectively. This inverse relationship between profit and farmyard manure and pesticides may be as result of high cost of pesticides which results in high cost of production.

The result of this study also shows that cumulative contributions of independent variables to the adoption of environmental management practices on income had coefficient of determination (R^2 Adjusted) value of 0.46. This implies that all the variables together, explained about 46 percent of the total variability in adoption of environmental management practices on income of the farmers in the study area. Ojo (2009) also reported the importance of socioeconomic factors in adoption of improved production technologies had a significant influences on farmers output, income and living standard.

Table 4.14: Regression result showing effect of adoption of environmental management practices on income of the farmers.

Variables	**Coefficients**	**Std. error**	**T-Value**
Constant	6.327	0.354	17.859***
Mulching	0.590	0.173	3.470***
Use of organic waste	-0.187	0.152	-1.235
Crop rotation	0.237	0.068	3.496***
Plant residue	0.194	0.115	1.680*
Minimum tillage	0.475	0.908	0.052
Planting of legume crops	-0.032	0.028	-1.115
Alley cropping	0.0011	0.0701	0.016
Agrochemical use	0.076	0.105	0.720

Farm yard manure	-0.025	0.014	-1.793*
Pesticides overuse	-0.312	0.128	-2.438**

***Significant at 1%, ** Significant at 5% level and * Significant at 10% level of probability

R^2=0.51, R^2 Adjusted = 0.46

4.7 Constraints faced by crop farmers in the study area

The problems faced by crop farmers in the study area were ranked according to their magnitude as stated by the farmers (Table 4.15). The problem of pest and disease was the most severe constraint of crop producers with about 53% of the respondent attesting to this fact. Pest and disease were responsible for pre-harvest and post-harvest losses by crop producers. This finding is in line with Abdulrahman *et al*, (2015) who in their study observed that pest and disease was a severe constraint militating against crop production, as well accounting for both pre and post-harvest losses.

About 36% of the respondents indicates bulkiness of the technogies ranked second, about 31% of the crop farmer indicate short of labour as constraints in the study area. According to the farmers, during active period of production-every household would have been engaged in his family farm work. The demand for labour is normally very high and expensive during the peak period of land clearing, ridging, harvesting, processing and weeding, these led to labour shortage in crop farming in the study area.

About 13% of the crop farmers indicated inadequacy of capital and credit facilities which rank second. This affects sorghum production in the study area, because the meager savings the farmers might have made/funds generated from relatives is not sufficient to satisfy various activities in crop production. Most of the farmers also complained of not having enough

money to purchase chemicals to combat these diseases, although the economic advantage of spraying could lead to increase yield thereby justify the costs they invested.

Table 4.15: constraints associated with adoption of environmental management practices(n=120)

Variable	*Frequency	Percentage	Rank
Pest and disease	129	52.7	1st
Bulkiness of technologies	89	36.3	2nd
Labour shortage	75	30.6	3rd
Lack/Inadequate capital	32	13.1	4th

* Multiple response was allowed

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The focus of this study was to evaluate factors influencing the adoption of recommended environmental management practices on agricultural production in three Local Governments Areas of Jigawa State, Nigeria. Primary data were collected from 120 respondents using

structured questionnaire. The statistical tools used to analyse the data were descriptive statistics, regression mode. The result of the analysis shows that 37% of the respondents fall within the age range of 31-40years with an average of 42 years, 50% of the respondents had household size ranged from 1-5 people. The majority (76.7%) of the farmers are literate. About43% of the farmers had farming experience range from 11-20 years. About 99% of the farmers finance their production through personal savings; majority (90%) of the farmers had land size ranging from 0.1-2.0 hectares. However, 94.2% of the farmers belong to one cooperative association or more while majority 57.5% of the crop farmers had no other source of income.

The result of this study also shows that cumulative contributions of independent variables to the adoption of environmental management practices had coefficient of determination (R^2 Adjusted) value of 0.58. This implies that all the variables together, explained about 58 percent of the total variability in adoption of environmental management practices in the study area. The relationship between selected socioeconomic and institutional factors and adoption of environmental management practices show that out of seven variables included in the analysis, four had significant influence on adoption of environmental technologies. These were education, membership of cooperatives, amount of credit borrowed and extension contact.

The effect of adoption of environmental management practices on income show that mulching and crop rotation had significant positive influences on income of the farmers.

Finally, the most important constraint to the adoption of adoption of environmental management practices were: pest and diseases, bulkiness of the technology, labour shortage and inadequate capital were major constraints faced.

