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FACTORS INFLUENCING ADOPTION OF FARO 52 RICE PACKAGE BY FARMERS IN SELECTED LOCAL GOVERNMENT AREAS OF NIGER STATE, NIGERIA

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BY

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DEDICATION

This dissertation is dedicated to my family (wife and children).

CERTIFICATION

This Dissertation by Abubakar, Habibu Ndagi (11210602115) has met the requirements for the award of the Master of Science (Agricultural Extension and Rural Development) of the Usmanu Danfodiyo University, Sokoto, and is approved for its contribution to knowledge.

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ACRONYMS

AATF	Africa Agricultural Technology Foundation
ADP	Agricultural Development project
AFDB	Africa Development Bank
AI	Adoption Index
ANOVA	Analysis of Variance
DRRP	Dissemination of Research Result programs
FAO	Food and Agriculture Organization
FARO	Federal Agricultural Research Oryza
IITA	International Institute for Tropical Agriculture
LGAs	Local Government Areas
NACGRAB	National Centre for Genetic Resources and Biotechnology
NCRI	National Cereals Research Institute
NERICA	New Rice for Africa
NPC	National Population Commission
NRDS	National Rice Development Strategy
NSRIC	Niger State Rice Investment Consortium
OFAR	On- Farm Adaptive Research
WARDA	World African Rice Development Association

ABSTRACT

The study assessed the factors influencing adoption of FARO 52 rice package by farmers in selected Local Government Areas of Niger state. Structured questionnaires were used for data collection. A multi-stage sampling procedure was employed where a total of 166 FARO 52 rice farmers were randomly sampled and proportionately drawn at 25% across each of the nine selected villages. Data were analyzed using descriptive and inferential statistics. The result indicated that the package recorded 15.1%, 51.2% and 33.7% low, medium and high adoption level respectively. The constraints identified by the study include: high cost of the technology, complexity, lack of technical skills and low availability of the inputs among others. The results of the linear regression model indicated that farmers' age, household size, farm size, farming experience, extension visits, training participation and membership of associations had a significant relationship with the adoption of FARO 52 rice package. In conclusion, the adoption of FARO 52 rice package as a whole was influenced by socio-economic and institutional factors. The study thus recommends that the concerned stakeholders should give priority attention to those socio-economic and institutional significant factors identified by this study while formulating development strategies and programs for different categories of farmers.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Rice (*Oryza sativa* L.) is an important food and cash crop in the world. It feeds more than half of the world's population (Ojohomon, 1995). The world grows 153.8 million hectares of rice annually with average worldwide yield of 3,885 kg/ha. This gives a production of 598.8 million metric tons, which is greater than that of either corn (590.8 million metric tons) or wheat (576.3 million metric tons) (FAO, 2011). Rice has become an important economic crop and the major staple food for millions of people in Sub-Saharan Africa (SSA) in general and Nigeria in particular (Africa Rice Centre, 2012). It is an important staple food and a commodity of strategic significance across much of Africa. Driven by changing food preferences in the urban and rural areas and compounded by high population growth rates and rapid urbanization, rice consumption in SSA has been growing by 6 percent per annum over the years, more than double the rate of population growth (FAO, 2011).

AATF (2012) however, revealed that the area under rice production in SSA has stagnated at about 8 million hectares, producing about 14.52 million tonnes per year against an annual consumption of 21 million tonnes. These production and consumption trends i]mply a production deficit of about 6.5 million tonnes per year valued at US$ 1.7 billion that is imported annually. In other word, AATF,(2012) added that insufficient rice production affects the wellbeing of over 20 million smallholder farmers in Africa who depend on rice as their main food.

In Nigeria, the demand for rice has been increasing at a much faster rate than in other West African countries since the mid 1970s. For instance, during the 1960s, Nigeria had the lowest per-capita annual consumption of rice in the sub-region (average of 3 kg). Since then,

Nigerian per-capita consumption levels have grown significantly at 7.3% per annum. Estimated annual rice demand for Nigeria in 2009 is said to be 5 million tonnes, while production is said to average about 2.21 million tonnes. The national rice supply-demand gap of 2.79 million tonnes is expected to be bridged by importation (NRDS, 2012) which has constituted serious drain on the nation's foreign exchange.

The potential land area for rice production in Nigeria is between 4.6 million and 4.9 million ha. Out of this, only about 1.7 million ha or 35 percent of the available land area is presently cropped to rice (WARDA, 2005). Rice is however, one of the major food crops cultivated by farmers in all agro-ecological zones of Nigeria and it is widely consumed by a large proportion of the population (Akande, 2001).

The main production ecologies for rice in Nigeria are rainfed lowland, rainfed upland irrigated lowland, deep water/floating and mangrove swamp. Of these, rainfed lowland rice has the largest share of the rice area (50%) and rice production (WARDA, 2005). In recent years, rice production has been expanding at the rate of 6% per annum in Nigeria, with 70% of the production increase due mainly to land expansion and only 30% being attributed to an increase in productivity (Hussein, 2000). Much of the expansion has been in the rainfed systems, particularly in the two major ecosystems that make up 78% of the upland and rainfed lowland systems (Awotide *et al.,* 2010). However, several factors are responsible for the low rice production. Nitrogen deficiency and drought have been cited as leading constraints to upland rice production, while high salinity is increasingly becoming a major problem in many rice growing areas of Africa. As a matter of fact, farmers in Nigeria are predominantly peasant. However, the leading constraints to adoption of crop improved technologies in include high cost of technology, lack of availability and accessibility of technology, absence of input support services, and lack of adequate training among farmers.

Niger State has the comparative advantage of the largest land mass of 10% of Nigeria's 80% arable land mass. The State has production capacity of 570,000 tonnes of rice and is ranked top in the country (NSADP, 2010). The State has comparative advantage in rice production as the largest rice producer in Nigeria and has potentials for rice export (Anons, 2003). For effective extension service programs, the state Agricultural Development Project (ADP) has three agricultural administrative zones. Lowland rice is mostly grown in Zone A while in Zone B both lowland and upland rice are cultivated. Rice is however, sparingly grown in Zone C (Ojohomon, 1995). The Rice Value Chain Intervention Development under the support of the African Development Bank (AFDB), the Niger State Rice Investment Consortium (NSRIC), and the Bida-Badeggi Rice Mill, which had the capacity to produce 30,000 tonnes per annum, are the major impetus for increased rice production in the State (NSDP, 2009).

In almost all areas of the globe where the agricultural transformation process has been documented, agricultural productivity growth has been driven by improved farm technologies, including improved seeds, fertilizer, and water control (Leeuwis, 2006). In an effort to increase agricultural productivity, researchers and extension agents in developing countries have typically promoted technological packages consisting of a number of components such as seed varieties, fertilizers, planting methods, and weed control (Doss, 2006). A technological package, according to Ekwe and Onunka (2006) is a technology developed with various recommended components for use in a specific production environment and to maximized farmers' output. An example is new variety of improved seed developed and released with its recommended practices. FARO 52 is an example of a rice variety developed for lowland ecology under rainfed condition with specific recommended practices involving the seed, rate of fertilizer application, establishment of nursery, transplanting depth, spacing and cultural operations. Imolehin and Wada (2002) submitted that cereals crop production packages are released along with descriptive features of the variety, specific adaptable environment, agronomic practices and expected field output after use. The technology package includes components such as high yielding rice varieties, fertilizers, herbicides and corresponding management practices. This study therefore, attempts to examine the factors that influence the level of adoption of FARO 52 rice production technology package in some Local Government Areas of Niger State.

1.2 Problem Statement

Technical change in the form of adoption of improved agricultural production technologies has been reported to have positive impacts on agricultural productivity growth in the developing world (Nin *et al.*, 2003). Promotion of technical change through the generation of agricultural technologies by research and their dissemination to end users plays a critical role in boosting agricultural productivity in developing countries (Mapila, 2011). Moreover, Minten and Barrett (2008) observed that the availability of modern agricultural production technologies to end users, and the capacities of end users to adopt and utilise these technologies are also critical. It is believed that an effective way to increase productivity is broad-based adoption of new farming technologies. In addition, as suggested by Oladele (2005) adoption of improved technologies will improve food security and reduce poverty if barriers to their continued use are overcome. As recognized by Doss (2003 and 2006) one way of improving agricultural productivity in particular, and rural livelihood in general, is through the introduction of improved agricultural technologies to farmers. Doss (2003) also opined that adoption of improved technologies is an important means to increase the productivity of small- holder agriculture in Africa, thereby fostering economic growth and improved wellbeing for millions of the poor households. Technological change in agricultural inputs which is fundamental to the transformation of Rural Africa has not been fully embraced by small-holder farmers in the region (Mapila, 2011).

It is worth knowing that lowland FARO varieties (44, 50 and 51) were among the earlier released varieties with pest and disease management practices to the farmers (NCRI, 2009). The lowland ecologies in which farmers in the study area grow these varieties were discovered to be prone to excessive iron deposit (iron toxicity) and susceptible to lodging due to their characteristics tall habit and heavy panicle. Hitherto, these varieties have no genetic potentials to withstand such environmental condition. Swiftly, in response to the needs of the rice farmers, the FARO 52 rice variety was developed with genetic potentials to resist iron toxicity and lodging (NACGRAB, 2004). The variety was developed by IITA/WARDA and packaged in collaboration with NCRI Badeggi which has the mandate for genetic improvement of rice crops. The package was promoted and disseminated through the NCRI Dissemination of Research Result (DRR) programmes in collaboration with state ADP extension programs. However, several years after its introduction the status of this package has not been ascertained with respect to its adoption level and characteristics of the users (Tiamiyu, 2009).

As a matter of fact, there is a general lack of understanding of the factors affecting the adoption of FARO 52 rice package in farming systems in the study area; no attempt has been made to ascertain reasons for the farmers' adoption behaviour in term of the package. Only with a thorough understanding of these factors can further insight be developed concerning strategies to promote technological packages (Jackline, 2002). Most of those who attempted to explain the adoption of production technologies in the study area base their assertions on subjective beliefs about the conventional practices of small-holder farmers, and not on analytical evidence. Therefore, an empirical description regarding factors affecting adoption and extent to which the package is adopted several years after its introduction is imperative.

Against this background, it is pertinent to explore the aspect of adoption of the package and evaluate its determinants in order to fill the gaps and contribute to scientific knowledge. This study, therefore, attempts to assess the factors influencing adoption of FARO 52 rice package by attempting to find answers to the following research questions**:**

i. What are the socio-economic characteristics of the farmers using FARO 52 rice package in the study area?

ii. What are the methods of extension used in disseminating FARO 52 rice package to the farmers?

iii. What is the level of awareness, information sources and level of adoption of FARO 52 rice package by the farmers in the study area?

iv. What are the factors influencing adoption of FARO 52 rice package by the farmers in the study area?

v. What are the reasons for adoption of FARO 52 rice package by the farmers in the study area?

vi. What are the constraints associated with adoption of FARO 52 rice package in the study area?

1.3 Objectives of the Study

The broad objective of the study was to assess the factors influencing adoption of FARO 52 rice package by farmers in selected LGAs of Niger State. The specific objectives were to:

i. describe socio-economic characteristics of the farmers using FARO 52 rice package in the study area.
ii. identify the extension methods used in disseminating FARO 52 rice package in the study area.
iii. determine the level of awareness and information sources and level of adoption of FARO 52 rice package by the farmers in the study area.
iv. assess the factors influencing adoption of FARO 52 rice package by farmers in the study area.
v. Identify the reasons for adoption of FARO 52 rice package by the farmers in the study area.
vi. identify the constraints associated with adoption of FARO 52 rice package among the users in the study area.

1.4 Hypotheses of the Study

Ho i: There is no significant relationship between farmer's socio-economic characteristics and adoption of FARO 52 rice package.

H_O ii: There is no significant relationship between institutional factors and adoption of FARO 52 rice package

1.5 Significance of the Study

By determining the factors that influence FARO 52 rice package adoption, this study would provide guidance to the rice technology development administrators and researchers for enhancing rice technology development program effectiveness. The added knowledge on which factors have the greatest influence on FARO 52 rice package adoption would help administrators make more informed decisions on how to promote rice technological packages. Understanding these factors is important for the scientists to generate and develop agricultural technologies, which suits to the current conditions of farmers. Policy makers too would benefit from the research output since they require micro-level information to formulate and revise policies and strategies. Another benefit from the research would be provision of an explanation to the current state of technologies used by farmers. Moreover, since FARO 52 is a high yielding rice variety, information emanating from this study would provide a strong case for increasing investment in the rice sector.

Similarly, the study would provide research organizations with empirical reports for further improvement and modification of the package to meet the expectations of ultimate beneficiaries. By and large, the findings from this research would provide a framework for policy makers to formulate or review policies and strategies that are technology-usage friendly, socio-culturally compatible and economically viable.

It is important and justifiable therefore, to conduct research in the area of crop production technology adoption, especially rice, with a view to ascertaining whether or not farmers have adopted the disseminated production technologies.

1.6 Scope and Limitations of the Study

The study was conducted in Gbako, Katcha and Lavun LGAs of Niger State. The study focused on socio- economic characteristics of farmers and some institutional factors in relation to level of adoption of FARO 52 rice package. However, due to limited resources the study area coverage was limited to the lowland rice producing LGAs in the State. Also, the questionnaire were written in English not in the language of the farmers. This was overcome with assistance of extension officers who interpreted the questionnaire for the farmers in the local language. More so, there was limitation of memory lapse by farmers to recall some quantitative information. This was overcome by rescheduling the visit in another time to allow the farmer to recollect the exact information required.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Rice Production in Nigeria

There are many varieties of rice grown in Nigeria. Some of these are considered 'traditional' varieties, others are improved/hybrid varieties introduced to the farmers. Rice is grown in paddies on lowland or upland fields, depending on the requirements of the particular variety; there is limited mangrove cultivation (Okoruwa *et al.,* 2007). New varieties are produced and disseminated by research institutes, especially NCRI Badeggi that has the mandate for genetic improvement of rice crops, promotion and dissemination of the using a multidisciplinary approach. In this connection, the idea is that diffusion of the newly improved rice cultivars is determined by their perceived success, adaptability to farmers' field condition, and the observable important effect of the new cultivar especially when they see it doing well in someone else's field, or if a variety is fetching a good price in the market.

The fields are usually ploughed immediately after the first rain, generally in June or July (NCRI, 2005). Farmers rarely had access to tractors, but most now undertake all land preparation and harvesting by hand. In some rice growing communities, women have a stake in rice production activities. To that effect, tasks are generally allocated along gender lines, but in some areas men and women work together. Women are typically responsible for the transplanting of seedlings to the fields and threshing, whilst it is often the men who hoe. In some part of the northern Nigeria, especially Niger state, men are responsible for all the production activities, and women partly take part in post harvest activities.

Most farmer produce one rice crop in each cropping season, but some have supplemented water supply by making irrigation channels which allow them to reap two or even three harvests in the year. This allows them to plant seedlings when there is less danger from disease or pests (Imolehin and Wada, 2002). At the same time, continuous planting depletes the soil nutrients more quickly and, as fertilizers are costly while very little are accessed by poor-resource farmers, many farmers are noticing the falling productivity of the soil. Similarly, Fertilizers and herbicides are expensive, and rice is favoured as a crop because it needs fewer inputs than maize (Okoruwa *et al*., 2007). In making available what is within the reach of rice growers as means of replenishing soil nutrients, some farmers use organic fertilizers, including a method of green manure application by which grass is allowed to grow and is then ploughed back into the soil. The use of organic fertilizers, though, is time consuming, and is not widespread; many farmers resign themselves to buying chemical fertilizers which they consider to be too expensive (Imolehin and Wada, 2002).

Rice is a water loving crop. The moment the fields have enough water the rice grows steadily with some varieties reaching maturity stage within three months especially early maturing varieties (90-100 days). Some farmers grow the rice seedlings in nurseries and then transplant them into the main fields, as this reduces vulnerability to disease; however, others see the transplanting process as too laborious and costly in time. Early maturing variety is mostly preferred by farmers, as this reduces risk of susceptibility to disease and allows the land to be used for other crops. Saka and Lawal (2009) diagnosed rice producing communities in South-western, Nigeria, and observed that it is rare for more than one crop of rice to be grown each year, many farmers intercrop rice with other cereals crops, particularly sorghum and maize.

Some post-harvest activities are done traditionally and take place right in the field such as drying, threshing and winnowing. Other processing of rice generally takes place away from the farm such as parboiling, milling and packaging. The par boiling is carried out in huge oil drums. After the rice has been parboiled, it is laid out on tarpaulins to dry. It is at this stage that there is a danger of small stones getting mixed up with the rice grains, reducing its marketability. Tiamiyu *et al.* (2010) reported that Nigerian rice faces competition from imported rice which is favoured for its long white grains. Imported rice, although widely considered less palatable, demands less time in preparation as it contains no stones or pebbles. Nevertheless, these could be get rid of by using rice post-harvest technologies developed by NCRI Badeggi including destoner. Raising the quality of Nigeria rice breeds might discourage rice importation, whilst boosting local production.

Nigerian rice farmers are known for rearing tropical livestock as an alternative means of sustenance. Farmers do intercrop rice with a variety of crops including sorghum, maize in upland ecology. Animals are grazed on open land and are fed on the crop residues.

2.1.1 Economic Importance of Rice

It was claimed by FAO (2011) that one third of the world's population depends on rice for 50% of their daily caloric intake. Rice is the only major grain crop that is grown almost exclusively for human food.

It is a staple food, accounting for more than 25% of cereals consumption in Nigeria. Rice has a great potential and can play a critical role in contributing to food nutritional security, income generation, poverty alleviation and socio-economic growth of Africa (Fakiyesi, 2001). Rice is said to be palatable and nutritious than the other coarse grains produced in Nigeria. Thus, it can also help meet the nutritional needs of the poor (WARDA, 2008).

Rice can be used for production of alcoholic drinks, bread and medium for growing mushroom. Hulls and husks of grain are used as fuel, beddings for poultry, packaging and insulation. The bran is found to be a valuable feed component in preparing livestock feed especially, for broiler starter mixing along with other feed component such as lime, soya bean. The bran is also fed to ruminants as feed supplements. Apart from food and laundering values, rice has wide industrial usage by cosmetic industries as thickening materials in calico printing, in the finishing of textiles and for making of dextrins, glucose and adhesives (Wijnhoud *et al.*, 2003).

