ADOPTION OF IMPROVED RICE PRODUCTION TECHNOLOGIES AMONG MEMBERS AND NON-MEMBERS OF RICE FARMERS ASSOCIATIONS IN KANO AND KADUNA STATES, NIGERIA

BY

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

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DECLARATION

I hereby declare that this Thesis titled "**Adoption of Improved Rice Production Technologies By Members and Non-members of Rice Farmers Associations in Kaduna and Kano States, North-West, Nigeria**" has been written by me and it is a record of my research work. No part of this work has been presented in any previous application for another degree or diploma at any institution. All cited information have been duly acknowledged in the text and a list of references provided.

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CERTIFICATION

This thesis titled "**Adoption of Improved Rice Production Technologies By Members and Non-members of Rice Farmers Associations in Kaduna and Kano States, North-West, Nigeria**" by Samson Oluyemi **ADELEYE** meets the regulations governing the award of Doctor of Philosophy degree in Agricultural Extension and Rural Sociology of Ahmadu Bello University, Zaria and is approved for its contribution to scientific knowledge and literary presentation.

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This work is humbly dedicated to the Lord God Almighty whose love for me is endless, to my Lord Jesus Christ whose grace is more than enough all the time and to the Holy Spirit whose help is priceless.

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ABSTRACT

This study was carried out to investigate the adoption of improved rice production technologies by members and non-members of Rice Farmers Associations in Kaduna and Kano States. A multi-stage sampling procedure was used to select 266 respondents comprising of 133 members and 133 non-members from both States while semi-structured questionnaire was used to collect data. Data collected were analysed by using descriptive statistics, Z-test, Chi-square and Tobit regression model. The results from the study showed that the most important source of information on rice production among members of Rice Farmers Associations in the study area was radio (17.3%) followed by other farmers (16.4%), and extension agent (13.3%). Non-members had radio as the most important source with 20.8% followed by other farmers (18.3%) and farmers' leader (17.6%). This implied that radio, other farmers, extension agent and farmers' leader were the preferred sources of information on rice production among rice farmers in the study area. The level of adoption was above 70% in 7 out of the 13 improved rice production technologies. These included use of tractor for land preparation, planting of improved rice variety, seed dressing with agrochemical, use of herbicide for land clearing, use of herbicide for weed control in rice fields, basal NPK fertiliser application and top dressing with urea. Adoption of rice crop residue as manure and use of rice milling machine among members was between 50 and 69%. Sorting of rice seeds for planting, rice-legume rotation, use of mechanical thresher and use of mechanical winnower were adopted by less than 50% of the respondents. On an average, 64% of members adopted improved rice production technologies compared to 57% of non-members. Test of significance showed that adoption of improved rice production technologies by members was significantly higher than that of non-members in the pooled data. In Kaduna, rice yield per hectare obtained among members was higher than that of non-members but not significantly different while in Kano, non-members had significantly higher rice yield than members. Rice yield obtained by non-members (2.67 tons/ha) in the pooled results was found to be significantly higher than that of members (2.23 tons/ha). Income, savings, means of transportation and source of drinking water were similar among members and non-members of Rice Farmers Associations. The study showed that the performance of members of Rice Farmers Associations varied from one State to another in the study area depending on the capacity of the associations to contribute to enhancement of their members' income. Major problems obstructing adoption of rice production technologies as identified by the respondents included difficulty in obtaining loans for purchase of farm inputs, low level of education, selling of rice to middlemen at poor price and poor access to machines for threshing, winnowing and milling. It is recommended that business development support should be given to Rice Farmers Associations to facilitate access to market information. In addition researchers and extension specialists should work with rice farmers using innovative approaches such as Farmers Field School to enhance better uptake of improved rice production technologies.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Agriculture is a major driver of economic growth in Nigeria with the involvement of 70% of the rural population in one form of production or the other and a contribution of about 40% to the Gross Domestic Product in 2010 (National Bureau of Statistic /Federal Ministry of Agriculture and Rural Development, 2010/2011). Over the years, Nigerian farmers working under difficult circumstances have deployed their local knowledge and expertise in ensuring that they feed the nation. A combination of increasing population and degradation of natural resource base for agricultural production has stretched the use of traditional agricultural system by farmers to the limit (Nye and Greenland, 1960).

Small scale farmers living in rural areas are the predominant producers of food in Nigeria. They still rely on traditional technology characterised by low productivity due to limited access to farm machines, fertiliser and improved seeds. According to the World Bank (2013), only 10 tractors are available per 100 hectares of farm land in Nigeria as compared to 241 tractors per 100 hectares in Indonesia. Fertiliser application in Nigeria is estimated at 13 kg per hectare while the fertiliser usage for the rest of the world is 100 kg per hectare (International Fertiliser Distribution Center, 2013).

Analysis of the relative increase in crop yields by the World Bank (2013) in developing countries indicate that Nigeria crop yields have the lowest growth rate of 0.2% from 1968-2008 as against 1.2% for China, 2.3% for Indonesia and 3% for Malaysia. Ojehomon, Abo, Ojehomon, and Unkwungwu (2006) stated that when farmers use improved technologies in their physical and economic environment, there is a wide yield gap difference between the farmers' output and what the researchers obtained. The wide disparity in yield is partly due to incomplete adoption of the technology package which is associated with stepwise adoption pattern of farmers, risk consideration and scarcity of funds (Shakya and Flinn, 1985). This necessitated the development of improved agricultural production technologies and establishment of extension services across the nation to aid farmers in the production of food crops and to facilitate the attainment of food self-sufficiency.

Self-sufficiency in rice production has been a major focus of food policy goal of successive Nigerian Government in the last two decades due to deficit in rice production which has cost a substantial amount of foreign exchange to import rice into the country (Tiamiyu, Akintola, and Rahji., 2009). Erenstein, Lancon, Osiname and Kabbeh (2004), affirmed that Nigeria has witnessed a well established growing demand for rice as propelled by rising caput consumption and consequently the insufficient domestic production had to be complimented with enormous import both in quantity and value at various times. Notwithstanding, in spite of the efforts made in the past by successive Nigerian Government, the country is yet to become self-sufficient in rice production even though significant progress has been made in certain areas.

Adesina (2014) reported that the need to achieve self sufficiency in food production is more pertinent in the rice sub-sector where the local consumption of the commodity is in excess of the quantity produced by farmers thus creating a demand for imported rice to meet the shortfall. Rapid population growth and urbanisation have significantly contributed to the increase in gap between supply and demand for rice in Nigeria. Rice consumption in the country is expected to reach 35 million tonnes by 2050 (Federal

Ministry of Agriculture and Rural Development, 2012). According to Adesina (2014), Nigeria is the second largest importer of rice in the world, spending about 356 billion Naira for about 2 million metric tonnes of imported milled rice; meaning that the sum of 1 billion Naira is spent on rice daily. The policy makers in the agricultural sector are keen to reverse the trend as there exists in the country the potential to raise local production to meet the demand for consumption of the commodity thereby saving foreign exchange and creating job opportunities especially among rural dwellers. Thus, Nigeria has developed the Agricultural Transformation Action Plan (ATAP) as a strategy for reducing rice importation to zero by the year 2015 (Adesina, 2014).

1.2 Problem Statement

In recent years, the Government of Nigeria through the Federal Ministry of Agriculture and Rural development has expressed strong commitment to ensuring that rice production is accelerated to the level where the country becomes self-sufficient by 2015 Improved rice production technology has been widely recognised as a critical input for increasing rice production in the country. In view of this, efforts have been made by the Government of Nigeria to ensure that farmers across the country access improved production technology through extension services. Moreover, rice farmers are being encouraged to form commodity associations to enhance adoption of improved rice production technology and increased income through better access to extension services and critical farm inputs. This is based on the premise that rice farmers who are members of Rice Farmers Associations perform better than non-members. While Odoemenem and Obinne, 2010 reported superior performance of cooperative members over non-cooperative members in terms of adoption of improved technology, Afolami, Obayolu, Agbonlahor and Lawal-Adebowale (2012) reported that there was no significant difference in the performance of cooperative and non-cooperative members in South-West Nigeria with respect to yield and profit. Another study among farmers in Abuja FCT (Ajah, 2012), reported that there was no significant difference in access to extension services and level of education among members and non-members of cooperative groups. On the basis of findings from past studies, there is a probability that members adopt more recommended practices and deliver better output with improved access to extension services and credit.

On the other hand, it is also possible that there is no difference in the performance of both members and non-members and farmers associations exist in nomenclature only and are not involved in actual delivery of services that add value to their members. In spite of the ambiguity around the issue, rice farmers in Nigeria are being encouraged to operate in groups or commodity associations to enhance the adoption of improved agricultural technologies. As far as rice production in Kaduna and Kano States is concerned, there is paucity of data validating or rejecting the premise that members perform better than non-members among rice farmers.

It is against this backdrop that the study investigated the adoption of recommended practices on rice production and its effects on level of living of members and non-members of Rice Farmers Associations in Kano and Kaduna. It was anticipated that the study would provide answers to the following research questions:

i. What are the socio-economic and institutional characteristics of members and non-members of Rice Farmers Associations in the study area?
ii. What are the sources of information on rice production in the study area?

iii. What is the level of awareness of improved rice production technologies among members and non-members?
iv. What is the extent of adoption of improved rice production technologies among members and non-members?
v. What are the factors influencing the adoption of improved rice production technologies by members and non-members?
vi. What are the effects of adoption of improved rice production technologies on rice yield among members and non-members of Rice Farmers Associations?
vii. What are the effects of adoption of improved rice production technologies on the level of living of members and non-members?
viii. What are the production constraints among rice farmers in the study area?

1.3 Objectives of the Study

The broad objective was to investigate the adoption of improved rice production technologies on rice production and its effects on yield and level of living among members and non-members of Rice Farmers Associations in the study area. The specific objectives of the study were to:

i. describe the socioeconomic and institutional characteristics of members and non-members of Rice Farmers Associations in the study area;
ii. determine the sources of information on rice production among members and non-members;
iii. assess the level of awareness of improved rice production technologies among members and non-members;
iv. determine the extent of adoption of improved rice production technologies among members and non-members;

v. examine the factors influencing the adoption of improved rice production technologies among members and non-members;

vi. assess the effects of adoption of improved rice production technologies on yield among members and non-members;

vii. determine the effects of adoption of improved rice production technologies on level of living among members and non-members; and

viii. determine the production constraints facing both members and non-members in the study area.

1.4 Justification of the Study

The rice value chain has been receiving considerable attention by the Federal Government in the last four years in an attempt to stimulate rice production and enhance national capacity in rice processing. For example, the Growth Enhancement Support scheme which is being implemented across the country is aimed at enhancing farmers' access to subsidised fertiliser and improved seeds. Moreover, modern rice processing mills have been installed in major rice clusters in the country. The study will provide empirical evidence on rice farmers' access to the GESS scheme in the study area.

Moreover, Agricultural Extension specialists are responsible not only for facilitating farmers' access to crop production technologies from National Agricultural Research Systems but also for ensuring that empirical study is conducted to determine the benefits or otherwise of the adopted technologies and to ascertain the extent to which they have been adopted by farmers in the study area.

The study is expected to provide empirical data that will confirm or invalidate the premise that members of Rice Farmers Associations in the study area are better than non-members in terms of adoption of improved rice production technologies and rice yield. The findings from the study will contribute to policy discourse on domestic rice production in the country

1.5 Hypotheses

i. There is no significant relationship between selected socio-economic characteristics and the adoption of improved rice production technologies by members and non-members.

ii. There is no significant difference in the adoption of improved rice production technologies by members and non-members of Rice Farmers Associations.

iii. There is no significant difference in rice yield by members and non-members.

iv. There is no significant difference in the level of living of members and non-members of Rice Farmers Associations in the study area.

CHAPTER TWO

LITERATURE REVIEW

2.1 Rice Production in Nigeria

Rice is a major cereal crop in Nigeria and its consumption is increasing rapidly due to urbanisation, relative ease of preparation, and convenience in storage (Ekeleme, Kamara, Omoigu, Tegbaru, and Onyibe, 2008). Rice production occurs in all agro-ecological Zones in Nigeria. The areas where rice is cultivated in Nigeria are classified into five ecosystems namely: rain-fed upland, rain-fed lowland, irrigated lowland, deepwater and mangrove. Rain-fed lowland accounts for 50% of the total area under rice cultivation followed by rain-fed upland (30%) and irrigated (16%) system (NBS/FMARD, 2011). Deepwater and mangrove swamp systems constitute the remaining 4% of the total land area. Rice is cultivated in about 32 States in Nigeria with a total land area of about 2.43 million hectares and annual production of 4.47 million metric tons of milled rice thus giving and average of 1.84 metric tons per hectare (NBS/FMARD, 2011).

Nigeria has depended largely on increasing land area for rice cultivation to improve production and there is a huge gap between the actual levels of production and the potential yields. The major rice producing States in Nigeria include Taraba, Kaduna, Niger and Kano. According to NBS/FMARD (2011), Taraba State has the largest land area under rice cultivation with 375,670 hectares representing 15.4% of the total land area, followed by Kaduna State with 344,890 hectares (14.17%). Niger State has 330,670 hectares (13.59%) while Kano contributes 219.060 hectares or 9% of the total land area under rice cultivation in Nigeria (NBS/FMARD, 2011). In terms of production, Kaduna State is the highest producer of rice with 732,420 metric tons representing 16.37 % of the total annual production in the country while other major rice producing States in order of importance are Niger with 636,670 metric tons (14.23%) and Kano contributing 422,050 metric (9.4%) tons (NBS/FMARD, 2011). In a survey on rice cultivation in Nigeria, Ojehomon, Adebayo, Ogundele, Okuruwa, Ajayi, Diagne, and Ogunlana (2009) reported that the most common field size among rice farmers studied was 1 to 1.5 hectares (59.26%) followed by those that cropped less than or 1hectare (30.92), while only 8.44% of farmers cropped 5.1 to 10 hectare. On an average, 3.3 hectares were cultivated during the survey year. About 84% of the rice farmers in Nigeria are men while women constitute 16%. Traditional rice varieties are cultivated by 44.9% of rice farmers while 55.1% grow improved varieties. Rice consumption is expected to rise from the present 5 million metric tons to at least 35 million metric tons by 2050 with increasing population. Nigeria has developed the Agricultural Transformation Action Plan (ATAP) as a policy instrument for enhancing self-sufficiency in the national production of the commodity.

2.2 Rice Production in Kaduna and Kano States

Kaduna State is one of the largest producers of rice in Nigeria with a land area of 344,890 hectares representing 14.17% of the total land area under the cultivation of the crop across the country (NBS/FMARD, 2011). Rice production in the State was 732,420 metric tons in 2011 accounting for 16.37% of the total production in the country. The average yield per hectare for the same period was 2.12 metric tons per hectare. Rice is cultivated in almost all the 23 Local Government Areas in the State. According to a survey of rice production clusters in Kaduna, 98% of the respondents have been applying fertiliser to their rice fields while 2% of them used it before (Erenstein, Lancon, Akande, Akpokodje and Ogundele; 2003). In the same manner, 72% of the respondents have continued to apply herbicide to their rice fields while 2% of them have stopped using it and 26% have never used it. Concerning mechanised land preparation, 69% of the respondents have never used it before while 28% of them have used it and 4% have discontinued the use of it.

Kano State is another major producer of rice in Nigeria with a land area of 219,060 hectares representing 9% of the total land area under the cultivation of the crop across the country. Rice production in the State was 422,050 metric tons in 2011 accounting for 9.4% of the total production in the country (NBS/FMARD, 2011). The average yield per hectare for the same period was 1.93 metric tons per hectare. The availability of irrigated schemes of Hadejia Jama'are River Basin Development Authority, and the vast Fadama area developed under the former National Fadama Development Authority, as well as the upland production areas of Tudun Wada and Rogo serve as impetus for rice production in the State. Kano has large processing clusters across the Local Government Areas including Kura, Garun Mallam and Bunkure where rice milling is done extensively. Rice grown in neighbouring Kaduna, Katsina, Jigawa and Bauchi States is also brought to Kano for processing and marketing. Rice marketing is well established in Kano State.

2.3 Sources of Information and Awareness of Improved Rice Production Technologies

Access to information on a particular agricultural innovation is the first step towards the creation of awareness among farmers. Various sources of information are used to disseminate agricultural technologies depending on the type technology and level of education of the farmers. Younger and better educated farmers have more contact with sources of information than uneducated ones (Onumadu, 2002). Personal and socio-economic characteristics are related to farmers' use of agricultural information. Opara, (2010) found a significant relationship between farmers' use of agricultural information and educational qualification, marital status, income and preferred media. On the other hand social participation, reliance on indigenous knowledge, tenancy status, gender, size of land cultivated, years of farming experience, part or full time farming and age did not correlate with agricultural information use. However, the combination of the above personal and socioeconomic variables was found to be effective in predicting farmers' use of agricultural information. Fadiji and Atala (2009) reported a positive significant relationship between utilisation of extension information and farmers' awareness, age, social participation, level of education, extension visits, access to radio and farm size. It is therefore, important to examine the effectiveness of information sources in agricultural production. According to Ayoade (2010) information from friends and mass media such as radio and television were found to be most effective among cowpea farmers in Oyo State. In addition there was a significant relationship between age, household Size, years of experience and effectiveness of information sources. Akinbode (1969) pointed out that the extent to which farmers use information sources could also be influenced by their socio-economic status.

In a study on the use of information sources by rice farmers in Southern Nigeria, Shegun and Adun (2002) discovered that the most important source of information was radio with 43% followed by neighbours (29%) and extension agents (28%). This is similar to the findings of Jirgi (2009) among rice farmers in Niger State, Nigeria where 56% of the farmers received information through the radio, 28% through extension agents, 10% through television and pamphlet 6%.

Olaniyi and Adewale (2012) found that majority of rural youth in Southwest Nigeria, in order of importance, accessed agricultural information from radio, fellow young farmers, extension agent, input dealers and cooperative societies. Idrisa, Ogunbameru, Ibrahim and Bawa (2012) examined the level of awareness about climate change among farmers in Borno State, Nigeria and found that 39.11% of the farmers who were aware got their information from extension agents, 26.67% from friends and neighbours, 11.11% through the media and 5.33% from NGOs. There is a relationship between sources of information and level of awareness. Adu and Adekoya (2008) confirmed that, farmers' information sources were significantly related to their awareness of forestry related technology. In an investigation on the level of awareness and use of Yam Minisett technique, Okoro (2008) reported that sources of information on the technique included extension agents (45.2%), farmers' friends (39.3%) schools (11.4%) and newspaper (0.6%). In addition only about 46.6% of the respondents were aware of the technique nationwide while 22.4% are using the technique. In a study on adoption of improved agricultural technologies disseminated via radio in Enugu State, Agwu (2008) reported major sources of information as other farmers (35.5%), followed by radio(28.1%), and extension agent (5.92%).

According to Fadiji, Atala, and Voh (2005) major sources of extension information among farmers in rural northern Nigeria were radio, extension agent and other farmers. With respect to farmers' awareness of HIV/AIDS prevention in Ondo State, Nigeria, Olaleye (2003) found that sources of information included friends and relative (98.3%), radio programme (90.0%), church/mosque(80.8%) and personal interaction of farmers with extension agents (69.2%). In many cases access to sources of information has been found to deliver tangible benefits to the farmers. Oladele (2004) reported a strong correlation between benefits of services received and sources of information on veterinary services.

In view of the above, it appears a comprehensive agricultural extension communication strategy can be built around the use of radio, extension agents and other farmers. It may be important to examine existing local structures among farmers for sharing of information on agricultural production and explore opportunities for making them work better as there exists a positive relationship between sources of information and benefits of services received by farmers.

2.4 Improved Rice Production Technologies

Increase in rice output, in recent times, has been driven mainly by increase in land area rather than an increase in productivity. A critical issue in achieving self sufficiency in rice production is the need to improve farmers' productivity. For example, New Rice for Africa (NERICA) was specifically developed by Africa Rice Centre (ex-WARDA) to solve the problem of low productivity of rice especially in upland production system. NERICA varieties have high yield potential and short growth cycle. Several of them possess early vigour during the vegetative growth phase and this is a potentially useful trait for weed competitiveness. In addition, a number of them are resistant to African pests and diseases, such as the devastating rice blast, to rice stem borers and termites.

They also have higher protein content and amino acid balance than most of the imported rice varieties (Jones, Dingkuhn, Johnson, and Fagade., 1999; Wopereis Diagne, Rodenburg, Sie, and Somado., 2008). Research by "Promoting Sustainable Agriculture in Bornu State" project (PROSAB) has shown that with good management, up to 8 tons ha^{-1} of paddy yield can be obtained by some of the NERICA varieties (PROSAB, 2006). According to Ojehomon *et al.* (2009), 45% of rice farmers across the country planted traditional rice varieties while 25% planted improved WARDA NERICA and 11% planted other improved varieties. The results of a study on adoption of improved rice varieties among small-holder farmers in South-western Nigeria show that farmers have responded appreciably to intervention programmes that promote the use of improved rice varieties with an adoption rate of 68.7%. The mean yield of improved rice varieties (1.60 t ha^{-1}) was significantly higher than the yield of the local varieties (1.15 t ha^{-1}) with a yield advantage of 38.7%. ITA 50 and Ofada were the most prominent improved and local rice varieties respectively (Saka, Okoruwa, Lawal, and Ajijola., 2005).

The improved cereal crop production innovations available to small scale farmers in Benue State include improved cereal varieties, fertiliser, pesticides and herbicides. Assessment of the adoption of these innovations showed that improved crop variety was adopted by 32.43% of the farmers in the study area followed by fertiliser with 27.03% and pesticides with 24.32%. Herbicide recorded the least rate of adoption with 16.22% (Odoemenem and Obinne 2010). In an impact study on adoption of NERICA varieties in Nigeria, Nguezet, Diagne, Okoruwa, and Ojemohon (2011) found a robust positive and significant impact of NERICA varieties adoption on farm household income and welfare as measured by capita expenditure and poverty reduction.

National Agricultural Extension and Research Liaison Services (as cited by Omotayo, 2001) assessed the adoption of technologies on selected food crops in some food crops across the country. NAERLS (1997) revealed that among the technologies extended to various crops in the study area, technology adoption was the lowest for rice. The assessment indicated that less than 20% adoption rate was recorded on improved varieties of rice, 7% for pesticides, 24% for fertilizer use and 16% for storage. The low adoption rate of some of the technologies was attributed to unavailability and high cost of the technologies. Umar, Ndanitsa, and Olaleye (2009) studied the adoption of improved rice production technologies among youth farmers in Gbako Local Government Area, Niger State and found that fertiliser application was adopted by 79% of the respondents while plant spacing practice was adopted by 19% of the respondents. In a study on adoption of improved rice production technologies in Jere Local Government Area of Borno State, Mustapha, Undiandeye, Sanusi, and Bakari (2012) revealed that majority of the respondents adopted rice production technologies with respect to high yielding varieties (77.5%), early maturing varieties (69.37%), use of herbicides (93.75%) and broadcasting method (55%).

Singha and Baruah (2011) reported that farmers were averse to adoption of recommendations of those relatively complex practices in nature such as seed treatment, application of manure and fertilisers, and plant protection measures under different farming systems. However, there are opportunities for ameliorating the complexity of certain practices through the deployment of appropriate extension methods. Rice production technology in Nigeria is comprised of recommended practices including use of improved variety, use of tractor for land preparation, seed treatment, basal NPK fertiliser application, use of herbicides, top dressing with Urea fertiliser, drying of harvested paddy on mats spread of concrete floors, use of rice residues as organic manure and rice-legume rotation (Adeosun Onyibe, and Salako; 2005 and Ekeleme *et al.,* 2008).

2.5 Diffusion and Adoption of Agricultural Technologies

In a study on hybrid maize adoption in the United States of America, Rogers (1983) reported that adoption occurred over more than ten years and most farmers dedicated a fraction to the new maize in the first years after adoption. The combination of external influences such as mass media, organisational or governmental mandates and internal influences such as strong and weak social relationships as well as distance from opinion leaders defines the social system which influences potential adopters (Rogers, 1983). Rogers (1962) defined rate of adoption as the relative speed at which participants adopt an innovation. Rate is usually measured by the length of time required for a certain percentage of the members of a social system to adopt an innovation. The rates of adoption for innovations are determined by individual's adopter category as individuals who first adopt an innovation require a shorter period when compared to late adopters.

Rogers (1995) presented four additional adoption/diffusion theories namely: innovation decision process theory, individual innovativeness theory, rate of adoption theory and perceived attributes theory. The focus of the innovation decision theory is on the users or adopters of the innovation as they advance over time through the five stages in the diffusion process. In the knowledge stage, they learn or acquire information about the innovation. This is followed by the persuasion stage in which they must be persuaded of the value of the innovation before they progress to the decision stage and make decision to adopt it. The next stage is the implementation stage and this involves the implementation of the innovation; and finally, at the confirmation stage, the decision must be reiterated or abandoned. The individual innovativeness theory asserted that individuals who are risk takers will adopt an innovation earlier in the adoption/diffusion process. The rate of adoption theory stated that diffusion takes place over time with innovations going through a slow, gradual growth period, followed by dramatic and rapid growth, and then a gradual stabilisation and finally a decline.

Roger (1995) affirmed that according to the perceived attributes theory, an innovation is judged based on five attributes namely: trialability, observability, relative advantage, complexity and compatibility. Trialability is the degree to which an innovation can be tried on a limited basis. Innovations that can be tried in parts are likely to be adopted more quickly than innovations that are not divisible. Observability is the extent to which the results of an innovation are visible to others. The easier it is for people to see the results of an innovation, the more likely they are to adopt it. The visibility of the results often stimulates peer discussion about the innovation and tends to dispel any doubts potential adopters may have. Relative advantage is the level to which an innovation has an advantage over other innovations or the present circumstance. As for complexity, the issue is that the innovation must be simple to learn or use. In terms of compatibility, the innovation must fit in or is compatible with the situations into which it will be adopted.

Feder, Just and Ziberman (1985) identified three categories of adoption namely: individual versus aggregate adoption; singular versus package of recommendations; and divisible versus non-divisible adoption. Individual adoption was defined as the degree of use of a new innovation when the farmer has complete information about the new innovation and its potential. Aggregate adoption was defined as the spread of an innovation within a given geographical area. Where the innovation is not divisible such as mechanisation or irrigation, the choice of how much land or resource to be allocated to the new and old innovation is involved in the adoption decision. However, for innovations that are divisible such as improved seeds, fertiliser and herbicide, the adoption process involved not only how much land to be allocated but the rate of application or intensity of use.