5.2 Conclusion

In general, previous adoption research indicates that farmer's socioeconomic, institutional factors have been helpful in explaining adoption of innovative farm practices. This study also found these variables useful in explaining the adoption of environmental management practices. Based on the findings of this study, it could be concluded that adoption of environmental management practices increases farmer's income.

5.3 Contribution of the study to knowledge

1. The study showed that the promoted environmental management technologies that farmers were most aware of where mulching (95.8%), use of organic waste (91.7%) and crop rotation (75%) and the least adopted were pesticide use (18.3%) and farmyard manure (19.2%).

2. The study found that extension agent (74.2%) was the important source of information on the promoted technologies while least important was television accounting for (23.3%)..

3. The study also found out 71.7% of the farmers are within the ages of 31-50 years old they are mainly adult and youth comprising only 16.7%.

4. However, the adoption of agrochemicals was too low (15.8%) though 30% are aware of it and has a perception mean score of 2.3

5.4 Recommendations

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

i. Cooperative membership was found to be positive and significantly influences participation at 5% level of probability. It is also recommended that farmers should join cooperative societies as this would facilitate access to vital information and credit provided mostly by financial institutions for crop farming which could in turn increase crop income of the farmers.

ii. Extension was found to be positive and significantly influences participation at 1% level of probability. It is also recommended that government and non-governmental organization dealing with extension agent should therefore embark more on the facilitation techniques of extension delivery. This will enable the farmers to identify their problems, determine their needs, and discover their potential themselves rather than always feeding them with information.

iii. The adoption of agrochemical use was found to be too low at same time the study found that the major constraint to adoption of recommended environmental practices was pest and diseases, therefore its became imperative in the packages of production of crop/animal production delivered to the farmers by the JARDA, MANR NGOs etc to have an elaborate component such as (classification of pesticides, spraying techniques, use of protective clothing, of crop protection products and cost benefit) which will guide the on how effectively over the menace at the same time mindful of the environment.

iv. The study had identified some constraint such as pest and disease, bulkiness of the technologies, inadequate capital and labour shortage and high cost of fertilizer that may affect adoption of environmental management practices. It is recommended that non-governmental organization and other intervening agencies on agriculture should ensure that strong institutional linkages and facilitation are created among farmers, input suppliers, credit institutions and market for effective service delivery. And also

farmers should be encourage to register with GES programme under agricultural transformation agenda to benefit from fertilizer input subsidy.

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Department of Agricultural Economics and Rural Sociology Ahmadu Bello University Zaria;

Dear Sir/ Madam

I am an MSc. Student of the above named institution and currently conducting a research on the 'factors influencing adoption of recommended environmental management practices by crop farmers in Jigawa state'. You are pleased expected to answer these questions based on facts and personal experience. All information provided will be kept absolutely confidential. Thanks for your co-operation.

In the following sections statements are made, please tick as appropriate using the key below to fill in appropriate answer(s).

SECTION A:PersonalandSocio-economicfeaturesofcrop

1. Sex: male ( ) female ( )

2. Please how old are you? -- ----- ----- --------- ---------- -----

3. What is highest educational attainment?

(a) No formal education ( )
(b) Primary school education ( )
(c) Secondary primary education ( )
(d) Tertiary education. ( )
(e) Quranic education ( )

4. What type of role do you play in your community?

(a) community head ( )
(b) family head ( )
(c) first male son ( )

(d) housewife ( )
(e) Others (pls specify) ( )

5 What is your marital status?
(a) Married ( )
(b) Single ( )
(c) Divorced ( )
(d) Widow ( )

6. What is the size of your household? ----------

7. What is your main occupation?

(a) Fish farming ( )
(b) Crop or livestock agriculture ( )
(c) Non-agriculture ( )
(d) Other s (specify) ( ) ……
(8) What are your sources of information concerning your farming business?
(a) mass media ( )
(b) Extension Agents ( )
(c) friends and relations ( )
(d) NGO s ( )
(e) others specify

9. What is your source of financing this farm?
(a) Savings ( )
(b) Bank loans ( )
(c) Cooperative institutions ( )
(d) Friends, and relations ( )
(e) Merchants and money lenders ( )
(F) others specify

(10) What is your approximate annual income?

11. What is your approximate income level per annum?- (Please express in naira)----------
----
----

12 . Do you have access to agricultural credit ?yes ( ) No ( )

13 If yes tick the sources of your credit or loan facilities :
(a) Savings ( )
(b) Bank loans ( )
(c) Cooperative institutions ( )
(d) Friends, and relations ( )
(e) Merchants and money lenders ( )

(f) others specify

(14) Do you participate in any programs aimed at promoting sustainable use of your land?