2.2 Introduction of FARO 52 Rice Package

Due to the existing potential which has not been translated to actual production of rice production in Nigeria, FARO 52 rice package was introduced after preliminary research work on the characterization of lowlands and on-farm demonstration based on collaboration among national and international agricultural research institutions. The main goal of FARO 52 package development is to allow intensification and diversification of the lowland production system and to achieve national food security by sharp increases in domestic rice production (IRRI, 2000).

Lowland rice account for 50% of the total rice produced in Nigeria (WARDA, 2005). In recent years, several rice varieties, together with efficient natural resource/crop management and pest and management technologies were introduced to rice farmers in Nigeria and other West and Central Africa countries. Typical examples are FARO 44 (SIPI), 51 and 52 (Imolehin and Wada, 2002). FARO 52 is an improved lowland rice variety developed by IITA/WARDA in collaboration with NCRI Badeggi, and released in the year 2001. The Acronyms FARO stands for Federal Agriculture Research Oryza. The FARO 52 is also popularly known by its old name as WITA 4. The number 52 indicates the position of the variety in the list of improved rice varieties released in Nigeria. It was developed as a package which comprises complementary technologies such as seed treatment, land preparation, nursery establishment, transplanting depth and space, rate of fertilizer application, rate of herbicide, water management, disease control and insect pest control.

FARO 52 is a variety prescribed for lowland ecology under rainfed condition. It has distinct characteristics of being high yielding, medium maturity (100-110 days), resistant to iron toxicity, medium height habit and resistant to lodging. The variety is easily identified by it common name among the cultivating communities in zone A of Niger state ADP administrative zone as Witafo, Anasaragi and Bokungi. It is also preferred due to its characteristic long-white grain, amylase constituent, none shattering of grain during processing, good threshing quality and ease of cooking. As a matter of fact, these characteristics represent consumers' interest and pricing.

Sequence to the earlier released varieties, FARO 52 was developed in response to the need of ultimate users in term of yield and stalk height; a cultivar that can overcome environmental related constraint especially iron toxicity. The variety under good ecology and good management practices has the potential paddy yield of 5-6 tons/ha. The crop is ready for harvest when the grains are hard and are turning yellow/brown. That is about 30-45 days after flowering or a month after 50% flowering.

2.3 Socio-Economic Characteristics of Farmers

This is a concept that describes both the economic and social factors that have important influence on social change and overall improvement of socio-economic status of individuals through technology adoption (Mamudu *et al.,* 2012). Also, Ogunsumi and Ewuola (2005) reported that socio-economic status of farmers is positively and strongly related to adoption. This report implied that the higher the socio-economic status, the higher the tendency to adopt innovation.

Jackline (2002) presented that age is another factor thought to affect adoption. She reiterated that age is said to be a primary latent characteristic in adoption decisions. However there is contention on the direction of the effect of age on adoption. Age was found to positively influence adoption of sorghum in Burkina Faso (Adesiina and Baidu-Forson, 1995). The effect is thought to stem from accumulated knowledge and experience of farming systems obtained from years of observation and experimenting with various technologies. However age has also been found to be either negatively correlated with adoption, or not significant in farmers' adoption decisions. In studies on technology adoption in Serra Leone age was either not significant or was negatively related to adoption. Older farmers, perhaps because of investing several years in a particular practice, may not want to jeopardize it by trying out a completely new method. In addition, farmers 'perception that technology development and the subsequent benefits, require a lot of time to realize, can reduce their interest in the new technology because of farmers' advanced age, and the possibility of not living long enough to enjoy it (Adesina and Zinnah, 1992).

Furthermore, level of farmers, education is an important socio-economic variable. Studies that have sought to establish the effect of education on adoption in most cases relate it to years of formal schooling (Feder *et al.*, 1995). Generally education is thought to create a favorable mental attitude for the acceptance of new practices especially of information-intensive and management-intensive practices (Doss, 2006). However, education is thought to reduce the amount of complexity perceived in a technology thereby increasing a technology's adoption. He further stressed that the ability to read and understand sophisticated information that may be contained in a technological package is an important aspect of adoption. Similarly, distribution of knowledge reduces the risk of adopting a new technology (Hussein, 2000). Increased education is thus expected to improve FARO 52 rice package adoption. A study on IPM practices on potatoes identified level of education as one of the major factors that positively affected the observed level of IPM practices (Jackline, 2002).

Farm size is frequently analyzed in many adoption studies (Adesiina and Baidu-Forson, 1995; Hussein, 2000; Balarabe, 2012). This is perhaps because farm size can affect and in turn be affected by the other factors influencing adoption. In fact, some technologies are termed ‘scale-dependant’ because of the great importance of farm size in their adoption. The effect of farm size has been found to be positive (Ugwumba, 2013). With small farms, it has been argued that large fixed costs become a constraint to technology adoption (Abara and Singh, 1993) especially if the technology requires a substantial amount of initial set-up cost, so-called “lumpy technology.” In relation to lumpy technology, Feder *et al.*(1995) further noted that only larger farms will adopt these innovations. In Bngladesh, for example, a recent study (Hussain *et al.*, 2001) found that large commercial farmers adopted new high-yielding rice varieties more rapidly than smallholders.

Also important are institutional factors. Extension contact and good extension programs are a key aspect in technology dissemination and adoption. Most studies analyzing this variable in the context of agricultural technology show its strong positive influence on adoption. In fact, Odoemenem and Obine (2010) reported that its influence can counter balance the negative effect of lack of years of formal education in the overall decision to adopt some technologies. The variable has a positive significant relationship with adoption of improved cereals production technologies by small-scale farmers in Nigeria. In the same direction, farming experience (years) was reported by Mamudu *et al.*, (2012) years of farming experience was positively significant in determining the level of adoption of modern agricultural technologies by households in Ghana.

2.4 Extension Methods for Disseminating Technology

Extension-teaching methods are the tools and techniques used to create situations in which communication can take place between the rural people and the extension workers. They are the methods of extending new knowledge and skills to the rural people by drawing their attention towards them, arousing their interest and helping them to have a successful experience of the new practices. One way of classifying the extension methods is according to their use and nature of contact. Based upon the nature of contact, they are divided into individual, group and mass contact methods.

2.4.1 Individual Contact Method

Extension methods under this category provide opportunities for face-to-face or person-to-person contact between the rural people and the extension workers. Individual contacts are often concern about seeking information on some field problems and introducing new idea. The purpose of this method could be answer to a request for help by farmer, to influence individual on some specific improved practices such as trying a new variety. Example of this method includes: farm and home visits, office calls, telephone calls, personal letter etc. These methods are very effective in teaching new skills and creating goodwill between farmers and extension workers (Oladosu *et al.*, 2004).

2.4.2 Group Contact Method

Under this category, rural people or farmers are contacted in groups which usually consist of 20 to 25 persons. For Asiabaka (2005) the type of outreach strategy used by extension is dependent on the number of people to be reached. These groups are usually formed around a common interest. These methods also involve a face-to-face contact with the people and provides an opportunity for the exchange of ideas, for discussions on problems and technical recommendations and finally for deciding the future course of action. Example includes: method demonstration meetings, leader training meetings, lecture meetings, conference and discussion etc. According to Hoffmann *et al.* (2009) group extension is the most important method for advising and promoting the interest of a large number of farmers. The more it is supplemented with individual and mass extension, the greater are its chances of success.

2.4.3 Mass or Community Contact Method

An extension worker has to approach a large number of people for disseminating new information and helping them to use it. This can be done through mass-contact methods conveniently. These methods are more useful for making people aware of the new agricultural technology quickly. A proper understanding of these methods and their selection for a particular type of work are necessary. According to Leeuwis (2006) farmers have different information requirement at each level of the innovation process. He further stressed that radio and posters or folk drama are the effective methods to make farmers aware of a new idea. To Hoffmann *et al.* (2009) at the interest stage detailed technical information should be printed and circulated, or group discussion meeting be arranged, or field days held at a demonstration site, or articles published in local newspaper. The general concept of extension delivery places the audience or target population to be reached at the centre of the process. It is worth of while for research and extension organizations to develop strategies that could be effective for communicating research messages to numerous target groups.

Efficient extension service delivery is attainable if a new technology is communicated through appropriate channels and techniques that are captivating in nature, and have potential of educating the targeted population in the social system. In addition to conventional extension methods, some organizations and agencies disseminate improved technologies through demonstration plots, mass media, on-farm trials and field visits. In the same vein, extension methods adopted by NCRI Badeggi for technology package include, among others, highway demonstration plots for creating public awareness, management training plots (MTPs), On-farm Adaptive Research (OFAR), adopted villages and schools strategy (Model villages and schools), farmers training, workshops for ADP Extension personnel and stakeholders, exhibitions and field days.

Extension methods for technology dissemination involve a triangulation of interpersonal methods, group methods and mass methods. Result and method demonstrations are essentially extension methods employed by state ADPs as a means of transforming the farmers from traditional-based practices to modern recommended ones. There is however, no single extension method that can be sufficient to drive decision of farmers to a change. Multiple approaches are usually employed to introduce a change through educating, teaching, guiding, supporting and assisting the targeted groups to use innovation appropriately. Also, the service of contact farmers is sought as a good method of communicating technology among the farming communities of Niger State. However, home visits as extension method are not much emphasized in the present ADP extension approach although extension guides, bulletins and posters abound for teaching farming techniques.

2.5 Awareness, Information Sources and Level of Adoption of Innovations by Farmers

Acquisition of information about a new technology demystifies it and makes it more available to farmers. Information reduces the uncertainty about a technology's

Performance hence may change individual's assessment from purely subjective to objective over time (Leeuwis, 2006). He further lamented that exposure to information about new technologies as such significantly affects farmers' choices about it. In the same connection, Ikejimba and Alabi (1998) claimed that information is acquired through informal sources like the media, extension personnel, fellow farmers, meetings, and farmers' organizations and through formal education. It is important that this information be reliable, consistent and accurate. Thus, the right mix of information properties for a particular technology is needed for effectiveness in its impact on adoption.

Adoption process begins with information acquisition through which the awareness or rather the first knowledge about technologies is obtained. The rate of adoption is usually measured by the length of time required for a certain percentage of members of a system to adopt an innovation. Extent of adoption on the other hand is measured from the number of technologies being adopted and the number of producers adopting them. Idrisa *et al.* (2007) measured the intensity of adoption in the order of the number of the components of the technology adopted by a farmer.

Depending on the technology being investigated, various parameters may be employed to measure level of adoption. Jirgi *et al.* (2008) used the producer's decision to adopt or not to adopt and subdivided respondents into two groups: Adopters and non-adopters. This study focuses on the extent of adoption of FARO 52 rice package and the factors influencing it. The low adoption ratio or indices indicate a slight uptake of the recommendations indicating between 1 – 33% compliance. The medium adoption level means an average degree of famer's compliance with the recommendations, that is, 34 - 66% adoption. The high adoption level explains complete adoption of the recommendations by the farmers, which is between 67 – 100 % adoptions.

2.6 Factors Influencing Adoption of Recommended Practices by Farmers

Several parameters have been identified as influencing the adoption behaviour of farmers from qualitative and quantitative models for the exploration of the subject. Social scientists investigating farmers' adoption behaviour have accumulated considerable evidence showing that demographic variables, technology characteristics, information sources, knowledge, awareness, attitude, and group influence affect adoption behaviour. A wide range of economic, social, physical, and technical aspect of farming influences adoption of agricultural production technology. Adoption studies in Africa (Adesina and Baidu-Forson, 1995) have identified farm and technology specific factors, institutional factors, policy variables, and environmental factors to explain the patterns and intensity of adoption. Elsewhere, Ogunsumi and Ewuola (2005) also reported that socio-economic status of farmers is positively and strongly related to adoption. This report implied that the higher the socio-economic status, the higher the tendency to adopt innovation. These evidences over decades of adoption studies have led to the categorization of adoption behaviour into innovators, early adopters, early majority, late majority and laggard and that the adoption behaviour of any agricultural technology would follow a normal distribution curve in a given social system (Rogers, 2003). However, Zhang and Owiredu (2007) reported that the total amount of land owned and/or cultivated by farmers, and use of government extension services by the farmers have a significant positive influence on the adoption of plantation establishment in Ghana. Mamudu *et al.* (2012) noted that security over land was among the factors that significantly affect the adoption of technology, with a high marginal effect on the probability of adoption.

The adoption of improved technology packages may, in part, be related to the way farmers receive the technologies introduced to them. The important factors in such a perception are the difficulties inherent in using a practice; the consistency or how adaptable the practice is in the context of the existing practices in which the farmers are already familiar with; and the expectations of the farmers using the practice (Abara and Singh, 1993). Perhaps it is not necessary to try and make clear-cut distinctions between different categories of adoption factors. Besides, categorization usually is done to suit the technology being investigated, the location, and the researcher's preference, or even to suit client needs. However, as some might argue, categorization may be necessary in regard to policy implementation (Zhang and Owiredu, 2007).

According to Doss and Morris (2009) adoption factors may be divided into three general categories: (1) characteristics of the technology; (2) characteristics of the farming environment into which the technology is introduced; and (3) characteristics of the farmer making the adoption decision. Important characteristics that can encourage or discourage adoption include the complexity of the technology, its profitability, riskiness, compatibility with other technologies or practices, and divisibility. Important characteristics of the farming environment that can affect technology adoption include agro-climatic conditions, the nature of prevailing cropping systems, the degree of commercialization of the cropping enterprise, farmers' knowledge and access to technical information, and the availability of physical inputs. A third set of factors that can affect the technology adoption process relates to farmers' personal circumstances, including ethnicity and culture, wealth, education, gender, and security of access to land.

According to Abara and Singh (1993) the factors that influence the adoption of modern agricultural production technologies are broadly categorised into economic factors, social factors and institutional factors. The economic factors include farm size, cost of technology, expected benefits from adoption of the technology, and off-farm activities. Farm size and the expected benefits are the only significant economic factors that influence the decisions of farm households involved in the study of adoption of modern agricultural production technologies by farm households in Ghana.

According to Jackline (2002) the broad categorizations of determinant factors in the literature of technology adoption are found to be economic factors, social factors and institutional factors. The social determinant factors include age of adopters, education, and gender concern. They are found to have significant influence on the technology adoption decision process. The economic factors are farm size, cost of technology, expected benefit and off-farm hours. The institutional aspect of the determinant factor includes information, extension contact, access to credit etc. For this study, some selected socio-economic and institutional factors were considered as parameters for determining the level of adoption of FARO 52 rice production package among the growers.

2.7 Reasons for Innovation Adoption

Individuals may have reason(s) for their action, decision and belief. Different characteristics of technologies may entice individuals or adoption units to make appropriate decision to adopt or reject innovations (Ismail, 2006). Reasons for a technology adoption decision are dependent on several factors including culture, personal desire, economic resources, prestige, taste (Isah et al., 2010). However, Saka and Lawal (2009) highlighted that reason for adopting a technology stems from the technology related features. For example, improved rice varieties in Southwestern Nigeria are widely adopted. The varieties were considered for adoption because of the field performance in term of growth and yield; ease of cooking, the grain color and shape, maturity duration among others. Similarly, Umar *et al*. (2009) presented that youth in most rice producing communities expressed reasons for the adoption of improved rice production technologies to include: simplicity, less costly, early maturity, grain color and shape and amylase peptic content.

Reasons for technology adoption are expressive from different viewpoints. Ugwumba (2013) submitted that adoption of oilpalm production technologies by the growers was linked to reasons including economic gains from the investment, storage quality of the palm oil, the taste and simplicity of processing. For Tiamiyu (2009) FARO varieties are mostly preferred to NERICA varieties on the reason of taste, organoleptic properties (amylase contents, swollenness and stickness), field performance (yield, resistance to some environmental related stress). As matter of choice and reason, palatability is an individual taste, while most importantly, ease and fast nature of parboiling associated with FARO 52 variety attracts marketers and consumers for patronage.

2.8 Constraints to Adoption of Agricultural Production Practices

Constraints are the factors or conditions inhibiting against the use of technical information, products and new ideas as recommended. Such condition could be biotic and abiotic factors e.g. flood, soil condition. Many factors interfere with adoption of technologies some of which are inherent in the technology itself, e.g. complexity. Untimely delivery and unavailability of technology retard the prompt decision of users to make use of technologies according to specifications e.g. lack of chemical fertilizer at the right period of cropping season. To Ojohomon *et al.* (2006) risk consideration and scarcity of funds, limited access to information and non-availability of complementary inputs such as fertilizer are other likely factors. Tiamiyu *et al.* (2010) however, reports that constraints for adopting rice production technologies include, among others, low capital, inadequate training, insufficient access to information, lack of technical knowledge and low soil fertility. Danstop and Diagne (2010) disclosed that lack of awareness of NERICA technology package was found to be a major constraint to NERICA adoption in Nigeria

Furthermore, Akpomedye (2009) observed that the main problems farmers are facing in the adoption of crop innovations in Sepele LGA of Delta State include lack of fund, lack of training by extension agent, inaccessibility to improved seed, inaccessibility to farm credit and unstable government policies. The results indicated that lack of fund is the most paramount problem confronting the farmers. In contrast, Ani *et al.* (2004) conducted a study on relationship between socio-economic characteristics of rural women farmers and adoption of farm technologies in Southern Ebonyi State, Nigeria which revealed that all the respondents (100%) were aware and interested in using the technologies but only 22% eventually adopted them. The respondents indicated that even though they were interested in using them, the technologies were not always available and when they become available, they were limited in quantities. Therefore, it could be posited here that the low adoption of these technologies could be attributed to low availability of seeds, lack of affordability on the part of the farmers due to high costs, lack of satisfaction derivable from the use of seeds comparable to the conventional types the farmers were used to rather than lack of information or awareness.

2.9 Theoretical Framework

2.9.1 Diffusion and Adoption Model

Diffusion is the process by which an innovation is communicated through certain channels over time among members of a social system (Rogers, 2005). Roger’s position portrays idea of how an innovation spreads among people. This also further suggests that diffusion process essentially encompasses the adoption process of several individuals over time. This is to say, innovation diffusion is more closely related to adoption process. In the same vein, Martins (2009) see diffusion process in a pessimistic perspective of how communication takes place among individuals. He stated that one of the cons of the diffusion of innovation approach is that the communication process involved is a one-way flow of information. The sender of the message has a goal to persuade the receiver, and there is little or no dialogue. The sender, in this situation, is the source of innovation which could be an individual or an institution. Overall, the perception here is that 4 main elements influence the spread of a new idea: the innovation, communication channels, time, and a social system. These elements work in conjunction with one another

The dominant model in the field of adoption and diffusion studies is the diffusion of innovations model by Everrette M. Rogers (Michelsen and Madlener, 2010). The model is composed of four basic theoretical approaches each focusing on a different element of the innovation process. These are combined to form a meta-theory of diffusion consisting of four components: innovation- decision process, the perceived attributes of the technology, the rate of adoption and individual innovativeness.