According to Feder *et al*. (1985) the intensity of adoption of divisible technologies can be determined at the individual level in a given period of time by the portion of farm area under the new innovation or quantity of input used per hectare in relation to the recommendations by the research system. The same scenario is applied to the aggregate level of adoption in a given geographical area. On the other hand, the level of adoption of non-separable agricultural innovations such as tractor and combine harvester at the farm level at a given period of time is binary as it relates to use or no use of the innovation but the aggregate measure becomes continuous.

2.6 Adoption Studies on Agricultural Technologies in Developing Countries

There are numerous empirical studies relating to adoption of new agricultural technologies in the era of Green Revolution in Asian countries about five decades ago. However, Ruttan (1977) made several generalisations from the large body of empirical studies as follows:

i. The new high yielding varieties were adopted at exceptionally rapid rates in those areas where they were technically and economically superior to local varieties.

ii. Neither farm size nor tenure has been a serious constraint to the adoption of new high yielding varieties of wheat and rice. While smaller farmers and tenants tended to lag behind larger farmers in the early years following the introduction of high yielding varieties, these lags have typically disappeared within a few years.

iii. Neither farm size nor tenure has been an important source of differential growth in productivity.

iv. The introduction of high yielding varieties has resulted in an increase in demand for labour.

v. Landowners have gained relative to tenants following the adoption of high yielding varieties.

Ruttan (1977) admitted that there are many exceptions to these generalisations because innovations have been introduced in environments with different economic, social and political institutions. A comprehensive survey of adoption of agricultural technologies in developing countries by Feder *et al*. (1985) found that farm Size, risk, human capital, labour availability, labour availability, access to credit and land tenure system were the most important factors influencing farmers' adoption behaviour. In Ecuador, Mauceri (2004) used ordered probit model to identify determinants and constraints of adoption of integrated pest management (IPM) techniques among potato farmers. It was found that access to information through farmers' field school was the main determinant of adoption of IPM, followed by field days, pamphlets, and exposure to farmers' field school participants.

2.7 Adoption Studies on Agricultural Technologies in Africa

Morris, Tripp, and Dankyi (1999) studied the adoption of maize production technology among farmers in Ghana and found that over one-half of the sample farmers planted improved maize varieties and a similar proportion (53%) planted at least part of their maize crop in rows while 21% applied fertiliser to their maize fields. About 37.5% of the respondents did not use any of the three recommended technologies which comprised of improved germplasm, fertiliser recommendations, and plant configuration as against 12.3% who practiced the three. Adoption of improved maize varieties and row planting without fertiliser was found to be most common among farmers.

Adesina and Baidu-Forson (1995) investigated the role of farmers' preferences in adoption decisions with Tobit models of modern sorghum and rice varietal technologies in Burkina Faso and Guinea respectively. The results show that farmers' subjective preferences for characteristics of new agricultural technologies are very important determinants of adoption behaviour. The major conclusion of the study was the need for future adoption studies to expand the range of variables used away from the broad socio-economic, demographic and institutional factors to include farmers' subjective perceptions of the characteristics of the new agricultural technologies.

Diagne (2006) obtained data from a sample of 1500 farmers to consistently estimate the NERICA's actual and potential adoption rates and determinants in Cote d'Ivoire using the Average Treatment Effect framework. The probability of adoption of NERICA in the population was estimated to be 27%. The author argued that the normally computed sample adoption rate procedure with the Logit model gave an underestimated 4% meaning that if the diffusion of NERICA were complete by 2000 then NERICA adoption would have been 23% higher than the 4% sample adoption rate.

In Mozambique, the adoption of new agricultural technologies remains low despite the efforts of the Ministry of Agriculture for several years. For example, in agricultural households, the adoption of improved variety of maize which is a staple crop in the country is less than 7%. In a study on determinants of agricultural technology adoption in Mozambique, Uaiene, Arndt and Masters (2009) found that households with higher levels of education and those with access to credit and extension advisory services as well as members of agricultural associations were more likely to adopt new agricultural technologies.

Bonabana-Wabbi (1998) assessed the factors affecting the adoption of agricultural technologies in Uganda with special reference to integrated pest management and found that farmers' participation in on-farm trials demonstrations, accessing agricultural knowledge through researchers, and prior participation in pest control training were associated with increased adoption of most recommendations on integrated pest management.

2.8 Adoption Studies on Agricultural Technologies in Nigeria

The adoption rate of any agricultural technology can be measured in terms of the number of farmers who adopt the technology or in terms of the total area on which the technology is adopted depending on the objective of the study (Morris *et al.*, 1999). In an adoption study on improved rice varieties among smallholder farmers in South West Nigeria, Saka *et al*. (2005) applied the logit regression model to both adopters and non-adopters to identify factors influencing the farmer's decision to adopt or not adopt the improved rice varieties while the linear regression was applied only to adopters to identify factors that influence the intensity of use after farmers might have decided to or adopted the improved rice varieties.

They found that a substantial proportion of land area grown to rice was cultivated with improved rice varieties with an adoption rate of 68.7% while the adoption rate for local varieties was 31.3%. Jamila *et al*. (2011) studied farmers' adoption of irrigated rice production in North East Nigeria using the logit model to empirically quantify the relative influence of various factors in the decision of the respondents to adopt the system of farming. The results of the logistic regression model indicated that the fit of the data was good as shown by the significance ($P<0.01$) of the X^2. The parameter estimates that five variables namely farming experience, household Size, gender, market availability and labour availability significantly influenced the choice of sole rice enterprise.

In the case of another study on determinants and effects of complimentary technology adoption on productivity of NERICA rice farming, Tiamiyu *et al*. (2009) analysed data obtained from sample survey of 227 NERICA rice farmers in Kaduna and Nassarawa States in the Guinea Savanna Zone using Tobit regression model. Tobit regression estimation indicated that farmer's technology score was affected significantly by farmers' level of education, extension visit, farming experience, land ownership status, credit use and level of rice commercialisation. Onyenweaku *et al.* (2007) examined the determinants of fertiliser adoption by rice farmers in Abia State, South East Nigeria using the Tobit model to unravel the decision to adopt or not to adopt the use of fertiliser. Tobit model estimates of factors affecting adoption and use intensity of chemical fertiliser in rice production showed that farm size, type of ecosystem, tillage type, education, population pressure on land, farmer's age and non-farm income to be positively and significantly related to adoption and use intensity of chemical fertiliser while field distance to the village, gender, access to credit and labour availability had indirect relationship with adoption and use intensity of chemical fertiliser.

In the cases above the decision to adopt or not is merely dichotomous with estimation of the functional relationship between the probability of adoption and a set of explanatory variables using logistic distribution for the Logit procedure and the normal distribution for Probit procedure. According to Feder (1985), the Logit/Probit methods examined the effects of regressors on the decision to adopt or not to adopt, but it did not measure the degree of adoption intensity. Some adoption studies in Nigeria used the Tobit model to determine farmers' extent and intensity of adoption of improved technologies. In an attempt to avoid flaws in conventional analytical approaches Amaza, Ellis-Jones, Kamara, Helsen and Gaya (2007) used a Participatory Impact Assessment (PASS) procedure in evaluating the adoption of improved crop technologies by farmers in the savanna of Bornu, North East Nigeria. In PASS, adoption rate was measured through discussion with participating groups, discussion with a number of key individual farmers and transect walk through arable areas. The results revealed that improved maize and soybean varieties had the highest adoption rates with maize (83%) and soybean (68%). Agwu (2004) investigated the socioeconomic characteristics and technology-related factors influencing adoption of improved cowpea production technologies among farmers in Bauchi and Gombe States of Nigeria.

The individual adoption scores of farmers were estimated by using the seven steps (not aware to rejection) adoption model while the step-wise multiple regression model was used to estimate adoption determinants. The results showed that the use of insecticides to control pests on cowpea farms had the highest score. Only farm size and level of formal education positively and significantly influenced adoption of improved cowpea technologies while three technologies namely: use of tractor for preparing cowpea farmlands, application of inorganic fertiliser and use of recommended plant configuration made the highest contribution in explaining differences in adoption of cowpea technologies among farmers.

2.9 Issues and Perspectives

In Nigeria, agricultural technologies are developed essentially by the public sector national agricultural research system comprising of 15 research institutes across the country with mandate for specific agricultural commodities. The research institutes are coordinated by the Agricultural Research Council of Nigeria under the Federal Ministry of Agriculture and Rural Development. As far as research on rice is concerned, the National Cereal Research Institute at Badeggi, Niger State and the international agricultural research institute, African Rice Centre have been playing significant roles in the development of rice production technologies. The Institute of Agricultural Research, Zaria and the Institute of Agricultural Research and Training, Ibadan have also contributed to the development of recommended practices on rice production. The National Agricultural Extension and Liaison Services is a major outlet for improved technologies to diffuse to farmers through the extension advisory services provided by the network of Agricultural Development Projects (ADPs) in every State in Nigeria and the Federal Capital Territory. Essentially, the diffusion of innovations on rice production follows a linear path from the international agricultural research centre to the National Agricultural Extension and Research Centres and then to the farmers through the ADPs. Farmers’ production constraints are expected to follow the same path from the ADPs back to the national agricultural research centres for the development of potential solutions.

2.10 Adoption of Improved Rice Production Technologies

Studies have shown that there is a relationship between socioeconomic characteristics of farmers and adoption of agricultural innovations. Atala (1980) and Okwocha (1998) reported a direct relationship between adoption of improved maize varieties and educational status of farmers. According to Akinola, Arega, Adeyemo, Sanogo, Olanrewaju, Nwoke, Nzuguheba, and Diels (2007), the adoption of an innovation is a function of demographic and socioeconomic characteristics of farmers. In a study on the determinants of sustainable agricultural technologies, Peter and David (2003) observed that adoption of agricultural innovations is affected by socioeconomic characteristics of farmers. The case of adoption of innovations in rice production and farmers' socioeconomic characteristics is not different. Farm size, frequency of extension contact and the yield rating of the improved rice varieties have been found to influence significantly the decision of farmers to adopt improved rice varieties in South-western Nigeria (Saka *et al.*, 2005). Odoemenem and Obinne (2010) in a study on factors influencing adoption of cereal crop production innovations in Benue State reported that the most important factors were extension contact, amount and use of credit and cooperative membership. The results obtained in a study on factors influencing adoption of irrigated rice production in North-east Nigeria showed that five factors namely farming experience, household Size, gender, market availability and labour availability significantly influenced adoption of irrigated rice production (Jamala, Sheu, and Garba; 2011).

Fertilizer has been a major component in the extension package on improved rice production technology. In a study on fertilizer adoption determinants in Abia State, South-east Nigeria, Onyenweaku, Okoye and Okorie (2007) found farm size, type of ecosystem, tillage type, education population, pressure on land, farmers' age and non-farm income to be positively and significantly related to adoption and use of chemical fertilizer. On the other hand, field distance to the village, gender, access to credit and labour availability had an indirect relationship with adoption and intensity of use of chemical fertilizers. The study also showed that there were no significant relationships between adoption and soil fertility status, field type, village distance to market and membership of social organisation. Fashola, Imolehin and Wakatsuki (2007) examined the socioeconomic factors affecting the adoption of sawah rice production technology in Nigeria and found membership of Rice Farmers Associations, educational level, length of residence in the village and land ownership to be significantly related to probability of adoption with all the variables being positively related while membership of farmers 'association was found to be inversely related to the probability of adoption of sawah rice technology. In terms of productivity levels among small-holder rice farmers in Anambra State, South-east Nigeria, Mbam and Edeh (2011) found farm size, cost of labour, and frequency of extension visit to be negatively related to farmers' productivity levels while years of education, fertilizer and use of improved variety were positively significant.

Ogundele and Okoruwa (2006) examined a selection of socioeconomic characteristics of the rice farmers under traditional and improved technology. With respect to age of farmers, they found that only those farmers within the productive age group of 20-45 years were likely to possess the necessary strength to carry out energy sapping farm operations such as land clearing, tilling, weeding and harvesting. They concluded that productivity would continue to decline due to decreasing strength and estimated the average age of rice farmers under traditional technology to be 42 years while that of the improved technology was 45 years (Ogundele and Okoruwa, 2006).

In terms of educational status of farmers, it was observed that farmers with higher levels of education were likely to be more efficient in the use of inputs than their counterparts with little or no education and that majority of farmers did not go beyond primary school, while the few who attempted secondary school education did not complete it (Ogundele and Okoruwa, 2006). The estimated average years of schooling for rice farmers using traditional technology was 7, while of the improved technology farmers was 8 years and with respect to contact with extension agents, it was discovered that the traditional technology rice farmers recorded 4 rice related visits during the cropping season while the improved technology farmers recorded 6 visits (Ogundele and Okoruwa, 2006). As regards farming experience, Ogundele and Okoruwa (2006), observed that the improved technology farmers were more experienced than the traditional technology farmers, with averages of 22 and 15 years of farming experience respectively. Concerning household size of farmers, Ogundele and Okoruwa (2006) reported that the improved technology farmers had larger households than their traditional counterparts, at an average size of 10 and 8, respectively. However, larger Size of household may not necessarily translate into higher use of family labour.

The analysis of socioeconomic characteristics between improved technology and traditional technology rice farmers indicated that there were no significant differences in the estimated means for experience and household size. However, there was a high level of significant differences for age, education and contact with extension agents between the two groups of farmers. In a study that examined the levels, determinants and effects of complimentary technology adoption on productivity of NERICA rice farming, Tiamiyu *et al.* (2009) reported that adoption of complimentary technology was affected significantly by farmers' level of education, extension visits, rice farming experience, tenure status, credit use and level of rice commercialisation.

Results from a study on the performance of male and female farmers in the Northern Guinea Savannah of Nigeria indicated that land; variable inputs and experience were significant implying that these variables would greatly influence the productivity of rice in the area (Ayoola, Dangbegnon, Dauda, Mando, Kudi, Amapu, Adeosun, and Ezui, 2011). Results of a study by Odoemenem (2010) on the determinants of adoption of new technology showed that about 75% of the farmers adopted recommended practices on rice production. Farmers who adopted rice production practices were younger in age with less number of years of farming experience but with greater contact with extension agents. In a study on 'Household Endowments and Poverty Reduction among Rice Farming Households in Rural Nigeria', Awotide, Diagne, Awoyemi, Ebiohomon and Ojehomon (2011) found that education of the household heads, access to mobile phone, amount of credit obtained, farm size, irrigation facility, possession of livestock, television set, radio set and number of rooms in a house had a poverty reducing effect even though only number of rooms in a house was statistically significant.

In a study on Farmers' Adoption Behaviour in Rice Technology under different farming systems in Assam, India, Singha and Baruah (2011) found that extension contact, annual income, innovation proneness and positive attitude towards farm diversification of farmers had positive and significant relationships with extent of adoption of improved rice cultivation practices under different farming systems. In a study on adoption of improved rice production technologies among youth farmers in Gbako Local Government Area, Niger State, Umar *et al*. (2009) found that income, extension contact and social participation had significant relationship with adoption.

2.11 Rice Farmers Associations

Conceptually, cooperatives are all types of business enterprises or organisations owned and controlled by members in the pursuit of perceived mutual benefits and need actualisation (Trewin, 2003). Farmer cooperatives are regarded as social instruments for making the market environment work for resource poor farmers who are faced with the challenge of limited and uncertain demand for the commodities they produce (Ilebani, 2010). Cooperatives can serve as an avenue for the capacity building of farmers and also help to reduce production costs by organising bulk purchases for their members. For example, Rice Farmers Association of Nigeria (RIFAN) is an umbrella association for rice farmers across the country with the main objectives of supporting their members on production, processing, and marketing of rice as well as supplying farm inputs at lower prices. The association has a strong presence among rice farmers in Niger, Bauchi, Kano, Kaduna, Bayelsa and Ogun State.

Cooperatives are useful in overcoming access barriers to assets, information, services, and markets for high value products; they also assist some Nigerian small scale farmers in solving land, labour and capital problems (Nweke, 1979 and Holloway, Nicholson, Delgado, Staal, and Ehui., 2000). Farmers' cooperative associations in Oyo State, Nigeria, function well as agent, medium, and target of change for agricultural extension in their domains (Jibowo, Farinde and Lawal., 1994). The role of local groups was also cited as a success factor in extension activities to combat soil degradation in Nepal and strengthening farmers' role in irrigation in the Philippines. Contrastingly, a survey by Savannah Conservation of Nigeria (2004) in Daudawa and Tafoki Local Government Areas of Katsina State, Nigeria reported that most farmers' groups in the study area were at their embryonic stage of development. They were found to be economically weak with low capacity in resource mobilisation and collective action for improved access of members to farm inputs and technical services. Findings of survey of farmers' groups in the Kano River Irrigation Project by Community Empowerment Initiative (2004) revealed that although most of the groups had legal registration status and a formal leadership structure, few had a good financial base or a sound income generating source. However, it is important to make a distinction between farmers' groups that were formed or established as a result of external intervention or inducement and those that were established by the farmers themselves in response to a collective livelihood challenge. The latter is more likely to be sustainable and beneficial to the farmers than the former especially when adoption of agricultural innovation is the focus. Several studies have revealed that farmers' group membership played significant roles in the adoption process. Faturoti, Agwu, Igbokwe and Tekouano (2008) and Nielson (2001) demonstrated how peer farmers' influence affected innovation adoption.

In a study on the effect of cooperative membership and participation on adoption decisions, Nwankwo, Peters and Bockelmann (2009) showed that there is a strong positive correlation between adopted innovations and awareness of source of recently adopted innovations indicating that those who became aware of new technologies from cooperatives trusted the information as reliable. A medium correlation was observed between acceptance of recommended innovations and awareness of source of information from extension agents while there was no correlation between acceptance of recommended innovation and awareness from input suppliers.

In an assessment of factors influencing the utilisation of improved cereal crop production innovations by small scale farmers in Benue State, Odoemenem and Obinne (2010) found a positive correlation between membership of cooperatives and adoption of innovations implying that farmers who are members of cooperative associations adopted more technologies than non-members. In another study on capital resource mobilisation and allocation efficiency by small scale cereal crop farmers of Benue State, Odoemenem (2007) concluded that cooperative membership enhanced access to information on improved technologies, material inputs of the technologies such as fertiliser and chemicals, and credit for the purchase of inputs and payment of hired labour. The capacity of farmers to learn and share agricultural innovations is crucial to the attainment of sustainable food production system. It has been observed that farmers who belong to cooperative groups are in a better position to access and adopt agricultural innovations than their counterparts who operate individually (Odoemenem and Obinne, 2010; Nwankwo *et al.,* 2009, Salahu and Oyegbami, 2008).

However, recent studies (Odoemenem and Obinne, 2010, Afolami *et al.,* 2012) are divided over the issue of effects of membership of cooperative associations on adoption of agricultural innovations and farmers' outputs. For example, membership of Farmers Associations was found to have no significant influence on the adoption of chemical pest control among cowpea farmers in Makarfi Local Government Area of Kaduna State, Nigeria (Omolehin, Ogunfiditimi, and Adeniji., 2007). According to Onyenweaku *et al.* (2007) there was no significant relationship between membership of social organisation and adoption of fertiliser among rice farmers in Bende Local Government Area of Abia State, Nigeria.

2.12 Effects of Adoption of Improved Rice Production Technologies on Farmers' Level of Living

Adoption of a particular innovation by an individual or an organisation usually leads to both positive and negative outcomes. According to Rogers (2005) three categories of outcomes namely desirable versus undesirable, direct versus indirect, and anticipated versus unanticipated are possible when an innovation has been adopted by individuals or a group of people. On the other hand, Wejnert (2002) identified public versus private and benefit versus cost as the two categories of outcomes following the adoption of an innovation. In this case, innovations are usually expected to deliver improvement of quality of life or the reform of organisational or social structure. Adoption of improved technology in crop production is expected to impact positively on farmers' level of living to justify public expenditure on agricultural research through improved well being of farmers and reduction of rural poverty.

In a study on agricultural technology adoption and poverty reduction, Mendola (2006) reported that adoption of high yielding variety had a positive effect on household well being in Bangladesh, South East Asia. However, it is not clear if the change can be described as a sustainable one. Kijima *et al*. (2008) conducted a study on the impact of NERICA in Uganda and found that NERICA adoption reduced poverty among farming households. In the same manner, De Janvry and Sadoulet (1992) observed a positive impact of adoption of agricultural technologies. Contrastingly, in a study conducted in Bangladesh, Hossain, Lewis, Bose and Chowdhury (2003) showed that the adoption of high yielding varieties of rice had a positive effect on the richer households but the effect on poor household was found to be negative.

In Zimbabwe, Bourdillon, Hebinck, Hoddinott, Kinsey, Marondo, Mudege and Owens (2002) observed that the adoption of high yielding varieties of maize increased the income of adopters marginally. In Nigeria, Ibrahim, Mustapha, and Nuhu (2012) studied the effects of adoption of rice Production technologies on farmers' income in Borno State. The results of the study showed that coefficients for seed selection, planting depth, irrigation system, water management and tube well were positively significant with respect to income from sales of rice. According to Awotide *et al.* (2012) the findings from the study on the impact of improved agricultural technology adoption on sustainable rice productivity (358.89 kg/ha) and rural farmers' welfare showed a significant positive impact on rice productivity and total household expenditure (N 32890.82). These suggested that adoption of improved rice varieties significantly generated an improvement in farming households' living standard. Moreover, they found that 67% of adopters and 63% of non-adopters owned a house while 20% of adopters and 28% of non-adopters had access to potable water. In terms of changes in living conditions of farming households it is difficult to establish a clear case of positive effect in favour of adopters as there are other factors that may contribute to changes in farmers' welfare apart from adoption of improved technology. Fabiyi and Kushwaha (2006) studied the adoption of selected agricultural innovations namely fertiliser, agrochemical, improved seeds, machinery and sprayers and their effects on farmers' income and standard of living in Bauchi Local Government Area of Bauchi State.

The results showed that the average income per hectare for among adopters was N 22,745 while that of partial adopters and non-adopters were N 18,931 and N 20,887 respectively. In addition, 10% of adopters and 60% of partial adopters fell under high standard of living, 55% of adopters and 35% of partial adopters fell under middle standard of living while 35% adopters, 59% partial adopters and 100% of non-adopters fell within the low standard of living. This led to the conclusion that the more the adoption of relevant agricultural innovations in rice production the more the increase in income and yield. However, improvement in living standard of farming households may not be attributable to adoption of improved technology alone as other factors may be responsible for the positive outcome recorded. In a study on adoption of New Rice for Africa (NERICA) technology in Ogun State, Nigeria, Adedeji, Nosiru, Akinsulu, Ewebiyi, Abiona, and Jimoh (2013) confirmed that the non-adopters of NERICA technological package had higher average output and average yield than the adopters of the technologies.

2.13 Rice Production Constraints

According to Ojehomon *et al.* (2009) factors constraining increased rice production can be biotic, abiotic and socioeconomic in nature. Biotic constraints are associated with living organisms and are most prevalent in upland strict ecology followed by mangrove and lowland. Irrigated and lowland supplemented with irrigation had the least prevalence of biotic constraints. Abiotic constraints are attributable to living organisms and the trend is similar to that of biotic constraints in terms of prevalence across ecologies (Ojehomon *et al.,* 2009). Socio-economic constraints are rooted in social and economic conditions under which farmers cultivate rice in the country and are most prevalent in upland ecology followed by lowland and mangrove. The major biotic constraints in rice production across ecologies in the country in decreasing order of importance were weeds, insects, birds, Rice Yellow Mottle Virus, African Rice Gall Midge and Bacterial Leaf Blight while low use of fertiliser, flooding and drought were the major abiotic constraints (Ojehomon *et al.*, 2009).

The most important socioeconomic constraints were high cost of fertiliser, high transport cost and difficulties in acquiring rice processing equipment (Ojehomon *et al.*, 2009). Odoemenem (2010) reported that farmers' perception of constraints to increasing rice production in Benue State in decreasing order of importance include disease, pest, unavailability of labour and high cost of fertilizer. In the north east Nigeria, farmers' perception of problems militating against rice production were lack of good land for cultivating rice, Quilea birds invasion, invasion of insect pests, flooding of rice fields and disease outbreak (Jamila Sheu and Garba, 2011). Umar *et al*. (2009) reported that major factors constraining rice production in Gbako Local Government Area, Niger State based on farmers' perception included pest invasion, inadequate knowledge of plant spacing and grazing problem. Farmers' perceptions are not only important in identifying constraints in agricultural production but are also necessary in generating options for addressing the constraints. For example Emodi and Dimelu (2012) reported that farmers' perception of strategies for enhancing rice innovation system in Southeast Nigeria included intensifying research on rice production, promotion of active extension, subsidy on fertiliser, and establishment of de-stoner mills.

Perception of farmers concerning critical issues constraining increased rice production provides an opportunity or an entry point for researchers, extension specialists and other relevant stakeholders to work with farmers to develop common understanding of the problems and to generate potential options for addressing them. It is increasingly recognised that innovation emerges out of the interplay of ideas from multiple sources. Valuable experiences are being generated across the world on how diverse actors can be encouraged to work together, and how new ideas and products, whether from formal research and from other sources, can be transformed into innovations that benefit thousands of resource poor farmers (Waters-Bayers, Saginga, Karia, Njuki and Wettasinha, 2008).This forms the bedrock for a participatory innovation development process that ensures that the final product is relevant to farmers' needs thereby enhancing its acceptance and adoption by them. Failure to involve the farmers in the innovation development process creates a gap between the research output and the farmers who are the end users of the product. Farmers' perceptions of major issues constraining sustainable production of rice can also form the basis for the development of joint extension programme between farmers and extension specialists.

CHAPTER THREE

THEORETICAL FRAMEWORK

As the study is focussed on adoption of agricultural technologies in rice production, the technologies being examined include the use of improved varieties of rice, basal fertilizer application, top dressing with urea fertiliser, use of tractor for land preparation, improved rice harvesting and processing methods, rice-legume rotation and use of rice residue as manure. The communication system is the public sector extension agency and other informal sources of information while the subjects are members and non-members of Rice Farmers Association in Kano and Kaduna States.