(a) Yes ( )

(b) No ( )

(15) If yes, how often do you participate in such program?

(a) Not regular ( )

(b) Monthly ( )

(c) Quarterly ( )

(d) Annual ( )

(e) Others specify) ( )

(16) If No why?

(a) (a) Charges are often too expensive ( )

(b) (b) There are no such programs in this area ( )

(c) (c) The contents of such programs are so academic ( )

(d) (d) Not aware of such programmes ( )

(17. Which of the following institutions have you benefited from in the course of your crop farming?

(e) Research Institutes/Universities ( )

(b) Extension Service o ADP ( )

(c) Radio ( )

(d) Television ( )

(e) News print ( )

(f) NGOs ( )

(g) Others (specify----------)

(18 What are your reasons for going into crop Farming?

(a) Commercial

(b) To complement income from other sources

(c) To provide the food need of the family

(d) Trial

(19) How long have been farming? (in years pls)

(20) How far is your farm from the closest extension agency? ----------

(21) What is the size of your farm?----------

. External orientation of farmer

22 (a) Do you travel out of your village? Yes( ) No ( )

(b) If yes where do you travel to? ( )
Other farms in the surrounding villages ( )
Other farms in the other local government areas ( )
Other states in the country ( )
Other countries in the world ( )

(23 How often do you visit other farms in a year? (No of times)……..

24 (a) Do you belong to an association, or cooperative society? Yes ( )
No ( )

(b) If yes which association/ society do you belong to?
Association of crop farmers ()
Farmers' cooperative ()
Religious association ()
Others (please specify ( )-
What are the benefit of being an association member----------
---

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(25) What is the approximate cost of adopting these recommended practices?

……

(26) How did you obtain your farm land ?

(a) Personally owned

(b) By rentage

(c) By lease

(d) Inherited

Others (specify)……..

(27) Please specify which type of ownership this farm is into:

(a) Owner operated ☐

(b) Partnership ☐

Others (please specify) ☐

(28) Approximately how much do you spend as your production cost per annum from your farm? …….

(29) Approximately how much do you realize as income in your crop farm per annum?……

Farmers awareness

30 Indicate which of the following Recommended Environmental management technologies you are aware of

S/No	Recommended practices	Highly aware	Aware	Undecided	Remotely aware	Unaware
1	Mulching .					
2	Household Waste utilization					
3	Controlled bush and trash burning					
4	Crop rotation					
5	Soak pits					
6	Inter cropping					
7	Rough tillage					
8	Fine tillage					
9	Spot burning					
10	Use of organic waste					
11	Use of inorganic fertilizer					
12	Planting vertiver grass/ crop rotation					
13	Ridging					

14	Tree planting					
15	Rainwater harvesting					
16	Controlled use of agrochemicals					
17	Zero tillage					
18	Use of Trenches					
19	**Use of crop residue**					
20	**Alley cropping**					
21	**Use of crop resistant varieties**					
22	**Planting of legume crops**					
23	**Planting of cover crops**					
24	**Bush fallow**					
25	**Liming**					
26	**Use of compost manure**					
27	**Contour bounding**					
28	**Terracing**					
29	**Green manuring**					
30	OTHERS					

Farmers' perception

31. (a) In the following perception statements indicate among the options which appropriately match your agreement or disagreement with the statements.

S/No	PERCEPTION STATEMENTS ON RECOMMENDED SOIL CONSERVATION PRACTICES	Strongly agree	Agree	Undecided	Disagree	Strongly Disagree
I	Not labour					

	intensive.					
2	Not expensive					
3	Conserves soil & water					
4	No external input is require in most of them					
5	Leads to increased crop yield					
6	Leads to good crop germination					
7	Local materials are mostly used					
8	Controls weeds and pests					
9	Assists in opening virgin lands					
10	Influences soil fertility					
11	Leads to food security					
12	Useful in cases where land is inadequate					
13	Some are expensive to manage					
14	Labour intensive					
15	Difficult to make					
16	Reduces soil fertility					
17	Increases water evaporation & moisture loss					
18	Reduces water infiltration					
19	They are time consuming					
	Leads to low yield					

	Prone to pests & diseases					
ATTRIBUTES OF RECOMMENDED PRACTICES						
	Compatible with culture of the land					
	Complement existing practices					
	Cost saving					
	Complexity in adopting it					

32. (b). How do you perceive the relevance of the recommended environmental management practices ?