Four main elements influence the spread of a new idea: the innovation, communication channels, time, and a social system (Rogers, 1995). These elements work in conjunction with one another: diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system. Rogers adds that central to this theory is process. Individuals experience five stages in accepting a new innovation: knowledge, persuasion, decision, implementation, and confirmation. If the innovation is adopted, it spreads via various communication channels.

The diffusion of innovations model describes the adoption and diffusion of innovations as a social communication process that influences technology adoption

(Michelsen and Madlener, 2010). A number of key assumptions underline the diffusion of innovations model. They include that of a decision being a process, which moves from change in knowledge over awareness and intention to a change in behaviour and that is determined by prior conditions, such as values and norms. Moreover, adopter characteristics and the technology's attributes influence the formation of stages of the decision process. Finally, this approach assumes that there are feedbacks between the different stages of the decision process.

The theoretical framework to be applied in this study is the innovation- decision process theory. The theory is based on time and five distinct stages (Nutley *et al.*, 2002). The first stage is knowledge. Potential adopters must first learn about the innovation. Second, they must be persuaded on the merits of the innovation. Third, they must decide to adopt the innovation. Fourth, once they adopt the innovation, they must implement it. Fifth, they must confirm that their decision to adopt was the appropriate decision. The decision must be reaffirmed or rejected by seeking reinforcement from others for decisions made, leading to continuation or discontinuation. Diffusion results once these stages are achieved (Rogers, 1995).

The above model will be applied to this study to presume the stages through which individual famer progresses in technology adoption decision. FARO 52 rice farmers are presumed to undergo five stages highlighted from the model of innovation adoption decision-making process. The adoption process (Figure 1) begins when a farmer moves from a state of ignorance that is, being unaware or ignorant to being aware (knowledge stage). This element is influenced by the farmers' socio-economic characteristics, personality variables and communication behaviours. The adoption decision-making process may continue and the farmer will develop favourable or unfavourable attitudes towards the package. If the farmers are persuaded, they will consequently demonstrate an interest in the FARO 52 rice package. The farmers' interest may be aroused by the perceived attributes of the package, which are said to be components of the persuasion element in the process. Subsequently, Farmer will proceed into the next stage of the adoption decision-making process, decision stage (see Figure 1). During this stage the farmer will compare the recommendations with what is current. Adoption may result if the comparison is favorable, or rejection may result if the comparison is unfavorable. Here, farmer's decision is not permanent; there may be decision to reject the recommendations and later adopt, or chose to adopt, and possibly later discontinue. The next phase (implementation) is to test the innovation. During this stage the farmers would want to experiment the recommendations on small scale, to see if it works for them. During this stage the farmers may need technical assistance from extension agents and others to reduce uncertainty about the consequence. They may reject the technology, because it failed the test. However, if the technology passes this test, they will adopt the recommendations. Having made decision to continue adoption, farmer moves to the fifth stage in the process (confirmation). During this stage, farmer will begin to look for support and reinforcements for decision made. Depending on the support for adoption and attitude of the farmer, discontinuance is also a possibility such as rejection after adoption.

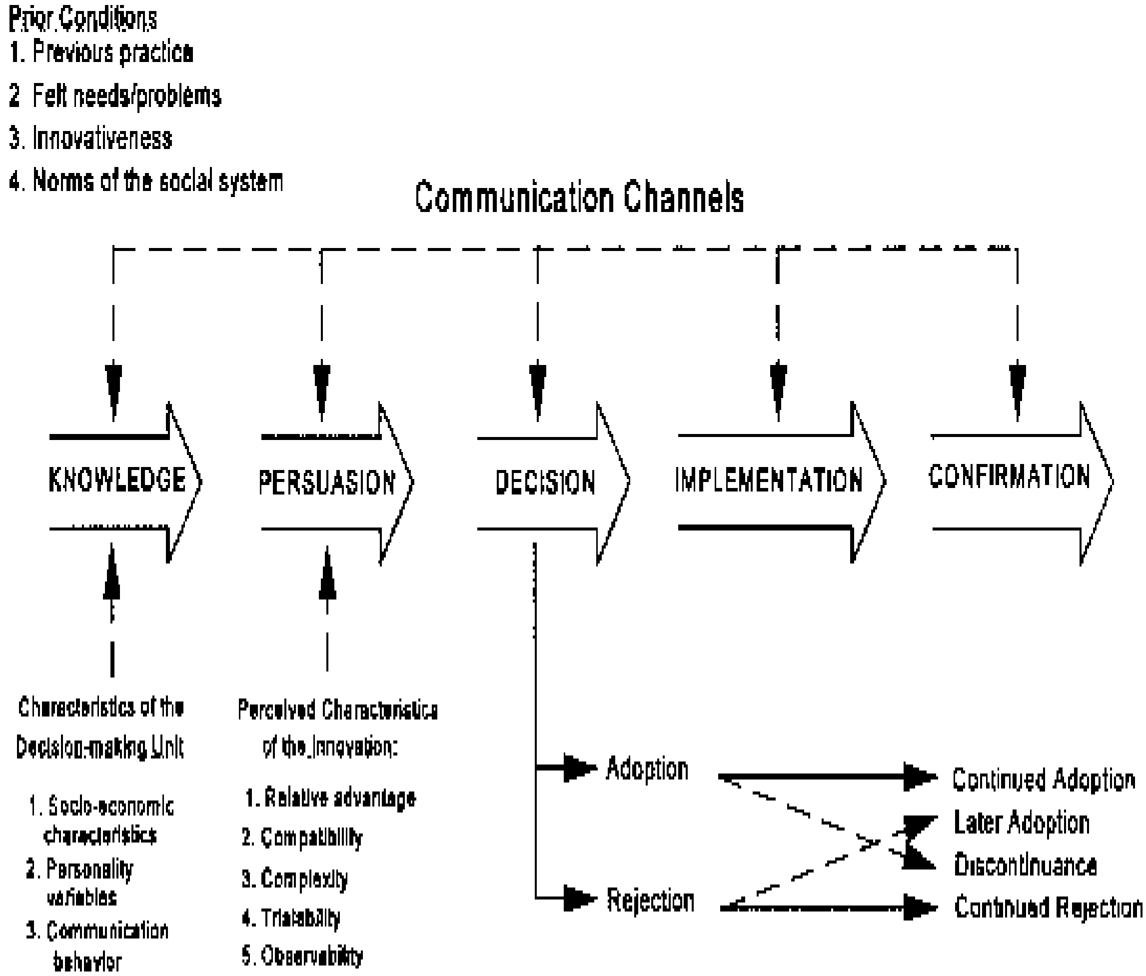

Figure1. Model of the Innovation-Decision Process

Source: Adapted from Rogers (1995)

2.9.2 Overview of the Concept of Innovation and Technology

The concept "innovation" ordinarily implies something new. All technologies, ideas and practices have origins or starting points and will be treated as innovations in a domain until their popularity is overwhelming (Adeniji *et al.,* 2007). An innovation is thus an idea, practice or product that is perceived as new by the potential users or adopters. Improved seed varieties, agrochemicals, fertilizers, new farming systems (organic and biological farming) are examples of agricultural innovations. Innovation, according to Ekong (2003), is an idea or thing perceived as new by the individual and it is essentially the newness or novelty of the idea that determines the individual's immediate reaction to it.

Rogers (2003) offered the following description of an innovation: An *innovation* is an idea, practice, or project that is perceived as new by an individual or other unit of adoption. An innovation may have been invented a long time ago, but if individuals perceive it as new, then it may still be an innovation for them.

Technology, according to Swanson (1996) is the application of knowledge for practical purpose which is generally used to improve the condition of human and natural environment and carry out some socio-economic activities. It is also considered a complex blend of materials, processes and knowledge. Innovation and technology are to be taken as synonyms (Rogers, 1995; Van den Ban and Hawkins, 1996). Technology is information, and exists only to the degree that people can put it into practice and use it to achieve values.

Rogers (1995) used the word 'technology' and 'innovation' synonymously and defines technology as the design for instrumental action that reduces the uncertainty in the cause-effect relationship involved in achieving a desired outcome. A more meaningful definition may be that a technology is a set of 'new ideas'. New ideas are associated with some degree of uncertainty and hence a lack of predictability on their outcome. For a technology to impact on the economic system, its blending into the normal routine of the intended economic system without upsetting the system's state of affairs is required. This entails overcoming the uncertainty associated with the new technologies.

Abara and Singh (1993) asserted that it is the actual application of the technical knowledge that would be termed 'technology'. It is clear that technology is aimed at easing work of the entity to which it applies. Most technologies are therefore consequently termed 'labor-saving', 'time-saving', 'capital-saving' or 'energy-saving' and so forth. To economists, this implies saving on resources that are scarce.

2.9.3 Types of Technology

Two categories of technology/innovation were identified by some literature: these are material technology also known as "hardware" component e.g. improved seeds, and knowledge-based technology also known as "software" component e.g. planting date (Swanson, 1996; Roger, 1995; Van den Ban and Hawkins, 1996). Material technology is said to be knowledge that is embodied into a technological product such as tools, equipment, agro-chemicals, improved plant varieties, etc. while knowledge-based technology is regarded as technical knowledge and management skills such as planting dates and information that will help the farmer to increase production.

According to Adekoya and Tologbonse (2005) technology composed of two parts: hardware and software. While hardware is "the tool that embodies the technology in the form of a material or physical object," software is "the information base for the tool" (Rogers, 2003). Since software (as a technological innovation) has a low level of observability, its rate of adoption is quite slow. This study is concerned with both types of technology.

The transfer of material technology to farmers for adoption has been described as simpler and straight unlike the transfer of knowledge-based technology (Swanson, 1996). Rationally, this is because the knowledge-based technologies entail training and transferring of technical knowledge and management skills to mostly poorly educated farmers.

2.9.4 Adoption Process

Adoption is a mental process through which an individual passes from first knowledge of an innovation to the decision to adopt and to confirmation of this decision (van den Ban and Hawkins, 1998). According to Feder *et al.* (1995) adoption is the decision to use a new technology, method, practice, *etc.* by a firm, farmer or consumer. As indicated by Dasgupta (1999) adoption is not a permanent behaviour. An individual may decide to discontinue the use of an innovation for a variety of personal, institutional or social reasons one of which could be the availability of an idea or practice that is better in satisfying his or her needs. In the other word, adoption at the individual level is defined as the degree of use of new technology when the farmer has full information about new the new technology and its potentials.

The adoption process is however, the change that takes place within individuals with regards to an innovation from the moment that they first become aware of the innovation to the final decision to use it. However, as emphasized by Ekong (2003) adoption does not necessarily follow the suggested stages from awareness to adoption; trial is not always practiced by farmers before adopting a new technology. Farmers may adopt the new technology by by-passing the trial stage. In some cases, particularly with environmental innovations, farmers may hold awareness and knowledge but because of other factors affecting the decision making process, adoption does not occur. Dasgupta (1999) indicated that the decision to adopt an innovation is not normally a single instantaneous act, it involves a process. Adoption is a decision-making process, in which an individual goes through a number of mental stages before making a final decision to adopt an innovation. Decision-making process is the process through which an individual passes from first knowledge of an innovation, to forming an attitude toward the innovation, to a decision to adopt or reject it, to implementation of the new idea, and to confirmation of the decision (Doss, 2006). Adoption is an individual process detailing the series of stages one undergoes from first hearing about a product to finally adopting it. As highlighted by Leeuwis (2006) a study on adoption indicated that adoption of innovation is not something that happens overnight, but rather it is the final step in a sequence of stages. Ideas varied about the precise number, nature and sequence of the stages through which people progressed. However, the most widely used characterization of stages in connection with adoption of innovation derived from Rogers (2005) elucidated the model built on normative theories about decision making models and consisted of the following stages: (1) awareness of the existence of a new innovation or policy measure, (2) interest in collecting further information about the innovation, (3) evaluation by reflecting on its advantages and disadvantages, (4) trial by testing the innovation on a small scale, (5) adoption/acceptance by applying the innovation. In addition, different sources of information are used in connection with different stages of adoption. Farmers usually become aware of innovations through the mass media. In latter stages, they tend to prefer interpersonal contact with somebody in whose competence and motivation they have confidence (Dasgupta, 1999). Dasgupta's overview of 300 studies in India shows that change agents are mainly influential during the early stages of the adoption process. In region where there are few agricultural mass media, demonstrations often play an important role in early stages.

The adoption or rejection of an innovation is the consequence of diffusion of an innovation (Dasgupta, 1999). He reported as the same, diffusion and adoption are thus closely interrelated even though they are conceptually distinct.

2.9.5 Elements in the Diffusion of Innovations

2.9.5.1 *Innovation*

According to Rogers (2003) an innovation is an idea, practice, or project that is perceived as new by an individual or other unit of adoption. Similar to this perspective, many researchers in the field of innovation adoption offered practical explanations that an innovation may have been invented a long time ago, but if individuals perceive it as new, then it may still be an innovation for them. It is the newness characteristics that make it an innovation. Adoption of such innovation is essentially more related to three steps (knowledge, persuasion, and decision) of the innovation-decision process. In addition, some innovation adoption perspectives are of the view that there is lack of diffusion research on technology clusters. For Ismail (2006) a technology cluster consists of one or more distinguishable elements of technology that are perceived as being closely interrelated.

Innovation adoption consequence is another important aspect of the diffusion process. Uncertainty is an important barrier to the adoption of innovation. Hence, the consequences may create uncertainty. Rogers (2005) offered explanation that consequences are the changes that occur in an individual or a social system as a result of the adoption or rejection of innovation. He further advised in order to reduce the uncertainty of adopting the innovation, proper awareness should be created among individuals in order to be informed about its merits and demerits. In the same connection, Ismail (2006) classified the consequences as desirable versus undesirable (functional or dysfunctional), direct versus indirect, and anticipated versus unanticipated (recognized and intended or not).

2.9.5.2 ***Communication Channels***

This is the second element of the diffusion of innovations process. A comprehensive description of this second element was offered by Dasgupta (1999), Rogers (2003) and Ismail (2006) that communication is a process in which participants create and share information with one another in order to reach mutual understanding. Thus, communication occurs through channels between sources. Ismail (2006) stated that diffusion is a specific kind of communication and includes these communication elements: an innovation, two individuals or other units of adoption, and a communication channel. For a message to exist there is always where it originates. A source, according to Adebayo and Adedoyin (2005) is the individuals or group working together or an institutions responsible for initiating communication and ensuring that the objectives of the exercise are clearly defined and achieved. Similarly, a channel is the means by which a message gets from the source to the receiver. The channels are mass media and interpersonal communication. Mass media include television, radio, newspaper, while interpersonal channels consist of a two-way communication between two or more individuals. On the general idea on effectiveness of a two-way communication, Rogers (2003) claimed that interpersonal channels are more powerful to create or change strong attitudes held by an individual. He further explained that with respect to interpersonal channels, the communication may have a characteristic of homophily, that is, the degree to which two or more individuals who interact are similar in certain attributes, such as beliefs, education, socioeconomic status, and the like, but the diffusion of innovations requires at least some degree of heterophily, which he referred to as the degree to which two or more individuals who interact are different in certain attributes.

The channel of communication can be categorized as localite channels and cosmopolite channels. Ismail (2006) viewed the two channels as possible means of communication between an individual member of the social system and outside sources. He further stressed that interpersonal channels can be local or cosmopolite; almost all mass media channels are cosmopolite. Because of these communication channels' characteristics, mass media channels and cosmopolite channels are more significant at the knowledge stage and localite channels and interpersonal channels are more important at the persuasion stage of the innovation-decision process.

2.9.5.3 *Time*

In behavioural research, time aspect is most ignored. However, Rogers (2005) is of the view that including the time dimension in diffusion research illustrates one of its strengths. The innovation-diffusion process, adopter categorization, and rate of adoptions all include a time dimension. This is because the entire process of innovation occurs over time. In the same perspective, Adekoya and Tologbonse (2005) opined that people differ when they are compared by how long it takes individuals to pass through the process of adoption, that is, innovativeness, which is the degree to an individual adopts innovation relatively earlier than other.

2.9.5.4 *Social System*

The social system is the last element in the diffusion process. Rogers (2003) cited in Ismail (2006) defined social system as a set of interrelated units engaged in joint problem solving to accomplish a common goal. This definition provides that certainly, diffusion of innovations takes place within the social system; it is influenced by the social structure of the social system in which it operates. The structure, by Rogers

(2003) is the patterned arrangements of the units in a system. In some cases, is often related to social stratification within a unit of society. The opinion leaders, the authority, head of household are some of the example of social structures. Similarly, Hoffman *et al.* (2009) claimed that the nature of the social system affects individuals' innovativeness, which is the main criterion for categorizing adopters. By his submission, it can be said that innovativeness of an individual is subject to the type of social systems in which diffusion process is taking place. The nature of social systems could be modern or traditional norms and values; they are capable to influence the rate of adoption within a social system.

2.9.6 The Innovation Decision Process

Basically, individual seeks information and engages in the processing activity of such information, where an individual is motivated to reduce uncertainty about the merits and demerits of an innovation. This suggests that innovation-decision process is about information seeking to create a new knowledge and reduce uncertainty among individuals. According to Van den Ban and Hawkin (1996) adoption process consist of five steps: awareness, interest, evaluation, trial and lastly, adoption. Subsequently, Rogers (2003) evolved the process with a reformed nomenclature to consist five steps: (1) knowledge, (2) persuasion, (3) decision, (4) implementation, and (5) confirmation. These stages typically follow each other in a time-ordered manner.