3.1 Adoption-Diffusion Theory

The classical adoption-diffusion model is comprised of two components namely diffusion process and adoption process**.** Rogers' book on Diffusion of Innovations (1962) defined the term diffusion as the process by which an innovation spreads and the diffusion process as the spread of new ideas from its source of invention or creation to its ultimate users or adopters. The four essential elements involved in the diffusion process are basically the innovation, its communication from one individual group to another, a social system within which the process occurs and a time period over which the process is concluded.

Rogers (1983) defined innovation as any idea, practice, or object that is perceived as new by an individual or other unit of adoption. Adopters are the minimal unit of analysis in diffusion research and in most studies they are individuals, but can also be organisations, clusters within social networks or countries (Meyer, 2004). Rogers

(1983) stated that diffusion takes place among people or organisations and that communication channels allow the transfer of information from one unit to another. Instant adoption of innovation is almost a rarity as the passage of time is essential for innovations to be adopted.

3.2 Economic Constraint Theory

Economic constraint paradigm is anchored on the theory in which farm households are perceived to be responsible for making decisions as to the type of crops to grow, how much of land area to allocate for the cultivation of each crop, and whether agricultural inputs will be used or not. Decision will be made depending on the overall goals and objectives of the household and degree of access to resources. A distinct feature of the model is the use of a single decision maker and the assumption that there is no divergence of views among household members.

Members of household are perceived to have similar utility function such that the result obtained when utility function of household is maximised is the same as the situation when the function of individual is maximised (Nguthi, 2008). Aikens, Havens and Flinn (1975) reported that observed adoption behaviour is largely influenced by asymmetrical distribution patterns of resource endowments while lack of access to land (Yapa and Mayfield, 1978) or capital (Havens and Flinn, 1976) could hinder adoption decisions significantly.

3.3 Central Source of Innovation Theory

The central source of innovation paradigm emphasises the transfer of technology from research institutes to farmers. This model is also known as the 'Transfer of Technology' approach and has been used for some time now to describe the diffusion of agricultural research and technology outputs. Innovations are perceived to diffuse progressively from the International Agricultural Research Institutes to National Agricultural Research System and National Extension System and finally to farmers (Biggs, 1990). In this case, research institutions are seen as the only source of agricultural innovations and farmers are regarded as adopters of innovations while production constraints of farmers are transmitted to extension specialists and researchers.

The process of technology generation and transfer is recognised as a linear process where researchers develop and demonstrate innovations to farmers for adoption through extension agents. Farmers' experience, knowledge and resources are ignored and farmers are seen as passive receivers of technology (Leeuwis and Van de Ban, 2004) The Transfer of Technology model has not performed up to expectation in many countries in Africa thus leading to a call for a new paradigm which allows farmers to work with other stakeholders including researchers and extension specialists to develop innovations with greater potential for addressing farmers' challenges.

3.4 Multiple Sources of Innovation or Innovation System Theory

Innovation is defined as anything new introduced into an economic or social process (Organisation for Economic Co-operation and Development, 1997). In the agricultural research context, innovation in its broadest sense covers the activities and processes associated with production, distribution, adaptation and use of new technical, institutional, organisational, managerial knowledge and service delivery (Hall, Mytelka, and Oyeyinka, 2005). According to Anandajayasekaram (2011), an Agricultural Innovation System is a collaborative arrangement bringing together several organisations working towards technological, managerial, organisational, institutional change in agriculture. It stresses that agricultural innovations emerge not only from agricultural research institutes but from multiple sources which may include farmers, extension agents, local artisans, innovative research practitioners and research oriented non-governmental organisations (Biggs, 1990). The innovation systems approach shifts attention away from research and the supply of scientific knowledge and technologies to an interactive multi-stakeholder process of change in which technology dissemination and market development are only some of the elements of the system (Sangiga, Chitsike, Njuki, Kaaria and Kanzikwera, 2007)

3.5 Evaluation of Agricultural Extension Programme

The decision to adopt rice production technology is expected to impact on the level of living of the target groups. An evaluation of an agricultural extension programme sheds light on whether the socio-economic conditions including standard of living of the target group have significantly changed as a result of the project activities (Administrative Committee Task Force. United Nations Organisation 1984). Ogunbameru, (1986) suggested a more simplified and complete approach to studying the effectiveness of agricultural extension programme which is termed “Reflective Evidence to Appraise Programme”. Reflective evidence means that the project participants estimate or reflect upon the amount of change and pay-off derived from the project. The above theoretical models are modified and utilised in assessing the effects of adoption of recommended rice production practices on the level of living of members and non-members of Rice Farmers Associations in the study area.

3.6 Group Formation and Collective Decision Making Theories

The study also benefits from the theories of group formation and collective decision making as rice farmers in the study area operate individually and in groups. A classic theory on group development states that when individuals share common activities, they will have more interaction and will develop positive or negative attitudes towards each other (Homans, 1950). Tuckman and Jensen (1977) asserted that all groups pass through 5 stages of development namely Forming, Storming, Norming, Performing and Adjourning. At the Forming stage, interested persons join the group and have a shared understanding of its purpose as a prelude to relationship building.

The group enters the Norming stage when members begin to set goals and expectations while roles of leaders and other members are assigned at the Storming stage in preparation for action. Members may express their dissatisfaction and look for ways of resolving their conflicts at the Storming stage. The Performing stage is characterised by interdependence and flexibility as members reach a conclusion on issues discussed and carry out necessary actions in the interest of the group.

The Adjourning stage is about the completion of agreed tasks and disengagement of members from the task and the group itself. The theories of collective decision making suggest that individuals under certain institutional arrangements and shared norms are capable of organising and sustaining cooperation that advances common interest of the group in which they belong (Ostrom, 1990). However, it is not in every case that group formation and collective decision making will benefit individual members. Therefore, it is also important to examine the extent to which group decisions have benefited individual members.

3.7 Conceptual Model

The conceptual model for the study is presented in Figure 1. It shows socioeconomic and institutional factors as independent variables, adoption of rice production technology as a dependent variable and yield, income and level of living as components of effect variable among members and non-members of Rice Farmers Associations in Kano and Kaduna States. The independent variables include age, household Size, farm Size, level of education, length of farming experience, source of labour and amount of credit. Others are access to extension contacts, gender and marital status. The dependent variable is the adoption of rice production technology comprising of use of improved variety, use of tractor for land preparation, seed treatment, basal NPK fertiliser application, use of herbicides, top dressing with Urea fertiliser, use of rice residues as organic manure and rice-legume rotation (Adeosun *et al.*, 2005 and Ekeleme *et al.*, 2008). The interaction between independent and dependent variables is expected to generate some effects in terms of changes in level of living, yield among members and non-members of Rice Farmers Associations.

Though the dependent variable is essentially a package of recommended practices, a farmer may choose to adopt one item suggesting that a rice grower does not have to adopt all the components of the package of recommendations on rice production to be considered an adopter. The rate of adoption is often measured by the length of time required for a certain percentage of members of a system to adopt a particular technology. On the other hand, the extent of adoption is measured from the number of technologies being adopted and the number of farmers adopting them.

Previous research efforts have proposed two methods for determining the adoption of agricultural technologies. The first is based on the expression of the number of farmers adopting a particular technology as a percentage of the total number of farmers under the study (Floyd, Harding, Paddle, Rasali, Subedi and Subedi, 1999), while the second expresses the land area put under a particular technology as a percentage of the total land area grown to the crop (Akino and Hayami 1975, Ahmed and Sanders 1991). However, for the scope of the study the first method was used.

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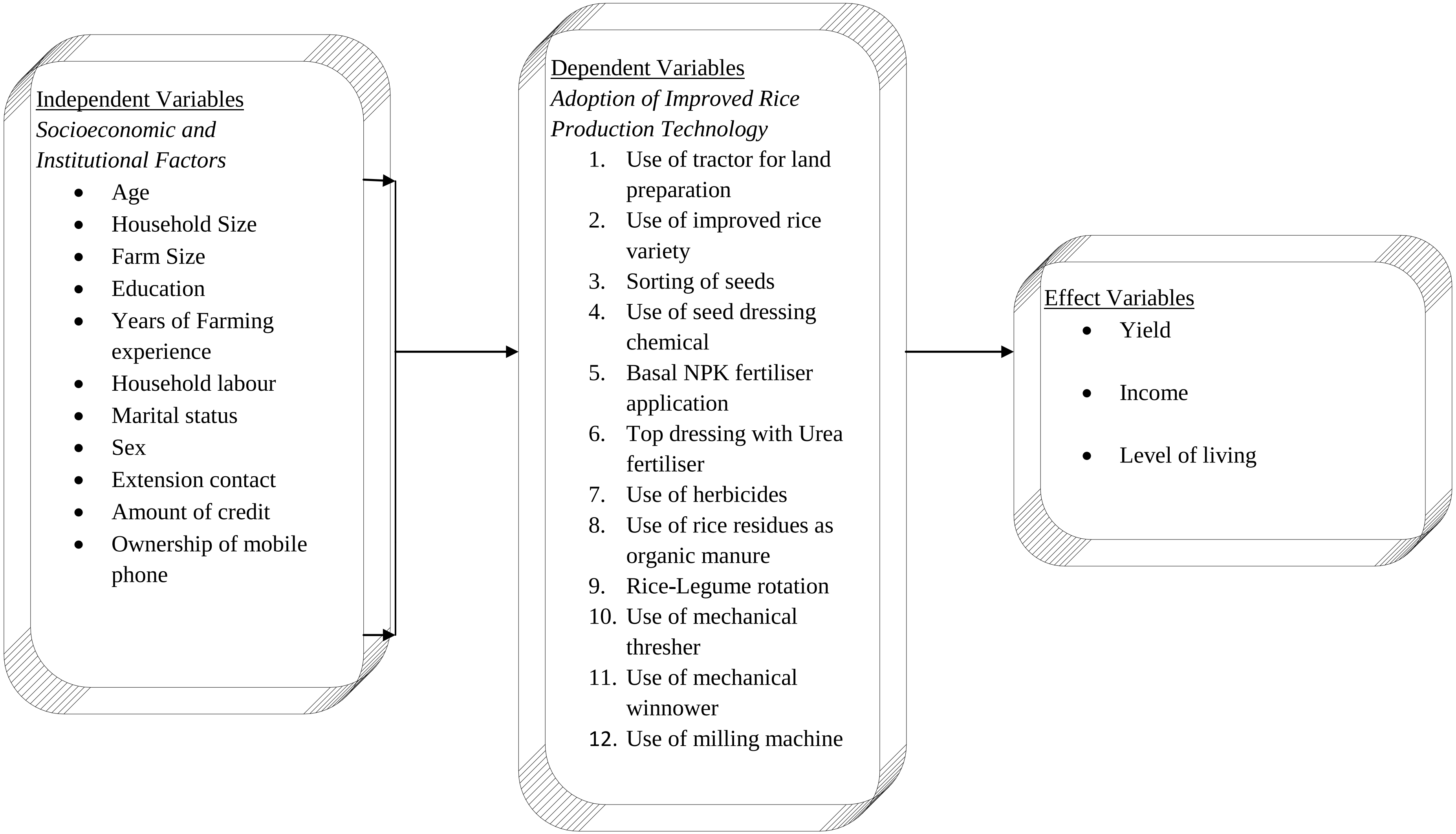

Figure 1: Conceptual Model of Adoption of Improved Rice Production Technologies among Rice Farmers Associations in Kaduna and Kano States, North West, Nigeria

CHAPTER FOUR

METHODOLOGY

4.1 The Study Area

The study was conducted in Kaduna and Kano States. Kaduna State lies between latitude 09^0 02'N and 11^0 32'S and between longitude 96^0 15'E and 08^0 60'E, at Coordinates: $10^0$31'23"N $7^0$26'25"E where it occupies a land area of 45,567km^2 with a projected population of 7,328, 597 in 2012 based on 3.2% annual growth rate (National Population Commission, 2006) and a population density of 500 people per kilometre especially within the Kaduna and Zaria axis. The State is made up of 23 Local Government Areas with an altitude of 500-1000m above sea level and an annual average rainfall of 1,272m (World Bank, 2008). The farming season in the State is characterised by the rainy season which lasts for six months from May to October and the dry season from November to April. Maize, Rice, Sorghum, Millet, Soybean and Groundnut are some of the major crops grown by farmers in the State. Kaduna State is one of the largest producers of rice in Nigeria with a land area of 344,890 hectares representing 14.17% of the total land area under the cultivation of the crop across the country (NBS/FMARD, 2011). Rice production in the State was 732,420 metric tons in 2011 accounting for 16.37% of the total production in the country. The average yield per hectare for the same period was 2.12 metric tons per hectare

Kano state is also located in the North-west geopolitical Zone of Nigeria between latitudes 13^0 N and 11^0 S and longitudes 8^0N and 10^0 E with a land mass of 20,760 km^2. It has a projected population of 11,206,688 million in 2012 based on National

Population Commission (2006). The average annual rainfall is 700mm with 35^0 C and 19^0 C as mean daily maximum and minimum temperature respectively. Major crops cultivated by farmers in the State include rice, maize, millet, cowpea, groundnut and vegetables. The Kano State Agricultural and Rural Development Authority is the agency of government mainly responsible for extension services in the State. Kano State is also a major producer of rice in Nigeria with a land area of 219,060 hectares representing 9% of the total land area under the cultivation of the crop across the country. Rice production in the State was 422,050 metric tons in 2011 accounting for 9.4% of the total production in the country (NBS/FMARD, 2011). The average yield per hectare for the same period was 1.93 metric tons per hectare

4.2 Sampling Procedure and Sample Size

Rice farmers from both States were the target population for the study. Multi-stage sampling procedure was used for selecting respondents. The first stage involved purposive selection of two Local Government Areas from each State. In this regard, Kura and Bunkure in Kano State were selected while in Kaduna State, Igabi and Kajuru were chosen because of the importance of rice in the areas. The sample frame for Rice Farmers Associations is constituted by nine hundred and thirty six (936) registered members based on figures for the selected LGAs provided by Kaduna Agricultural Development Programme and Kano Agricultural and Rural Development Authority. In the second stage of sampling, two settlements noted for rice cultivation were selected from each of the 4 LGAs.

In Kura LGA in Kano, Bakin Kogi and Rimin Kwarya were selected while Refawa and Bela were selected in Bunkure LGA. The selected locations for Igabi LGA in Kaduna

State were Fako and Ligyara. In Kajuru LGA, Kasuwan Magani and Kallah were selected for the study because of widespread rice cultivation in the areas.. The locations were selected based on the presence of rice growers both as members and non-members of Rice Farmers Associations. From the sample frame of 936 members of Rice Farmers Associations, 133 respondents (14%) were selected randomly across settlements in the two States for the study. The same number of non-members of Rice Farmers Associations was selected randomly from each location giving a total of sample size of 266 respondents comprising of 133 members and 133 non-members.

Table 1: Distribution of respondents in the Study Area

State	LGA	Settlement	No of Associations	Sample Frame	*Sample Size		Total
					Members	**Non-members**	
Kano	Kura	BakinKogi	6	152	22	22	44
		RiminKwarya	5	127	18	18	36
	Bunkure	Refawa	5	132	19	19	38
		Bela	8	211	31	31	62
Sub-total					**90**	**90**	**180**
Kaduna	Igabi	Fako	5	113	16	16	32
		Ligyara	4	101	14	14	28
	Kajuru	Kasuwan-Magani	2	44	6	6	12
		Kallah	2	56	7	7	14
Sub-total					**43**	**43**	**86**
Total			**37**	**936**	**133**	**133**	**266**

Source: Reconnaissance Survey, 2013 *Sample size is 14% of Sample frame

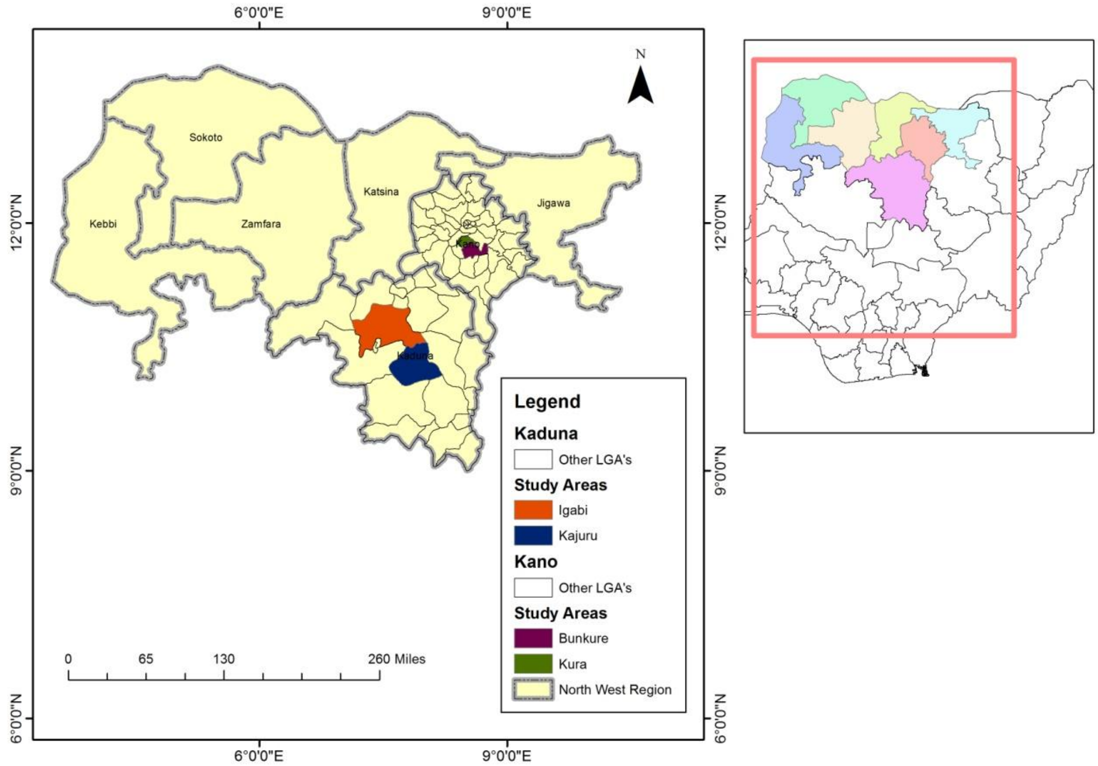

Figure 2: Map of Northwest region showing the study area

4.3 Data Collection Instruments and Sources of Data

Data was collected through the administration of questionnaire with the help of trained enumerators. The questionnaire was divided into five sections and administered by the researcher and trained enumerators from Kaduna Agricultural Development Programme and Kano Agricultural and Rural Development Authority. Section A brought out information on the socioeconomic and institutional characteristics of the respondents while Section B elicited information on the respondents' level of awareness of rice production recommended practices. Information on adoption of rice production recommended practices was the main thrust of Section C. Section D extracted information on effects of adoption of recommended rice production practices on rice paddy output, income and rice yield while Section E addressed issues on effects of adoption on level of living of farmers and rice production constraints among farmers in both States.

4.4 Data Analysis

Descriptive statistics and Inferential Statistics were used to analyse the data collected through the questionnaires

4.4.1 Descriptive statistics

Data collected on socioeconomic and institutional characteristics were analysed using frequency distribution, mean and percentage. The descriptive statistics were used to describe the socioeconomic characteristics of members and non-members of Rice Farmers Associations in Objective 1. The same analytical techniques were used in Objective 2 on awareness of improved rice production technology and adoption of improved rice production technology in Objective 3 among members and non-members.

4.4.2 Z - statistic

Z - statistic was used to test whether there are significant differences or not in the socioeconomic characteristics (Objective 1), awareness and adoption of improved rice technology (Objectives 2 and 3) as well as effects of adoption of improved rice technology on yields and level of living (Objectives 5 and 6) among members and non-members of Rice Farmers Associations.   Z was calculated using the formula below:

$$Z = \frac{m_1 - m_2}{\sqrt{\frac{sd_1}{n_1} + \frac{sd_2}{n_2}}}$$

Where, m_1 = mean of members, m_2 = mean of non-members, sd_1 = standard deviation of members, sd_2 = standard deviation of non-members, n_1 = number of members and n_2 = number of non-members.

4.4.3 Tobit Regression Model

Tobit Regression model was used to determine the factors influencing the adoption of rice production technology package among rice farmers in Kaduna and Kano and in the pooled data. The improved rice production technologies include: use of tractor for land preparation, improved variety, sorting of rice seeds for planting, seed treatment, basal NPK fertiliser application, top dressing with Urea fertiliser, use of herbicides for land clearing, herbicide application for weed control in rice fields, use of rice residues as organic manure, and rice-legume rotation, use of rice milling machine, use of mechanical thresher and use of mechanical winnower. The level of adoption of improved rice production technology or the adoption index (Y) was valued between 0 and 1. Adoption index Y = 0 if the farmer did not adopt any of the recommended practices on improved rice production technology while Y > 0 if the farmer adopted one or more than one of the recommended practices. According to Greene (2000), the Tobit model for a continuous dependent variable is thus:

$$Y_i^* = \beta_0 + \beta_i X_i + \mu_i$$

$$Y_i = Y_i^* \text{ if } \beta_o + \beta_i X_i + \mu_i > 0 \quad \ldots\ldots \quad (1)$$

$$Y_i = 0 \text{ if } \beta_0 + \beta_i X_i + \mu_i \leq 0$$

Where: Y_i = ratio of dependent variable index

Y_i^* = latent variable and the solution to utility maximization problem of intensity of the dependent variable subjected to a set of explanatory variables and conditional on being above or below a certain limit,

β_i = vector of unknown parameters, and

μ_i = error term which is normally distributed with mean 0 and variance σ^2

X_i = vector of the explanatory variables (i = 1, 2, 3, ...12) such as :

X_1 = Age (in actual number of years)

X_2 = Educational level (number of years spent on formal education)

X_3 = Household size (number of persons)

X_4 = Household labour (number of persons in the household involved in farm work)

X_5 = Quantity of rice produced (Tons/hectare)

X_6 = Farm size (hectare)

X_7 = Farming experience (Number of years as a rice farmer)

X_8 = Marital status (married = 1, otherwise = 0)

X_9 = Sex (male = 1, female = 0)

X_{10} = Access to extension services (yes = 1, otherwise = 0)

X_{11} = Amount of credit received (Naira)

X_{12} = Ownership of mobile phone (yes = 1, otherwise = 0)

4.4.4 Likert type scale

Perceptions of farmers on issues constraining adoption of improved rice production technology were measured through questionnaire. A list of perception statements were given on a 4-point Likert type scale with four response options (4 = Strongly Agree, 3 = Agree, 2 = Disagree, 1 = Strongly Disagree). The values were added to get 10 and divided by 4 to give a mean score of 2.5. The mean score for each respondent was calculated for each item. Any variable with mean score that is equal to or greater than 2.5 is regarded as positive while a mean score that is less than 2.5 is regarded as negative.

4.5 Definition and Measurement of Variables

4.5.1 Independent variables

4.5.1.1 Socioeconomic characteristics

a) Age (X_1)

Age is expected to influence technology adoption. Adesina and Zinnah (1993) found that age was negatively correlated with adoption. This is explained by the assumption that as a farmer grows older, there is a decrease in tendency to take risk or try new ideas. On the other hand young farmers may be more willing to try new technologies. According to Tiamiyu *et al*. (2009), young farmers are more likely to adopt new technologies if they are not constrained by limited resources while older farmers are less likely to use new technologies if they require extra physical labour. Age was measured as the number of years a farmer has lived as at the time of data collection.

b) Level of education (X_2)

It is expected that level of technology adoption will be affected by farmers' education. Farmer's level of education is reflected in the ability to access, understand and utilise information for making decisions at the appropriate time. Studies by Atala, 1980; Feder *et al*., 1985; Chaves and Riley, 2001 have shown that farmers' level of education is positively related to adoption of agricultural innovations. Level of education was categorised as follows:

(i) No formal education = 0

(i) Primary = 1

(ii) Secondary = 2

(iii) Tertiary = 3

c) Household size (X_3)

Household size was measured as the number of people living in the farmers' household. Household size is expected to affect technology adoption positively. The variable has been found to influence adoption of agricultural innovations by farmers (Jamala *et al.*, 2011). Larger households provide an opportunity for internal sourcing of labour for field work thus reducing external labour requirement. This is more significant for innovations that require considerable level of labour force. Household size refers to the number of people living in the farmers' household. However, all the members of the household may not be involved in farm work.

d) Number of household labour (X_4)

This variable was defined as the number of individuals in the farmer's household that is engaged in farm work. The number of persons in the farmer's household available for farm work is expected to impact positively on technology adoption.

e) Quantity of rice produced (X_5)

Quantity of rice produced in the last cropping season was measured in tons.

g) Farm Size (X_6)

Farm size is expected to influence adoption of rice production technologies. Farm size refers to the total area of land (in hectares) possessed by the farmer. Adesina and Zinnah (1993) found a positive correlation between farm size and adoption while De Souze *et al*. (1999) reported a negative correlation of farm size with adoption of innovation. However, Bonabana (1998) found no association among the two variables. Farm size was measured in hectares (Ha.)

i) Farming experience (X_7)

It is expected that length of farming experience will affect technology adoption positively or negatively depending on the age of the farmer. Several studies have shown that farming experience has an influence on adoption of agricultural innovations (Tiamiyu *et al*., 2009; Ogundele and Okoruwa, 2006). The years of farming experience has been found to have a positive relationship with adoption on one hand while the same variable has been linked with a negative association with adoption on the other hand. In this study farming experience refers to the number of years a farmer has been growing rice.

j) Marital status (X_8)

Marital status was measured as follows: (married = 1, otherwise = 0). Marital status enhances the capacity of farmers to have household members who can contribute to the labour requirement for the adoption of improved rice production technologies. It was expected that marital status would have a positive influence on technology adoption.

k) Sex (X_9)

Sex was also measured as follows: (male = 1, female = 0). The variable was predicted to have positive or negative effect on adoption of rice production technologies as male farmers are in a better position to access productivity enhancing inputs such as fertiliser, credit and extension advisory services than their female counterpart. Consequently, the variable was expected to have a positive influence on technology adoption among male farmers and a negative influence among female farmers.

l) Ownership of mobile phone (X_{12})

Ownership of mobile phone is becoming an important issue for market information and access to agricultural inputs such as improved seeds and fertilisers by farmers. Farmers with mobile phones are expected to be in a better position to access information and inputs that will enhance adoption of rice production technology than their counterparts who do not have access to mobile phones. Ownership of mobile phone would be measured as dummy (1 = User and 0 = Otherwise)

4.5.1.2 Institutional characteristics

m) Access to extension services (X_{10})

It is more likely that access to extension service will correlate positively with adoption of agricultural innovations. Previous studies reported a positive significant relationship between number of extension contacts and adoption (Odoemenem and Obinne, 2010; Saka *et al.*, 2005). Access to extension services was measured as follows: (yes = 1, otherwise = 0). It was expected that access to extension would have a positive influence on technology adoption

n) Amount of credit (X_{11})

Amount of credit was measured as the amount of credit received by farmer in a cropping season for rice production. Adoption of agricultural innovations can be hindered where farmers do not have access to credit to facilitate the purchase of farm inputs. Consequently farmers with access to credit or diverse sources of finance for farming are more likely to adopt agricultural innovations than their counterparts with no access to credit. Amount of credit was expected to have a positive influence on technology adoption.

