NIGERIAN AGRICULTURAL JOURNAL
ISSN: 0300-368X
Volume 55 Number 1, April 2024 Pg. 161-170
Available online at: http://www.ajol.info/index.php/naj
https://www.naj.asn.org.ng

Adoption of Improved Production Technologies among Rice Farmers in Wase Local Government Area, Plateau State, Nigeria

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Abstract

This study assessed the adoption of improved production technologies among rice farmers in Wase Local Government Area of Plateau State, Nigeria. A multistage sampling technique was used in the selection of 160 respondents for the study. Descriptive statistics, a four-point Likert scale and Logit regression were used to achieve the objectives of the study. Findings from the study revealed the farmers were 40 years old on average. A greater percentage (67%) of the farmers was men and 91% of them were married. About 44% of the respondents attained secondary level of education and had a mean farming experience of 8 years. More than half (64%) of the respondents major occupation was farming, which they practiced on average farm sizes of 1.6 hectares. The mean annual income of the farmers was estimated at N 202, 356. Improved rice production technologies, such as appropriate time of harvesting (3.44), land preparation by tractors (3.42), recommended time of weeding (3.41), appropriate planting dates (3.25), use of herbicides (3.24), improved seed varieties (3.11), application of recommended fertilizer (3.05), nursery practice and transplanting (2.73) all had high levels of awareness and adoption respectively among the farmers. Age, educational status, farming experience, farm size, extension contact and annual income were significant determinants of adoption of improved rice production technologies. High cost of technology (69%), inadequate extension contact (61%), and inadequate credit access (48%) and lack of accessibility of some technologies (28.0) were identified as the major constraints to the adoption of improved rice production technologies. The study recommended the subsidization of inputs (improved seeds, fertilizers and agro-chemicals) by the government to reduce the cost of production.

Keywords: Adoption, improved production technologies, rice farmers

Introduction

Rice (Oryza Sativa) is a cereal crop which has become a staple food of considerable strategic importance in many developing and many developed countries, where its consumption among urban and rural poor households has increased considerably (Abubakar *et al.*, 2016; Ajala and Gana, 2015; WARDA, 2010). According to the West Africa Rice Development Association (WARDA, 2003), it is the second most important cereal crop in the world after wheat in terms of production. It has held a major place over the years as a critical crop for the food security and economic growth of countries around the world. According to FAO (2000), over 50% of the global population relies on the crops for about 80% of their food needs. However, local consumption of rice in Africa is substantially higher than domestic production, requiring more imports that take up a significant portion of the country's meagre foreign exchange reserves (Buah *et al*., 2011). African local production has not been able to keep up with the rate of increase in demand. Over the course of the last 50 years, Africa has expanded its rice production from approximately 3.14 million metric tonnes to 14.60 million tonnes. The majority of this gain in output comes from an extension of the crop's planted area rather than from higher yields (Buah *et al*., 2011). Rice is still produced and consumed in large quantities in Sub-Saharan Africa. Despite being the biggest rice producer in West Africa, Nigeria nevertheless imports a significant amount of rice. In 2009, the average annual production of rice in Nigeria was 2.21 million tonnes, whereas the country's anticipated annual need was 5 million tonnes. The goal of importation, according to the National Rice Development Strategy (NRDS, 2009), is to close the 2.79 million tonnes national rice supply-demand gap, which has been a major financial burden on the nation. Nigeria's mismatch in rice supply and demand is taking a long time to correct for a number of reasons. These factors include competition from imported rice, a dearth of rice varieties with high yields and good grain quality and a slow pace of improvement in best practices. Additional reasons include problems with weeds, insect pests, disease problems, birds, poor land preparation, inconsistent and uneven rainfall distribution, and a lack of training for important stakeholders (Dontsop-Nguezet *et al*., 2011). Low input and crop management practices used by small-scale rice farmers, along with a deficiency in water control techniques, further limit local production. Nigeria can produce enough rice on its own since almost all the country's ecologies are suitable for growing rice. Nigeria has a large disparity between its production and consumption of rice, therefore increasing domestic production is crucial.

Over time, rice consumption in sub-Saharan Africa has increased, more than tripling the rate of population growth, due to factors such as shifting food preferences in both urban and rural areas, high rates of population growth, and rapid urbanization (Food and Agricultural Organization (FAO), 2011). Since the mid-1970s, Nigeria's demand for rice has been growing significantly faster than that of other West African nations (Dontsop and Diagne, 2010). Nigeria's yearly milled rice demand is estimated by the Food and Agricultural Organization of the United States to be 5 million tonnes, compared to the country's paddy production of roughly 4.8 million tonnes. The difference between the national supply and demand for rice is filled by imports, which have drastically reduced the nation's foreign exchange reserves. Every person consumes averagely 32 kg of rice annually, with around 2 million hectares of land used for rice farming (FAOSTAT, 2013). Even though Nigeria has a large area of fertile land and is a significant rice producer, the country still has challenges in reaching rice self-sufficiency. Utilizing contemporary farming methods has the potential to greatly boost agricultural output and accelerate the shift from low-productivity subsistence farming to a high-productivity agro-industrial sector (World Bank, 2008). According to research station reports, the application of new technologies and improved management practices should result in significant yield gains in rice production (Oyekanmi *et al*., 2008; Nwite *et al*., 2008). If Nigeria intends to reverse the existing food insecurity issue, agricultural production must be intensified through the use of contemporary technologies. Enhancing rice production requires farmers to adopt and utilize these modern technologies to their full potential.