2.9.6.1 *The Knowledge Stage*

Knowledge is the first stage in the innovation-decision process. For Adekoya and Tologbonse (2005) awareness and understanding about an innovation reach individual for the first time. That is, in this stage, an individual learns about the existence of innovation and *seeks* information about the innovation. Since this stage is about information seeking, some hypothetical questions can be developed by individuals about innovation. These include: what is this technology, how does it operate, and why is it being introduced are the critical questions in the knowledge phase. During this phase, according to Waterman (2004) individual attempts to determine what the innovation is and how and why it works. In a similar submission, Rogers (2005) claimed that the questions formed three types of knowledge: (1) awareness-knowledge, (2) how-to-knowledge, and (3) principles-knowledge. He further explained that awareness-knowledge represents the knowledge of the innovation's existence. This type of knowledge is more effectively achieved through the use of mass media (radio, television and extension materials). This type of knowledge can also motivate the individual to learn more about the innovation and, eventually, to adopt it. Also, it may encourage an individual to learn about other two types of knowledge. The how-to-knowledge which contains information about how to use an innovation correctly. This helps individual to overcome the problem of non-adoption as a result of technicality that is always embedded with new practice. The principles-knowledge: this form of knowledge includes the functioning principles describing how and why an innovation works. An innovation can be adopted without this knowledge, but the misuse of the innovation may cause its discontinuance. In fact, an individual may have all the necessary knowledge, but this does not mean that the individual will adopt the innovation because the individual's attitudes also shape the adoption or rejection of the innovation.

2.9.6.2 *The Persuasion Stage*

Having learned about the innovation, individual predisposes to developing attitudes toward the innovation. Persuasion is the second stage of the process described by Asiabaka (2005) as a stage of forming and changing attitudes. His assertion can further be expounded to see persuasion stage as a phase which occurs when the individual has a negative or positive attitude toward the innovation, but the formation of a favourable or unfavourable attitude toward an innovation does not always lead directly or indirectly to an adoption or rejection. From this explanation, it can be said that the individual shapes his or her attitude after he or she knows about the innovation. On this note, it can be said that individual is persuaded to the merit of adopting the technology, they must be persuaded of the value of the innovation through its attribute, which are components of the persuasion element in the model such as its relative advantage, compatibility, simplicity trialability and observability. So, the persuasion stage follows the knowledge stage in the innovation-decision process.

Furthermore, a psychological dimension may still be used to understand persuasion as offered by Rogers (2005) who states that while the knowledge stage is more cognitive- (or knowing-) centred, the persuasion stage is more affective- (or feeling-) centred. Thus, the individual is involved more sensitively with the innovation at the persuasion stage. Individuals continue to search for innovation evaluation information and messages through the decision stage.

2.9.6.3 *The Decision Stage*

Subsequently, individual chooses to adopt or reject the innovation. While adoption refers to full use of an innovation as the best course of action available, rejection means not to adopt an innovation (Waterman, 2008). Naturally, an innovation is divisible, that is, an individual can decide to adopt the innovation as a whole set or partly adopt some units or components. The realistic view is that if an innovation has a partial trial basis, it is usually adopted more quickly, since most individuals first want to try the innovation in their own situation and then come to an adoption decision.

However, rejection is possible in every stage of the innovation-decision process. Ismail (2006) expressed two types of rejection: active rejection and passive rejection. In an active rejection situation, an individual tries an innovation and thinks about adopting it, but later he or she decides not to adopt it. A discontinuance decision, which is to reject an innovation after adopting it earlier, may be considered as an active type of rejection. In a passive rejection (or non-adoption) position, the individual does not think about adopting the innovation at all. In the same direction, there are antecedents that may contribute in the decision process such as the components of the key elements in the model. This includes socio-economic characteristics, communication behaviour, the social system and attribute of the innovation. The decision could be optional, collective or authority.

2.9.6.4 ***The Implementation Stage***

At the implementation stage, individual develops attitude of putting the innovation into practice. However, it is a common knowledge that an innovation brings the newness in which some degree of uncertainty is involved in diffusion. Thus, individuals or adoption units may seek technical assistance from change agents to reduce the degree of uncertainty about the consequences. Moreover, the implementer may chose to try out an innovation on a small scale in order to evaluate and compare the effect with the previous ideas. If individual completely implement the practice in his field, it serves as a model for others to learn and copy. It thus expedites the process of diffusion among individuals in the society.

2.9.6.5 ***The Confirmation Stage***

Sequel to the innovation-decision already been made individual looks for support for decision at the confirmation stage. Accordig to Asiabaka (2005) and Ismail (2006) decision can be reversed if the individual is exposed to conflicting messages about the innovation. However, the individual tends to discontinue the innovation and seeks supportive alternative option that is better in satisfying his or her needs. In addition, Ismail as above states that depending on the support for adoption of the innovation and the attitude of the individual, later adoption or discontinuance happens during this stage. Since different innovation adoption behaviours are bound to occur at this stage, therefore, change agents have the task of guiding and supporting the implementers in order to sustain them on the use of the new practice.

2.9.7 Attributes of Innovations

Rogers (2005) defined the rate of adoption as "the relative speed with which an innovation is adopted by members of a social system". For instance, the number of individuals who adopted the innovation for a period of time can be measured as the rate of adoption of the innovation. The perceived attributes of an innovation are significant predictors of the rate of adoption.

Thus the attributes of innovations are:

2.9.7.1 *Relative Advantage*

Relative advantage is the degree to which an innovation is perceived as being better than the idea it supersedes. The degree of relative of relative advantage is often expressed in economic profitability (Rogers, 1995 cited in Asiabaka, 2005). In other word, relative advantage can be measured in terms of social benefits and not necessarily on financial aspect. Naturally, people are known to prefer an innovation which is better than another one. It is assumed that the higher the relative advantage of a new idea, the higher the probability of its widespread acceptance and use by farmers. Waterman, (2008) is of the view that the relative advantage can be subdivided into economic and non-economic categories. The economic categories are related to the profitability of the technology while non-economic feature are a function of variable including saving of time.

Moreover, Rogers (2003) categorized innovation into two types: preventive and incremental (non-preventive) innovations. A preventive innovation is a new idea that an individual adopts now in order to lower the probability of some unwanted future event. Preventive innovations usually have a slow rate of adoption so their relative advantage is highly uncertain. However, incremental innovations provide beneficial outcomes in a short period. Another motivation factor in the diffusion process is the compatibility attribute.

2.9.7.2 ***Compatibility***

In some diffusion research, relative advantage and compatibility were viewed as similar, although they are conceptually different. Rogers (2003) stated that "compatibility is the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters". Conceptually, compatibility is the extent to which a recommended farm practices or innovation is seen as consistent with current and existing practices, values and past experiences of farmers. An idea in conflict with important beliefs and social values of a community will be rejected. However, according to Ismail (2006) lack of compatibility in technological package with individual needs and consistence with past experience may negatively affect the individual's technology use. From this submission, it can be said that if an innovation is compatible with an individual's desire, then uncertainty will reduce and the speed of adoption of the innovation will increase. Thus, even naming the innovation is an important part of compatibility. What the innovation is called should be meaningful to the potential adopter. That is, innovation should be compatible to socio-cultural environment of individual.

2.9.7.3 *Complexity*

Rogers (2005) defined complexity as the degree to which an innovation is perceived as relatively difficult to understand and use. In addition to this definition, complexity can be described as the difficulty or ease with which new farm practices and innovations can be understood, learned and adopted by the farmers. Simple ideas will be adopted more readily than complex technologies. Waterman, (2008) supported the assertion that If the innovation is perceived as complicated or difficult to use, an individual is unlikely to adopt it. This means that some innovations are clear and easy to understand while others are not. Also, Asiabaka (2005) held that simple technologies which are user-friendly will be adopted more by resource-poor farmers than complex and difficult technologies. Although, Martins (2009) added that opposite to the other attributes, complexity is negatively correlated with the rate of adoption. Thus, excessive complexity of an innovation is an important obstacle in its adoption. A technology might have different levels of complexity. If hardware and software are user-friendly, then they might be adopted successfully for the delivery of course materials.

2.9.7.4 Trialability

Trialability is the extent to which a new idea or technology can be adopted on a small scale for experimental purposes and observation. In the process of adoption, the farmer tries out ideas on a small scale before taking too much risk of full adoption. The decision to adopt depends on the level of success achieved in the trial stage. The point of emphasis is on how easily an innovation may be experimented. If a user is able to test an innovation easily, the individual will be more likely to adopt it.

According to Rogers and Ismail (2003 and 2006), trialability is the degree to which an innovation may be experimented with on a limited basis. In a similar opinion, trialability is positively correlated with the rate of adoption. The more an innovation is tried, the faster its adoption is. This can simply be put that earlier adopters can see the trialability attribute of innovations as more important than later adopters.

2.9.7.5 *Observability*

Observability is the extent that an innovation is visible to others. An innovation that is more visible drives communication among the individual's peers and personal networks and in turn creates more positive or negative reactions (Waterman, 2008). Expressively, it can be described as the degree to which the result of a new idea or practice is visible to farmers. If the result of the innovation cannot be demonstrated, the farmer is unlikely to be convinced. The farmer therefore, requires the assistance of local leaders and extension workers to increase his knowledge as to how the benefits of the technology can be more visible to him.

According to Adeniji *et al.* (2007) the last characteristic of innovations is observability, and is defined *as* the degree to which the results of an innovation are visible to others. Similar to relative advantage, compatibility, and trialability, observability also is positively correlated with the rate of adoption of an innovation.

In summary, Ismail (2006) and Martins (2009) are of the view that innovations offering more relative advantage, compatibility, simplicity, trialability, and observability will be adopted faster than other innovations. On the contrary, Surendra (2001) observed that getting a new idea adopted, even when it has obvious advantages, is difficult. Consequently, all of these attributes of innovations speed up the innovation-diffusion process.

2.9.8 Adopter Categories

Adopter category is a form of classifications of members of a social system on the basis of innovativeness. Individuals are classified based on their personal and socio-economic characteristics and according to their scores on an adoption index. This classification includes innovators, early adopters, early majority, late majority, and laggards. In each adopter category, individuals are similar in terms of their innovativeness.

2.9.8.1 *Innovators*

Innovators are the first individuals to adopt an innovation. They are characteristically willing to take risks, youngest in age, have the highest social class, have great financial liquidity, are very social and have closest contact to scientific sources and interaction with other innovators. They have the character of risk tolerance which always endears them to adopting technologies which may ultimately fail. Although, their financial resources help absorb these failures.

According to Ike and Gideon (2006) basically the innovators have wide range of contacts and they are independent in thoughts and adoption process. They are mostly regarded as experimenters and they constitute the first group to adopt new ideas. On the whole, they are known for a unique characteristic of being adventurous and venturesome. Other members of the social system rely on them as reliable sources of extension messages.

2.9.8.2 *Early Adopters*

This is the second fastest category of individuals who adopt an innovation. These individuals have the highest degree of opinion leadership among the other adopter categories. As a result of leadership personality, they are often rely on by friends and neighbours in their farming communities. Early adopters are typically younger in age, have a higher social status, have more financial lucidity, advanced education, and are more socially forward than late adopters (Ekong, 2003).

On this note, Ismail (2006) is of the view that since early adopters are more likely to hold leadership roles in the social system, other members come to them to get advice or information about the innovation. In fact, leaders play a central role at virtually every stage of the innovation process, from initiation to implementation; particularly in deploying the resources that carry innovation forward. Thus, as role models, early adopters' attitudes toward innovations are more important. Similarly, the members of this group tend to have objective evaluations about the new idea that reach members of the social system through the interpersonal communication strategies. Finally, early adopters concede to a new idea by adopting it earlier before majority members of the social system do.

2.9.8.3 *Early Majority*

Explicit description of this group is that individuals in this category adopt an innovation after a varying degree of time. This time of adoption is significantly longer compare to innovators and early adopters. Early Majority tend to be comparatively slower in the adoption process. To this effect, Ike and Gideon (2006) claimed that in this category farmer does not take lead in using new ideas but usually adopts before the average member of his community. They constitute majority by 34.0% in the normal distribution curve of adoption index. They often deliberate and adopt innovation by conviction. Furthermore, they do adopt innovations earlier than the half of their peers in the community. Thus, their innovation decision usually takes more time than it takes innovators and early adopters.

2.9.8.4 *Late Majority*

Individuals in this category will adopt an innovation after the average member of the society. These individuals approach an innovation with a high degree of scepticism and after the majority of society has adopted the innovation. Late Majority are typically sceptical about an innovation, have below average social status, very little financial lucidity, very little opinion leadership.

Similar to the early majority, Ismail (2006) observed that the late majority constitutes one-third of all members of the social system who wait until most of their peers adopt the innovation. Although they are sceptical about the innovation and its outcomes, they show high level of fear of risks in the adoption decision process. Therefore, to facilitate adoption process interpersonal network s among peers should convince or persuade member of this group to adopt the innovation.

2.9.8.5 ***Laggards***

Individuals in this category are the last to adopt an innovation. Unlike some of the previous categories, individuals in this category show little or no opinion leadership. Ike and Gideon (2006) expressed that these individuals typically show little interest in extension contact, they are suspicious of innovations; they have an aversion to change-agents and tend to be advanced in age. Laggards typically tend to be focused on traditions, likely to have lowest social status, be oldest of all other adopters, in contact with only family and close friends.

Rogers (2003) and Ismail (2006) offered comprehensive descriptions of this category that, laggards have the traditional view and they are more sceptical about innovations and change agents than the late majority. They are the most localized group of the social system; therefore, their interpersonal networks mainly consist of other members of the social system from the same category. Moreover, they first want to make sure that an innovation works before they adopt. Thus, laggards tend to decide after looking at whether the innovation is successfully adopted by other members of the social system in the past. Due to all these characteristics, laggards' innovation-decision period is relatively long.

2.10 Conceptual Model of the Study

The conceptual framework of this study was built on the premise that the socio-economic characteristics of innovation decision-making units and institutional factors have influence on adoption of FARO 52 rice package. In general, these factors were conceptualised to have a range of effects on the technology adoption decision and influence on the level to which decision-making units adopt innovative ideas. Thus, the dependent variable for the conceptual model of this study was the level of adoption of FARO 52 rice package. The independent variables were socio-economic factors (age, education, farming experience, farm size and household size); institutional factors (access to market, extension visits, exposure to mass media, training and membership of associations). The arrows indicate the relationship expected between the independent and dependent variables.

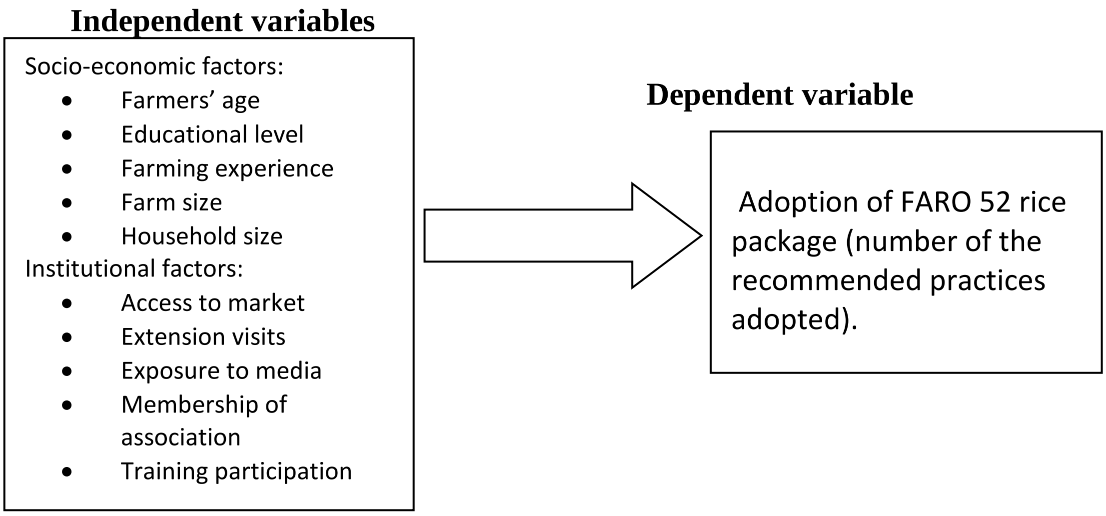

Figure 2: Conceptual Framework showing Factors Influencing Adoption of FARO 52 Rice Package

CHAPTER THREE

3.0 METHODOLOGY

3.1 The Area of Study

Niger State is in the Guinea Savannah Zone of Nigeria. The state is bordered to the North-West by Kebbi State to the South by Kogi State to the South-West by Kwara State. Kaduna state and the Federal Capital Territory, Abuja borders the state to the North-East and South-East respectively. It lies between Latitude 8^0 10’N and 11^0 30’N, longitude $6^0$20’E and 9^0 03’E. (Ojohomon *et al.,* 2006). Niger State covers about 84,80km^2, which is about 8.2% of the total land area of Nigeria. It has distinct dry and wet seasons and an annual rainfall of between 1,300 mm and 1,600 mm. The minimum temperature, which is 25^{o}C, occurs in December - January whiles the maximum that is 38^{o}C, in March - April. The vegetation is Guinea Savanna with mixture of trees, shrubs, herbs, and grasses.The Lixisols, Cambisols and Luvisols are common soils in the study area. The soils are of low to medium fertility levels and can be used for growing cereals, root and tree crops (Ojohomon *et al.,* 2006). Niger State has a population of 3,954,772 people (NPC, 2006). Niger state projected population for the year 2014 stands at 5,966,367 (UNPFA, 2014).

3. 2 Sampling Technique and Sample Size

A multi-stage sampling technique was employed for the study. In the first stage, three Local Government Areas (LGAs) were purposively selected. These were Katcha, Lavun and Gbako of Niger State. FARO 52 is a lowland ecology specific variety, and these LGAs have a long history of lowland rice production. As a matter of fact, they are the areas where lowland is extensively grown in the state. In the second stage, three lowland rice producing villages were randomly selected from each of the LGAs to make a total of nine villages. In the third stage, a total sample of 166 rice farmers adopting

FARO 52 rice package were randomly selected by proportionately drawing 25% of the adopters in each of the selected villages (Table 3.1)

Table 3.1: Study Population and Sample Size

	Name of the selected LGAs and villages	Estimated number of FARO 52 rice package adopters	Selected FARO 52 rice package adopters (25%)
KATCHA LGA			
i.	Bakeko	52	13
ii.	Logunma	104	26
iii.	Egbanti	36	9
LAVUN LGA			
i.	Amfani	96	24
ii.	Doko	120	30
iii.	Mambe	96	24
GBAKO LGA			
i.	Edozhigi	80	20
ii.	Ndagbachi	24	6
iii.	Batagi	56	14
TOTAL		664	166

3.3 Data Collection Methods and Sources

Primary data were collected with the use of structured questionnaire as the survey instrument. The exercise was conducted with assistance of extension officers overseeing the selected areas of study. The field work was carried out beginning from the month of February through March to November, 20014.