4.5.2 Dependent variables

4.5.2.1 Adoption (Y)

The adoption of improved rice production technologies is the dependent variable and was determined by asking the farmers through questionnaire to indicate whether they adopted each component of the technology package or not. In this case adoption was measured as 0 for non-adoption and between 0 and 1 for adoption. The maximum score per respondent was 13 while the minimum was 0. The adoption score for each respondent was determined by calculating the number of recommended rice production practices adopted by the farmer for the production of rice. For the Tobit analysis, adoption index $Y = 0$ if the farmer did not adopt any of the recommended practices on improved rice production technology while $Y > 0$ if the farmer adopted one or more than one of the recommended practices.

4.5.3 Effect variables

4.5.3.1 Rice paddy output

Rice paddy output was measured through questionnaire. Each respondent was asked to indicate the number of 100kg bags of rice paddy harvested in the previous season.

4.5.3.2 Income from rice production

Income from sales of rice paddy was measured through questionnaire. Each farmer was asked to specify the amount of money collected for each bag of rice paddy sold**.**

4.5.3.3 Rice yield per hectare

Rice yield was measured as the quantity of rice obtained by the farmer from one hectare of land area.

4.5.3.4 Savings

Amount saved by respondents was determined by collecting information through questionnaire. Each respondent was asked to signify the amount of money saved from income obtained from rice production as at the time of the interview.

4.5.3.5 Possession of transport facility

The respondents were asked through structured questionnaire to specify the type of transport facility they possess. Possession of transport facility was scored as follows: Truck = 4, Car = 3, Motorcycle = 2, Bicycle = 1 and None = 0.

4.5.3.6 Sources of drinking water

The source of drinking water in the household of each respondent was determined by collecting information through structured questionnaire. Each respondent was asked to indicate the source of drinking water. Source of drinking water by household was scored as follows: Borehole = 3, Protected well = 2, Unprotected well = 1, River/Stream = 0.

4.5.3.7 Completion of post-secondary education

Each respondent was asked to state the number of household members who have completed post-secondary education. The information was collected through structured questionnaire

4.5.3.8 *Access to formal education by household members*

Each respondent was asked to state the number of household members who have no formal education. The information was collected through structured questionnaire

CHAPTER FIVE

RESULTS AND DISCUSSION

5.1 Socioeconomic Characteristics of Members and Non-members of Rice Farmers Associations in Kaduna and Kano States

5.1.1 Marital status

The distribution of respondents by marital status is presented in Table 2. Marital status is an important socioeconomic factor affecting adoption of agricultural technology. In Kaduna State, there were more married respondents (93%) among members of Rice Farmers Association than non-members (83%). However, non-members had a greater percentage of single respondents (15%) than members (4%). The percentage of married respondents among non-members (61%) was slightly greater than that of members in Kano. Similarly, single respondents were 40% among members and 38% among non-members. Kano State had more single respondents among members (40%) and non-members (38%) than Kaduna (4% and 15%) while Kaduna had more married respondents (93% and 83%) than Kano (60% and 61%).

Pooled results show that 70% of the respondents were married among members as compared to 68% among non members. Respondents that were single by marital status constituted 29% and 30% among members and non-members of Rice Farmers Associations respectively. Farmers who are married are likely to have family labour force that can contribute to farm labour especially when the agricultural technology in question is labour intensive. Nmadu, Sallawu and Omojeso (2015) reported that large percentage of married respondents among cocoa farmers is an indication of the fact that more members of the farm family will likely be available for crop production.

Table 2: Distribution of Members and Non-members of Rice Farmers Associations in Kaduna and Kano States by Marital Status

Marital Status	**Kaduna**		**Kano**		**Pooled**	
	Members	**Non-members**	**Members**	**Non-members**	**Members**	**Non-members**
Single	2 (4.7)	6 (14.9)	36 (40.2)	34 (38.1)	38 (29)	40 (30)
Married	40 (93.0)	36 (83.0)	54 (59.8)	55 (60.8)	94 (70)	91(68)
Separated	1 (2.3)	1 (2.1)	0 (0)	1 (1.1)	1 (1)	2 (2)
Total	**43 (100)**	**43 (100)**	**90 (100)**	**90 (100)**	**133 (100)**	**133 (100)**

Source: Field Survey 2014 Figures in parenthesis are percentages

5.1.2 Sex

The distribution of respondents by sex is presented in Table 3. In Kaduna State, male rice farmers were 65% among members and 63% among non-members as compared to 35% female rice farmers among members and 38% among non-members. Male rice farmers were 88% among members and 86% among non-members while female rice farmers were 12% among members and 14% among non-members in Kano. There were more female rice farmers in Kaduna than in Kano. From the pooled results, male rice farmers constituted 80% among members and non-members. Female rice farmers were 20% among members and 22% among members of Rice Farmers Associations in the two States.

The results showed that there are more female rice farmers in Kaduna than in Kano and that women are not just involved in playing supportive role in certain aspects of rice production such as processing but some are also active in rice production. The implication is that rice farmers should not be seen as men alone but to recognise that there are women rice farmers in the study area. This should be an important consideration in the planning, implementation and evaluation of development interventions in rice production. In terms of the effect of gender on adoption of improved technologies, Jamala *et al*. (2015) found that gender is one of the factors significantly influencing adoption of irrigated rice production while Onyenweaku *et al*. (2007) reported an indirect relationship between gender and adoption and intensity of use of chemical fertilisers. However, Doss and Morris (2001) observed insignificant effect of gender on adoption in their study on factors influencing improved maize technology in Ghana suggesting that females and males adopted the technology equally. According to Bonabana (1998), women were more likely to borrow money for the adoption of technologies requiring capital for input and men were more willing to adopt high risk technologies in Uganda.

Table 3: Distribution of respondents by sex

Sex	**Kaduna**		**Kano**		**Pooled**	
	Members	**Non-members**	**Members**	**Non-members**	**Members**	**Non-members**
Male	28 (64.6)	27 (62.5)	79 (87.6)	77(85.6)	106(80.0)	104(77.9)
Female	15 (35.4)	16 (37.5)	11(12.4)	13(14.4)	27(20.0)	29(22.1)
Total	**43 (100)**	**43 (100)**	**90(100)**	**90(100)**	**133(100)**	**133(100)**

Source: Field Survey 2014 Figures in parenthesis are percentages

5.1.3 Age

The distribution of respondents by age is presented in Table 4. The average age of members of Rice Farmers Associations in Kaduna State were 39 years and 33 years for non-members meaning that members were older than non-members. In Kano State, mean age was 44 years among members and 43 years among non-members. The age difference among members and non-members in Kano was marginal. Mean age was 42 years for members and 40 years for non-members in the pooled data. The significance of the average age of the respondents in the study area is that the rice farmers are still within the productive age group and can cope with the energy demand for rice production. The difference in age among members and non-members was found to be significant (P<0.05) in Kaduna and insignificant in Kano as the calculated Z-value (3.081) is higher than the tabulated Z-value (1.96) in the former and lower (0.914) than the tabulated Z-value (1.96) in the latter. The pooled results showed no significant age difference (P<0.05) among members and non-members as the calculated Z-value (1.680) is lower than the tabulated Z-value (1.96). Okwoche and Obinne (2010) found no significant difference in the mean age of women cooperative members (38) and non-members (40) in Benue State, North Central Nigeria. In South West Nigeria, Afolami *et al*, (2012) obtained 46.75 and 48.7 years as the mean age of rice farmers in Ekiti and Ogun States respectively. Ogundele and Okoruwa (2006) found that the estimated average age of rice farmers under traditional technology was 42 years while 45 years was obtained among rice farmers under improved technology. They asserted that rice farmers within the productive age group of 20-45 years are likely to have the necessary physical stamina required to carry out farm operations. According to Odoemenem (2010), farmers who adopted recommended practice on rice production were younger in age.

Table 4: Test of significance and distribution of respondents by age

Age (Year)	**Kaduna**		**Kano**		**Pooled**	
	Members	**Non-members**	**Members**	**Non-members**	**Members**	**Non-members**
≤ 20	2 (4.65)	5 (11.6)	2 (2.22)	1 (1.11)	4 (3.01)	6 (4.51)
21-40	28 (65.11)	29 (67.5)	43 (47.78)	40 (44.44)	71 (53.38)	69 (51.88)
41-60	10 (23.26)	9 (20.9)	35 (38.89)	43 (47.78)	45 (33.83)	52 (39.10)
> 60	3 (6.98)	0	10 (11.01)	6 (6.67)	13 (9.78)	6 (4.51)
Total	**43 (100)**	**43 (100)**	**90 (100)**	**90 (100)**	**133 (100)**	**133 (100)**
Mean	38.84	33.33	43.83	42.98	42.22	39.86
Cal. Z	2.204*		0.508		1.680	
Tab. Z	1.96		1.96		1.96	

Figures in parenthesis are percentages. *Sig. at P<0.05. Source: Field Survey 2014

5.1.4 Household size

The distribution of respondents by household size is presented in Table 5. Mean household size among members of Rice Farmers Associations in Kaduna (9) was slightly lower than that of non-members (11) even though the difference was not significant. In Kano State, mean household size among members (10) was significantly higher ($P<0.05$) than the figure for non-members (7) based on the result of the Z-test. The pooled results also show no significant difference between the mean household size among members (10) and non-members (8) at $P<0.05$. The household size may be related to the number of household members that will be available for farm work. There is a probability that the larger the household size the greater the volume of farm work that will be absorbed by household labour. This socio-economic variable is expected to influence the adoption of technology that has considerable labour requirement.

Okwocha and Obinne (2010) reported a significant difference in the household size of women cooperative members (9) and non-members (8) in Benue, North Central Nigeria. These figures are much lower than the results Afolami *et al*. (2012) obtained among rice farmers in Ekiti (6.52) and Ogun States (6.91). Rice farmers who adopted improved technology were found to have a larger household size (10) than their counterpart (8) who practiced traditional technology of rice production though the difference was not significant (Ogundele and Okoruwa, 2006). Afolami *et al*. (2012) observed that the average number of household members actively involved in farm work was 4.23 in Ekiti State and 3.94 in Ogun State, South West Nigeria.

Table 5: Test of significance and distribution of respondents by household size

Household Size	Kaduna		Kano		Pooled	
	Members	Non-members	Members	Non-members	Members	Non-members
≤5	13 (30.2)	10 (23.2)	29 (32.3)	50 (55.6)	42 (31.58)	60 (45.11)
6-23	28 (65.2)	29 (67.6)	58 (64.5)	40 (44.4)	86 (64.66)	69 (51.88)
24-41	2 (4.6)	3 (7.0)	3 (3.2)	0	5 (3.76)	3 (2.26)
42-59	0	1 (2.2)	0	0	0	1 (0.75)
Total	**43 (100)**	**43 (100)**	**90 (100)**	**90 (100)**	**133 (100)**	**133 (100)**
Mean	8.69	11.37	9.93	6.68	9.53	8.20
Cal. Z	-1.697		3.77*		1.657	
Tab. Z	1.96		1.96		1.96	

Figures in parenthesis are percentages.*Sig. at P<0.05. Source: Field Survey 2014

5.1.5 Household members involved in farm work

The distribution of respondents by household members involved in farm work is presented in Table 6. Mean figure of household members involved in farm work among members of Rice Farmers Associations was found to be higher than the number obtained for non-members in both States and also in the pooled results. Mean household members involved in farm work among members in Kaduna (4) was higher than that of non-members (5) though the difference was not significant based on the outcome of the Z-test. In Kano State, mean household members involved in farm work among members (3.12) was significantly higher (P<0.05) than the figure for non-members (2.06) as confirmed by the result of the Z-test. The pooled results show no significant difference between the mean household members involved in farm work among members (3.43) and non-members (3.01) at P<0.05. The number of household members involved in farm work is an important factor in technology adoption especially when the technology is labour intensive. Household members were more involved farm work among members of Rice Farmers Associations than non-members in Kano and in pooled data. Afolami *et al*. (2012) observed that the average number of household members actively involved in farm work was 4.23 in Ekiti State and 3.94 in Ogun State, South West Nigeria.

Table 6: Test of significance and distribution of respondents by household labour

Household members as labour	Kaduna		Kano		Pooled	
	Members	Non-members	Members	Non-members	Members	Non-members
0-3	19 (44.2)	23 (53.5)	49 (54.6)	70 (77.3)	68 (51.4)	93 (70.0)
4-7	17 (39.5)	14 (32.6)	36 (40.2)	18 (20.6)	53 (40.0)	32 (24.3)
8-11	7 (16.3)	5 (11.6)	5 (5.2)	2 (2.1)	12 (8.6)	7 (5.0)
>11	0 (0)	1 (2.3)	0 (0)	0 (0)	0 (0)	1 (0.7)
Total	**43 (100)**	**43 (100)**	**90(100)**	**90(100)**	**133(100)**	**133(100)**
Mean	4.00	4.95	3.123	2.062	3.43	3.01
Calculated Z-value	-1.061		2.696*		1.043	
Tabulated Z-value	1.96		1.96		1.96	

Figures in parenthesis are percentages. * Sig. at P< 0.05. Source: Field Survey 2014

5.1.6 Years of experience in rice farming

Table 7 shows the distribution of respondents by years of experience in rice farming. Mean years of experience in rice production among members of Rice Farmers Associations was higher than the number obtained for non-members in the pooled results and in also in both States. Mean years of experience in rice production among members in Kaduna State (15.09) was higher than that of non-members (13.74) but the difference was not significant based on the result of the Z-test. In Kano State, mean years of experience in rice production among members (16.88) was significantly higher (P<0.05) than the figure for non-members (11.53) as confirmed by the result of the Z-test. The pooled results also show significant difference between the mean years of experience in rice production among members (17.43) and non-members (12.07) at P<0.05 as the calculated Z-value (4.156) is higher than the tabulated Z-value (1.96). Farming experience can have positive or negative effect on adoption. With more experience, rice farmers can be cautious and unwilling to take risk relating to technology adoption than farmers who have less experience. Afolabi *et al.* (2012) obtained 15.61 and 13.63 as years of experience in among rice farmers in Ogun and Ekiti States respectively. According to Ogundele and Okoruwa, (2006) the average years of rice farming experience among rice farmers adopting improved technology was 22 while farmers with traditional technology had 15 though the difference was not significantly different.

Table 7: Test of significance and distribution of respondents by rice farming experience (years).

Years of Rice Farming Experience	Kaduna		Kano		Pooled	
	Members	**Non-members**	**Members**	**Non-members**	**Members**	**Non-members**
<4	0(0)	6 (14)	1 (1)	1 (1)	1(1)	7 (5)
12-19	5(11)	6 (14)	21 (23)	17 (19)	27 (20)	21(17)
20-27	7(17)	10 (23)	17(19)	10(11)	24 (18)	19 (14)
28-35	9(20)	5 (12)	7 (8)	2 (2)	16 (12)	7 (5)
>35	0(0)	0 (0.00)	7 (8)	2 (2)	6(5)	3 (2)
Total	**43(100)**	**43 (100)**	**90 (100)**	**90 (100)**	**133(100)**	**133(100)**
Mean	15.086	13.743	16.883	11.523	17.480	12.072
Calculated Z-value	0.616		3.819*		4.156*	
Tabulated Z-value	1.96		1.96		1.96	

Figures in parenthesis are percentages. * Sig. at P< 0.05. Source: Field Survey 2014

5.1.7 Years of formal education

The distribution of respondents by years of formal education is shown in Table 8. Majority of members (47%) of Rice Farmers Association in Kaduna had no formal education followed by 35% with primary education and 19% with secondary education. A similar trend was observed among non-members in that 42% had no formal education while those with primary education were 28% and those with secondary education were 28% as well. In Kano, 43% of members had no formal education followed by 34% with secondary education and 12% with primary education. The trend was similar among non-members as 42% had no education while 43% had secondary education and 11% had primary education. Pooled results showed that 44% of members and 42% of non-members had no formal education. About 29% of members and 38% of non-members had secondary education while 20% of members and 17% of non-members had primary education. Farmers with formal education are likely to have the capacity to understand and adopt process driven technologies than their counterpart with no formal education. Okwocha and Obinne (2010) found that the average number of years of formal education was 12 years among women cooperative members and 9 years among non-members in Benue State, North Central Nigeria though the difference was not significant. Ogundele and Okoruwa (2006) noted that farmers with higher levels of education are likely to be more efficient in the use of inputs than those with little or no education. They observed that the average years of schooling for farmers adopting improved technology was 8 years compared to 7 years for farmers using traditional technology. The level of education has an implication for adoption of improved agricultural technologies in that education increases the capacity of farmers to comprehend and utilise information received on recommended agricultural practices (Rogers, 1983)

Table 8: Distribution of respondents by level of formal education

	Kaduna		Kano		Pooled	
	Members	**Non-members**	**Members**	**Non-members**	**Members**	**Non-members**
None	20 (46.5)	18 (41.9)	39 (43.3)	38(42.2)	59(44.40)	56 (42.1)
Primary	15 (34.9)	12 (27.9)	11(12.2)	10(11.1)	26(19.5)	22(16.5)
Secondary	8 (18.6)	12(27.9)	31 (34.4)	39 (43.3)	39 (29.3)	51 (38.3)
*Post S.	0	1 (2.3)	9 (10.0)	3 (3.3)	9 (6.8)	4 (3.0)
Total	**43 (100)**	**43 (100)**	**90(100)**	**90(100)**	**133(100)**	**133(100)**

Source: Field Survey 2014 *Post Secondary

5.1.8 Size of rice fields

The distribution of respondents by size of rice field is presented in Table 9. In Kaduna State, 44.5% of members and 57.5% non-members of Rice Farmers Associations cultivated 1 to 3 hectares of land. The same size of rice field was cultivated by 60.8% of members and 77.3% of non-members of Rice Farmers Associations in Kano State. The pooled data showed that majority of members (56%) and non-members (71%) cultivated 1 to 3 hectares of land. In Kaduna State, the average size of rice field cultivated by members was 4.03 hectares and 3.27 hectares for non-members.

There was no significant difference in the size of rice field cultivated by the two groups of farmers in Kaduna State given that the calculated Z-value (1.506) is lower than the tabulated Z-value (1.96). In Kano State, the average size of rice field cultivated by members was 3.88 hectares while the average holding for non-members was 2.66 hectares. The Z-test showed a significant difference in the average holdings of the two categories of farmers at $P<0.05$ as the calculated Z-value (4.093) is higher than the tabulated Z-value (1.96). For the pooled data, mean size of rice field for members was 3.93 hectares and that of non-members was 2.59 hectares. The mean farm size of members of Rice Farmers Associations in Kaduna and Kano States was found to be significantly (3.93) higher than that of non-members (2.59) at P<0.05 in view of the fact that the calculated Z-value (4.26) is greater than the tabulated one (1.96). Farm size is related to level of wealth and social status of the farmers and it can affect technology adoption positively or negatively. For example, farmers with larger farm size are more likely to adopt use of tractor for land preparation than those with smaller farm size. In South West, Nigeria Afolami *et al.* (2012) obtained 1.72 and 1.64 hectares as farm size among cooperative and non-cooperative rice farmers whereas the average size of farm cultivated by women cooperative members in Benue State (5.10) was significantly higher (3.02) than that of non-members (Okwoche and Obinna, 2009).

Table 9: Test of significance and distribution of respondents by size of rice field in hectares

Size of Rice Field	Kaduna		Kano		Pooled	
	Members	**Non-members**	**Members**	**Non-members**	**Members**	**Non-members**
<1	1 (2.12)	2 (4.26)	6 (6.18)	7 (7.22)	6(4.86)	8 (6.25)
1-3	19 (44.48)	24 (57.45)	54 (60.82)	70 (77.32)	74 (55.56)	94 (70.83)
4-6	17 (40.43)	12 (27.66)	14 (15.46)	13 (15.46)	32 (23.61)	26 (19.44)
7-9	2 (4.26)	4 (8.51)	4 (3.09)	0 (0.00)	4 (3.47)	4 (2.78)
10-12	4 (8.51)	1 (2.13)	9(10.31)	0 (0.00)	13 (9.72)	1 (0.69)
>12	0 (0.00)	0 (0.00)	3 (4.12)	0 (0.00)	4 (2.78)	0 (0.00)
Total	**43 (100)**	**43 (100)**	**90 (100)**	**90 (100)**	**133 (100)**	**133 (100)**
Mean	4.032	3.266	3.884	2.660	3.932	2.592
Calculated Z-value	1.506		4.093*		4.260*	
Tabulated Z-value	1.96		1.96		1.96	

Source: Field Survey 2014. Figures in parenthesis are percentages. * Sig. at P < 0.05.

5.1.9 Use of mobile phone

The distribution of respondents by use of mobile phone is presented in Table 10. In Kaduna State there were more users of mobile phones (81%) among non-members of Rice Farmers Associations than among members (77%). The reverse is the case in Kano State as 95% of the respondents among members used mobile phones compared to 85%

among non-members. The pooled results followed the trend in Kano with greater percentage of mobile phone users (89%) among members than among non-members (86%). Both members and non-members in Kano State surpassed their respective counterparts in Kaduna State in terms of usage of mobile phones. Non-users of mobile phones constituted 23% among members and 18% among non-members in Kaduna and 5% among members and 12% among non-members in Kano State. The pooled results indicate that non-users of mobile phones were 11% among members and 15% among non-members. Kaduna State had more non-users of mobile phones among members and non-members than their respective counterparts in Kano State.

Chi-Square values showed that there is no significant relationship between membership of Rice Farmers Associations and usage of mobile phones in Kaduna and Kano States as well as in the pooled results. According to NBS/FMARD (2011), there were 7,976,466 farmers in Nigeria who own mobile phones with 4.5% of them in Kaduna and 6.0% in Kano. Ownership of mobile phone facilitates farmers' access to subsidised fertiliser and improved seeds through the Growth Enhancement Support Scheme of the Federal Government of Nigeria. In a study on effectiveness of GESS in Kwara State, North central Nigeria, Adebo (2014) reported that 86% of the respondents possessed mobile phones.

In terms of socioeconomic characteristics of members and non-members of Rice Farmers Associations in the two States, apart from level of formal education, the study found significant differences in age, household size, household labour, years of experience in rice farming, farm Size and ownership of mobile phones.

Table 10: Distribution of respondents by use of mobile phone

		Users of Mobile phone	**Non-users mobile phone**	**Total**	**Chi-Square χ^2**
Kaduna	Members	33(77.1)	10(22.9)	43(100)	0.253(0.615)
	Non-members	35(81.3)	8 (18.3)	43(100)	
	Total	**68(79.2)**	**18(20.8)**	**86(100)**	
Kano	Members	85(94.8)	5(5.2)	90(100)	3.159(0.076)
	Non-members	79(87.6)	11(12.4)	90(100)	
	Total	**164(91.2)**	**16(8.8)**	**180(100)**	
Pooled	Members	118(89.0)	15(11.0)	133(100)	0.774(0.379)
	Non-members	114(85.5)	19(14.5)	133(100)	
	Total	**232(87.2)**	**34(12.8)**	**266(100)**	

Figures in parenthesis are percentages except for Chi-square values.

5.2 Institutional Characteristics of Members and Non-members of Rice Farmers Associations in Kaduna and Kano States

5.2.1 Access to extension agents

The distribution of respondents by access to extension agents is presented in Table 11. Among rice farmers in Kaduna State, 52% of members of Rice Farmers Associations and 35% of non-members had access to extension agents from Kaduna State Agricultural Development Programme. This implied that about 48% of members and 65% of non-members did not have access to extension agents. The results showed that members of Rice Farmers Associations had better access to extension agents than non-members. The Chi-Square value obtained confirmed the existence of a significant relationship at $P<0.10$ between access to extension agents and membership of Rice Farmers Associations. In Kano State 86% of members of Rice Farmers Associations and 66% of non-members had access to extension agents from Kano State Agricultural and Rural Development Authority.

The results implied that about 25% of members and 44% of non-members did not have access to extension agents. There is a significant relationship at P<0.01 between access to extension agents and membership of Rice Farmers Associations in the State. Both members and non-members of Rice Farmers Associations in Kano State had better access to extension agents than their corresponding groups in Kaduna State. In the pooled data, 75% of members of Rice Farmers Associations and 56% of non-members had access to extension agents while 25% of members and 44% of non-members did not have access to extension agents.

Extension agents are more likely to prefer reaching farmers who operate in groups than those who operate individually. The value of the Chi-Square obtained indicated a significant association at P<0.01 between access to extension agents and membership of Rice Farmers Associations. Ogundele and Okoruwa (2006), found a significant difference in the number of contacts with extension agent among rice farmers adopting improved technology and those using traditional system.

Okwocha and Obinne (2010) also observed a significant difference in extension contacts among women cooperative members and non-members in Benue State. However, Ajah (2012) reported that there was no significant difference (p>0.05) in cooperative and non-cooperative members’ access to extension services though the mean responses indicated that cooperative farmers had, slightly, more access to extension services than non-cooperative farmers.