Recommended practices	Highly relevant	Moderately relevant	Lowly Relevant	Not relevant
Mulching .				
Household Waste utilization				
Controlled bush and trash burning				
Crop rotation				
Soak pits				
Inter cropping				
Rough tillage				
Fine tillage				
Spot burning				
Use of orgarnic waste				
Use of inorganic fertilizer				
Planting vertiver grass				
Ridging				
Tree planting				

Rainwater harvesting				
Controlled use of agrochemicals				
Zero tillage				
Use of Trenches				
Use of crop residue				
Alley cropping				
Use of crop resistant varieties				
Planting of legume crops				
Planting of cover crops				
Bush fallow				
Liming				
Use of compost manure				
Contour bounding				
Terracing				
Green manuring				
OTHERS				

LEVEL OF ADOPTION OF RECOMMENDED SOIL CONSERVATON PRACTICES

33. Indicate which of the following recommended soil conservation practices you have adopted according to the options provided:

S/No	Recommended practices	Awareness	Interest	Evaluation	Trial	adoption
I	Mulching .					
2	Household Waste					

	utilization					
3	Controlled bush and trash burning					
4	Crop rotation					
5	Soak pits					
6	Inter cropping					
7	Rough tillage					
8	Fine tillage					
9	Spot burning					
10	Use of orgarnic waste					
11	Use of inorganic fertilizer					
12	Planting vertiver grass					
13	Ridging					
14	Tree planting					
15	Rainwater harvesting					
16	Controlled use of agrochemicals					
17	Zero tillage					
18	Use of Trenches					
19	**Use of crop residue**					
20	**Alley cropping**					
21	**Use of crop resistant varieties**					
22	**Planting of legume crops**					
23	**Planting of cover crops**					
24	**Bush fallow**					
25	**Liming**					
26	**Use of compost manure**					
27	**Contour bounding**					
29	**Terracing**					
30	**Green manuring**					

31	OTHERS					

RATE OF ADOPTION OF RECOMMENDED SOIL CONSERVATON PRACTICES

34. Among the following recommended soil conservation practices you have adopted how long in weeks , months or years did it take you to adopt them?

S/No	Recommended practices	Tick the technologies adopted by you	No of years it took you to adopt them	Remarks		
I	Mulching .					
2	Household Waste utilization					
3	Controlled bush and trash burning					
4	Crop rotation					
5	Soak pits					
6	Inter cropping					
7	Rough tillage					
8	Fine tillage					
9	Spot burning					
10	Use of orgarnic waste					
11	Use of inorganic fertilizer					
12	Planting vertiver grass					

13	Ridging					
14	Tree planting					
15	Rainwater harvesting					
16	Controlled use of agrochemicals					
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24	**Bush fallow**					
25	**Liming**					
26	**Use of compost manure**					
27	**Contour bounding**					
28	**Terracing**					
29	**Green manuring**					
30	OTHERS					

35 Generally, how can you rate the effectiveness of the adopted technologies according to the table below:

Categories of effect/ Rating of the effects	*Highly effective*	*Moderately effective*	*Effective*	*Lowly effective*	*Not effective*
Effect on					

increased crop yield					
Effect on soil water retension					
Effect on reducing pests and diseases					
Effect on soil water percolation					
Effect soil erosion control					
Effect on water drainage					
Effect on increasing soil fertility					
Effect on reducing land preparation cost					
Effect on soil water management					
Effect on pest and disease control					
Effect on reducing labour cost					
Effect on maximizing land utilization					
Effect on minimizing environmental hazards					

36 On the total, approximately how much did it cost you (in ₦aira) did it cost you to adopt these recommended environmental management practices?----------
----

FARMERS' CONSTRAINTS

37. . Please tick the on the table below the constraints which you encountered in the course of adopting the recommended environmental management practices according to the level of seriousness.

CONSTRAINTS	*VERY SERIOUS*	*SERIOUS*	*NO EFFECT*	*NOT SERIOUS*	*NOT VERY SERIOUS*
Leads to pests and diseases					
Difficult to make or adopt					
Labour intensive					
Not pest resistant					
Time consuming					
Leads to low yield					
Mulching causes termite attack					
Reduces soil fertility					
No prior knowledge or training on the use					
Leads to soil drieness					
Limits water infiltration					
Expensive					

THANKS FOR YOUR RESPONSE