3.4 Analytical Techniques

The analytical tools used for the study include both descriptive and inferential statistics. Descriptive statistics such as frequency count and percentages was used for achieving objectives i, ii, v and vi. Objective iii was analyzed by calculating technology adoption index of each adopter using the adoption quotient method. To achieve objective iv, a multiple regression model (linear function form) was used to assess the factors influencing adoption of FARO 52 rice package by the farmers. The model was also used to test the null hypotheses of the study.

3.4.1 Multiple Regression Model Specification

In statistics, regression analysis is a statistical technique for estimating the relationships among variables. It includes many techniques for modeling and analyzing several variables, when the focus is on the relationship between a dependent variable and one or more independent variables.

1. The technique is used when exploring linear relationships between the predictor and criterion variables – that is, when the relationship follows a straight line.
2. The criterion variable that you are seeking to predict should be measured on a continuous scale (such as interval or ratio scale).
3. The predictor variables that you select should be measured on a ratio, interval, or ordinal scale. A nominal predictor variable is legitimate but only if it is dichotomous, i.e. there are no more than two categories. For example, sex is acceptable (where male is coded as 1 and female as 0) but gender identity (masculine, feminine and androgynous) could not be coded as a single variable. Instead, you would create three different variables each with two categories (masculine/not masculine; feminine/not feminine and androgynous/not

androgynous).The term dummy variable is used to describe this type of dichotomous variable (Amit, 2009).

The multiple regression models for the study are specified as follows:

Linear regression model:

Y = $bo + biX_1 + b_2X_2 + b_3X_3 + \ldots + b_{11}X_{11} + ei$

Where

Y = Number of recommended practices adopted by i^th^ farmer

Xs = subscripts for explanatory variables

X_3 = farmer's age (years). X_4 = education. X_5 = Household size. X_6= Farm size. X_7= Farming experience. X_8 = extension visits. X_9 = Farmer's income. X_{10} = Exposure to media. X_{11} = Training participation. X_{12} = Access to market. X_{13} = Membership of farmer association

$\mathbf{b_0}$ = constant,$\mathbf{b_1}$ $\mathbf{b_2}$ = coefficient, $\boldsymbol{U}$ = error terms.

Semi-log regression function model:

Y = $a+b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3$ +------------------------------------+ $b_{11} \log X_{11}$

Double-log regression function model:

LogY = $\log a + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3$ +------------------------ + $b_{11} \log X_{11}$

3.4.2 Adoption Index

Adoption index shows an extent of use of a number of recommended practices by farmers which is measured by adoption score (number of improved practices used) or by an adoption quotient (number of improved practices used over total number of recommended practices). Score may be arbitrarily scaled to arrive at some categorization of adoption, for example low, medium and high (Maiangwa *et al.*, 2007; Ramaswamy, 1993). For the purpose of this study, adoption index were calculated to obtain each farmer's level of use of multiple practices from the 10 recommended components of FARO 52 rice package and finally categorized into low, medium and high level of adoption. In order to determine the level of adoption of the package, adoption index of individual farmers was calculated using the following formula of adoption quotient adapted from Tadesse, (2008). This was done to achieve objective iii of the study

$$AI_i = \sum_{i=1}^{n} \frac{\left(\frac{STAi}{STi} + \frac{ENAi}{ENi} + \frac{LPAi}{LP} + \frac{SPAi}{SPi} + \frac{TRDAi}{TRDi} + \frac{WMAi}{WMi} + \frac{FAAi}{FAi} + \frac{HBAi}{HBi} + \frac{DCAi}{DCi} + \frac{ICAi}{ICi}\right)}{Np}$$

Where i = 1, 2, 3, 4, n, and n = total number of farmers.

N_P = number of practices

AI = adoption Index of i^{th} farmer

STA = seed treatment by i^{th} farmer (g)

ST = seed treatment recommended for the crop (g)

ENA = establishment of nursery (seed incubation) by i^{th} farmer (days)

EN = establishment of nursery (seed incubation) recommended for the crop (days)

LPA = land preparation by i^{th} farmer (numbers)

LP = land preparation recommendation for the crop (numbers))

SPA= spacing by i^{th} farmer (cm)

SP = spacing recommended for the crop (cm)

TRDA = depth of transplanting by i^{th} farmer (cm)

TRD = depth of transplanting recommended for the crop (cm)

WMA = water management by i^{th} farmer (cm)

WM = water management recommended for the crop (cm)

FAA = fertilizer rate by i^{th} farmer (bags/ ha)

FA = fertilizer rate recommended for the crop (bags/ha)

HBA = rate of herbicide used by i-th farmer (ml/ liter)

HB = rate of herbicide recommended for the crop (ml/ liter)

DCA = rate of disease-control chemical applied by i^{th} farmer (ml/liter)

DC = rate of disease-control recommended chemical application for the crop (ml/liter)

ICA = insect control chemical applied by i^{th} farmer (liter/ ml)

IC = insect control chemical control recommended for the crop (liter/ml)

The actual adoption index score ranges from 0 – 1. The adoption score of 0 implies non-adoption and the adoption score of 1 implies the farmers adopted all the recommended components. Thus, adoption indices of the farmers were categorized into four, that is, non – adoption = 0, low adoption = 0.01 – 0.33; Medium adoption = 0.34 – 0.66; and high adoption = 0.67 – 1.0. Adoption index is thus a continuous dependent variable which is influenced by socio-economic characteristics of farmers and other factors as independent variables. Adoption index of the sampled farmers was further subjected to descriptive analysis in frequency and percentage to identify the actual distribution of the farmers in each category of adoption index. The low adoption indices indicate a slight uptake of the recommendations, that is, 1 – 33%. The medium indices mean an average degree (34 – 66%) of famer's compliance with the recommendations. The high indices explain complete adoption of the package by the farmers, that is, 67 – 100% compliance with the recommendations.

3.4.3 Recommended Components of the Package

FARO 52 is a rice variety specified to be grown in lowland ecology which was released in 2001 and registered in the same year. The recommended component technologies for the package and their measurement are as follows:

i. **Seed Treatment:** it is a pre-planting operation recommended to ensure uniform seedling emergence. The technology recommends application of Apron Star™ or any seed dressing chemical at rate of one sachet (1g) per 4kg before being spread on a well puddle nursery bed. The purpose is to prevent against seed borne pathogens. This practice was measured by taking the actual ratio of seed dressing chemical (g) applied by i^{th} farmer per 4kg of seed and dividing it by the actual recommended rate.

ii. **Establishment of Nursery:** this technology involves the practices of seed incubation by covering with polyethylene bags or raffia palm for seed to sprout and nursery preparation. The sprouted seeds are spread uniformly on a puddle nursery bed. Seedlings' age was recommended to be at 21 days before being transplanted. The aim is to ensure that the seedlings have the vigor to withstand the transplanting shock and related environmental stress. Measurement of this practice was by identifying the actual age of the seedlings adopted before being transplanted by i^{nth} farmer to the main field over the recommended 21 days.

iii. **Land Preparation:** the practice comprise number of tillage operations: (1) disc plow of the field immediately after harvest to expose the rhizomes to the sun. Subsequently, (2) harrowing of the field for about 2 weeks to kill weeds, (3) construction of bounds around the field to retain water and suppress weeds. Adoption ratio of this practice was calculated by identifying the number of operations adequately adopted by i^{nth} farmer divided by the 3 recommended by the research system.

iv. **Transplanting Depth:** it was recommended to transplant seedlings to the main plot at depth of 4cm. In order to get the ratio for this technology, the actual depth (cm) of seedling transplanting practiced by the farmer was identified and divided by the recommended 4cm.

v. **Spacing:** it is agronomic practice that requires maintaining appropriate spacing of seedling stands to ensure optimum yield. Transplant seedlings to the main field at a spacing of 20 x 20 cm between and within the rows (intra and inter spacing). The spacing is expected to be complied with to realise potential yield of FARO 52 at 5-6 tonnes/ha. It was measured by identifying the spacing (cm) adopted by i^{nth} farmer over the recommended spacing (cm).

vi. **Water Management:** a well bounded field containing water that could be maintained to a desirable depth is required for effective water management in rice field. This refers to maintaining the water in the main field up to 5cm depth from one week after transplanting until grain matures. Rice is a water loving crop, hence the sufficient volume of water is recommended to keep the crop fit and to suppress weed growth. It was measured by taking the actual ratio of the water depth (cm) practiced by i^{th} farmer from one week after transplanting divided by the 5cm recommended water depth.

vii. **Fertilizer Rates:** this is a recommended technology that requires farmers to apply 200 kg/ha (4 bags) of NPK 80 - 40 - 40 before transplanting and work the fertilizer well into the soil. Also, apply 100kg/ha (2bags) of urea with 2 splits at 4-6 weeks after transplanting. Subsequently, apply 100 kg/ha (2bags) of urea at panicle initiation. Thus, a total of 400kg (8 bags) of inorganic fertilizer per hectare are recommended. This was measured by identifying the actual quantity of bags of inorganic fertilizer rate used per hectare by i^{nth} farmer divided by the recommended rate.

viii. **Herbicide:** it is a post emergence application of chemical weed control in rice transplanted field to kill most broad leaf weeds, sedges and grasses. It was recommended to apply Delmin Forte (2,4-D) plus Propan 360 (propanil) at 250ml in 20 liters of water per hectare, 3 weeks after transplanting. This practice was measured by identifying the actual ratio (ml/litre) of herbicide used by the farmer and dividing it by the recommended rate (ml/litre) of the herbicide.

ix. **Disease Control:** is a plant protection practice. Rice is commonly susceptible to some diseases including Rice Yellow Mottle Virus (RYMV), blast, brown spot, grain discoloration, etc. The control measure is that farmers are to remove surrounding weeds to destroy the alternate host of RYMV to reduce the virus infection. For the control of rice blast, Benlate^{TM} (50% of benomyl) at 150ml per knapsack sprayer (15 liters) have to be sprayed to control rice blast and grain discoloration. Depending on the disease infection, rice blast a fungal disease is the prevailing disease noticeable in rice environments in the study area. The practice was measured by identifying the actual ratio (ml/litre) of Benlate^{TM} applied by i^{nth} farmer per knapsack sprayer and dividing it by the recommended rate.

x. **Pest Control:** it is a crop protection practice which comprises both cultural and chemical control measures depending on the pest infestation. This includes early sowing; synchronized planting of rice field to escape from Diopsis infestation. To control rice bugs, Decis^{TM} at 1liter/ha in 500 liters of water is recommended. It is obvious that rice bugs are more prevalent in the study area, hence the chemical control method. The practice was measured by identifying the actual litres/ha of Decis^{TM} in 500 litres of water used by i^{nth} farmer divided by the recommended rate.

3.4.4 Definition of Variables and Priori Expectations

Dependent Variable: using multiple regressions, the dependent variable of the study was adoption level of FARO 52 rice package, denoted Y (AI). Level of adoption in this shows the extent of use of a number of recommended practices over the total number of the recommended practices.

Independent Variables: these are variables which are thought to have influence on level of adoption of the FARO 52 rice package. These explanatory variables are: age (X_1), level of education (formal) (X_2), household size (X_3), farm size (X_4), farming experience (X_5), extension visits (X_6), farmer's annual income (X_7), exposure to media (X_8), training participation (X_9), access to market (X_{10}) and membership of farmers' associations (X_{11}).

The independent variables for the study were:

Age of the Farmers: this refers to chronological age or how old is the farmer, that is, number of years lived by the farmer. Farmer's age and adoption of technology are associated. As a farmer's age increases, it is expected that the farmer becomes conservative. Therefore it is priori expected that farmer's age and level of adoption relate negatively. Thus, as a farmer's age increases the level of technology adoption is expected to decrease (Dereje, 2006).

Level of Education: it was measured by number of formal school years completed by the farmer. Education (formal) is assumed to increase farmers' ability to obtain, process, and use information relevant to the adoption of FARO 52 production package. It is expected that educated individuals can make better decision to adopt components of the package than non-educated ones. In this study, education was treated as a continuous variable that was measured in number of years spent in formal school system. Level of adoption is expected to associate positively with farmer's level of formal education (Dereje, 2006 and Rahimeto, 2007).

Farm Size: The variable was measured in number of hectares of land devoted to rice production. It was hypothesized that as the farm size have positive relationship with the level of adoption of FARO 52 rice package.

Farming Experience: This was measured in number of years a farmer had started rice cultivation on his own. Experience of the farmer is likely to have a range of influence on adoption. Experience improves the farmer's skill in production operations. Higher skill increases the opportunity of not undertaking the traditional enterprise. Farmers with higher experience appear to have often full information and better knowledge and are able to evaluate the advantage of the technology (Abdoulaye *et al.,* 2014). So, it is a priori expected that farming experience associates positively with the level of adoption.

Household Size: This was measured in term of number of wives, children and dependents living in a household. It often determines how much family labour was put into the farm activities (Adeniji *et al.*, 2007). The priori expectation is that household size will have a positive influence on the level of technology adoption.

Extension Visits: it was measured by number of extension agent contacts with the farmer in the last 2 years. This is expected to have a positive effect on the level of adoption of FARO 52 rice production package. Extension visits are to expose farmers to availability of information expected to stimulate adoption. A positive relationship is expected between extension visits and the level of adoption of a new technology.

Mass media Exposure: it was measured in terms of number of different media (TV, radio, print) a farmer is exposed to on agricultural programs in the last 2 years. Mass media play the greatest role in creating awareness in shortest time possible over large area of coverage. It is thus expected to have positive influence on FARO 52 package adoption. This was confirmed by Abdoulaye *et al.*(2014) who stated that access to radio and television is expected to have positive influence on the level of technology adoption.

Access to Market: it refers to distance from farmer's home to the market in kilometres. The possibility of farmers to locate a market for demand and supply of their farm inputs and produce is an important factor in adoption studies. This is because households located near a market will incline to buy more improved agricultural inputs and they can easily sell their farm produce in the market. Therefore, the variable was treated as a continuous variable measured in kilometres. As market distance increases, the level of adoption is expected to decrease (Dereje, 2006 and Rahimeto, 2007). It is priori expected that market distance will relate negatively with the level of adoption of FARO 52 rice production package.

Membership of Association: This is a voluntary participation in a group or society on the ground of a common interest and similar belief. The variable was measured in terms of years of being a active member of farmer's cooperatives, societies and clubs. It was expected to assist farmers to get easy access to credit facilities and other production inputs. It can also enhance access to information about technologies. This variable is expected to be positively related to technology adoption. Membership of agricultural associations is included because it has been shown that farmers within a group learn from each other how to grow and market crops. The evidence suggests that network effects are important for individual decisions, and that, in the particular context of agricultural innovations, farmers share information and learn from each other (Odoemenem and Obine, 2010).

Participation in Training: this refers to number of rice production trainings attended by the farmer in the last 2 years. The trainings are designed to equip farmers' technical ability to adopt the technologies according to the recommendations. Hence, participation in the training is expected to positively influence farmers’ adoption behaviour (Saka and Lawal, 2009).

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

This chapter presents the results and discussion of research findings. The data collected were summarized and analyzed based on the objective of the study and hypothesis that guided the study.

4.1 Socio-Economic Characteristics of the Respondents

This provides information on the descriptive analysis using frequency and percentage distribution of respondents.

4.1.1 Age Distribution of the Respondents

Age is an important factor affecting crop production, consumption and household food security in Nigeria (Balarabe, 2012).

Table 4.1: Distribution of Respondents according to Age (n=166)

Age (years)	Frequency	Percentage
20 – 30	42	25.3
31 – 40	82	49.4
41 – 50	30	18.1
51 – 60	8	4.8
>60	4	2.4
Total	**166**	**100**

Source: *Field survey, 2014*

Results presented in Table 4.1 indicate that 49.4% of the FARO 52 rice package adopters were within the age range of 31-40 years and 25.3% fall within 20-30 years of age. These are the economically active age brackets and people in this age brackets are usually self motivated and innovative (Yunusa, 1999). Similarly, Isah *et al.* (2010) supported that younger farmers are more receptive to new ideas than older ones. They may have much wider contacts with outside farming and alternative employment opportunities. They are therefore much more willing to take risk in adopting new practices than older farmers.

4.1.2. Level of Education

According to Balarabe (2012) educational level does not only increase productivity, but also increases ability to understand and evaluate the information on new techniques and processes being disseminated through extension services.

Table 4.2: Distribution of Respondents according to Level of Education (n=166)

Educational level (years)	Frequency	Percentage
0	24	14.4
1 – 5	58	34.9
6 – 10	64	38.6
>10	20	12.0
Total	**166**	**100**

Source: *Field survey, 2014*

Results in Table 4.2 show that 38.6% of adopters had 6 – 10 years of formal schooling, while few (14.4%) were discovered to have no formal education. This implies that adopters with their higher level of literacy and formal education would be more inclined to readily accept technological changes in their farming occupation. Expectedly, well educated farmers have human capital to more fully understand and utilize information than those without formal education. The literacy level helps the farmers to uptake innovations faster. Adewumi *et al.* (2007) have similarly posited that extent of literacy helps to eradicate ignorance and promote adoption of new technology. It helps farmers to interpret the technology packages transferred to them by development agencies

4.1.3 Household Size

Household size refers to number of persons in a family including wives, children and dependents which in a conventional agricultural system determines the labour force for farm activities. Household size is an important variable which indicate availability of labour to the household (Yunusa, 1999).

Table 4.3: Distribution of Respondents according to Household Size (n= 166)

Household size	Frequency	Percentage
1 – 5	20	12.0
6 – 10	54	32.5
11 – 15	34	20.5
16 – 20	31	18.7
>20	27	16.3
Total	166	100

Source: *Field survey, 2014*

Table 4.3 reveals that 32.5% of the adopters had 6 and10 members in their respective households, while 20.5% had a family size between 11 and15 members. The findings suggest availability of labour force for farming in the study area. Thus, the adopters of FARO 52 rice package have more labour force to implement the recommended technological practices. Therefore, decision to use innovative information and ideas are most likely to be sustained among the adopters' group. This is in conformity with Danstop and Diagne(2010) who observed that large household had propensity towards technology adoption which count on availability of labour force for farming. The finding was also supported by Mignouna *et al.* (2011) who reported that adopters of maize technologies had larger households than non-adopters in Western Kenya.

4.1.4 Farm Size

Farm size is an indicator of wealth, social status and influence within a farming community. It is regarded as hectares of farmland used by individual farmer for rice production in the study area.