Table 11: Chi-Square analysis and distribution of respondents by access to extension agents

Location	Membership	Access to extension agents	No access to extension agents	Total	Chi-Square χ^2
Kaduna	Members	22(52.1)	21(47.9)	43(100)	2.709*(0.100)
	Non-members	15(35.4)	28(64.6)	43(100)	
	Total	**37(43.7)**	**49(56.3)**	**86(100)**	
Kano	Members	77(85.6)	13(14.4)	90(100)	10.137***(0.001)
	Non-members	59(66.0)	31(34.0)	90(100)	
	Total	**136(75.8)**	**44(24.2)**	**180(100)**	
Pooled	Members	99(74.5)	34(25.5)	133(100)	11.075***(0.001)
	Non-members	74(55.9)	59(44.1)	133(100)	
	Total	**173(65.2)**	**93(34.8)**	**266(100)**	

Figures in parenthesis are percentages except for Chi-Square values,
*** P<0.01, ** P<0.05, * P<0.10.

5.2.2 Amount of credit

The distribution of respondents by amount of credit obtained for cropping activities is presented in Table 12. Mean amount of credit obtained for rice production among members of Rice Farmers Associations was higher than the figure obtained for non-members in the pooled results and also in both States. Amount of credit obtained by both members and non-members of Rice Farmers Associations in Kano State was higher than that of their respective counterparts in Kaduna State. Mean amount of credit among members in Kaduna State was significantly higher (N 20,050) than that of non-members (N 7,052) at P<0.05 as the calculated Z-value (2.275) is greater than the tabulated Z-value (1.96). In Kano State, mean credit among members (N 66,845) was significantly higher (P<0.05) than the figure for non-members (N 27,150) based on the result of the Z-test. For the pooled data, amount of credit obtained by members was N 51,725 while that of non-members was N 21,229. Farmers who belong to cooperative associations are more likely to obtain agricultural credit than those who operate as individuals. There is a significant difference in the mean amount of credit obtained for rice production by members and non-members of Rice Farmers Associations at P<0.05 in the pooled results. Okwocha and Obinne (2010) found significant difference in the amount of agricultural credit obtained by women co-operators (N 43,350) and non-cooperators (N 22,183). In the pooled data from Ekiti and Ogun States, Afolami *et al*. (2012) reported that 19.4% of the respondents had access to credit as opposed to 80.6% with no access.

Table 12: Distribution of respondents by amount of credit (in Naira)

Amount of credit (Naira)	**Kaduna**		**Kano**		**Pooled**	
	Members	**Non-members**	**Members**	**Non-members**	**Members**	**Non-members**
0	22 (52)	33 (69)	42 (45)	64 (72)	63 (48)	95 (71)
1000-50,000	15 (35)	15 (31)	10 (11)	3 (3)	26 (19)	16 (12)
51,000-100,000	5 (11)	0 (0)	26 (30)	18 (20)	31 (23)	17 (13)
101,000-150,000	0 (0)	0 (0)	6 (7)	1 (1)	6 (5)	1 (1)
>150,000	1 (2)	0 (0)	6 (7)	4 (4)	7 (5)	4 (3)
Total	**43 (100)**	**43 (100)**	**90 (100)**	**90 (100)**	**133 (100)**	**133 (100)**
Mean	20,052	7,052	66,845	27,150	51,725	21,229
Cal. Z	2.275*		2.656*		2.889*	
Tab. Z	1.96		1.96		1.96	

Figures in parenthesis are percentages. * Sig. at P<0.10.

5.2.3 Awareness of growth enhancement support scheme (GESS)

The distribution of respondents by awareness of Growth Enhancement Support Scheme (GESS) is presented in Table 13. GESS is an initiative of the Federal Ministry of Agriculture and Rural Development that is aimed at enhancing farmers' access to improved seeds and fertiliser at subsidised rate. In Kaduna State, there was a greater awareness of GESS among non-members (85%) than among members (77%) of Rice Farmers Associations. In Kano State, awareness of GESS was 100% among non-members and 98% among members. In the pooled results, awareness of GESS was 91% among members and 95% among non-members. Awareness of GESS was found to be higher among non-members than among members in the two States and in the pooled results. Chi-Square values show that there is no significant relationship between membership of Rice Farmers Associations and awareness of GESS in Kano and Kaduna States and in the pooled results. In a study on effectiveness of GESS in Kwara State, North Central Nigeria, Adebo (2014) reported that all the respondents were aware of the technology.

Table 13: Chi-Square analysis and distribution of respondents by awareness of GESS seeds and fertiliser

Location	Membership	Aware of GESS seeds and fertiliser	Not aware of GESS seeds and fertiliser	Total	Chi-Square χ^2
Kaduna	Members	33(77.1)	10(22.9)	43(100)	1.094(0.296)
	Non-members	37(85.4)	6(14.6)	43(100)	
	Total	**70(81.3)**	**16(18.8)**	**86(100)**	
Kano	Members	88(97.9)	2(2.1)	90(100)	2.021(0.155)
	Non-members	90(100)	0(0.0)	90(100)	
	Total	**178(99.0)**	**2(1.0)**	**180(100)**	
Pooled	Members	121(91.0)	12(9.0)	133(100)	1.933(0.164)
	Non-members	127(95.2)	6(4.8)	133(100)	
	Total	**248(93.1)**	**18(6.9)**	**266(100)**	

Figures in parenthesis are percentages except for Chi-Square values

5.2.4 Registration for GESS

The distribution of respondents by registration for Growth Enhancement Support Scheme (GESS) is presented in Table 14. In Kaduna 52% of members of Rice Farmers Associations and 54% of non-members registered for GESS while 48% of members and 46% of non-members did not register for it. There is no significant relationship between membership of association and registration for GESS. The results for Kano State show that 98% of members of Rice Farmers Associations and 100% of non-members registered for GESS while 2% of members did not register for it. No significant relationship was found between membership of association and registration for GESS. More rice farmers registered for GESS in Kano State than in Kaduna State.

In the pooled results, 83% of members of Rice Farmers Associations and 85% of non-members registered for GESS. There is no significant relationship between membership of association and registration for GESS meaning that registration for GESS was not influenced by membership of Rice Farmers Associations in the two States. Subsequently, members of Rice Farmers Associations in the two States are not different from non-members in terms of registration for GESS. In a study on effectiveness of GESS in Kwara State, North Central Nigeria, Adebo (2014) reported that all the respondents registered for the technology.

Table 14: Chi-Square analysis and distribution of respondents by registration for GESS

Location	**Membership**	**Registered for GESS**	**Did not register for GESS**	**Total**	**Chi-Square χ^2**
Kaduna	Members	22(52.1)	21(47.9)	43(100)	0.042(0.838)
	Non-members	23(54.2)	20(45.8)	43(100)	
	Total	**46(53.1)**	**40(46.9)**	**86(100)**	
Kano	Members	88(97.9)	2(2.1)	90(100)	2.021(0.155)
	Non-members	90(100.0)	0(0.0)	90(100)	
	Total	**178(99.0)**	**2(1.0)**	**180(100)**	
Pooled	Members	110(82.8)	23(17.2)	133(100)	0.229(0.633)
	Non-members	113(84.8)	20(15.2)	133(100)	
	Total	**223(84)**	**43(16)**	**266(100)**	

Figures in parenthesis are percentages except for Chi-Square values.

5.2.5 Access to improved seeds and fertiliser through GESS

The distribution of respondents by access to improved seeds and subsidised fertiliser through Growth Enhancement Support Scheme (GESS) is presented in Table 15. In Kaduna 52% of members of Rice Farmers Associations and 40% of non-members received improved seeds and subsidised fertiliser through GESS while 48% of members and 60% of non-members did not receive the inputs through GESS. There is no significant relationship between membership of association and access to improved seeds and subsidised fertiliser through GESS.

The results for Kano State show that 98% of members of Rice Farmers Associations and 100% of non-members obtained improved rice seeds and subsidised fertiliser through GESS while 2% of members did not receive the inputs. No significant relationship was found between membership of association and access to GESS inputs. More rice farmers collected farm inputs through GESS in Kano State than in Kaduna State. In the pooled results, 83% of members of Rice Farmers Associations and 80% of non-members registered obtained GESS inputs. There is no significant relationship between membership of association and access to GESS inputs meaning that collection of inputs was not influenced by membership or non-membership of Rice Farmers Associations in the two States. In a study on effectiveness of GESS in Kwara State, North central Nigeria, Adebo (2014) reported that 51% and 87.2% of the respondents benefitted from subsidised improved rice seeds and two bags of fertiliser each. Considering the totality of the institutional characteristics of members and non-members of Rice Farmers Associations in the two States, the study found significant differences in the amount of credit and access to extension agents to the advantage of members.

This might have contributed to greater capacity on the part of members of Rice Farmers Associations to cultivate larger rice fields than non-members. The study found no significant relationship between membership status of rice farmers and other GESS related factors examined. This is quite expected as access to GESS seeds and fertiliser is largely determined by the capacity of individual farmers to register for the scheme.

Table 15: Chi-Square analysis and distribution of respondents by access to GESS seeds and fertiliser

Location	Membership	Access to GESS seeds and fertiliser	No access to GESS seeds and fertiliser	Total	Chi-Square χ^2
Kaduna	Members	22(52.1)	21(47.9)	43(100)	1.510(0.219)
	Non-members	17(39.6)	26(60.4)	43(100)	
	Total	**39(45.8)**	**47(54.2)**	**86(100)**	
Kano	Members	88(97.9)	2(2.1)	90(100)	2.021(0.155)
	Non-members	90(100.0)	0(0.0)	90(100)	
	Total	**178(99.0)**	**2(1.0)**	**180(100)**	
Pooled	Members	110(82.8)	23(17.2)	133(100)	0.364(0.546)
	Non-members	106(80.0)	27(20.0)	133(100)	
	Total	**216(81.4)**	**50(18.6)**	**266(100)**	

Figures in parenthesis are percentages except for Chi-Square values. Source: Field Survey 2014

5.3 Sources of information on rice production among Members and Non-members of Rice Farmers Associations in Kaduna and Kano States

5.3.1 Sources of information on rice production among members and non-members of Rice Farmers Associations in Kaduna State

Sources of information on rice production among members and non-members of Rice Farmers Associations in Kaduna State is presented in Table 16. There were 197 entries of which radio constituted 23% followed by other farmers with 19.8%, farmers' leader 14.7% and extension agent 12.2%. This suggests that radio, other farmers, farmers' leader and extension agent were the main sources of information on rice production among this category of farmers. The situation analysis on information sources on rice production among non-members is largely similar to that of members.

Table 16: Sources of information on rice production among members and non-members of Rice Farmers Associations in Kaduna State

Source of Information	**Members**		**Source of Information**	**Non-members**	
	Frequency	**%**		**Frequency**	**%**
Radio	45	22.8	Radio	46	22.5
Other farmers	39	19.8	Other farmers	35	17.2
Farmers' Leader	29	14.7	Farmer's leader	34	16.7
Extension Agent	24	12.2	Television	24	11.8
Television	21	10.7	Extension agent	19	9.3
Mobile Phone	14	7.1	Input supplier	18	8.8
Input Supplier	10	5.1	Mobile phone	13	6.4
Agric Show	8	4.1	Newspaper	7	3.4
Newspaper	4	2.0	Agric show	7	3.4
Field Day	3	1.5	Field day	1	0.5
Total	197	100	Total	204	100

Source: Field Survey 2014. Multiple Responses

Of the 204 entries received, the major sources of information in order of importance are radio (22.5%), other farmers (17.2%), farmers' leader (16.7) and television (11.8%). In both cases, extension agent is not among the best three sources of information on rice production. On the other hand, the analysis shows that farmers depend on multiple information sources and a combination of sources highlighted above may be a better way of reaching farmers with information on rice production.

5.3.2 Sources of information on rice production among members and non-members of rice Farmers Associations in Kano State.

Concerning sources of information on rice production among members of Rice Farmers Associations in Kano State as presented in Table 17, there were 578 entries with radio constituting 15.4% followed by other farmers (15.2%), extension agent (13.7%) and farmers' leader (12.8%). This implies that radio, other farmers, extension agent and farmers' leader are the main sources of information on rice production among this category of farmers. The result of the analysis on information sources on rice production among non-members is to some extent similar to that of members. Of the 450 entries received, the major sources of information in order of importance are radio (20%), other farmers (18.9%), farmers' leader (18%) and input supplier (14.9%).

Table 17: Sources of information on rice production among members and non-members of Rice Farmers Associations in Kano State

Source of Information	**Members**		**Source of Information**	**Non-members**	
	Frequency	**%**		**Frequency**	**%**
Radio	89	15.4	Radio	90	**20.0**
Other Farmers	88	15.2	Other Farmers	85	**18.9**
Extension Agent	79	13.7	Farmers' Leader	81	**18.0**
Farmers' Leader	74	12.8	Input Supplier	67	**14.9**
Input Supplier	73	12.6	Extension Agent	55	12.2
Mobile Phone	57	9.9	Mobile Phone	24	5.3
Agric Show	55	9.5	Agric Show	22	4.9
Field Day	53	9.2	Field Day	19	4.2
Television	7	1.2	Newspaper	6	1.3
Newspaper	3	0.5	Television	1	0.2
Total	578	100.0	Total	450	100.0

Source: Field Survey 2014. Multiple Responses

Among the members, extension agent is the only external source in the list of major sources of information on rice production whereas input supplier is the only external and major source of information on rice production among non-members. As observed among rice farmers in Kaduna, the analysis shows that farmers depend on multiple information sources and a combination of sources highlighted above may be a better way of reaching farmers with information on rice production.

5.3.3 Sources of information on rice production among members and non-members of rice Farmers Associations in Kaduna and Kano States

Sources of information on rice production among members of Rice Farmers'

Association in Kaduna and Kano States are presented in Table 18. There were 775 entries with radio constituting 17.3% followed by other farmers (16.4%), farmers' leader (13.3%) and extension agent (13.3%). This meant that radio, other farmers, extension agent and farmers' leader were the main sources of information on rice production among this category of farmers. The outcome of the analysis on information sources on rice production among non-members is to some extent similar to that of members. Of the 654 entries received, the major sources of information in order of importance were radio (20.8%), other farmers (18.3%), farmers' leader (17.6%) and input supplier (13.0%).

The study showed that among the members, extension agent was the only external source in the list of major sources of information on rice production whereas input supplier was the only external source of information on rice production among non-members. The analysis of the pooled data indicated that farmers depended on multiple information sources and a combination of sources highlighted above might be a better way of reaching them with information on rice production. This is somewhat in line with the findings of Fadiji *et al*. (2005) that radio, extension agent and other farmers were the major sources of extension information among farmers in rural northern Nigeria. However, among rice farmers in Niger State, Jirgi *et al*. (2009) found that 56% of the farmers received information through the radio, 28% through extension agents, 10% through television and pamphlet 6%. Among rice farmers in Benue State, Odiaka (2010) observed that 80-83% of the respondents obtained information on rice production through the radio, 21-40% through the television and 48-76% through mobile phone. It appears the nature of the technology farmers are interested in will determine the choice of the source of information.

Table 18: Sources of information on rice production among members and non-members of Rice Farmers Associations in Kaduna and Kano States

Source of Information	Members		Source of Information	Non-members	
	Frequency	**%**		**Frequency**	**%**
Radio	134	17.3	Radio	136	20.8
Other Farmers	127	16.4	Other Farmers	120	18.3
Extension Agent	103	13.3	Farmers' Leader	115	17.6
Farmers' Leader	103	13.3	Input Supplier	85	13.0
Input Supplier	83	10.7	Extension Agent	74	11.3
Agric Show	63	8.1	Mobile Phone	37	5.7
Mobile Phone	71	9.2	Agric Show	29	4.4
Television	28	3.6	Television	25	3.8
Field Day	56	7.2	Field Day	20	3.1
Newspaper	7	0.9	Newspaper	13	2.0
Total	**775**	**100.0**		**654**	**100.0**

Source: Field Survey 2014. Multiple Responses

5.4 Awareness of Improved Rice Production Technologies among Members and Non-members of Rice Farmers' Associations in Kaduna and Kano States.

5.4.1 Overall awareness of improved rice production technologies

The analysis of the overall awareness of improved rice production technology among members and non-members of rice farmers association in Kaduna and Kano States is presented in Table 19. The overall awareness index is an indication of the level of awareness of improved rice production technology among members and non-members of Rice Farmers Association in Kaduna and Kano States. The highest and obtainable awareness index was 1 and the least was 0.There was a marginal difference in the overall awareness index of improved rice production technology among members and non-members of Rice Farmers Associations in Kaduna State. The overall awareness index among members was 0.79 and that of non-members was 0.78. No significant difference was found in the awareness index among the two groups of rice farmers based on the Z-test value given that the calculated Z-value (0.904) is lower than the tabulated Z-value (1.96). In Kano State the overall awareness index was 0.77 and 0.72

among members and non-members respectively. The Z-test value shows that there is a significant difference at P<0.05 because the calculated Z-value (3.799) is higher than the tabulated Z-value (1.96). In the pooled data, the overall awareness index among members (0.78) was significantly higher than that of non-members (0.74) at P<0.05 since the calculated Z-value (3.598) was greater than the tabulated Z-value (1.96).

This showed that 78% of members and 74% of non-members were aware of improved rice production technology and that members were more aware than non-members thus necessitating the rejection of the null hypothesis and the acceptance of the alternate hypothesis. In a study on adoption of rice technology among farmers in Niger State, Jirgi *et al.* (2009) reported that 78% of the respondents were aware of improved rice varieties. Okoro (2008) investigated the level of awareness of Yam Minisett technique and found that 46.6% of the respondents were aware of the technique nationwide. In most cases, the level of awareness of improved technology is higher than the level of adoption since awareness of a technology may not necessarily lead to adoption.

Table 19: Overall awareness of improved rice production technology among members and non-members of rice farmers association in Kaduna and Kano States

Awareness Index	**Kaduna**		**Kano**		**Pooled**	
	Members	**Non-members**	**Members**	**Non-members**	**Members**	**Non-members**
0.30-0.59	2(4.17)	4(8.33)	0(0.00)	4(4.44)	2(1.45)	8(5.80)
0.60-0.89	33(77.08)	34(79.17)	72(80.00)	79(87.78)	105(78.99)	113(84.78)
0.90-1.00	8(18.75)	5(12.50)	18(20.00)	7(7.78)	26(19.57)	12(9.42)
Total	**43(100)**	**43(100)**	**90(100)**	**90(100)**	**133(100)**	**133(100)**
Mean	0.79	0.78	0.77	0.72	0.78	0.74
Calculated Z-value	0.904		3.799*		3.598*	
Tabulated Z-value	1.96		1.96		1.96	

Figures in parenthesis are percentages. * Sig. at P <0.10. Source: Field Survey 2014.

5.4.2 Awareness of each improved rice production technology

Table 20 shows the analysis of the awareness of each improved rice production technology among members and non-members of rice farmers association in Kaduna and Kano States. For the purpose of analysis, awareness index of each of the 13 components of improved rice production technology was categorised into high, average and low. High awareness index was considered to be ≥ 0.7; average was from 0.5 to 0.69 and low was < 0.5. Considering the 13 components of improved rice production technology among members of Rice Farmers Associations in Kaduna, the awareness index was high in 10, average in 1 and low in 2. A similar trend is observed among non-members.

The improved rice production technology with high awareness index among members and non-members include: use of tractor for land preparation, planting of improved rice variety, sorting of rice seeds for planting, seed dressing with agrochemical, use of herbicide for clearing, use of herbicide for weed control in rice fields, basal NPK fertiliser application, top dressing with urea, use of rice crop residue as manure and use of rice milling machine. Awareness index of rice-legume rotation was average while use of mechanical thresher and use of mechanical winnower recorded low awareness index among the two groups of farmers in Kaduna State. Across the components of improved rice production technology there was no significance difference in mean awareness index obtained among members and non-members on the basis of the fact that the calculated Z-value (1.767) is lower than the tabulated Z-value (1.96) at $P<0.05$. Of the 13 components of improved rice production technology, the awareness index was high in 9, average in 3 and low in 1 among members of Rice Farmers Associations in Kano State. The components of improved rice production technology with high awareness index among members include: use of tractor for land preparation, planting of improved rice variety, seed dressing with agrochemical, use of herbicide for clearing, use of herbicide for weed control in rice fields, basal NPK fertiliser application, top dressing with urea, use of rice crop residue as manure and use of rice milling machine. For rice-legume rotation, use of mechanical thresher and use of mechanical winnower, awareness index was average while sorting of seeds for planting recorded low awareness index. The pattern is slightly different among non-members in Kano State where there were 7 high, 3 average and 3 low awareness index.

The improved rice production technology with high awareness index among non-members include use of tractor for land preparation, planting of improved rice variety, seed dressing with agrochemical, use of herbicide for clearing, use of herbicide for weed control in rice fields, basal NPK fertiliser application and top dressing with urea. Awareness index was average for use of mechanical thresher, use of mechanical winnower and use of milling machine while sorting of rice seeds, use of rice crop residue as manure and rice-legume rotation recorded low awareness index among non-members.

With respect to all the improved rice production technologies the mean awareness index obtained in Kano among members was higher (0.78) than that of non-members (0.72) but not significantly different on account of the fact that the calculated Z-value (1.219) is lower than the tabulated Z-value (1.96) at $P<0.05$. A similar trend is observed in the pooled data and this suggests that awareness of each of the recommended practices on improved rice production technology is not significantly different among members and non-members of Rice Farmers Associations in Kano and Kaduna States.

Table 20: Awareness index of each improved rice production technology among members and non-members of Rice Farmers Associations in Kaduna and Kano States

Improved Rice Production Technology Package	Kaduna		Kano		Pooled	
	Members	Non-members	Members	Non-members	Members	Non-members
1.Tractor for land preparation	0.81	0.79	0.84	0.93	0.83H*	0.88H
2.Improved rice variety	0.84	0.85	0.84	0.94	0.84H	0.91H
3.Sorting of seeds for planting	0.88	0.77	0.44	0.21	0.59A*	0.40L*
4.Seed dressing material	0.90	0.86	0.72	0.90	0.79H	0.89H
5.Herbicide for land clearing	0.99	0.98	0.86	0.96	0.91H	0.96H
6.Herbicide for weed control after planting rice (pre-emergence)	0.98	1.00	0.97	0.96	0.97H	0.97H
7.Basal NPK fertiliser application	0.99	0.98	0.96	0.98	0.97H	0.98H
8.Urea fertiliser application (Top dressing)	0.98	0.96	1.00	0.96	0.99H	0.96H
9.Rice crop residues as manure	0.83	0.81	0.76	0.42	0.79H	0.55A
10.Rice-legume rotation	0.61	0.59	0.57	0.22	0.58A	0.35L
11.Mechanical thresher	0.39	0.43	0.68	0.63	0.58A	0.56A
12.Mechanical winnower	0.41	0.31	0.68	0.62	0.59A	0.51A
13.Rice milling machine	0.71	0.73	0.76	0.61	0.74H	0.65A
Mean	0.80	0.77	0.78	0.72	0.79H	0.75H
Calculated Z-value	1.767		1.219		1.493	
Tabulated Z-value	1.96		1.96		1.96	

Source: Field Survey 2014. Figures in parenthesis are percentages. H = High, A = Average, L = Low

5.5 Adoption of Improved Rice Production Technologies among members and non-members of Rice Farmers Associations in Kaduna and Kano States

5.5.1 Overall adoption index of improved rice production technologies among members and non-members of Rice Farmers Associations in Kaduna and Kano State

The analysis of the overall adoption of improved rice production technologies among members and non-members of rice farmers association in Kaduna and Kano States is presented in Table 21. The overall adoption index is an indication of the performance of members and non-members of Rice Farmers Associations in Kaduna and Kano States as regards adoption of improved rice production technology. In this case, the value ranged from 0 to 1. The mean overall adoption index obtained among members (0.70) of Rice Farmers Associations in Kaduna was significantly higher than that of non-members (0.64) at $P<0.05$ given that the calculated Z-value (2.180) was greater than the tabulated Z-value (1.96). This implied that members were better adopters of improved rice production technology than non-members.

Members of Rice Farmers Associations in Kano were also found to be better adopters of improved rice production technology than non-members as the overall mean adoption index for members (0.62) was significantly higher than the value obtained among non-members (0.54) at $P<0.05$ based on the result of the Z-test. The same trend was observed in the pooled data where the overall mean adoption index for members (0.65) was found to be significantly higher than that of non-members (0.58) at $P<0.05$ as the calculated Z-value (5.598) was greater than the tabulated Z-value (1.96).

Table 21: Overall adoption of Improved Rice Production Technologies among members and non-members of Rice Farmers Associations in Kaduna and Kano States

Overall Adoption Index	**Kaduna**		**Kano**		**Pooled**	
	Members	**Non-members**	**Members**	**Non-members**	**Members**	**Non-members**
0.00-0.29	0(0.00)	0(0.00)	0(0.00)	3(3.33)	0(0.00)	4(2.90)
0.30-0.49	3(6.25)	6(14.58)	5(5.56)	13(14.44)	8(5.80)	18(13.77)
0.50-0.69	24(56.25)	24(56.25)	62(68.89)	68(75.56)	85(64.49)	92(68.84)
0.70-1.00	16(37.5)	13(29.17)	23(25.56)	6(6.67)	40(29.71)	19(14.49)
Total	43(100)	43(100)	90(100)	90(100)	133(100)	133(100)
Mean	0.696	0.643	0.619	0.539	0.646	0.575
Calculated Z-value	2.180*		5.578*		5.598*	
Tabulated Z-value	1.96		1.96		1.96	

Source: Field Survey 2014 Figures in parenthesis are percentages. * Sig. at $P< 0.05$.

5.5.2 Adoption of each improved rice production technology by members and non-members of Rice Farmers Associations in Kaduna State

Table 22 shows the analysis of the adoption of each improved rice production technology among members and non-members of rice farmers association in Kaduna State. Adoption score of each of the 13 components of improved rice production technology was categorised into high, average and low for the purpose of analysis. High adoption score was considered to be ≥ 0.7; average was from 0.5 to 0.69 and low was < 0.5. Considering the 13 components of improved rice production technology the adoption score was high in 8, average in 2 and low in 3 among members and high in 6, average in 5 and low in 2 among non-members of Rice Farmers Associations in Kaduna.

The components of improved rice production technology with high adoption score among members included: use of planting of improved rice variety, sorting of rice seeds for planting, seed dressing with agrochemical, use of herbicide for clearing, use of herbicide for weed control in rice fields, basal NPK fertiliser application, top dressing with urea and use of rice crop residue as manure. Adoption index of use of tractor for land preparation and use of milling machine was average while rice-legume rotation, use of mechanical thresher and use of mechanical winnower recorded low adoption index among members. For non-members adoption index was also high for the same components as members apart from sorting of seeds and seed dressing with average adoption score. Other components with average adoption index for non-members included use of milling machine, rice-legume rotation and use of tractor for land preparation.

Table 22: Adoption of improved rice production technologies by members and non-members of Rice Farmers Associations in Kaduna State

Improved Rice Production Technology	Frequency and percentage of Adopters		Adoption Score	
	Members	Non-members	Members	Non-members
1.Tractor for land preparation	29(66.67)	23(54.17)	0.67A*	0.54A
2.Improved rice variety	31(72.92)	31(72.92)	0.73H*	0.73 H
3.Sorting of seeds for planting	36(83.33)	33(68.75)	0.83H	0.69A
4.Seed dressing material	33(77.08)	29(60.42)	0.77H	0.60A
5.Herbicide for land clearing	43(100)	43(100)	1.00H	0.98H
6.Herbicide for weed control after planting rice (pre-emergence)	43(100)	43(100)	1.00H	0.98H
7.Basal NPK fertiliser application	43(100)	43(100)	1.00H	0.98H
8.Urea fertiliser application (Top dressing)	43(100)	43(100)	0.96H	0.92H
9.Rice crop residues as manure	43(100)	35(81.25)	0.92H	0.81H
10.Rice-legume rotation	20(45.83)	23(54.17)	0.46L*	0.54A
11.Mechanical thresher	4(10.42)	3(6.25)	0.10L	0.06L
12.Mechanical winnower	4(8.33)	1(2.08)	0.08L	0.02L
13.Rice milling machine	22(52.08)	22(50.00)	0.50A	0.50A
Mean			0.70H	0.64A
Calculated Z-value			2.810*	
Tabulated Z-value			1.96	

Source: Field Survey 2014. Figures in parenthesis are percentages. H = High, A = Average, L = Low. Figures in parenthesis are percentages. * Sig. at P< 0.10.

Adoption index of use of mechanical winnower and use of mechanical thresher was low among non-members. Across the recommended practices or components of improved rice production technology the mean adoption index obtained among members (0.70) was significantly higher than that of non-members (0.64) at P<0.05 given that the calculated Z-value (2.810) was higher than the tabulated Z-value (1.96).

5.5.3 Adoption of the recommended practices on improved rice production technology by members and non-members of rice Farmers Associations in Kano State

The analysis of the adoption of each improved rice production technology among members and non-members of rice farmers association in Kano State is presented in Table 23. Of the 13 components or recommendations on improved rice production technology the adoption index was high in 7, average in 2 and low in 4 among members and high in 7 and low in 6 among non-members of Rice Farmers Associations in Kano. Improved rice production technologies with high adoption score among members and non-members included: use of tractor for land preparation, use of planting of improved rice variety, seed dressing with agrochemical, use of herbicide for clearing, use of herbicide for weed control in rice fields, basal NPK fertiliser application and top dressing with urea.

Adoption of use of rice crop residue as manure and use of rice milling machine among members was average based on the adoption score. Sorting of rice seeds for planting, rice-legume rotation, use of mechanical thresher and use of mechanical winnower recorded low adoption score among members. In the case of non-members, the extent of adoption was low for use of crop residue as manure and rice milling machine in addition to the same components with low level of adoption among members. With respect to each improved rice production technology the mean adoption index obtained among members (0.61) was not significantly higher than that of non-members (0.53) as the calculated Z-value (1.290) was lower than the tabulated Z-value (1.96) at $P<0.05$.

Table 23: Adoption of recommended practices on improved rice production technology by members and non-members of Rice Farmers Associations in Kano State

Improved Rice Production Technology	**Frequency and percentage of Adopters**		**Adoption Score**	
	Members	**Non-members**	**Members**	**Non-members**
1.Tractor for land preparation	66(73.63)	74(81.32)	0.74H*	0.81H
2.Improved rice variety	66(73.63)	86(94.51)	0.74H	0.95H
3.Sorting of seeds for planting	27(29.67)	11(12.09)	0.30L	0.12L*
4.Seed dressing material	69(76.92)	82(90.11)	0.77H	0.90H
5.Herbicide for land clearing	69(76.92)	84(92.31)	0.77H	0.92H
6.Herbicide for weed control after planting rice (pre-emergence)	88(97.80)	86(94.51)	0.98H	0.95H
7.Basal NPK fertiliser application	63(70.33)	80(87.91)	0.70H	0.88H
8.Urea fertiliser application (Top dressing)	90(100)	88(96.70)	1.00H	0.97H
9.Rice crop residues as manure	46(51.65)	21(23.08)	0.52A*	0.23L
10.Rice-legume rotation	45(49.45)	9(9.89)	0.49L	0.10L
11.Mechanical thresher	22(24.18)	0(0.00)	0.24L	0.00L
12.Mechanical winnower	20(21.98)	1(1.10)	0.22L	0.01L
13.Rice milling machine	45(50.55)	9(9.89)	0.51A	0.10L
Total				
Mean			0.61A	0.53A
Calculated Z-value			1.290	
Tabulated Z-value			1.96	

Source: Field Survey 2014. Figures in parenthesis are percentages. H = High, A = Average, L = Low. Figures in parenthesis are percentages. * P< 0.10.

5.5.4 Pooled data on adoption of each improved rice production technology by members and non-members of rice Farmers Associations in Kaduna and Kano States

The analysis of the adoption of each improved rice production technology among members and non-members of rice farmers association in Kaduna and Kano States is presented in Table 24. Similar to the results obtained among rice farmers in Kano State, of the 13 recommendations or components of improved rice production technology the adoption index was high in 7, average in 2 and low in 4 among members and high in 7 and low in 6 among non-members of Rice Farmers Associations in Kaduna and Kano States. With respect to each improved rice production technology, the mean adoption index obtained among members (0.64) was higher than that of non-members (0.57) but not significant since the calculated Z-value (1.785) was lower than the tabulated Z-value (1.96) at P<0.05. This meant that members of Rice Farmers Associations in both States were not significantly different from non-members in terms of adoption of the recommendations on improved rice production technology. In the pooled results, about 73% of members and 87% of non-members adopted improved variety of rice. In a study on the adoption of improved rice technology among youths in Niger State, Umar *et al*. (2009) reported that 77% of the respondents adopted improved rice variety

Table 24: Pooled data on adoption of each improved rice production technology by members and non-members of Rice Farmers Associations in Kaduna and Kano States

Improved Rice Production Technology	**Frequency and percentage of Adopters**		**Adoption Score**	
	Members	**Non-members**	**Members**	**Non-members**
1.Tractor for land preparation	95(71.22)	96(71.94)	0.71H*	0.72H
2.Improved rice variety	98(73.38)	116(87.05)	0.73H	0.87H
3.Sorting of seeds for planting	64(48.20)	42(31.65)	0.48L*	0.32L
4.Seed dressing material	102(76.98)	106(79.86)	0.77H	0.80H
5.Herbicide for land clearing	113(84.89)	125(94.24)	0.85H	0.94H
6.Herbicide for weed control after planting rice (pre-emergence)	133(100)	133(100)	0.99H	0.96H
7.Basal NPK fertiliser application	107(80.58)	122(91.37)	0.81H	0.91H
8.Urea fertiliser application (Top dressing)	133(100)	126(94.96)	0.98H	0.95H
9.Rice crop residues as manure	87(65.47)	57(43.17)	0.65A*	0.43L
10.Rice-legume rotation	64(48.20)	33(25.18)	0.48L	0.25L
11.Mechanical thresher	26(19.42)	3(2.16)	0.19L	0.02L
12.Mechanical winnower	23(17.27)	2(1.44)	0.17L	0.01L
13.Rice milling machine	68(51.08)	32(23.74)	0.51A	0.23L
Mean			0.64A	0.57A
Calculated Z-value			1.785	
Tabulated Z-value			1.96	

Source: Field Survey 2014. Figures in parenthesis are percentages. H = High, A = Average, L = Low. Figures in parenthesis are percentages. * P< 0.10.

The use of tractor for land preparation was adopted by 71% and 72% of members and non-members respectively. This is higher than 54% obtained by Ornan *et al*. (2010) as the level of adoption of use of tractor for land preparation among rice farmers in Adamawa State. About 51% of members and 23% of non-members adopted rice milling machine respectively. Umar *et al*. (2009) found that 43% of respondents adopted rice machine among farmers in Niger State.

5.5.5 Utilisation of NPK fertiliser among members and non-members of Rice Farmers Associations in Kaduna and Kano States

The analysis of utilisation of NPK fertiliser among members and non-members of Rice Farmers Associations in Kaduna and Kano States is presented in Table 25. Majority of members (88%) and non-members (94%) of Rice Farmers Associations in Kaduna used 1 to 10 bags of NPK 15.15.15 fertiliser on their rice fields. The average rate of NPK fertiliser applied per hectare was 83 kg among members and 70 kg among non-members. This was much lower than the recommended rate of 200 kg per hectare. The mean NPK fertiliser rate applied by members was higher than that of non-members though the difference was not significantly different based on the Z-test value.

In Kano State, majority of members (53%) of Rice Farmers Associations applied 11 to 20 bags of NPK 15.15.15 fertiliser on their rice fields while majority of non-members (37%) applied 11 to 20 bags of NPK fertiliser. The mean rate of NPK fertiliser applied per hectare in Kano was 188 kg among members and 283 kg among non-members. The mean NPK fertiliser rate applied by non-members was higher than that of members but the difference was not significant at $P<0.05$ as the calculated Z-value (0.433) was smaller than the tabulated Z-value (1.96). In the pooled data, majority of members

(48%) applied 1 to 10 bags of NPK 15.15.15 fertiliser while majority of non-members (53%) applied 1 to 10 bags. The mean rate of NPK fertiliser applied per hectare was 160 kg among members and 220 kg among non-members. The mean NPK fertiliser rate applied by members was lower than that of non-members though the difference was not significantly different based on the Z-test value. In a survey on rice production in Nigeria, Erenstein *et al*. (2003) reported that NPK fertiliser dosage among rice farmers in the country was 150kg per hectare while Usman *et al*. (2013) obtained 85.6 kg per hectare. This was much lower than the rate of NPK applied per hectare by members and non-members of Rice Farmers Associations.

Table 25: Quantity of NPK fertiliser utilised for rice production by members and non-members of Rice Farmers Associations in Kaduna and Kano States

No of bags of NPK applied	**Kaduna**		**Kano**		**Pooled**	
	Members	**Non-members**	**Members**	**Non-members**	**Members**	**Non-members**
0	0(0.00)	0(0.00)	2(2.22)	3(3.33)	2(1.45)	3(2.17)
1-10	38(87.50)	40(93.75)	24(26.67)	29(32.22)	64(47.83)	71(53.62)
11-20	3(8.34)	3(6.25)	48(53.33)	34(37.78)	50(37.68)	36(26.81)
21-30	1(2.08)	0(0.00)	16(17.78)	22(24.44)	16(12.32)	21(15.94)
31-40	1(2.08)	0(0.00)	0(0.00)	2(2.22)	1(0.72)	2(1.45)
Total	43(100)	43(100)	90(100)	90(100)	133(100)	133(100)
Mean	6.71	4.56	14.567	15.078	12.56	11.42
Calculated Z	1.808		-0.433		1.054	
Tabulated Z	1.96		1.96		1.96	
Rate of NPK applied (kg per hectare)	83	70	188	283	160	220

Figures in parenthesis are percentages. Source: Estimates from Field Survey 2014

5.5.6 Usage of Urea fertiliser by members and non-members of Rice Farmers Associations in Kaduna and Kano States

The analysis of utilisation of Urea fertiliser among members and non-members of Rice Farmers Associations in Kaduna and Kano States is presented in Table 26. Majority of members (75%) and all non-members of Rice Farmers Associations in Kaduna used 1 to 5 bags of Urea fertiliser on their rice fields. The average number of bags of Urea fertiliser used by members (5.4) was significantly higher than that of non-members (3.13) at $P<0.05$ based on the Z-test value. The mean rate of Urea fertiliser applied per hectare was 67 kg among members and 48 kg among non-members. The recommended rate is 100-150 kg . In Kano State, majority of members (38%) of Rice Farmers Associations and non-members (58%) applied 1 to 5 bags of Urea fertiliser on their rice fields. The average number of bags of Urea fertiliser used in Kano was 5.42 among members and 3.13 among non-members. The quantity of Urea used by non-members was significantly higher than that of members. The mean rate of Urea fertiliser applied per hectare was 91 kg among members and 87 kg among non-members. In the pooled data, majority of members (51%) and non-members (65%) used 1 to 5 bags of Urea fertiliser. The average number of bags of Urea fertiliser used was 7.10 among members and 4.64 among non-members.

Table 26: Quantity of Urea fertiliser utilised for rice production by members and non-members of Rice Farmers Associations in Kaduna and Kano States

No of bags of Urea fertiliser applied	**Kaduna**		**Kano**		**Pooled**	
	Members	**Non-members**	**Members**	**Non-members**	**Members**	**Non-members**
0	0(0.00)	0(0.00)	2(2.22)	3(3.33)	2(1.45)	3(2.17)
1-5	32(75.00)	32(77.08)	35(38.89)	52(57.78)	68(51.45)	86(64.49)
6-10	8(18.75)	4(8.33)	37(41.11)	32(35.56)	44(33.33	35(26.09)
11-15	1(2.08)	3(6.25)	8(8.89)	2(2.22)	9(6.52)	5(3.62)
16-20	2(4.17)	3(6.25)	7(7.78)	1(1.11)	9(6.52)	3(2.90)
>20	0(0.00)	1(2.08)	1(1.11)	0(0.00)	1(0.72)	1(0.72)
Total	43(100)	43(100)	90(100)	90(100)	133(100)	133(100)
Mean	5.42	3.13	7.10	4.64	6.51	4.11
Calculated Z	2.330*		4.010*		4.584*	
Tabulated Z	1.96		1.96		1.96	
Rate of urea applied (kg per hectare)	67	48	91	87	83	79

Figures in parenthesis are percentages. * Sig. at $P< 0.05$

The quantity of Urea fertiliser used by members was significantly higher than that of non-members based on the Z-test value. The mean rate of Urea fertiliser applied per hectare was 83 kg among members and 79 kg among non-members. According to Erenstein *et al*. (2003) the rate of Urea fertiliser applied per hectare by rice farmers in a survey on rice production in Nigeria was 69 kg.

5.5.7 Usage of herbicide for rice production by members and non-members of Rice Farmers Associations in Kaduna and Kano States

The analysis of utilisation of herbicide among members and non-members of Rice Farmers Associations in Kaduna and Kano States is presented in Table 27. Majority of members (47%) and non-members (69%) of Rice Farmers Associations in Kaduna used 1-5 litres of herbicides on their rice fields. The average quantity of herbicide used was 8.56 litres among members and 6.42 litres among non-members. The average quantity of herbicide applied by members was higher than that of non-members at $P<0.05$ though the difference was not significant based on the Z-test value. The quantity of herbicide applied per hectare was 2.1 litres among members and 2.0 litres among non-members in Kaduna. In Kano State, majority of members (55%) of Rice Farmers Associations and non-members (76%) applied 1-5 litres of herbicide on their rice fields.

The average quantity of herbicide applied in Kano was 5.26 litres among members and 3.09 litres among non-members. The quantity of herbicide applied by members was significantly higher than that of non-members as indicated by the result of the Z-test. The average quantity of herbicide applied per hectare was 1.4 litres among members and 1.2 litres among non-members in Kano. In the pooled data, majority of members (53%) and non-members (79%) applied 1 to 5 litres of herbicide. The mean herbicide rate applied by members was significantly higher than that of non-members since the calculated Z-value (3.718) was greater than the tabulated Z-value (1.96). The rate of herbicide applied per hectare by members and non-members (1.6 litres) in the pooled results was lower than 2.5 litres per hectare reported by Erenstein *et al*. (2003) in a survey on rice production in some selected States in Nigeria.

Table 27: Quantity of herbicide utilised for rice production by members and non-members of Rice Farmers Associations in Kaduna and Kano States

Quantity of Herbicide in litres/ha	**Kaduna**		**Kano**		**Pooled**	
	Members	**Non-members**	**Members**	**Non-members**	**Members**	**Non-members**
0	0(0.00)	0(0.00)	3(3.33)	7(7.78)	3(2.17)	7(5.07)
1-5	21(47.92)	30(68.75)	50(55.56)	76(84.44)	70(52.90)	105(78.99)
6-10	11(25.00)	7(16.67)	33(36.67)	6(6.67)	43(32.61)	13(10.14)
11-15	6(14.58)	4(8.33)	1(1.11)	0(0.00)	8(5.80)	4(2.90)
16-20	2(4.17)	0(0.00)	3(3.33)	1(1.11)	5(3.62)	1(0.72)
>20	3(8.33)	2(6.25)	0(0.00)	0(0.00)	4(2.90)	3(2.17)
Total	43(100)	43(100)	90(100)	90(100)	133(100)	133(100)
Mean	8.56	6.42	5.26	3.09	6.40	4.25
Calculated Z	1.550		4.28*		3.718*	
Tabulated Z	1.96		1.96		1.96	
Rate of herbicide (litre per hectare)	2.1	2.0	1.4	1.2	1.6	1.6

Figures in parenthesis are percentages. Source: Estimates from Field Survey 2014* Sig. at P< 0.05

5.6 Socio-economic and Institutional Factors Influencing Adoption of Improved Rice Production Technology among members and non-members of Rice Farmers Associations in Kaduna and Kano States

5.6.1 Determinants of adoption of improved rice production technology among farmers in Kaduna State

The Tobit regression analysis of determinants of adoption of improved rice production technologies among farmers in Kaduna State is presented in Table 28. The improved rice production technology adoption index of members and non-members of Rice Farmers Associations in Kaduna State was regressed against socio-economic and institutional characteristics including age of farmers, gender, marital status, household

Size, household members involved in farm work, number of years of experience in rice cultivation, number of years spent in formal education, Size of rice field, rice yield, access to extension agent, amount of credit and ownership of mobile phone. The variables that were significant in explaining the adoption of improved rice production technology among rice farmers in Kaduna State included: age of farmers, gender, marital status, years of formal education, access to extension agent and ownership of mobile phone. The variables were positively related to adoption of improved rice production technology.

Table 28: Results of Tobit regression analysis on determinants of adoption of improved rice production technology among farmers in Kaduna State

Variable	Coefficient	Standard Error	t	P>[t]
Age	0.0041	0.00156	2.61***	0.011
Gender	0.1003	0.03708	2.70***	0.008
Marital Status	0.3100	0.04716	6.57***	0.000
Household Size	0.0059	0.00399	1.48	0.143
Household labour	-0.0086	0.00704	-1.23	0.224
Years of planting rice	-0.0006	0.00198	-0.32	0.747
Years of formal education	0.0146	0.00341	4.26***	0.000
Size of rice field	-0.000	0.00790	-0.00	0.997
Rice Yield	0.0003	0.00062	0.42	0.675
Access to extension agent	0.0757	0.03777	2.01**	0.048
Amount of credit	-0.00000141	0.00000105	-1.34	0.185
Ownership of mobile phone	0.1598	0.01965	3.22***	0.002
Constant	0.4562	0.07643	5.97	0.000
Sigma	0.1416	0.01071		
Log likelihood	60.478			
Log likelihood ratio Chi^2	34.61			
Prob> Chi^2	0.00			
Pseudo R^2	-0.4009			

*** Sig. at P<0.01, ** * Sig. at P< 0.05, * Sig. at P<0.10

5.6.2 Determinants of adoption of improved rice production technology among farmers in Kano State

The Tobit regression analysis of determinants of adoption of improved rice production technologies among farmers in Kano State is presented in Table 29. The socio-economic and institutional characteristics that were significant in explaining the adoption of improved rice production technology among rice farmers in Kano State included: age of farmers, gender, marital status, number of years spent in formal education, Size of field, access to extension agent, amount of credit and ownership of mobile phone.

Table 29: Results of Tobit regression analysis on determinants of adoption of improved rice production technology among farmers in Kano State

Variable	Coefficient	Standard Error	t	P>[t]
Age	0.0059	0.0011	5.39***	0.000
Gender	0.1117	0.0297	3.76***	0.000
Marital Status	0.0709	0.0429	1.65*	0.101
Household Size	0.0016	0.0029	0.55	0.584
Household labour	0.0094	0.0079	-1.18	0.240
Years of planting rice	0.0032	0.0019	-1.61	0.108
Years of formal education	0.0039	0.0019	1.97**	0.050
Size of rice field	0.0100	0.0046	-2.17**	0.032
Rice Yield	0.0003	0.0001	2.13**	0.035
Access to extension agent	0.1583	0.0258	6.12***	0.000
Amount of credit	-0.00000033	0.000000171	1.93*	0.055
Ownership of mobile phone	0.1428	0.0330	4.33***	0.000
Constant	0.6811	0.0446	15.27	0.000
Sigma	0.1417	0.0075		
Log likelihood	165.665			
Log likelihood ratio Chi^2	85.01			
Prob> Chi^2	0.000			
Pseudo R^2	-0.35			

*** P<0.01, ** P<0.05, * P<0.10

5.6.3 Determinants of adoption of improved rice production technology among farmers in Kaduna and Kano States (pooled)

The Tobit regression analysis of determinants of adoption of improved rice production technologies among farmers in Kaduna and Kano States is presented in Table 30. The socio-economic and institutional characteristics that were significant in explaining the adoption of improved rice production technology in the pooled data from members and non members of Rice Farmers Associations in Kaduna and Kano States included: age of farmers, marital status, household Size, years spent in rice cultivation, access to extension agent and amount of credit. Concerning the determinants of adoption behaviour, rice farmers in the two States were assessed independently to examine possible differences in the results of the Tobit analysis. Age of the farmer was one of the socioeconomic characteristics that influenced significantly the adoption of rice farmers in the three models (Kaduna, Kano and pooled data). The coefficient of age was positive in Kaduna and Kano but negative in the pooled data. The implication of negative coefficient of age in the pooled data is that as the age of the farmer increases, the probability of adopting improved rice production technology decreases. Previous studies have shown that young farmers with better education and exposure to new ideas are more likely to adopt new innovations and bear more risk than older farmers (Awotide *et al*., 2010). Gender influenced significantly the adoption behaviour of rice farmers in Kaduna and Kano but was not significant in the pooled data.

The coefficient of gender was positive in the two models meaning that extent of adoption of improved rice production technology by male rice farmers was greater than that of their female counterpart. Similar findings were reported by Onumadu *et al*. (2014) and Awotide *et al*. (2010). Adoption behaviour of rice farmers was significantly influenced by marital status in the three models. The coefficient of marital status was positive in the three models. This suggested that rice farmers who are married were better than their colleagues whose marital status was single or separated in terms of adoption of rice production technology. This might be attributable to the post-harvest and marketing support married rice farmers are likely to receive from their spouses. Number of years in formal education influenced significantly the adoption behaviour of rice farmers in the Kaduna and Kano models. The coefficient of number of years in formal education was positive in the Kaduna and Kano models. The probability of adopting improved rice production technology is greater with farmers who have appreciable level of education than with those with little or no education. This is in consonance with the findings of Ajewole (2010) and Onumadu *et al.* (2014). Access to education enhances farmers' awareness of new ideas on agricultural production and application of new techniques for increased production.

Access to extension agent was found to influence significantly the adoption behaviour of rice farmers in the study. The coefficient of access to extension agent was positive in the three models meaning that the interaction between farmers and extension agent had a positive effect on adoption of improved rice production technology. This is corroborated by the findings of Tiamiyu *et al*. (2009) and Awotide *et al*. (2010). The adoption behaviour of rice farmers was also influenced significantly by ownership of mobile phone. The coefficient of ownership of mobile phone was positive in the Kaduna and Kano models suggesting that the probability of adoption of improved rice technology is greater among rice farmers who possess mobile phones than their counterparts who do not have mobile phones. This might be related to the fact that access to improved rice seeds and subsidised fertiliser through the GESS is tied to ownership of mobile phone by individual farmers. The improvement in the those variables that are significant will probably lead to a higher level of adoption of improved rice production technology

Table 30: Results of Tobit regression analysis on determinants of adoption of improved rice production technology among farmers in Kaduna and Kano States (Pooled)

Variable	Coefficient	Standard Error	t	P>[t]
Age	-0.0033	0.0008	-3.95***	0.000
Gender	0.0219	0.0199	-1.10	0.272
Marital Status	0.0626	0.0281	2.23**	0.027
Household Size	0.0038	0.0018	2.04**	0.042
Household labour	-0.0034	0.0036	-0.95	0.345
Years of planting rice	0.0018	0.009	1.83*	0.068
Years of formal education	-0.004	0.0015	-0.25	0.802
Size of rice field	-0.0018	0.0031	-0.58	0.563
Rice Yield	-0.000	0.0000	-0.61	0.544
Access to extension agent	0.0068	0.0177	3.86***	0.000
Amount of credit	-0.000000217	0.000000133	-1.63*	0.104
Ownership of mobile phone	0.0261	0.0211	1.24	0.217
Constant	0.6293	0.0397	15.82	0.000
Sigma	0.1219	0.0053		
Log likelihood	176.598			
Log likelihood ratio Chi^2	58.79			
Prob> Chi2	0.000			
Pseudo R^2	-0.1997			

*** P<0.01, ** P<0.05, * P<0.10

5.7 Effects of Adoption of Improved Rice Production Technology on Rice Output and Income among Members and Non-members of Rice Farmers Associations in Kaduna and Kano States

5.7.1 Rice paddy output of members and non-members of rice Farmers Associations in Kaduna and Kano States

The test of significance of the effects of adoption of improved rice production technology on rice output among members and non-members of Rice Farmers Associations in Kaduna and Kano States is presented in Table 31. The quantity of rice paddy harvested by members on an average was significantly higher (45 bags or 4.5 tons) than that of non-members (26 bags or 2.6 tons) in Kaduna State whereas no significant differences were observed in the rice paddy output of members (121 bags or 12.1 tons) and non-members (140 bags or 14.00 tons) in Kano and in the pooled data

(97 bags or 9.70 tons and 104 bags 10.4 tons). However, non-members recorded higher rice paddy output than members in Kano and in the pooled data.