Table 4.4: Distribution of Respondents according to Farm Size (n=166)

Farm size (ha.)	Frequency	Percentage
<1	8	4.8
1 – 2	35	21.1
2.1 – 3.1	52	31.3
3.2 – 4.1	44	26.5
>4.1	27	16.3
Total	**166**	**100**

Source: *Field survey*, *2014*

The findings presented in Table 4.4 show that some proportion of adopters (31.3%) used 2.1 – 3.1 hectares of land for rice production, while few (26.5%) had used between 3.2 and 4.1hectares. This implies that there was a limited land for rice production in the study area. These findings substantiated the fact that rice production in Nigeria is characterized by small-scale production (Yunusa, 1999). This is supported by Ajiberfun (2006) who reported that the size of farm generally portrays the size of operation as it has major impact on the level of resource use efficiency of small-scale farming. In the same connection, Rahemeto (2007) observed that some adopters (35.2%) of Haricot beans production package in Ethiopia have comparatively larger farm size of between 2.5 - 3.5 hectares. Farmers with larger land size can afford the expenses on new agricultural technologies and also can bear the risk in case of failure of crop. This means that farmers who have relatively large farms will be more motivated to adopt improved haricot bean technologies; and the reverse is true for small-scale farmers.

4.1.5 Farming Experience

Experience is a form of knowledge and skills that facilitate modern technology adoption. It is the frequency of exposure to events and or activities from which an individual or group may gather knowledge, opinion, and skills. According to Balarebe (2012), farming experience is expected to help farmers in boosting crop production through knowledge acquired from years of farming.

Table 4.5: Distribution of Respondents according to Farming Experience (n=166)

Farming experience (years)	Frequency	Percentage
<5	16	9.6
5 – 10	30	18.1
11 – 15	20	2.1
16 – 20	58	34.9
>20	42	25.3
Total	**166**	**100**

Source: *Field survey, 2014*

Results in Table 4.5 reveals that some (34.9%) of adopters were found to have between 16 and 20 years of rice farming experience, while 25.3% had more than 20 years of experience. This implies that virtually all the FARO 52 rice package adopters have been in rice farming profession for quite some period of time and are not new in farming activities. Tiamiyu, (2009) lamented that farmers who have more years of rice production experience are more likely to be innovators and technically skilful to demonstrate new technology with or without minimum assistance from extension agent. This agrees with Babatunde (2003) who reported that more often than not, farmers' technology adoption is predetermined by their years of farming experience and ability to perceive superiority of new idea over the indigenous knowledge. This is consistent with Hussein (2000) who asserted that greater proportion(81%) of rice technology adopters in Niger state had farming experience of between 15 and 20 years. It can be seen that though FARO 52 rice technological package seems to be in existence for years amongst farmers in the study areas, ten years could be good enough to acquire necessary experience for a successful adoption of the package.

4.2 Extension Methods for Disseminating FARO 52 Rice Package

Extension teaching methods are techniques used to create situations in which communication can take place between the rural people and the extension system. They are the methods of disseminating new knowledge and skills to the rural people by drawing their attention, arousing their interest and helping them to have a successful experience of the new practices (Oladosu *et al.,* 2004).

Technology dissemination methods involved practical teaching and guiding of the farmers to carry out field operations according to recommendations. Different approaches are developed to suit different extension services and research information disseminations. Extension methods are dynamic and strategic to help meet the need of targeted individuals.

Table 4.6: Distribution of Respondents according to Extension Methods for Disseminating FARO 52 Rice Package (n=166)

Methods	Frequency	Percentage
Demonstration (OFAR)	87*	46.5
Management training plots	16	8.6
Field visits	32	17.1
Farm Broadcast	10	5.3
Farmer group	42	22.5
Total	187*	100

Source: *Field survey, 2014.* **Multiple Response*

The findings presented in Table 4.6 show that many (46.5%) of the adopters were reached and taught the production package through demonstration technique using on farm-adaptive research approach. It is a participatory field experiment usually managed by the farmers and supervised by extension agent. Demonstration of new technology is conducted on a strategic farm land within farm communities for farmers to observe and compare the performance of new technology with their own indigenous technology (Imolehin and Wada, 2002). On the other hand, some proportion (41.2%) of the non-adopters conceded that the package was disseminated to them through group contact methods. This implies that the package was disseminated through multiple approaches capable of driving the farmers' decision to technology uptake. This is tune with Adekoya and Tologbonse (2005) who suggested that no single extension method can be sufficient to drive decision of farmers to a change. Multiple approaches are employed to introduce a change through educating, teaching, guiding and assisting potential adopters to use innovations appropriately. In the same vein, Hoffman *et al.* (2009) observed that group extension is the most important method for advising and promoting the interest of a large number of farmers. The more it is supplemented by individual and mass extension, the greater are its chances of success.

4.2.1 Awareness of FARO 52 Rice Package

Table 4.7: Distribution of Respondents according to Awareness of FARO 52 Rice Package (n= 166).

Awareness	Frequency	Percentage
Yes	166	100
No	0	0
Total	166	100

Source: *Field survey, 2014*

Table 4.7 reveals that 100% of the adopters were aware of the FARO 52 rice production package. This suggests that there is awareness of the package among the rice farmers in the study area. The finding implies that awareness which is the first element in the innovation adoption process had been created through the combined effort of NCRI and NSADP extension agents. The goal of this effort was to bring the initial knowledge to the farming communities about the new products, ideas and practices which are achievable through the use of diversified means of reaching the targeted farmers such as community mobilization programmes, extension printed materials and use of mass media. According to Abdoulaye *et al.* (2014) who asserted that farmers with first-hand information from research and extension agents have higher awareness and use in all introduced technologies. Contrary to this, Jirgi *et al.* (2009) submitted that there was 100% awareness among the rice farmers in Katcha LGAs although there was not 100% compliance with the technological recommendations from the research institutes and extension agency.

4.2.2 Sources of Information

Agricultural research information is vital in keeping the farmers on the modern trends of agricultural practices. The sources could be an organizations, individuals or groups from where the research messages emanate. The messages are communicated through appropriate channels to reach out to targeted audience or receivers. In general, Adedoyin (2005) stated that mass media and interpersonal channels are the most recognized sources of agricultural technology information.

Table 4.8: Distribution of Respondents according to Sources of Information on FARO 52 Rice Package (n = 166)

Sources	Frequency	Percentage
Radio	15	7.0
Television	4	1.9
Extension agent	134*	62.6
Farmers' association	24	11.2
Fellow farmer	34	15.9
Print media	3	1.4
Total	214*	100

Source: *Field survey, 2014* **Multiple Response*

Results in Table 4.8 reveal that 62.2% of the adopters received information about the package from extension agents, while 15.9% received first information about the package from fellow farmers. The goal was to bring innovation information to farm communities. This is tune with Adeniji *et al.* (2007) who observed that extension agents were the major channels through which 62.8% of farmers received first hand information on improved cotton production practices in Katsina state.

The findings imply that multiple sources of information were used to reach farmers about the new package in the study area. It also implies that technology adoption and diffusion can be complemented through the roles of multiple players involving farmers' associations, fellow farmers and mass media (television, radio, print media).

The above findings are further corroborated by Odomenem and Obine (2010) who affirmed that the sources of information on improved cereal crop technology package available to the farmers included extension workers, fellow farmers/neighbours and mass media. The primary goals of these information sources are to create awareness by diffusing among potential adopters useful and practical information on the innovation and encourage its application. Same as above, agricultural extension workers constitute the most important source of information to the farmers as 40.54% of them obtained information from the extension agents. Hussein (2000) revealed that 24.32% of technology adopters got information on improved rice crop technology package through fellow farmers/neighbours. It can therefore be inferred that extension workers and fellow farmers/neighbours were more effective than the mediated information sources.

4.2.3 Level of Adoption of FARO 52 Rice Package by Farmers in the Study Area.

FARO 52 as a rice production package was released with 10 components production technologies. The objective was to determine the level of adoption of the package by the adopters, and the extent of use of each of the components.

Table 4.9:Distribution of Respondents according to Adoption Index (n=166)

Adoption category	Adoption index range	Frequency	Percentage
Low adopters	0.01- 0.33 (1 - 33%)	25	15.1
Medium adopters	0.34 - 0.66 (34 - 66%)	85	51.2
High adopters	0.67 - 1.0 (67 - 100%)	56	33.7
Total		166	100

Source: *Field survey, 2014*

As depicted in Table 4.9 above average proportion (51.2%) of the adopters lies in the medium adoption category. This signifies the proportion of adopters that were at the medium adoption level, meaning a medium degree of compliance with the recommendations. The reason could be traceable to the limited farm land, low availability of the recommended inputs and moderate financial status. In the same vein, it can be deduced that an average financial status of the adopters, training participation and their average number of contacts with extension agents were the possible socio-economic and institutional factors that could be accounted for their medium adoption level of the package. More so, some (33.7%) of the adopters were discovered to be at high adoption level. Obviously, the reasons that could be adduced for their being in the high category include: high technical ability, high level of formal education and farming experience, better financial position, training and frequent contacts with the extension agent. That is, the high level adopters had years of formal schooling above the mean average, and also their level of income, farm land, households size, training and extension contact all above the mean average. However, 15.1% at low level adoption was as a result of inadequate training, relatively low extension contact, limited farm land and low financial resources.

The findings were corroborated by Ojohomon *et al.* (2006) who reported that some farmers in Ndaloke village of Niger state partially (fairly moderate) adopted the recommended technologies. The implication of this finding is that the FARO 52 rice production package was practiced at varying degree of adoption among the farmers in the study area. This was defined by their respective adoption index. Similarly, it implies that adopters were not static and permanent at a single level of technology adoption; they tend to progress and sometime regress from one level to another which is an indication of farmers' behaviour in term of technology adoption. This remark is in consonance with Adekoya and Tologbonse. (2005) who observed that the position of an individual in an adoption category is not permanent and will vary with time, type of innovation and other variations in some factors capable of influencing adoption. So, a low adopter may jump into high adopter category if time is slightly extended.

Similar finding was reported by Tadesse (2008) from a study on farmers' evaluation and adoption of improved onion production technology package in South Ethiopia that among the sampled households, 51.3% lies in the medium adopter category. In the same vein, Singh *et al.*(2010) on study of adoption level and constraints in rice production technology in Jabalpur, India reported that 51.0% of farmers were found at medium level of adoption.

To understand the adoption level of the recommended practices adoption scores of each of the practices were further subjected to descriptive analysis in frequency and percentage to identify the actual distribution in the category of adoption index. The aim is to provide analytical evidence to enable the study to make a generalized conclusion on which of the component recorded the low, medium and high level of adoption.

Table 4.10: Distribution of Respondents according to Adoption Level of FARO 52 Component Production Technologies (n=166)

Adoption category	**Adoption scores**	**Components**									
		ST	EN	LP	SP	TRD	WM	FA	HB	DC	IC
Low adoption	0.01 – 0.33	65 (39.2)	28 (16.9)	23 (13.9)	21 (12.7)	76 (45.8)	88 (53.0)	33 (19.9)	18 (10.8)	50 (30.1)	55 (33.1)
Medium adoption	0.34 – 0.66	54 (32.5)	52 (31.3)	59 (35.5)	107 (64.5)	52 (31.3)	46 (27.7)	85 (51.2)	96 (57.9)	79 (47.6)	81 (48.8)
High adoption	0.67 – 1.0	47 (28.3)	86 51.8)	84 (50.6)	38 (22.8)	38 (22.9)	32 (19.3)	48 (28.9)	52 (31.3)	37 (22.3)	30 (18.1)

Source: *Field survey, 2014*

ST: seed treatment; **EN:** establishment of nursery; **LP:** land preparation; **SP:** spacing; b transplanting depth; **WM:** water management; **FA:** fertilizer rate; **HB:** rate of herbicide; **DC:** disease chemical control method; **IC**: Insect chemical control method.

Figures in Parenthesis indicate percentage of adopters.

4.2.3.1 *Seed Treatment*

Results presented in Table 4.10 show that adoption of seed treatment practice recorded 39.2% of adopters in low adoption level. More so, very few proportions (32.5% and 28.3%) of adopters were found in the medium and high adoption level respectively. The low level adoption could probably be attributed to some institutional and psychological factors which include lack of interest in the recommendation, high cost and low availability of the inputs, and lack of adequate extension information. The finding agrees with the pattern of technology adoption by rice farmers in India as reported by Singha and Baruah (2012) that in general, rice farmers were found to have low adoption of seed treatment practice under a study of adoption level of three farming systems in Assam, India.

4.2.3.2 *Establishment of Nursery*

Table 4.10 reveals that above average proportion (51.8%) of adopters were found in the high level adoption of the recommended nursery practices and compliance with the age of seedlings (21 days) before being transplanted to the main field. The high adoption level may be as a result of their previous traditional based knowledge and skills of seedling raising operations, which though contributed to their ability to use improved trend of raising seedlings. In addition, training, frequent extension contact and youthful age are the probable reasons for the high adoption level of this component technology in the study area.

The findings entirely indicate an impressive level of adoption of this component which conformed to the earlier finding by Hussein (2000) that 52% of lowland rice cultivators under rainfed and irrigation system in Niger state were in complete (high) adoption of the recommended nursery practice and age of the seedlings. However, few proportions (31.3 and 16.9%) of the adopters were in the medium and low adoption level respectively.

4.2.3.3 *Land Preparation*

Land preparation here refers to tillage operations which comprise ploughing, harrowing and construction of bounds to retain water. The results (Table 4.10) indicate that the land preparation recommended practice recorded 50.6% of adopters in the high adoption level. It is believed that adopters in this category were already used to the land preparation practices traditionally. So, this technology was seen as a compatible innovation even though requires tractor use for the operations. This impressive high adoption level could be traceable to the long accessibility of the inputs; conviction in the technology and better financial position to hire tractor(s) for the operations. This assertion is supported by Jirgi *et al.* (1999) that 54-65% of rice farmers in Niger State were adopters of the recommended field preparation practices basically because of their belief in the practices, years of farming experiences and its compatibility with the farmers' traditional practices. In the other hand, the technology recorded 35.5% and 13.9% of adopters in the medium and low adoption level respectively.

4.2.3.4 *Spacing*

Spacing here refers to the recommended seedling transplanting space (20 x 20 cm between and within rows). The results indicate spacing recommendation recorded a larger proportion (55.4%) of medium level adopters. The likely reasons for this adoption level could be a relatively small number of training participations and limited farm land. In addition, 24.7% of adopters were, hitherto, able to adopt this recommended spacing at high level. The number of adopters in this category could be assumed to have higher literacy level and more formal education, more training participation and frequent contact with extension agents. In the same vein, the low adoption (12.7%) of this recommendation could be as a result of lack of technical skill; drudgery and time consuming in measuring the spacing; and insufficient farming experience that is good enough to expose farmer to modern traditions.

Moreover, the result implies that the recommended spacing was at medium level having the majority of adopters in medium adoption category. The finding is in contrast to Ojohomon (1995) who reported low adoption level of the recommended transplanting space for lowland rice cultivation among the rice farmers in Ndaloke village under Lavun LGA of Niger states. However, Hussein (2000) has reported that there was adequate compliance with the recommended spacing for lowland rice across rice growing communities in Niger state.

4.2.3.5 ***Transplanting Depth***

Transplanting depth here refers to 4cm depth recommended for seedling transplanting operation. The findings reveal that the recommendation recorded 45.8% low level adopters. The probable reasons for low adoption in this context could be linked to low or inadequate know-how to practice the exact transplanting depth. Also, a reason may be the complexity and drudgery embedded in the technology itself and time consumption. In other word, those in the medium and high adoption category recorded 31.3% and 22.9% adoption respectively. The finding implies that this practice was not adopted by the majority of the rice farmers in the study area. It can be deduced that measuring the exact recommended 4cm for transplanting depth requires some level of technical competence and considerable years of farming experience. The poor- resource farmers have no means to procure a motorized device to carry out the operation, therefore, resort to manual operations which are tedious and labour intensive. This is in consonance with Adekoya and Tologbonse (2005) who have observed that if an innovation is perceived as complicated or difficult to use, an individual is unlikely to adopt it. Furthermore, Hossain *et al.* (2001) reported that rice farmers in Baglandesh were in partial (poor) adoption of the recommended depth for seedling transplant.

4.2.3.6 *Water Management*

For this study, water management refers to the recommended practice of maintaining up to 5cm water depth in the rice field from one week after transplanting until grain matures. The results show that the practice recorded 53.0% low adoption level which indicates a very poor compliance with the recommendation. However, low compliance with this recommendation occurred probably as a result of difficulty to maintain the exact ratio of 5cm water depth. This obviously could lead farmers to using the available alternative option, which is the traditional farm practices the farmers were earlier used to before the advent of the new method. The low compliance of this component may also be traced to lack of conviction in the idea, time consumption and labour intensive. In this development, Rogers (2003) stated that if an innovation is perceived to be not trialable at farm level is swiftly reinvented to match with farm conditions, or rejected to continue with the use of a more trialable option.

4.2.3.7 *Fertilizer Rates*

This entails the rate of inorganic fertilizer recommended for used. Results of the study have indicated that moderate proportion (45.2%) of the medium level adopters have adopted the recommended fertilizer rate. The rate has however, been adopted by 28. 9% of high level adopter and 19.9% of low level adopters. The results show that adoption of the recommended fertilizer rate has generally been at medium level among the farmers. This finding is in consistence with Ojohomon *et al.* (2006) who observed that farmers who adopted the improved rice variety in lowland also adopted the use of fertilizer rate. This is because these two inputs are complementary. However, the probable reason for medium adoption level of this recommendation may be said to be high cost of the fertilizer and low-availability of the fertilizer at right time and enough quantity. However, Idrisa *et al.*, (2012) reported that farmers' non-adoption may be caused by the cost and insufficient supply of chemical fertilizer. The level of fertilizer applied by farmers depended on its availability and the farmers' purchasing power. When little quantity is available as a result of short supply or lack of fund, consequently below recommended quantity and dosage is applied.

4.2.3.8 *Herbicide*

The use of agro-chemicals remains an effective solution to most infested rice field. The efficacy of herbicides has been tested at farm level and farmers are buying into the modern trend of weed control. Lowland ecology is an inland valley with appreciable level of moisture that harbours proliferation of grasses and sedges.

The findings indicate that above average proportion (57.9%) of the adopters have adopted the herbicide recommended practice of the package at medium level. This could be attributed to low availability of the agro-chemicals, limited labour force and high cost of the technology The finding is in contrast to Ojohomon *et al.* (2006) who observed that the adoption of herbicide was low relative to improved variety and fertilizer because hand weeding readily substituted herbicide. Also, 31.3% of the adopters have recorded a high adoption level of the recommendation. This group of adopters saw the use of herbicides as an effective weed control option other than hand weeding; despite the cost of herbicide and principle knowledge required before its application. The medium adoption level could be attributed to the available farm size, high cost and low availability of the herbicides, long distance to input market.