Table 31: Effects of adoption of improved rice production technology on rice output among members and non-members of rice farmers association in Kaduna and Kano States

Rice Paddy Output (No of 100 kg bags)	**Kaduna**		**Kano**		**Pooled**	
	Members	**Non-members**	**Members**	**Non-members**	**Members**	**Non-members**
1 – 50	31(73.33)	39(91.11)	13(14.43)	11(12.37)	44(33.10)	50(37.32)
51 – 100	9(20.00)	2(4.44)	42(46.39)	29(31.96)	51(38.03)	31(23.24)
101 – 200	2(4.44)	2(4.44)	25(28.87)	26(28.87)	28(21.13)	28(21.13)
201 – 300	1(2.22)	0(0.00)	6(6.19)	21(23.71)	6(4.93)	22(16.20)
301 – 400	0(0.00)	0(0.00)	3(3.09)	3(3.09)	3(2.11)	2(2.11)
401 – 500	0(0.00)	0(0.00)	1(1.03)	0(0.00)	1(0.70)	0(0.00)
Total	43(100)	43(100)	90(100)	90(100)	133(100)	133(100)
Mean	45.13	25.50	120.79	140.03	96.82	103.74
Calculated Z	2.763*		-1.616		-0.809	
Tabulated Z	1.96		1.96		1.96	

*Sig at P< 0.10.

5.7.2 Analysis of income from sales of rice paddy among members and non-members of Rice Farmers Associations in Kaduna and Kano States

The test of significance of the effects of adoption of improved rice production technology on income from rice paddy among members and non-members of Rice Farmers Associations in Kaduna and Kano States is presented in Table 32. Income was calculated based on number of bags of rice produced by the farmers. The income from rice paddy harvested by members on an average was significantly higher (N 247,491) than that of non-members (N 134,127) in Kaduna State whereas no significant differences were observed in the income of members (N 626,146) and non-members (N 728,628) in Kano and in the pooled data (N 501,886 and N 564,027). However, non-members recorded higher income than members in Kano and in the pooled data. The analysis showed that members of Rice Farmers Associations were not superior to non-members in terms of income realised from the sale of rice paddy. In other words, membership of Rice Farmers Associations did not have a significant effect on income among the two groups of farmers in the pooled results. In a study on effects of membership of cooperative societies on rice production in South west Nigeria, Afolami *et al.* (2012) found no significant difference in the total revenue of members (N 394,671) and non-members (N 361,552) even though members made more money than non-members.

Table 32: Effects of adoption of improved rice production technology on income among members and non-members of rice Farmers Associations in Kaduna and Kano States

Income in Naira	**Kaduna**		**Kano**		**Pooled**	
	Members	**Non-members**	**Members**	**Non-members**	**Members**	**Non-members**
n=	43	43	90	90	133	133
Mean	247,491	134,127	626,146	728,628	501,886	564,027
Cal. Z	2.566*		-1.565		-1.363	
Tab. Z	1.96		1.96		1.96	

* Sig. at P< 0.10.

5.7.3 Rice yield of members and non-members of Rice Farmers Associations in Kaduna and Kano States

The test of significance of the effects of adoption of improved rice production technology on rice yields among members and non-members of Rice Farmers Associations in Kaduna and Kano States is presented in Table 33. In Kaduna State, the mean rice yield in tons/ha of members (1.61) was higher than that of non-members (1.47) though the difference was not significantly different whereas in Kano State the mean rice yield obtained among non-members in Kano State (3.22) was significantly higher than that of members (2.51) at $P<0.05$. It appears the effect of membership of farmers associations on rice yield per hectare was location specific. In the pooled data, the mean rice yield obtained among non-members (2.67) was also significantly higher than that of members (2.23) at P<0.05 as the calculated Z-value (3.329) was greater than the tabulated Z-value (1.96). The result of the analysis of rice yield among members and non-members in Kaduna is similar to the finding of Afolami *et al.* (2012) who reported no significant difference in the rice yield of members (1.43 tons/ha) and non-members (1.41 tons/ha). However, the result of the analysis of rice yield among members and non-members in Kano and in the pooled results contradicted the findings of Afolami *et al*. (2012). The analysis of the pooled results showed that members of Rice Farmers Associations were different from non-members in terms of average rice yield per hectare. This necessitated the rejection of the null hypothesis stating that there is no significant difference in the effect of adoption of improved rice production technology on rice yield among members and non-members of Rice Farmers Associations in the study area. Consequently the alternate hypothesis was accepted. The rice yield obtained by members in the pooled result (2.23 tons/ha) is comparable to 2.10 tons/ha reported by Usman *et al*. (2013) and lower than 1.43 tons/ha recorded by Afolami *et al*. (2012) among members of rice cooperative societies in South West Nigeria.

It was expected that rice yield per hectare among members of Rice Farmers Associations would be higher than that of non-members in the two States and in the pooled results. This is contrary to the results obtained in the current study where rice yield of members was not significantly higher than that of non-members in Kaduna and the rice yield of non-members was found to be significantly higher than that of members in Kano and in the pooled results. Further enquiry on the situation in Kano revealed that the Rice Farmers Associations in the study area only exist in names and not in actual delivery of services that add value to members meaning that they may not be different from non-members in the real sense. Consequently, joining of Rice Farmers

Associations by rice farmers may not necessarily lead to greater output unless the associations deliberately embark on activities that bring tangible benefits to their members. In a study on effects of farmers' cooperative membership on rice production in South West Nigeria, Afolami *et al*. (2012) observed that almost all the rice cooperative groups were established to serve as receptacles for subsidised agricultural services and inputs rather than real producer organisations that seek to attract commercial providers of services and ensure efficient marketing of their farm output. This is also corroborated by Agbo (2009) who reported that most of the farmers that joined cooperatives did so to attract services from government thereby perceiving cooperatives as government agency rather than an autonomous business outfit.

Table 33: Effects of adoption of improved rice production technology on rice yields among members and non-members of Rice Farmers Associations in Kaduna and Kano States

Rice Yield in tons/hectare	**Kaduna**		**Kano**		**Pooled**	
	Members	**Non-members**	**Members**	**Non-members**	**Members**	**Non-members**
Mean	1.61	1.47	2.51	3.22	2.23	2.67
Calculated Z-value	1.562		3.388*		3.329*	
Tabulated Z-value	1.96		1.96		1.96	

* Sig. at P< 0.10

5.8 Effects of Adoption of Improved Rice Production Technology on Level of Living of Members and Non-members of Rice Farmers Associations in Kaduna and Kano States

5.8.1 Analysis of savings from rice production among members and non-members of Rice Farmers Associations in Kaduna and Kano States

Adoption of improved rice production technologies was expected to have a positive effect on the amount of money saved by rice farmers. In this case the amount of money saved by the farmers was considered to be an indicator of their level of living. The test of significance of the effects of adoption of improved rice production technology on savings among members and non-members of Rice Farmers Associations in Kaduna and Kano States is presented in Table 34. The money saved by members was higher than that of non-members in Kaduna, Kano and in the pooled data though the differences were not significant. In Kaduna State, the amount saved by members was N 43,000 while that of non-members was N 31,000. The amount saved by members and non-members in Kano was higher than the figures recorded by their counterparts in Kaduna State. On an average, members of Rice Farmers Associations in Kano saved about N 80,000 compared to N 76,000 by non-members. In the pooled data, the amount saved by members was N 67,000 compared to N 60,000 by non-members. Based on this analysis, the adoption of improved rice production technology did not produce a significant difference in the level of living as indicated by the savings among members and non-members of Rice Farmers Associations in Kaduna and Kano States. In other words, membership of Rice Farmers Associations did not have a significant effect on the savings of rice farmers in the two States.

Table 34: Savings among members and non-members of Rice Farmers Associations in Kaduna and Kano States

Savings in Naira	**Kaduna**		**Kano**		**Pooled**	
	Members	**Non-members**	**Members**	**Non-members**	**Members**	**Non-members**
Mean	43,073	31,014	79,869	76,241	67,070	60,510
N=	43		90		133	
Calculated Z-value	1.264		0.279		0.723	
Tabulated Z-value	1.96		1.96		1.96	

Source: Estimates from Field Survey 2014

5.8.2 Analysis of means of transportation among members and non-members of Rice Farmers Associations in Kaduna and Kano States

Means of transportation was considered as an indicator of level of living of the farmers. Adoption of improved rice production technologies was expected to contribute to level of living of farmers over time due to enhanced productivity. The analysis of means of transportation among members and non-members of Rice Farmers Associations in Kaduna and Kano States is presented in Table 35. The score on means of transportation ranged from 0 to 1.

The means of transportation score of members was higher than that of non-members in Kaduna, Kano and in the pooled data though the differences were not significant. In Kaduna State, the score was 0.75 among members while that of non-members was 0.66. The mean transportation score observed among members and non-members in Kaduna was higher than the figures recorded by their counterparts in Kano State. On an average, members of Rice Farmers Associations in Kano had a score of 0.66 compared to 0.62 by non-members. In the pooled data, the score was 0.69 compared to 0.64 by non-members.

The results of the analysis showed that the adoption of improved rice production technology did not produce a significant difference in the level of living as indicated by the score on means of transportation among members and non-members of Rice Farmers Associations in Kaduna and Kano States. In other words, membership of Rice Farmers Associations did not have a significant effect on the means of transportation of rice farmers in the two States.

Table 35: Means of transportation score among members and non-members of Rice Farmers Associations in Kaduna and Kano States

Transportation Index	Kaduna		Kano		Pooled	
	Members	Non-members	Members	Non-members	Members	Non-members
Mean	0.75	0.66	0.66	0.62	0.69	0.64
N=	43	43	90	90	133	133
Calculated Z-value	1.325		0.841		1.495	
Tabulated Z-value	1.96		1.96		1.96	

Source: Estimates from Field Survey 2014

5.8.3 Analysis of sources of drinking water score among members and non-members of rice Farmers Associations in Kaduna and Kano States

Enhanced productivity resulting from adoption of improved rice production technologies was expected to contribute to safer source of drinking water which is an indicator of level of living among the farmers. The analysis of sources of drinking water score among members and non-members of rice Farmers Associations in Kaduna and Kano States is presented in Table 36. Maximum drinking water score obtainable was 1 and the least was 0. In Kaduna, the mean score obtained by members (0.65) was not significantly higher than that of non-members (0.58) at $P<0.05$ as the calculated Z-value (1.658) was lower than the tabulated Z-value (1.96).

In Kano, the mean drinking water scores obtained by members (0.67) and non-members (0.76) were higher than the scores for their respective counterparts in Kaduna State. The mean score among non-members of Rice Farmers Associations in Kano was significantly higher than that of members at $P<0.05$ based on the Z-test indicating that the source of drinking water among non-members was better than that of members. The pooled data showed no significant difference in the mean score among members (0.67) and non-members (0.7).

Table 36: Drinking water score among members and non-members of rice Farmers Associations in Kaduna and Kano States

Drinking water score	Kaduna		Kano		Pooled	
	Members	**Non-members**	**Members**	**Non-members**	**Members**	**Non-members**
Mean	0.65	0.58	0.67	0.76	0.67	0.70
N=	43	43	90	90	133	133
Calculated Z-value	1.658		3.571*		1.368	
Tabulated Z-value	1.96		1.96		1.96	

Source: Estimates from Field Survey 2014 * Sig. at P< 0.10

5.8.4 Analysis of household members who have completed post-secondary education among members and non-members of Rice Farmers Associations in Kaduna and Kano States

Completion of post-secondary education was seen as an indicator of level of living among the rice farmers. The analysis of household members who have completed post secondary education among members and non-members of rice Farmers Associations in Kaduna and Kano States is presented in Table 37. It was expected that the higher the number of household members who have completed post-secondary school, the better the level of living of the rice farmers. The average number of household members who completed post-secondary education among members of Rice Farmers Associations was higher than the number obtained among non-members in both States and in the pooled data. In Kaduna State, the mean figure for members (0.104) was not significantly higher than the number for non-members (0.00) at P<0.05. There was no significant difference in the mean figures for both categories of farmers in Kano State even though the figure for members was higher than that of non-members. In the pooled data, the average number of household members who had completed post-secondary education among members (0.109) was significantly higher than the number for non-members (0.029) at P<0.05 based on the outcome of the Z-test. This analysis showed a significant difference in the level of living of both groups of rice farmers as indicated by the number of household members who had completed post-secondary education among members and non-members of Rice Farmers Associations in Kaduna and Kano States.

Table 37: Household members who have completed post-secondary education among members and non-members of Rice Farmers Associations in Kaduna and Kano States

Number of Household members	Kaduna		Kano		Pooled	
	Members	Non-members	Members	Non-members	Members	Non-members
Mean	0.104	0.000	0.111	0.044	0.109	0.029
n=	43	43	90	90	133	133
Calc.Z-	1.944		1.284		2.067*	
Tab Z	1.96		1.96		1.96	

Source: Estimates from Field Survey 2014 *P< 0.10.

5.8.5 Analysis of household members with no access to formal education among members and non-members of Rice Farmers Associations in Kaduna and Kano States

Access to formal education is related to the level of living of the rice farmers. The analysis of household members with no access to formal education among members and non-members of Rice Farmers Associations in Kaduna and Kano States is presented in Table 38. It was expected that the level of living of the household would be positively influenced by the level of education of household members. The average number of household members who had not received formal education at all was higher among non-members (1.978) of Rice Farmers Associations than among members (1.063) in Kaduna State and in the pooled (1.022 and 0.790) data but the reverse was the case in Kano State where the figure for members (0.644) was higher than that of non-members (0.511). However, there were no significant differences in the number of household members who had not received formal education among members and non-members of

Rice Farmers Associations in Kano and Kaduna States in the pooled data and in the two States based on the Z-test.

This suggested that membership of Rice Farmers Associations did not have a significant effect on the level of living of rice farmers in terms of the number of household members who had not received formal education at all. This may be due to greater consideration for household members as source of farm labour by both members and non-members of Rice Farmers Associations. In a study on effects of adoption of selected rice innovations among adopters and non-adopters in Bauchi State, Fabiyi and Kushwaha (2006) found that all the non-adopters had a low standard of living while greater percentages of adopters had high and middle standard of living. In this case standard of living was not defined in terms of measurable indicators.

Table 38: Household members with no access to formal education among members and non-members of Rice Farmers Associations in Kaduna and Kano States

Number of Household members	Kaduna		Kano		Pooled	
	Members	**Non-members**	**Members**	**Non-members**	**Members**	**Non-members**
Mean	1.063	1.978	0.644	0.511	0.790	1.022
N=	43	43	90	90	133	133
Calculated Z-value	-1.385		1.029		-0.938	
Tabulated Z-value	1.96		1.96		1.96	

Source: Estimates from Field Survey 2014

5.9 Constraints on Adoption of Improved Rice Production Technology by Members and Non-members of Rice Farmers Associations in Kaduna and Kano States

5.9.1 Constraints on adoption of improved rice production technology by members and non-members of rice Farmers Associations in Kaduna State

5.9.1.1 Farmers' experience on farm inputs for rice production

The perceptions of farmers about farm inputs for rice production were characterised by high cost of farm inputs, difficulty in obtaining farm inputs, difficulty in accessing loans for the purchase of farm inputs, non-availability of seed dressing chemical, non-availability of tractor hiring services and untimely availability of fertiliser (Table 39). However, farmers were of the opinion that herbicides were easily available for their use.

5.9.1.2 Farmers' view on rice production technology development and uptake

Farmers' perceptions of improved rice production technology and development were characterised by low awareness of information on improved rice production technology, poor adoption of rice-legume rotation, failure of researchers to develop rice production technology with farmers, and poor access to improved varieties (Table 40). In addition, the farmers did not regard non-application of crop residues to rice field, lack of ownership of mobile phones and reluctance of rice farmers to try new technology, as constraints to rice production.

5.9.1.3 Farmers' observation on rice production capacity development

In terms of capacity development of rice growers, farmers agreed that hands-on trainings on use of improved rice production technology were not available to them and that there was no opportunity for them to learn and share experiences with one another. In addition they contended that adoption of improved technology was hindered by their low level of education. However, they did not see failure to operate in groups and association as a problem militating against rice production (Table 41).

5.9.1.4 Farmers' experience on marketing of rice

On marketing of rice, offering of low price of rice by middlemen was seen as a problem by farmers in addition to lack of information on market prices of rice, difficulty in selling rice at a good price by farmers and preference for imported rice by consumers (Table 42).

5.9.1.5 Farmers' view on improved rice processing capacity

On the issue of improved rice processing capacity, farmers agreed that winnowing, threshing and milling machines were not easily available for them to use (Table 43).

5.9.1.6 Analysis of farmers' opinions on issues relating to natural disaster in rice production

With respect to natural disaster in rice production, farmers affirmed that flooding of rice fields, invasion of rice field by birds and attack of rice field by other pests were major problems (Table 44).

5.9.1.7 Farmers' view on issues relating to extension service delivery

Lack of advisory services by extension agents and absence of extension agents were seen by farmer as issues for extension service delivery in rice production (Table 45).

5.9.2 Constraints on adoption of improved rice production technology by members and non-members of rice Farmers Associations in Kano State

5.9.2.1 *Farmers' experience on farm inputs for rice production*

Difficulty in accessing farm inputs including herbicides and seed dressing materials was a major constraint to rice production based on the perception of rice farmers in Kano State. However, they objected to the statements that cost of farm inputs, availability of fertiliser at the right time, and access to credit and tractor hiring services were constraints on adoption of improved rice production technology (Table 46).

5.9.2.2 *Farmers' view on rice production technology development and uptake*

The farmers perceived that awareness of improved rice production technology, failure of researchers to work with farmers in the development of rice production technology, ownership of mobile phones and poor access to improved rice varieties were major issues limiting the uptake of improved rice production technology (Table 47). Nevertheless, they opposed the perception statements that failure of farmers to apply crop residue to their fields and to practice rice legume rotation as well as farmers' conservative tendency were obstacles to adoption of improved rice production technology.

5.9.2.3 *Farmers' observation on rice production capacity development*

Farmers' perception of rice production capacity development was shaped by lack of opportunity to learn and share experiences with one another and inability of some rice farmers to operate in groups or association. They raised objections to the statements that hands-on training on use of improved rice production technology was not available to them and that low level of education made it difficult for them to adopt improved methods (Table 48).

5.9.2.4 Farmers' experience on marketing of rice

In terms of rice marketing, farmers perceived that the major constraint was lack of access to market information on rice. They did not regard offering of low price by middlemen, selling of rice at good price and consumers' preference for imported rice as challenges to rice production (Table 49).

5.9.2.5 Farmers' view on improved rice processing capacity

Contrary to expectation, farmers opposed the perception statements that threshing, winnowing and milling machines were not available for their use in the study area (Table 50).

5.9.2.6 Farmers' opinions on issues relating to natural disaster in rice production

The statements about the destruction of rice fields by birds, flooding of rice field and damage of rice field by pests as constraints to rice production in the study area were rejected by the farmers suggesting that adequate measures might have been taken to avert the problems (Table 51).

5.9.2.7 Farmers' view on issues relating to extension service delivery

Concerning extension service delivery farmers assented to the statements that there are no extension agents in the study area and hence rice farmers do not receive advisory services from them (Table 52).

Table 39: Observations of rice farmers in Kaduna State on issues relating to farm inputs for rice production

Issue	Frequency				Total	Weighted Sum				Total	Weighted Mean	Remark
	Strongly Agree	Agree	Disagree	Strongly Disagree		Strongl y Agree	Agree	Disagree	Strongly Disagree			
1.Farm inputs are expensive	21(21.88)	59(61.46)	16(16.67)	0(0.00)	96(100)	84	177	32	0	293	3.05	Agree
2.Farm inputs are very difficult to obtain	7(7.29)	64(66.67)	24(25.00)	1(1.04)	96(100)	28	192	48	1	269	2.80	Agree
3. Farmers find it very hard to obtain loans for the purchase of farm inputs	52(54.17)	38(39.58)	5(5.21)	1(1.04)	96(100)	208	114	10	1	333	3.47	Agree
4. Seed dressing materials are not available for farmers to use	7(7.29)	49(51.04)	39(40.63)	1(1.04)	96(100)	28	147	78	1	254	2.65	Agree
5. Herbicides are not easily available for farmers to use	6(6.25)	33(34.38)	56(58.33)	1(1.04)	96(100)	24	99	112	1	236	2.46	Disagree
6. Tractor hiring services for land preparation are not available	13(13.54)	43(44.79)	39(40.63)	1(1.04)	96(100)	52	129	78	1	260	2.71	Agree
7. Fertilisers are not available at the right time for rice farmers to use	47(48.96)	42943.75)	6(6.25)	1(1.04)	96(100)	188	126	12	1	327	3.41	Agree

Figures in parenthesis are percentages. Source: Estimates from field survey (2014)

Table 40: Observations of rice farmers in Kaduna State on issues relating to rice production technology development and uptake

Issue	Frequency					Weighted Sum				Total	Weighted Mean	Remark
	Strongly Agree	Agree	Disagree	Strongly Disagree	Total	Strongly Agree	Agree	Disagree	Strongly Disagree			
1. Farmers are not aware of information on improved rice production technology	8(8.33)	52(.17)	36(37.50)	0(0.00)	96(100)	32	156	72	0	260	2.71	Agree
2. Farmers do not apply crop residues to their rice fields	1(1.04)	28(29.17)	67(69.79)	0(0.00)	96(100)	4	84	134	0	222	2.31	Disagree
3. Farmers do not practice rice-legume rotation	9(9.38)	33(34.38)	51(54.13)	3(3.13)	96(100)	36	99	102	3	240	2.50	Agree
4. Researchers did not work with farmers to develop rice production technology	22(22.92)	53(55.21)	19(19.79)	2(2.08)	96(100)	88	159	38	2	287	2.99	Agree
5. Farmers do not have mobile phones	4(4.17)	33(34.38)	50(52.08)	9(9.38)	96(100)	16	99	100	9	224	2.33	Disagree
6. Farmers are used to local methods of growing rice and do not want to try modern methods	3(3.13)	45(46.88)	39(40.63)	9(9.38)	96(100)	12	135	78	9	234	2.44	Disagree
7. Farmers do not have access to improved rice varieties	11(11.46)	50(52.08)	34(35.42)	1(1.04)	96(100)	44	150	68	1	263	2.74	Agree

Table 41: Observations of rice farmers in Kaduna State on issues relating to rice production capacity development

Issue	**Frequency**				**Total**	**Weighted Sum**				**Total**	**Weighted Mean**	**Remark**
	Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**		**Strongly Agree**	**Agree**	**Disagree**	**Strongly Disagree**			
1. Hands on trainings on use of improved rice production technology are not available to farmers	13(13.54)	66(68.75)	16(16.67)	1(1.04)	96(100)	52	198	32	1	283	2.94	Agree
2. Rice farmers do not operate in groups or associations	1(1.04)	28(29.19)	61(63.54)	6(6.25)	96(100)	4	84	122	6	216	2.25	Disagree
3. No opportunity for farmers to learn and share experiences with one another	5(5.21)	41(42.71)	49(51.04)	1(1.04)	96(100)	20	123	98	1	242	2.52	Agree
4. Low level of education makes it difficult for farmers to adopt improved methods	17(17.71)	70(72.92)	8(8.33)	1(1.04)	96(100)	68	210	16	1	295	3.07	Agree

Figures in parenthesis are percentages. Source: Estimates from field survey (2014)

Table 42: Observations of rice farmers in Kaduna State on issues relating to marketing of rice

Issue	Frequency				Total	Weighted Sum				Total	Weighted Mean	Remark
	Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**		**Strongly Agree**	**Agree**	**Disagree**	**Strongly Disagree**			
1.Middlemen offer low price to farmers for their rice	33(34.38)	55(57.29)	8(8.33)	0(0.00)	96(100)	132	165	16	0	313	3.26	Agree
2.Rice farmers do not have information about market prices of rice	7(7.29)	70(72.92)	19(19.97)	0(0.00)	96(100)	28	210	38	0	276	2.88	Agree
3.Farmers cannot sell their rice at a good price	18(18.75)	69(71.88)	9(9.38)	0(0.00)	96(100)	72	207	18	0	297	3.09	Agree
4.Consumers prefer imported rice to rice grown locally	22(22.92)	37(38.54)	26(27.08)	11(11.46)	96(100)	88	111	52	11	262	2.73	Agree

Table 43: Observations of rice farmers in Kaduna State on issues relating to improved rice processing capacity

Issue	Frequency				Total	Weighted Sum				Total	Weighted Mean	Remark
	Strongly Agree	Agree	Disagree	Strongly Disagree		Strongly Agree	Agree	Disagree	Strongly Disagree			
1.Threshing machine are not available for threshing of rice paddy	22(22.92)	59(61.46)	15(15.63)	0(0.00)	96(100)	88	177	30	0	295	3.07	Agree
2.Machines are not available for winnowing of rice	28(29.17)	56(58.33)	11(11.46)	1(1.04)	96(100)	112	168	22	1	303	3.16	Agree
3.Milling machines are not available for milling rice	9(9.38)	46(47.92)	35(36.46)	6(6.25)	96(100)	36	138	70	6	250	2.60	Agree

Figures in parenthesis are percentages. Source: Estimates from field survey (2014)

Table 44: Observations of rice farmers in Kaduna State on issues relating to natural disaster and rice production

Issue	Frequency				Total	Weighted Sum				Total	Weighted Mean	Remark
	Strongly Agree	Agree	Disagree	Strongly Disagree		Strongly Agree	Agree	Disagree	Strongly Disagree			
1.Rice fields often get flooded	23(23.96)	49(51.04)	22(22.92)	2(2.08)	96(100)	92	147	44	2	285	2.97	Agree
2.Rice fields are often destroyed by pests	4(4.17)	80(83.33)	10(10.42)	2(2.08)	96(100)	16	240	20	2	278	2.90	Agree
3.Rice fields are	3(3.13)	78(81.25)	13(13.54)	2(2.08)	96(100)	12	234	26	2	274	2.85	Agree

often attacked by birds

Table 45: Observations of rice farmers in Kaduna State on issues relating to extension service delivery

Issue	**Frequency**				**Total**	**Weighted Sum**				**Total**	**Weighted Mean**	**Remark**
	Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**		**Strongly Agree**	**Agree**	**Disagree**	**Strongly Disagree**			
1.Extension agents do not provide advisory services on rice to farmers in my area	12(12.50)	45(46.88)	37(38.54)	2(2.08)	96(100)	48	135	74	2	259	2.70	Agree
2.There are no extension agents in my area	16(16.67)	35(36.46)	42(43.75)	3(3.13)	96(100)	64	105	84	3	256	2.67	Agree

Figures in parenthesis are percentages. Source: Estimates from field survey (2014)

Table 46: Observations of rice farmers in Kano State on issues relating to farm inputs for rice production

Issue	Frequency				Total	Weighted Sum				Total	Weighted Mean	Remark
	Strongly Agree	Agree	Disagree	Strongly Disagree		Strongly Agree	Agree	Disagree	Strongly Disagree			
1.Farm inputs are expensive	0	31	111	38	180	0	93	222	38	353	1.96	Disagree
2.Farm inputs are very difficult to obtain	7	128	40	5	180	28	384	80	5	497	2.76	Agree
3.Farmers find it very hard to obtain loans for the purchase of farm inputs	4	14	49	113	180	16	42	98	113	269	1.49	Disagree
4.Seed dressing materials are not available for farmers to use	5	135	32	7	179	20	405	64	7	496	2.77	Agree
5.Herbicides are not easily available for farmers to use	20	138	18	3	179	80	414	36	3	533	2.98	Agree
6.Tractor hiring services for land preparation are not available	12	39	28	97	176	48	117	56	97	318	1.81	Disagree
7.Fertilisers are not available at the right time for rice farmers to use	6	17	49	107	179	24	51	98	107	280	1.56	Disagree

Figures in parenthesis are percentages. Source: Estimates from field survey (2014)

Table 47: Observations of rice farmers in Kano State on issues relating to rice production technology development and uptake

Issue	Frequency				Total	Weighted Sum				Total	Weighted Mean	Remark
	Strongly Agree	Agree	Disagree	Strongly Disagree		Strongly Agree	Agree	Disagree	Strongly Disagree			
1.Farmers are not aware of information on improved rice production technology	3	120	47	9	179	12	360	94	9	475	2.65	Agree
2.Farmers do not apply crop residues to their rice fields	5	66	28	81	180	20	198	56	81	355	1.97	Disagree
3.Farmers do not practice rice-legume rotation	8	37	36	99	180	32	111	72	99	314	1.74	Disagree
4.Researchers did not work with farmers to develop rice production technology	5	140	10	24	179	20	420	20	24	484	2.70	Agree
5.Farmers do not have mobile phones	19	139	8	13	179	76	417	16	13	522	2.92	Agree
6.Farmers are used to local methods of growing rice and do not want to try modern methods	9	76	71	24	180	36	228	142	24	430	2.39	Disagree
7.Farmers do not have access to improved rice varieties	3	150	22	4	179	12	450	44	4	510	2.85	Agree

Table 48: Observations of rice farmers in Kano State on issues relating to rice production capacity development

Issue	Frequency				Total	Weighted Sum				Total	Weighted Mean	Remark
	Strongly Agree	Agree	Disagree	Strongly Disagree		Strongly Agree	Agree	Disagree	Strongly Disagree			
1.Hands on trainings on use of improved rice production technology are not available to farmers	1	83	86	9	179	4	249	172	9	434	2.42	Disagree
2.Rice farmers do not operate in groups or associations	38	57	85	0	180	152	171	170	0	493	2.74	Agree
3.No opportunity for farmers to learn and share experiences with one another	13	91	74	2	180	52	273	148	2	475	2.64	Agree
4.Low level of education makes it difficult for farmers to adopt improved methods	0	20	127	33	180	0	60	254	33	347	1.93	Disagree

Figures in parenthesis are percentages. Source: Estimates from field survey (2014)

Table 49: Observations of rice farmers in Kano State on issues relating to marketing of rice

Issue	Frequency				Total	Weighted Sum				Total	Weighted Mean	Remark
	Strongly Agree	Agree	Disagree	Strongly Disagree		Strongly Agree	Agree	Disagree	Strongly Disagree			
1.Middlemen offer low price to farmers for their rice	0	13	44	123	180	0	39	88	123	250	1.39	Disagree
2.Rice farmers do not have information about market prices of rice	1	113	48	18	180	4	339	96	18	457	2.54	Agree
3.Farmers cannot sell their rice at a good price	1	25	34	117	177	4	75	68	117	264	1.49	Disagree
4.Consumers prefer imported rice to rice grown locally	6	43	10	121	180	24	129	20	121	294	1.63	Disagree

Table 50: Observations of rice farmers in Kano State on issues relating to improved rice processing capacity

Issue	Frequency				Total	Weighted Sum				Total	Weighted Mean	Remark
	Strongly Agree	Agree	Disagree	Strongly Disagree		Strongly Agree	Agree	Disagree	Strongly Disagree			
1.Threshing machine are not available for threshing of rice paddy	3	41	15	121	180	12	123	30	121	286	1.59	Disagree
2.Machines are not available for winnowing of rice	1	41	19	119	180	4	123	38	119	284	1.58	Disagree
3.Milling machines are not available for milling rice	18	48	10	104	180	72	144	20	104	340	1.89	Disagree

Figures in parenthesis are percentages. Source: Estimates from field survey (2014)

Table 51: Observations of rice farmers in Kano State on issues relating to natural disaster and rice production

Issue	Frequency				Total	Weighted Sum				Total	Weighted Mean	Remark
	Strongly Agree	Agree	Disagree	Strongly Disagree		Strongly Agree	Agree	Disagree	Strongly Disagree			
1.Rice fields often get flooded	4	48	23	105	180	16	144	46	105	311	1.73	Disagree
2.Rice fields are often destroyed by pests	0	40	36	104	180	0	120	72	104	296	1.64	Disagree
3.Rice fields are often attacked by birds	0	24	53	103	180	0	72	106	103	281	1.56	Disagree

Table 52: Observations of rice farmers in Kano State on issues relating to extension service delivery

Issue	Frequency				Total	Weighted Sum				Total	Weighted Mean	Remark
	Strongly Agree	Agree	Disagree	Strongly Disagree		Strongly Agree	Agree	Disagree	Strongly Disagree			
1.Extension agents do not provide advisory services on rice to farmers in my area	31	144	4	1	180	124	432	8	1	565	3.14	Agree
2.There are no extension agents in my area	27	144	2	5	178	108	432	4	5	549	3.08	Agree

Figures in parenthesis are percentages. Source: Estimates from field survey (2014)

CHAPTER 6

SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Summary

The study investigated the adoption of improved rice production technology among members and non-members of Rice Farmers Associations in Kano and Kaduna States, North-West Nigeria. This was against the backdrop of divided conclusions from previous studies about the beneficial effects or otherwise of membership of Rice Farmers Associations on adoption of improved rice production technology and rice yield. Moreover, it is important to have empirical evidence in support of the current emphasis on formation of cooperative groups among rice farmers in Kano and Kaduna States as a strategy for promoting increased productivity and ultimately better level of living.

Multi-stage sampling procedure was used to select 133 members of Rice Farmers Associations and 133 non-members giving a total of 266 purposively and randomly selected respondents from Kano and Kaduna States. Data collected were analysed using descriptive statistics, Z-test, Chi-Square (X^2) and Tobit Regression analysis.

The pooled results of the analysis of the socioeconomic characteristics of members and non-members of Rice Farmers Associations showed that 70% of members were married and 29% single whereas 68% of non-members were married and 30% single. Male respondents were 80% and female 20% among members. Non-members had 78% male respondents and 22% female respondents. Mean age of respondents was 42 years among members and 40 years among non-members. Average number of householders involved in farm work was 3.43 among members and 3.01 among non-members. The mean years of experience in rice farming was 17.48 among members and 12.07 among non-members. In terms of years in formal education, 44% of members and 42% of non-members had no formal education while 19.5% of members and 17% of non-members had primary school education. Only 29.3% of members and 38% of non-members had secondary school education. Average size of rice field was 3.93 hectares among members and 2.59 hectares among non-members. Users of mobile phones constituted 89% among members and 86% among non-members. Apart from size of rice field and years of experience in rice farming no significant differences were observed in other socioeconomic characteristics among members and non-members of Rice Farmers Associations.

In terms of institutional characteristics, there were significant differences in amount of credit received and access to extension agents among members and non-members. Members had access to more credit (N 51,725) than non-members (N 21,229) and members had more access (75%) to extension agents than non-members (56%). With the exception of amount of credit received and access to extension agent, no significant differences were observed in the institutional characteristics of members and non-members such as awareness of GESS, registration for GESS and access to GESS improved seeds and fertiliser.

Access to GESS improved seeds and fertiliser was not influenced by membership of Rice Farmers Associations. Awareness of GESS was 91% among members and 93% among non-members while 83% of members and 85% of non-members registered for GESS. About 83% of members and 80% of non-members had access to GESS seeds and fertiliser.

The most important source of information on rice production among members of Rice Farmers Associations in the study area was radio (17.3%) followed by other farmers (16.4%), and extension agent (13.3%). Non-members had radio as the most important source with (20.8%) followed by other farmers (18.3%) and farmers' leader (17.6%). This showed that radio, other farmers, extension agent and farmers' leader were the preferred sources of information on rice production among rice farmers in the study area.

With respect to overall awareness of improved rice production technologies the mean awareness index obtained among members (0.78) was significantly higher than that of non-members (0.74) meaning that members of Rice Farmers Associations were more aware of improved rice production technologies than non-members. However, no significant differences were observed in the awareness of each improved rice production technology among members and non-members of Rice Farmers Associations in the study area.

Of the 13 improved rice production technologies the level of adoption was high in 7 among members as they were adopted by over 70% of the respondents. These included: use of tractor for land preparation, planting of improved rice variety, seed dressing with agrochemical, use of herbicide for clearing, use of herbicide for weed control in rice fields, basal NPK fertiliser application and top dressing with urea. Adoption of rice crop residue as manure and use of rice milling machine among members was observed to be average as the technologies were adopted by 50 to 69% of the respondents. Sorting of rice seeds for planting, rice-legume rotation, use of mechanical thresher and use of mechanical winnower were adopted by less than 50% of the respondents and hence the level of adoption was classified as low. In the case of non-members, the extent of adoption was high for the same technologies with high level of adoption among members. The extent of adoption was low for use of crop residue as manure and rice milling machine in addition to the same technologies with low level of adoption among members.

There were significant differences in the overall adoption of improved rice production technologies as members were found to be better in adoption of the technology than non-members. This might be attributed to better access to credit facilities and extension service delivery. There were no significant differences in the utilisation of NPK fertiliser among members and non-members in Kaduna, Kano and in the pooled data though non-members used more NPK than members in Kano and in the pooled data while members used more NPK than non-members in Kaduna. The average number of bags of Urea used by members was significantly higher than that of non-members in Kaduna, Kano and in the pooled data. On the other hand, the average quantity of herbicide used by members was significantly higher than that of non-members in Kano and in the pooled data while no significant difference was observed among members and non-members in Kaduna.

There were no significant differences in the adoption of each improved rice production technology among members and non-members even though adoption was greater among members (65%) than non-members (58%).

Age of farmers, marital status, household size, years spent in rice cultivation, access to extension agent and amount of credit were the socio-economic and institutional characteristics that were significant in explaining the adoption of improved rice production technology in the pooled data from members and non-members of Rice Farmers Associations in Kaduna and Kano States.

In Kaduna, rice yield per hectare obtained among members was higher than that of non-members but not significantly different while in Kano, non-members had significantly higher rice yield than members Conversely to theoretical expectation, rice yield obtained by non-members (2.67 tons/ha) in the pooled results was found to be significantly higher than that of members (2.23 tons/ha). Rice Farmers Associations in the study area appear to exist in names alone and may not delivering services that will add value to the members.

Apart from household members with completion of post-secondary education, no significant differences were observed in the effects of adoption on level of living among members and non-members of Rice Farmers Associations. Other indicators of level of living examined included: income, savings, means of transportation, source of drinking water and household members with no formal education.

6.2 Conclusion

The level of adoption was high in 7 out of the 13 improved rice production technologies as they were adopted by over 70% of the respondents. These included: use of tractor for land preparation, planting of improved rice variety, seed dressing with agrochemical, use of herbicide for clearing, use of herbicide for weed control in rice fields, basal NPK fertiliser application and top dressing with urea. Adoption of rice crop residue as manure and use of rice milling machine among members was observed to be average as the technologies were adopted by 50 to 69% of the respondents. Sorting of rice seeds for planting, rice-legume rotation, use of mechanical thresher and use of mechanical winnower were adopted by less than 50% of the respondents and hence the level of adoption was classified as low. In the case of non-members, the extent of adoption was high for the same technologies with high level of adoption among members. The level of adoption was low for use of crop residue as manure and rice milling machine in addition to the same technologies with low level of adoption among members.

The results from the study showed that members of Rice Farmers Associations in the study area were better than non-members in terms of overall awareness and adoption of improved rice production technologies. This might be attributed to better access to extension agents and agricultural credit by members. However, the superiority of members over non-members with respect to adoption of improved rice production technologies did not lead to better rice yield per hectare. The study has shown that the capacity of Rice Farmers Associations must be strengthened for them to embark on activities that will enhance the productivity of their members. The associations appear to exist in names only and not in delivering of services that would add value to their members. Apart from access to formal education by household members, adoption of improved rice production technology did not produce significant differences in level of living among members and non-members as indicated by other effect variables.

6.3 Recommendations

The implications of the major findings from the study are as follows:

(i.) There is a need for business development support for Rice Farmers Associations in the study area. The study has shown that encouraging rice farmers to form groups is not necessarily a panacea for increased productivity. The argument that farmers who belong to associations are better able to access farm inputs such as fertilisers, herbicides and improved seeds is no longer a strong case. In the current scheme of things a rice farmer does not have to belong to an association to access improved seeds and fertiliser through GESS. The Federal Ministry of Agriculture and other relevant State agencies should ensure that existing Rice Farmers Associations are equipped with appropriate business development skills beyond provision of farm inputs to ensure that rice farmers gain access to formal markets and derive maximum benefits from membership of Rice Farmers Associations.

(ii). More attention should be given to recommended practices on improved rice production technology with low adoption. The National Agricultural Extension System should raise awareness of the recommendations on rice-legume rotation, sorting of rice seeds for planting as well as mechanised rice harvesting and processing as the study confirmed that the adoption of these recommended practices was low among rice farmers in the two States. An innovative participatory extension approach like the Farmers Field School can be introduced to enhance adoption of improved rice production technologies.

(iii) In view of the importance of farmers' access to information on rice production, the most important sources of information identified in the study should be equipped to facilitate technical knowhow on rice production among rice farmers. These sources of information included radio, other farmers, farmers' leader and extension agent. A combination of these sources will work better for farmers than one source.

(iv) The study has shown that access to credit is a major catalyst for adoption of improved rice production technology by farmers and higher rice yield. In this regard, it is recommended that the Federal Government and other relevant agencies should develop innovative approaches for ensuring that members of Rice Farmers Associations are better able to access agricultural credit for increased production. Private sector entities that are involved contractual agreement with rice farmers such as buy-back and out-growers scheme should be encouraged to provide farm inputs to farmers on credit to boost their farm production.

(v). The Federal Government of Nigeria and other relevant agencies should invest more in infrastructural development of rural communities as the study has shown that adoption of improved rice production technology alone did not deliver appreciable difference in the level of living of rice farmers.

6.4 Contributions to knowledge

The study established that:

(i) The mean adoption index of improved rice production technologies among members of rice farmers associations is (0.65) higher than non-members (0.38).

(ii) Adoption of improve rice production technologies has cause an average increase in rice output from 1.43 ton/ha to 2.33 tons/ha among members of rice farmers associations in both Kano and Kaduna States.

(iii) Adoption of improve rice production technologies has increased the income of participants rice farmers by 65% than non-member of rice farmers association in both Kano and Kaduna States.

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APPENDIX

QUESTIONNAIRE FOR MEMBERS AND NON-MEMBERS OF RICE FARMERS ASSOCIATIONS

Department of Agricultural Economics and Rural Sociology, Faculty of Agriculture, Ahmadu Bello University, Zaria

Dear Sir/Madam,

I am a postgraduate student of Ahmadu Bello University, Zaria, currently working on the following topic **"Adoption of Improved Rice Production Technologies by members and non-members of Rice Farmers Associations in Kaduna and Kano States, North-West Nigeria"**

Kindly answer the following research questions in respect to this work. Your responses will be treated with confidentiality.

Yours sincerely,

OLUYEMI ADELEYE

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SECTION A

1.0 <u>Socioeconomic characteristics of farmers</u>

1.1 Age of farmer: (   )   1.2 Sex: Male (   )   Female (   )

1.3 Marital Status:

Single	Married	Separated	Widow	Widower

1.4 Religion:

Christianity	Islam	Traditional	None

1.5 How many people are in your household? (   )

1.6 How many members of your household work with you on the farm? (   )

1.7 For how long have you been planting rice? (   )

1.8 What is your level of education?

No formal	Incomplete	Complete	Incomplete	Complete	Tertiary

education	Primary education	Primary education	Secondary education	Secondary education	education

1.9 How many years have you spent in formal education? (   )

1.10 Which of the following associations do you belong to?

Rice Farmers' Association	Cooperative and Thrift Society	Community Development Association	All Farmers' Association	Others (Specify)	None

1.11 What is your major occupation?

Trading	Farming	Fishing	Civil Servant	Others (specify).............	

1.12 What is your secondary occupation? (   )

1.13 Which crop is the most important source of income for your household?
(   )

1.14 Which crop is the most important source of food for your household?
(   )

1.15 Do you grow other crops apart from rice? Yes ( ) No ( )

1.16 What was the Size of your rice field in hectare in 2013 cropping season? (   )

1.17 How did you obtain the land you are using for rice cultivation?

Inheritance	Purchase	Lease	Gift	Others specify....................

1.18 Has there been a change in the area of your rice field since 2012?

No change in area of rice field	Increase in area of rice field	Decrease in area of rice field

1.19 What are the sources of labour for your field work on rice?

Household labour alone	Household plus hired labour	Hired labour alone	Other farmers

1.20 What was the total milled rice harvest (no of 100kg bags) from 2013 cropping season?
(   )

1.21 What proportion of your total rice harvest from 2013 did you sell for cash?

All	More than half	Half	Less than half	None

1.22 Does an extension agent from Kaduna ADP visit you?
Yes ( ) No ( )

1.23 If the answer to 1.22 is yes, how many times did the extension agent visit you in 2013 cropping season? ( )

1.24 Did you obtain credits for your farm activities the last cropping season?
Yes ( ) No ( )

1.25 If the answer to 1.24 is yes, what were the sources of the credit?

Personal savings	Relatives	Cooperative	Local money lender	Bank	None

1.26 What was the amount of credit? ( )

1.27 Do you have a mobile phone?
Yes ( ) No ( )

1.28 Are you aware of the Government programme that gives subsidised fertiliser and improved rice seeds to farmers through information received by mobile phone?
Yes ( ) No ( )

1.29 If the answer to 1.28 is yes, did you register for the Government programme that gives subsidised fertiliser and improved rice seed to farmers through information received by mobile phone?
Yes ( ) No ( ) I do not know how to register ( )

1.30 If the answer to 1.29 is yes, did you receive subsidised fertiliser and rice seeds from the Government through information received by mobile phone?
Yes ( ) No ( )

1.31 Type of rice production system

Upland	Lowland	Irrigated

1.32 Source of rice seeds planted

Previous harvest	Input supplier	Extension agent	Market	Other farmers	Seed company

1.33 How do you store your rice?

Silo	Bags	Rhombus	Drums	Not applicable

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SECTION B

2.0 Sources of information and awareness of rice production recommended practices

2.1 Which of the recommended practices on improved rice production technology are you aware of?

Improved rice production technology	Not aware	Aware
a. Use of tractor for land preparation		
b. Use of improved variety		
c. Sorting of seeds for planting		
d. Use of seed dressing chemical		
e. Herbicide application for land clearing before planting of rice		
f. Herbicide application for weed control after planting rice (pre-emergence)		
g. Basal NPK fertiliser application		
h. Top dressing with urea fertiliser		
i. Use of crop residues as manure		
j. Rice-legume rotation		
k. Use of mechanical thresher		
l. Use of mechanical winnower		
m. Use of rice milling machine		

2.2 Do you receive information on rice production and processing through the following sources?

Source of information	**Yes ( )**	**No ( )**
1. Radio		
2. Television		
3. Extension agent		
4. Input supplier		
5. Newspaper		
6. Field day		
7. Agricultural show		
8. Other farmers		
9. Farmers' Leader		
10.Mobile phone		
11. Farmers' Association		

2.3 (If the answer is Yes in 2.2) How often do you receive information on rice production and processing through the following sources?

Source of information	**How often does the farmer receive information through each source?**					
	Every week	**Once or twice in a month**	**3 to 4 times in a year**	**Twice in a year**	**Once in a year**	**Never**
1. Radio						
2. Television						

3.Extension agent						
4. Input supplier						
5. Newspaper						
6. Field day						
7.Agricultural show						
8.Other farmers						
9.Farmers' Leader (*Serikin numa)*						
10.Mobile phone						
11Farmers' Association						

2.4 Did you attend any farmers' training on rice production and processing from 2012 to 2013 cropping season? Yes ( ) No ( )

2.5 If the answer to 2.4 is yes, how many times did you attend farmers' training on rice production and processing from 2012 to 2013 cropping season? ( )

2.5 Did you meet with other rice farmers in your area to discuss about rice production and processing from 2012 to 2013 cropping season? Yes ( ) No ( )

2.6 If the answer to 2.5 is yes, how many times did you meet with other rice farmers in your area to discuss about rice production and processing from 2012 to 2013 cropping season?

( )

....

SECTION C

3.0 Adoption of recommended practices on improved rice production technology by farmers

3.1 Which of the recommended practices on improved rice production technology do you adopt on a regular basis?

Rice production technology	Yes ( )	No ( )
a. Tractor for land preparation		
b. Improved rice variety		
c. Sorting of seeds for planting		
d. Seed dressing material		
e. Herbicide for land clearing		
f. Herbicide for weed control after planting rice (pre-emergence)		
g. Basal NPK fertiliser application		
h. Urea fertiliser application (Top dressing)		
i. Rice crop residues as manure		
j. Rice-legume rotation		
k. Mechanical thresher		

l. Mechanical winnower		
m.Rice milling machine		

SECTION D

5.0 Effects of adoption of improved rice production technology on yield and income.

5.1 How many milled rice bags of 100kg capacity did you harvest from your rice fields in 2013 cropping season? (   )

5.2 How much did you sell a bag of rice in 2013 cropping season? (   )

5.3 How many bags of milled rice of 100 kg capacity did you harvest from your rice field in 2012?

(   )

5.4 How much did you sell a bag of rice in 2012 cropping season? (   )

5.5 How will you compare the quantities of inputs you used in 2013 cropping season with those of 2012 cropping season?

Input used in **2012 rice cropping season** (if any)	Quantity of input used in **2012 rice cropping season**	Input used in **2013 rice cropping season** (if any)	Quantity of input used in **2013 rice cropping season**
Improved seeds (kg)			
NPK fertiliser(No of bags)			
Urea fertiliser (No of bags)			
Herbicide (No of Litres)			
Credit			
Farm Size (Hectare)			

6.0 Effects of rice production on level of living of farmers

6.1 What type of transportation facility do you have?

None	Bicycle	Motorcycle	Car	Truck

6.2 What is the source of drinking water in your household?

Borehole	Protected well	Unprotected well	River/stream	Rain

6.3 What kind of ICT facilities do you possess?

None	Radio	Television	Mobile Phone	Video player

6.4 How many members of your household are in primary school? (   )

6.5 How many members of your household have completed primary school education?
(   )

6.6 How many members of your household are in secondary school? (   )

6.7 How many members of your household have completed secondary school? (   )

6.8 How many members of your household are in post-secondary school? (   )

6.9 How many members of your household have completed post-secondary school education?
(   )

6.10 How many members of your household have not attended formal school at all?
(   )

6.11 Have you saved money for growing rice in the 2014 cropping season?
Yes (   )   No (   )

6.12 If the answer to 6.11 is yes, how much have you saved for growing rice in 2014?
(   )

6.13 If the answer to 6.11 is yes, is the money you have saved enough to buy all the inputs you will need for cultivating rice in the 2014 cropping season?
Yes (   )   No (   )

6.14 Did you fall sick throughout last year? Yes (   )   No (   )

6.15 If the answer to 6.13 is yes, how many times did you fall sick last year? (   )

6.16 Did any member of your household fall sick throughout last year? Yes (   ) No (   )

6.17 How many members of your household fell sick last year? (   )

....

SECTION E

7.0 Problems militating against adoption of improved rice production technology and suggestions for improvement

7.1 What do you see as the problems militating against the adoption of improved rice production technology in your area?

Problem militating against adoption of improved rice production technology	**Perception of farmer**			
	Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**
1. Extension agents do not provide advisory services on rice to farmers in my area				
2. Farm inputs are expensive				
3. Farm inputs are very difficult to obtain				
4. Farmers find it very hard to obtain loans for the purchase of farm inputs				
5. Hands on trainings on use of improved rice production technology are not available to farmers				
6. Farmers are not aware of information on improved rice production technology				
7. Farmers do not have access to improved rice varieties				
8. Tractor hiring services for land preparation are not available				
9. Fertilisers are not available at the right time for rice farmers to use				
10. Seed dressing materials are not available for farmers to use				
11. Farmers do not apply crop residues to their rice fields				
12. Herbicides are not easily available for farmers to use				
13. Farmers do not practice rice-legume rotation				
14. There are no extension agents in my area				
15. Researchers did not work with farmers to develop rice production technology				
16. Farmers do not have mobile phones				
17. Rice fields often get flooded				
18. Rice fields are often destroyed by pests				
19. Rice fields are often attacked by birds				
20. Farmers cannot sell their rice at a good price				
21. Threshing machine are not available for threshing of rice paddy				
22. Machines are not available for				

winnowing of rice				
23. Milling machines are not available for milling rice				
24. Consumers prefer imported rice to rice grown locally				
Problem militating against adoption of improved rice production technology	**Perception of farmer**			
	Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**
25. Rice farmers do not operate in groups or associations				
26. No opportunity for farmers to learn and share experiences with one another				
27. Middlemen offer low price to farmers for their rice				
28. Rice farmers do not have information about market prices of rice				
29. Low level of education makes it difficult for farmers to adopt improved methods				
30. Farmers are used to local methods of growing rice and do not want to try modern methods				

Other comments..................

Thank You.