4.2.3.9 *Disease Control*

Disease control here means type (Benlate™) and rate (1.5kg a.i, kg/ha, in 500 liters of water) of chemicals prescribed for disease control in the rice plantation. In general, rice crop is susceptible to various diseases in the tropic that require proper management and protection measures.

The results reveal that the recommended practice recorded 47.6% of the medium level adopters, while 30.1% and 22.3% low and high level adopters have adopted respectively. The finding agrees with Singh and Jay (2010) who posited that the use of chemicals for disease control was averagely practiced by the rice farmers. The situation however, could be attributed to inadequate training among farmers, cost of the chemical, low availability of the disease control chemicals and distance from the input markets.

4.2.3.10 *Insect Control*

Insect control here is the chemical control measures against insects in the rice field by the used of Decis™ at 1liter/ha in 500 liters of water.

The results show that 48.8% of the medium level adopters had adopted the recommended insect control measure, while 51.2% of the high and low adopters put together were found to have adopted this technology. The finding is in tune with Odoemenem and Obine (2010) who reported that adoption index of cereals crop farmers in Benue state with respect to herbicide and insecticide indicated medium level of adoption. He further remarked that the farmers were interested in the use of the technology. Unfortunately, they were constrained by lack of enough fund to buy enough quantity of the recommended technology, and lack of technical information and training.

4.3 Factors Influencing Level of Adoption of FARO 52 Rice Package

This is to explore the influence of the chosen parameters on adoption of the package. The assumption is that technology adoption is caused by several factors including socio-economic, institutional and technology related characteristics. For this study, both socio-economic and institutional factors are considered to determine their influence on the adoption of FARO 52 rice package using multiple regression models, and to test the stated null hypotheses using the same model.

Table 4.11: Analysis of Factors Influencing Adoption of FARO 52 Rice Package

Variables		**Coefficient**	**Std. Err.**	**t- value**	**p> | t |**
Level of adoption	(Y)				
Age	(X_1)	-.001	.001	-2.27**	0.024
Level of education	(X_2)	-.001	.002	-0.69^{NS}	0.492
Household size	(X_3)	.006	.002	2.98***	0.003
Farm size	(X_4)	.020	.012	1.73*	0.086
Farming experience	(X_5)	.015	.003	5.01***	0.000
Extension visits	(X_6)	.009	.002	5.00***	0.000
Farmers' annual income	(X_7)	3.22e-07	.000	1.03^{NS}	0.306
Exposure to media	(X_8)	.000	.002	0.13^{NS}	0.899
Training participation	(X_9)	.040	.010	4.19***	0.000
Access to markets	(X_{10})	.001	.001	1.17^{NS}	0.244
Membership of farmer' associations	(X_{11})	.008	.002	5.10***	0.000

Source: *Field survey, 2014*

Sig. Codes: *** (1%), ** (5%), * (10%), NS (Not *significant at specified level*)

R- Squared = 0 .9763. Adjusted R^2 = 0.9747. **F** statistic = 577.95 on 11 and 154 DF.

Prob > F = 0.000

Multiple regression models including the linear, semi-log and double-log regression functions were used for the analysis of the factors influencing adoption of FARO 52 rice package and the test of hypothetical assumptions of the study (Appendix IV).The linear model was chosen as the lead model for the analysis because of its sensitivity in the measure of the variables than the semi-log and double –log functions. This was reflected in its highest F-statistics value and number of significant T- values that conform to a priori expectations of the study. Since the R-squared was 0.97 and the ANOVA shows that F-value (577.95) was highly significant at 1% this model was taken as a good-fit in explaining the factors influencing adoption of FARO 52 rice package by farmers.

The results presented in Table 4.11 show that seven of the eleven variables included in the model were found to have significant influence on adoption FARO 52 rice package. These were age, household size, farm size, farming experience, extension visits, training participation, membership of farmers associations.

The result of the regression model estimation gave an R^2 value of 0.9763 which implies that the variables included in the model were able to explain about 97 percent of variation in adoption of FARO 52 rice package. The unexplained variation can be attributed to random errors and other uncertainties. Each regression coefficient shows the extent to which variation in the independent variable explains the variation in the adoption of the package.

Results of the analysis show that the relationship between age and adoption of FARO 52 rice package was statistically significant ($P<0.05$). The negative coefficient suggests a negative influence on the adoption of the package in the study areas. It was hypothesized that age as a socio-economic factor has no significant relationship with the adoption of the FARO 52 rice package. Thus, by this finding the hypothesis is hereby rejected. This underscores the fact that older farmers are risk-averse and more conservative than the younger ones to adopt new technologies. In other word, the adoption of the package decreases as the adopters advance in age. This is in consonance with findings by Mahmud *et al.* (2012) on adoption of modern agricultural production technologies by farm household in Ghana that old farmers tend to be less productive, and usually conservative and abhorring innovation information. The younger farmers were more innovative and enthusiastic to venture into new way of doing things. In the same vein, age has also been found to be negatively correlated with technology adoption level in studies on adoption of land conservation practices in Niger (Adesinna and Baidu-Forson, 1995). Older farmers, perhaps because of investing several years in a particular practice, may not want to jeopardize it by trying out a completely new method.

Household size of the adopters was found to have positive and significant ($P<0.05$) influence on adoption of FARO 52 rice package in the study area. The result in other word, suggests a positively significant relationship between the household size of the adopters and adoption of the package. By this finding, the hypothesis that household size has no significant relationship with adoption FARO 52 rice package is hereby rejected. Household size is an important socio-economic variable that determine availability of labour to the household (Yunusa, 1999). In adoption studies, increase in household size increases technology adoption provided the bulk of household members are productive (Balarabe, 2012). Households with large family size may readily adopt new agricultural production practices than those with smaller family size since labour force is available. This is in tune with Adeniji *et al.*(2007) who found a positive relationship between household size and adoption of improved agricultural production practices. However, the finding contradicts Odoemenem and Obine (2010) who presented that household size had a negative relationship with adoption, suggesting that adoption level was lower among large households because large households tend to attach greater importance to food security than those that were small in size.

The results further reveal that farm size had positive and significant relationship with adoption of FARO 52 rice package at 10% level of significance. This signifies a positively influence of the farm size on the adoption of the package. That is, a unit increase in farm size could result to a significant influence on the adoption of the package by .0202 in the study area. Farm size was identified as an important socio-economic factor by (Jackline, 2002) in an adoption study of agricultural technologies. In the same direction, farm size was modelled as a socio-economic factor for this study. Thus, the hypothesis that there is no significant relationship between the farm size and adoption of the FARO 52 rice package is by this finding rejected. This is consistence with Ugwumba (2013) who stated that farm size was positive and statistically significant determinants of adoption of oil palm production technologies. Thus, farmers who are able to put an additional hectare of land into rice production are more likely to try the recommended practices and eventually adopt them. A larger farm size allows one to experiment with new crop varieties and even practice crop diversification in order to hedge against the risk of crop failure. This result agree with Ekwe and Onunka (2006) who reported that farm size significantly and positively influenced the decision to adopt Sweet potato production technologies in Abia State, Nigeria.

Farming experience was also discovered to have significant influence on the adoption of FARO 52 rice package. This was reflected in the positive coefficient and significant level ($P<0.01$) of the variable. This further refers that as the adopters' farming experience increases by 1 year there could be a corresponding influence on the adoption of FARO 52 rice package by.015 in the study area. It implies that adoption of the package is directly related to years of farming experience. Hussein (2000) studied adoption of rice production technologies in Niger State and identified Farming experience as an important socio-economic variable. To that effect, this study modelled farming experience as socio-economic factor. Therefore, the hypothesis that there is no significant relationship between farming experience and adoption of FARO 52 rice package is hereby rejected. Experience improves farmers' skill at production (Balarabe, 2012). A more experienced farmer may have a lower level of uncertainty about innovations performance and also be able to evaluate the advantage of technology being considered. This is supported by Mamudu *et al.*(2012) year of farming experience was positively significant in determining the adoption of modern agricultural technologies by farm household in Ghana. Umar *et al.* (2009) have also reported that only experience in farming has significant influence on the adoption of improved rice technologies among youth in Gbako Local Government Area of Niger State. However, this contradicts Awotide *et al.* (2010) who reported a negative relationship between farming experience and adoption of improved rice varieties in Nigeria.

The coefficient of extension visits was found to be positive and significant ($P<0.01$). This indicates positive relationship between the extension services and adoption of FARO 52 rice package. It suggests that extension visits had positive influence on the adoption of FARO 52 rice package. In other word, a unit increase in the number of extension visits had lead to an influence on the adoption of the package by .009 in the study area. Extension visit was identified as an institutional factor by (Adeniji *et al.,* 2007). For this study, extension visits was modelled as an important institutional factor. Therefore, the hypothesis that extension visits has no significant relationship with adoption of FARO 52 rice package is hereby rejected. The implication is that, frequency of extension visits for dissemination of information and advisory services would give the adopters more confidence to sustain the use of the package. This is in tune with Odoemenem and Obine (2010) who observed that the variable for extension contact had a positive coefficient, indicating that adoption of cereals crop technologies increases with increase in the number of extension visits and services offered to farmers. They further stressed that constant meeting/frequency of extension contact between the extension personnel and the farmers would enlighten the latter and create better awareness for the potential gains of improved agricultural innovations.

The results also indicate a positive and significant (P<0.01) relationship between the number of training attended on improved rice production techniques and adoption of FARO 52 rice package. The finding signifies that training has a positively significant influence on the adoption of the package in the study area. Dereje (2006) identified farmers' training participation as an institutional factor. To this effect, this study had modelled training participation as an important institutional factor. Thus, the hypothesis that training has no significant relationship with adoption of FARO 52 rice package is by this finding rejected. The results imply that adopters with relatively reasonable number of training participation would be more equipped in term of technical skills and management than those with little /no training participation. The technical knowledge helps farmers to effectively adopt the recommended practices. Dereje (2006) and Rahimeto (2007) reported that training participation equips farmers with technical skills and detail knowledge required for the use of improved technologies, such knowledge would have influence on adoption decision. In the same vein, NCRI, (2010) revealed that number of trainings organized for rice farmers on production, management practices and post-harvest techniques in the year 2005 – 2007 had positive and significant contributory influence on the level of adoption of practices and techniques recommended for rice farmers in Niger State.

The analysis of years of being an active member of farmers' association reveal that the variable had positive coefficient (.0077) and was highly significant (P<000). The result is an indication that membership of association has positive relationship with the adoption of FARO 52 rice package. Farmers' membership of associations was treated as an important institutional factor in most of adoption studies (Umar *et al.*, 2009; Singha and Baruah, 2012). Therefore, for this study it was modelled as an institutional factor. Thus, the hypothesis that there is no significant relationship between the membership of farmers' association and adoption of FARO 52 rice package is by this analysis rejected. The result of analysis of this variable is in consonance with Umar *et al. (*2009) who held that years of being a active member of cooperatives and societies had positive and significant influence on rice improved technology adoption. This stems from the fact that members of the association have more access to information on new technology which is vital in agricultural production and value-chain. Similarly, Cooperative membership had a positive coefficient and significant relationship with adoption of haricot bean production package in Alaba, Southern Ethiopia (Rahimeto, 2007). This implies that farmers who are members of cooperative organizations adopted more technologies than non-members (Odoemenem and Obine, 2010). However, Ogunsumi and Ewuola (2005) reported a negative relationship of membership of farmers' co-operatives with adoption of soybean production technologies in Southwest, Nigeria.

4.4 Reasons for Adoption of FARO 52 Rice Package

Reason here refers to a psychological behaviour of making choices based on the need, interest and taste of an individual. Different qualities may entice different individuals to make choices, but, most importantly individual tends to make sure that the choice is rational and appropriate in satisfying the needs and desires. As a matter of behaviour, the choices are sometimes influence and dependent on several factors including culture, personal desire, economic resources, prestige, taste etc.

Table 4.12: Distribution of Respondents based on Reasons for Adoption of FARO 52 Rice Package (n=166).

Reasons	Frequency	Percentage
High yielding	76*	35.0
Moderate tall habit	20	9.2
Resistance to iron toxicity	42	19.4
Non-shattering	22	10.1
Amylase contents	26	12.0
Long white grain	15	6.9
Threshing quality	16	7.4
Total	217*	100

Source: *Field survey, 2004* **Multiple Responses*

The results presented in Table 4.12 reveal that 28.1% of the adopters had expressed reason for adoption of FARO 52 package was that the seed is a variety that has characteristic of being a high yielding cultivar. The variety has potential yield of 5 - 6 tonnes/ha under good ecology and appropriate management practices (NCRI, 2005). However, 19.4% of the adopters had indicated the reason to be its resistance to iron toxicity. Iron toxic element (excessive iron deposit) is easily identified by rice farmers through shiny brown traces that appear in water of a lowland ecology. It affects morphological appearance of the rice plant and its general performance. More so, 13.8% of the adopters had preferred the variety base on its quality of a long white grain. The grain shape and colour determine the market value; in fact, it attracts more patronage and fetches relatively higher price. Also, the variety was cherished by 10.1% of adopters as result of amylase constituent of the grain. Amylase content is the starch component of rice grain called amylase pectin. The grains of FARO 52 variety has a low glutinous content and intermediate (between 25 -27) amylase pectin, which determines the cooking quality of rice. The variety has the quality of high swollenness and moderate stickiness when cooked. It is therefore seen by some adopters as a motivating factor base on which the choice is made. Tiamiyu (2009) reported that FARO varieties were more preferred by the farmers than NERICA varieties in North central zone of Nigeria on the ground of organoleptic property and field performance. In the same connection, Saka and Lawal (2009) observed that the improved rice varieties in south western Nigeria were overwhelmingly adopted as a result of its economic value, the taste, field performance and environmental adaptability. As matter of choice, palatability is an individual taste, while most importantly, ease and fast nature of parboiling associated with FARO 52 variety attracts marketers and consumers for patronage.

4.5 Constraints to Adoption of FARO 52 Rice Package

Constraints to adoption refer to inhibiting factors that lead to low or non-adoption of a technology. Constraints are often analyzed in several adoption studies in order to discover the probable problems and difficulties faced by farmers in technology adoption. They are categorized to include: biotic and abiotic; socio-economic and technology related constraints.

Table 4.13: Distribution of Respondents based on Constraints to FARO 52 Rice Package Adoption (n=166)

Constraints	Frequency	Percentage	Ranking
Lack of technical skills	46	16.2	3
Complexity	22	7.7	4
High cost	106*	37.3	1
low availability	58*	20.4	2
Lack of credit facilities	16	5.6	6
Heavy weed growth	10	3.5	7
Disease infestation	6	2.1	8
Limited land	20	7.0	5
Total	284*	100	

Source: *Field survey, 2014* *Multiple Response*

The results of the study in Table 4.13 reveal that sizeable proportion (32.2%) of the adopters were constrained by the high cost of the fertilizers, agro-chemicals and tractor hiring to carry out tillage operations. However, it was ranked first in the order of magnitude. In addition, lack of technical skills was indicated by 18.8% of the adopters as a main constraint to complete adoption of the package, which was ranked second in order of importance. So also, low availability of the recommended inputs constitutes an important constraint to 16.4% of the adopters, while complexity was a constraint to 7.4% of the adopters. The results imply that adopters were faced with one constraint or the other in the study area. The situation had resulted to different adoption behaviour including low, medium and possibly discontinuance.

Several adoption studies highlight some constraints faced by farmers that are engaged in production of various crops. Singh and Jay (2010) reported constraints faced by rice farmers in Jabalpur, India include high cost of technology, low availability of the required inputs, lack of training and lack of conviction in the technology. In the same vein, Umar *et al.* (2009) observed that 45.95% and 8.12% of the youth farmers in Gbako LGAs of Niger state were constrained by inadequate technical knowledge and flood disasters respectively in the adoption of improved rice technologies. Also, Pawa (2010) mentioned 26.67% of cassava farmers in Mokwa LGA of Niger State were constrained by lack of credit facilities. Similarly, Imolehin and Wada (2002) revealed that notably constraints faced by rice farmers in the field are weed infestation, disease incidence and floods.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The study examined factors influencing adoption of FARO 52 rice package among farmers in selected Local Government Areas of Niger State, Nigeria. A total of 166 FARO 52 rice package adopters were proportionately drawn at 25% from three LGAs and nine villages, and they were interviewed using a structured questionnaire. The data generated from the study were subjected to both descriptive and inferential statistical analysis.

The broad objective was to assess the factors influencing adoption of FARO 52 rice package by farmers, and the specific objectives were to describe the socio-economic characteristics of the adopters in the study area; identify the types of extension methods used in dissemination of the package; determine the farmers' level of adoption of the package; assess the factors influencing the adoption of the package; identify the reasons for adoption of the package and to identify the constraints associated with the farmers in term of adoption of the package so as to make recommendations base on the finding of the study.

Findings of the study revealed that 49.4% of the adopters fall within the age of 31-40 years. Also, 38.6% of the adopters had 6-10 years of formal schooling. In addition, 32.5% of the adopters had 6-10 household members. Similarly, 31.3% of the adopters had between 2.1 -3.1 hectares of land. Furthermore, 34.9% of the adopters had 16-20 years of farming experience.

The results show that the extension methods used in dissemination of the package were demonstrations (OFAR) (46.5%), farmers' group (22.5%), field visits (17.1%), Management training plots (8.6%) and farm broadcast (5.3%).The results have further indicate the level of awareness (100%) among the adopters. The sources of information on FARO 52 rice package to include radio (7.0%), extension agent (62.6%), fellow farmers (15.9%) and farmers' association (11.2%) among others.

The findings of the study also reveal the level of adoption of FARO 52 rice package to be low level adoption (15.1%), medium level adoption (51.2%) and high level adoption (33.7%).

The inferential statistic was used to assess the factors influencing adoption of the package and test of the null hypotheses. The results of multiple regression (linear model) analysis indicate that the following variables were significant: age, household size, farm size, farming experience, extension visit, training attended and membership of associations. The analysis shows an R^2 value of 0.97 which implies that the variables included in the model were able to explain about 97 percent of variation in level of adoption of FARO 52 rice package in the study area.

The adopters' reasons for their adoption of the FARO 52 rice package including the variety was analyzed and 28.1% of the adopters had indicated the reason to be mainly due to its characteristic of being high yielding 35.0%), resistant to iron toxicity (19.4%), amylase content (12.0) among others.

Constraints associated with the adoption of the package were identified and ranked in the order of magnitude. High cost recorded (37.3%) and ranked first in the order of importance, low availability (20.4%), lack of technical skills (16.2%), complexity (7.7%) among others.

5.2 Conclusion

Based on the findings of the study, it can be concluded that the package as a whole recorded 51.2% medium level adoption, 33.7% high level adoption and 15.1% low level adoption. The relatively complex recommended practices had recorded low level adoption. These are seed treatment, transplanting depth and water management. In addition, the chosen socio-economic and institutional factors had significant influence on the adoption of the package in the study area. By implication, rice production package adoption could be sustained among the farmers provided the constraints identified by this study are addressed. This could lead to a significant increase in the level of adoption of new ideas thereby increasing rice productivity.

The study also concludes that the adopters of the package were faced with some difficulties militating against optimizing the use of the package as a full technological option to maximize their farm outputs. The constraints were identified to include high cost, low availability of inputs, and lack of technical skills to adequately implement the recommendations among others.

5.3 Recommendations

- **i.** In view of the low technical skills to adopt the package, the study hereby recommends that research institutions and extension agencies should intensify effort to organize more training programs that would have direct bearing on the improvement of technical skills of the farmers. Therefore, intensive hands-on training should be emphasised this will go a long way to remedy the challenges of low technical competence among the farmers.
- **ii.** In addition, to overcome the problem of high cost of the recommended inputs, the study further recommends that taxes and charges on agricultural inputs should be reduced such that the prices of the inputs could be affordable to poor-resource farmers.
- **iii.** Low availability of the agro-chemicals components of the package, the study further recommends that government, through farmers' support schemes, should support the farmers with timely supply of the needed agro-chemicals at

subsidised rate and enough quantity including inorganic fertilizers, herbicides, and chemicals for the control of insect and disease infestations.

iv. The farmers on their own part should take advantage of their existing associations to access credit facilities from various financial institutions such as micro finance and agricultural banks. This would enable them to expand their investment into rice productions especially FARO 52 rice variety.

v. For the complexity of the recommended practices, the study recommends that extension message should be made simple and more relevant to the farmers' situations. Also, frequency of extension visits should be enhanced to enable the farmers have constant contact with the agent to relate their field problems for advice and solution.

vi. A limited land is a constraint to large scale farming. The farmers should diversify to acquire more land areas through their functional cooperatives; the land can be shared to financial member of the society.

vii. Government should properly utilize the agricultural inputs delivery systems such as Growth Enhancement Scheme (GES) to supply weedicides to rice farmers timely and adequately. The scheme should not be restricted to fertilizer and seed distribution alone.

viii. Disease infestation constraint can be overcome through the services of specialist (plant protectionists) who should be responsible for proactive measures against disease outbreak. The specialist should train the rice farmers on various techniques of remedy the disease problems as well as protective measures against future occurrence.

5.4 Area for Further Studies

Further research focus is required using inferential statistics to analyse the five elements in the model of innovation-decision process and specifically sub-elements in the persuasion stage (relative advantage, compatibility, complexity, trialability and observability). The emphasis is to establish with empirical evidence the actual position or stage that farmers are operating during the period under survey, and to identify the effect of the attributes of the technology on farmers' technology adoption decision.

5.5 Contributions of the Study to Knowledge

i. Previously, no research study has been undertaken to establish with empirical evidence the status of FARO 52 rice package among the farmers in the study area. This study has provided analytical information to that effect; thus, there was an added knowledge on the level of adoption of the package as a whole as well as level of each component of the package.

ii. In addition, there was a general lack of understanding of the factors influencing the adoption of FARO 52 rice package in the entire farming systems. This study was able to ascertain with analytical proof the factors that have significant influence on the adoption of the package.

iii. The study was able to establish and explained with the descriptive analytical technique the farmers' sources of information and the extension methods actually used in the process of dissemination of the package.

iv. Social research is policy focussed. Hence, an effort was made to identify constraints to the adoption of FARO 52 rice package. The knowledge about these constraints is a requisite tool based on which policies; strategies and intervention programs can be developed.

v. Through the descriptive analysis, the study was able to ascertain the reasons for adoption of the package by the sampled farmers. Understanding the reasons for their adoption behaviour is vital for technological adoption behavioural studies.

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APPENDICES

APPENDIX 1: Questionnaire for farmers adopting FARO 52 rice package

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Research topic: FACTORS INFLUENCING ADOPTION OF FARO52 RICE PACKAGE BY FARMERS IN SELECTED LOCAL GOVERNMENT AREAS OF NIGER STATE

Dear respondent,

The following questions have been set to understand the level of adoption of FARO 52 rice production package by farmers in Gbako, Lavun and Katcha Local Government Area of Niger state.

It is my appeal that you patiently and sincerely provide answers to the questions. The responses will be treated confidentially and will not have any negative consequence on you whatsoever.

Yours faithfully,
Habibu Ndagi Abubakar.

Identification:
Respondent number ____________
Name of the respondent ____________
Name of the community ____________

i. **SOCIO-ECONOMIC CHARACTERISTIC OF THE RESPONDENTS:**

1. Age of the respondent ________ years
2. Educational level of the respondent

Educational level	**Year spent**
Primary education [ ]	
Secondary education [ ]	
Post-secondary [ ]	
Adult literacy [ ]	

3. Gender. Male [ ]. Female [ ].
4. Experience in rice cultivation ______ years
5. Experience in FARO 52 cultivation _____ years
6. Household size (family and dependents) ________ people
7. Farm size :
   A. Total own farm land ______ ha.
   B. Own farm land under FARO 52 cultivation ________ ha.
8. Primary Occupation of the respondent:
a. Farming [ ] = 1
b. Civil service [ ] = 2
c. Others specify ………………….. = 3
9. What is the estimated income generated from farming in the last cropping season? _____ Naira
10. Off – farm activities by the respondent:
    a. Trading [ ]
    b. Artisans [ ]
    c. Farm produce freelance [ ]
11. Have extension agent ever visited you for extension services? a. yes ( ) b. No ( )
12. If yes, indicate the number of contact with the agent __________ in the last two years.

ii. EXTENSION METHOD USED FOR DISSEMINATION OF THE PACKAGE

13. Are you aware of the FARO 52 rice package? a yes [ ] b No [ ]
14. Indicate the period of years you are aware of the package
    a. >4 year
    b. 4-6
    c. 7-9
    d. >10
15. From what source did you receive information about FARO 52 production technologies?
    a. Radio [ ]
    b. Television [ ]
    c. Extension agent [ ]
    d. Farmers' associations [ ]
    e. Fellow farmers [ ]
    f. Print media __________
16. Indicate the extension method used for the introduction of the FARO 52 production technologies.
    a. Demonstration (OFAR) [ ]
    b. Management training plots [ ]
    c. Field visit [ ]
    d. Farm Broadcast [ ]

e. Farmer group [ ]

17. Did you decide to adopt the recommended component of the package?
    a. Yes [ ]
    b. No [ ]
18. If a above, did you continue with the adoption of the package?
    a. Yes
    b. No
19. If b above, indicate the reasons for discontinuance
    a. Alternative technology
    b. Time consuming
    c. Complexity
    d. Less economic benefits
    e. Inaccessibility of the recommended inputs

iii. LEVEL OF ADOPTION BY THE RESPONDENT

20. indicate the recommended technology components and the rate you adopted

S/N	**Component technologies**	**Farmers' rate**
1	Seed treatment (g\ha.) [ ]	
2	Establishment of nursery (days) [ ]	
3	Land preparation(number) [ ]	
4	Spacing (cm) [ ]	
5	Transplanting depth (cm) [ ]	
6	Water management (cm) [ ]	
7	Fertilizer application (bags/ha.) [ ]	
8	Herbicide (liter/ha.) [ ]	
9	Disease control (kg/ha.) [ ]	
10	Insect-pest control (liters/kg) [ ]	

21. Indicate the perceived attributes of the package ?
    a. Relative advantage [ ]
    b. Compatibility [ ]
    c. Simplicity [ ]
    d. Trialability [ ]
    e. Observability [ ]
22. Indicate reason for preference for FARO 52 rice variety
    a. High yielding
    b. Moderate tall habit
    c. Resistance to iron toxicity
    d. Non-shatering
    e. Amylase content

f. Long white grain

g. Threshing quality

iv. FACTORS INFLUENCING LEVEL OF ADOPTION OF THE PACKAGE

23. Do you have access to market? a. Yes [ ] = 1 b. No [ ] = 0
24. If yes, specify the estimated distance to the market ________ km
25. Do you have exposure to mass media? a. yes [ ] b. No [ ]
26. If yes, specify the number of mass media you were exposed to in the last one years

Mass media	Number of contact
Radio	
Television	
Extension materials	
Newspaper	

27. Have you participated in FARO 52 rice production training? Yes [ ]. No [ ]
28. Specify the number of training on FARO 52 rice production you had participated in the last 5 years? ________________
29. Do you belong to a farmers' association? a. yes [ ]. b. No [ ]
30. If yes, specify the number of years of being active member of the association Years. ______

v. CONSTRAINTS TO ADOPTION OF THE PACKAGE

31. indicate the constraints you encountered in adopting the FARO 52 rice package.

a. Lack of technical skills [ ]
b. Complexity [ ]
c. High cost of technology [ ]
d. Low availability [ ]
e. Lack of crdit facilities [ ]
f. Heavy weed growth [ ]
g. Disease infestation [ ]
h. Limited land [ ]

APPENDIX II: Analysis of socio-economic characteristics of FARO 52 rice farmers

AGE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	20	8	4.8	4.8	4.8
	23	1	.6	.6	5.4
	25	2	1.2	1.2	6.6
	26	1	.6	.6	7.2
	27	5	3.0	3.0	10.2
	28	6	3.6	3.6	13.9
	29	4	2.4	2.4	16.3
	30	15	9.0	9.0	25.3
	31	14	8.4	8.4	33.7
	32	9	5.4	5.4	39.2
	33	11	6.6	6.6	45.8
	34	9	5.4	5.4	51.2
	35	4	2.4	2.4	53.6
	36	4	2.4	2.4	56.0
	37	4	2.4	2.4	58.4
	38	5	3.0	3.0	61.4
	39	4	2.4	2.4	63.9
	40	18	10.8	10.8	74.7
	41	3	1.8	1.8	76.5
	42	2	1.2	1.2	77.7
	43	3	1.8	1.8	79.5
	45	4	2.4	2.4	81.9
	46	3	1.8	1.8	83.7
	47	3	1.8	1.8	85.5
	49	2	1.2	1.2	86.7
	50	10	6.0	6.0	92.8
	51	2	1.2	1.2	94.0
	59	2	1.2	1.2	95.2
	60	4	2.4	2.4	97.6
	67	1	.6	.6	98.2
	70	2	1.2	1.2	99.4
	72	1	.6	.6	100.0
	Total	166	100.0	100.0	

EDUCATION

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	24	14.5	14.5	14.5
	1	1	.6	.6	15.1
	2	1	.6	.6	15.7
	3	5	3.0	3.0	18.7
	4	10	6.0	6.0	24.7
	5	41	24.7	24.7	49.4
	6	7	4.2	4.2	53.6
	7	10	6.0	6.0	59.6
	8	9	5.4	5.4	65.1
	9	20	12.0	12.0	77.1
	10	18	10.8	10.8	88.0
	12	4	2.4	2.4	90.4
	13	6	3.6	3.6	94.0
	14	9	5.4	5.4	99.4
	15	1	.6	.6	100.0
	Total	166	100.0	100.0	

HOUSEHOLD SIZE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	2	1.2	1.2	1.2
	2	7	4.2	4.2	5.4
	3	6	3.6	3.6	9.0
	4	3	1.8	1.8	10.8
	5	2	1.2	1.2	12.0
	6	21	12.7	12.7	24.7
	7	4	2.4	2.4	27.1
	8	8	4.8	4.8	31.9
	9	11	6.6	6.6	38.6
	10	10	6.0	6.0	44.6
	11	13	7.8	7.8	52.4
	12	9	5.4	5.4	57.8
	13	6	3.6	3.6	61.4
	14	4	2.4	2.4	63.9
	15	2	1.2	1.2	65.1
	16	6	3.6	3.6	68.7
	17	10	6.0	6.0	74.7
	18	8	4.8	4.8	79.5
	19	3	1.8	1.8	81.3
	20	4	2.4	2.4	83.7
	21	15	9.0	9.0	92.8
	22	6	3.6	3.6	96.4
	23	6	3.6	3.6	100.0
	Total	166	100.0	100.0	

FARMSIZE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0.5	8	4.8	4.8	4.8
	1	13	7.8	7.8	12.7
	1.5	11	6.6	6.6	19.3
	2	11	6.6	6.6	25.9
	2.1	8	4.8	4.8	30.7
	2.5	28	16.9	16.9	47.6
	3.1	16	9.6	9.6	57.2
	3.2	5	3.0	3.0	60.2
	3.3	1	.6	.6	60.8
	3.4	1	.6	.6	61.4
	3.5	23	13.9	13.9	75.3
	3.7	1	.6	.6	75.9
	3.8	1	.6	.6	76.5
	4	11	6.6	6.6	83.1
	4.1	1	.6	.6	83.7
	4.5	4	2.4	2.4	86.1
	5	23	13.9	13.9	100.0
	Total	166	100.0	100.0	

FARMING EXPERIENCE

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	.6	.6	.6
	3	8	4.8	4.8	5.4
	4	7	4.2	4.2	9.6
	5	5	3.0	3.0	12.7
	6	4	2.4	2.4	15.1
	7	6	3.6	3.6	18.7
	8	8	4.8	4.8	23.5
	9	5	3.0	3.0	26.5
	10	2	1.2	1.2	27.7
	11	7	4.2	4.2	31.9
	12	3	1.8	1.8	33.7
	13	5	3.0	3.0	36.7
	15	5	3.0	3.0	39.8
	16	14	8.4	8.4	48.2
	17	12	7.2	7.2	55.4
	18	8	4.8	4.8	60.2
	19	8	4.8	4.8	65.1
	20	16	9.6	9.6	74.7
	21	21	12.7	12.7	87.3
	22	10	6.0	6.0	93.4
	23	11	6.6	6.6	100.0
	Total	166	100.0	100.0	

EXTENSION METHODS

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	66	39.8	39.8	39.8
	2	16	9.6	9.6	49.4
	3	32	19.3	19.3	68.7
	4	10	6.0	6.0	74.7
	5	42	25.3	25.3	100.0
	Total	166	100.0	100.0	

AWARENESS

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	166	100.0	100.0	100.0

INFORMATION SOURCES

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	24	14.5	14.5	14.5
	2	20	12.0	12.0	26.5
	3	42	25.3	25.3	51.8
	4	22	13.3	13.3	65.1
	5	26	15.7	15.7	80.7
	6	16	9.6	9.6	90.4
	7	16	9.6	9.6	100.0
	Total	166	100.0	100.0	

REASONS FOR ADOPTION

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	9	5.4	5.4	5.4
	2	22	13.3	13.3	18.7
	3	51	30.7	30.7	49.4
	4	38	22.9	22.9	72.3
	5	15	9.0	9.0	81.3
	6	10	6.0	6.0	87.3
	7	6	3.6	3.6	91.0
	8	15	9.0	9.0	100.0
	Total	166	100.0	100.0	

CONSTRAINTS TO ADOPTION

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	28	16.9	16.9	16.9
	2	4	2.4	2.4	19.3
	3	64	38.6	38.6	57.8
	4	27	16.3	16.3	74.1
	5	40	24.1	24.1	98.2
	6	3	1.8	1.8	100.0
	Total	166	100.0	100.0	

APPENDIX III: Analysis of farmers' level of adoption of FARO 52 rice package

Adoption index	Frequency	Percent	Valid Percent	Cumulative Percent
0.2	9	5.4	5.4	5.4
0.3	12	7.2	7.2	12.7
0.33	4	2.4	2.4	15.1
0.35	7	4.2	4.2	19.3
0.4	9	5.4	5.4	24.7
0.45	5	3.0	3.0	27.7
0.5	18	10.8	10.8	38.6
0.55	7	4.2	4.2	42.8
0.56	1	.6	.6	43.4
0.6	24	14.5	14.5	57.8
0.65	11	6.6	6.6	64.5
0.66	3	1.8	1.8	66.3
0.67	4	2.4	2.4	68.7
0.7	2	1.2	1.2	69.9
0.75	5	3.0	3.0	72.9
0.8	5	3.0	3.0	75.9
0.85	6	3.6	3.6	79.5
0.9	8	4.8	4.8	84.3
1	26	15.7	15.7	100.0
Total	166	100.0	100.0	

APPENDIX IV: Results of Multiple Regression Models Showing Analysis of Factors Influencing Adoption of FARO 52 Rice Package

Linear Functional Form				Semi-log Model			Double-log Model		
Variables	**Coefficient**	**Std err**	**t-value**	**Coefficient**	**Std err**	**t-value**	**Coefficient**	**Std err**	**t-value**
AGE	-.001	.001	-2.274**	.045	.023	1.987**	-.002	.001	-2.978**
EDU	-.001	.002	-.688	-.012	.005	2.546**	-.001	.001	-.695
HHSZ	.006	.002	2.984***	-.001	.008	-.160	.005	.002	3.021**
FRMSZ	.020	.012	1.729*	.013	.038	.350	.023	.011	2.122**
FRMEXP	.015	.003	5.011***	.026	.021	1.226	.013	.003	4.721***
EXTV	.009	.002	5.002***	-.006	.007	-.914	.009	.002	5.420***
FAINC	3.222E-7	.000	1.027	.124	.030	4.169***	1.519E-8	.000	.052
EXPMD	.000	.002	.127	-.005	.004	-1.161	.000	.002	.125
TRNG	.040	.010	4.195***	.350	.032	10.912***	.010	.009	1.156
ACCMKT	.001	.001	1.170	.004	.004	.865	.001	.000	1.128
MFASSO	.008	.002	5.103***	-.007	.006	-1.124	.008	.001	5.680***
R-Squared	0.976			0.947			0.959		
F-statistics	577.947***			491.033***			325.53***		

******* (1%)**, **** (5%)**, ***(10%)

AGE (Age of the farmers), EDU (level of education), HHSZ (Household size), FRMSZ (Farm size), FRMEXP (Farming experience), EXTV (Extension Visits), FAINC (Farmer’s Annual Income), EXPMD (Exposure to media), TRNG (Training attended), ACCMKT (Access to market) and MFASSO (Membership of Associations).