Despite the potential benefits of adopting agricultural technological innovations, most developing countries still have very low adoption rates, especially in sub-Saharan Africa (SSA), where agriculture is the backbone of the economy (Ambali *et al*., 2021). Empirical evidence suggests that improved agricultural technology contributes to poverty reduction and increased farm profitability in developing countries (Kassie *et al*., 2011). The willingness and capacity of small-scale farmers to adopt new technologies created in research institutes is a major factor in agricultural progress. According to Oyewole and Ojeleye (2015), agricultural innovations hold minimal significance unless they can be used to enhance the financial and communal welfare of the individuals involved. Nigeria has a lot of natural resources, but it hasn't been able to produce enough rice to meet the demand from its expanding population. The disparity between domestic demand and supply has gotten wider over the past few decades due to the commodity's increasing importance among households across the nation. The bulk of Nigeria's rice is grown by small-holder farmers who use traditional farming methods on small plots of land to produce low yields, widening the gap between supply and demand (Oyewole and Ojeleye, 2015).Based on research findings, farmers continue to mostly use outdated rice-growing methods that give low yields and, as a result, low productivity, and have not fully embraced newer methods. A farmer linkage system scheme has enabled the National Cereals Research Institute (NCRI) to provide end users with access to appropriate rice production technologies that have been produced and developed via extensive adaptive research conducted in Nigeria. Notwithstanding, several investigations have demonstrated a notable disparity in the utilization of technology compared to Nigerian farmers, especially with regard to rice farming. This is because many rural farmers often find it difficult to find improved inputs for rice production that works well in their particular region (Awotide *et al*., 2012). The primary reasons for this low rice production could be attributed to farmers' aversion to changing their traditional agricultural practices and their ignorance of newer, better technologies. Additionally, the production environment that farmers work in can limit their enthusiasm for adopting enhanced production technologies in rice cultivation, which can limit the benefits of higher productivity that come with using these technologies (Makusidi, 2017). In addition, there are underlying factors that influence the adoption rate of improved technology and have the potential to either boost or decrease it. Examining those institutional and socioeconomic issues is therefore relevant. This made conducting this study necessary. The study's main goal is to determine whether rice farmers in Wase Local Government Area of Plateau State, Nigeria, have adopted new technologies for improving rice production.

Hypothesis of the Study

$H0_1$: Adoption of improved rice production technologies is not significantly correlated with the socioeconomic characteristics of rice farmers.

Methodology

The study was conducted in Wase Local Government Area of Plateau State, Nigeria, which is situated some

216 km south-east of Jos, the Plateau State capital. The Local Government consists of four (4) districts, namely: Wase, Bashar, Lamba, and Kadorko. The population of Wase Local Government Area was 159,861 people as of the 2006 census, with an urban area of 1750 km2 and the land covers an area of 4,587 square kilometers. The annual rainfall is 1,083 mm and 27.4 °C average temperature. The principal crops produced by the local government are maize, sorghum, rice, groundnut, cotton, vegetables, and beans. The major livestock are cattle, sheep, goats, poultry, and pigs.

Sampling Technique

A multi-stage sampling technique was adopted to select the sample size for this study. The first stage involved a purposive selection of only two out of the four districts in the Local Government Area for the study. The districts chosen have a sizable population that cultivates rice. They include; Lamba, and Kadorko. In the second stage, four communities from each of the two districts were systematically selected at random, yielding a total of eight (8) communities for the study. The third step involved a random selection of twenty (20) rice farmers from every one of the chosen communities, bringing a total of one hundred and sixty (160) respondents for the study. The data for this study was sourced primarily. The primary data were generated through administration of a well-structured questionnaire designed in line with the objectives of the study.

Method of data analysis

Descriptive statistics such as frequencies, percentages, and mean were used to describe the socio-economic characteristics of the farmers (objective i) and the constraints on the adoption of improved rice production technologies (objective v). The four point Likert scale was used to assess the level of awareness of improved rice production technologies (objective ii) as well as the level of adoption of improved rice production technologies (objective iii). The logic regression model was used to determine the factors that influence the adoption of improved rice production technologies (objective iv).

Model Specification

Four Point Likert Scale

Respondents' level of awareness and adoption of improved rice production technologies (IRPT) were both determined using the four point Likert scale. The Likert scale is a measure of attitudes, preferences, and subjective reactions by eliciting a response along the lines of strength of agreement with the scale items (Likert, 1932). To determine the level of awareness, responses were rated on a 4-point Likert scale thus: fully aware (4), aware (3), seldom aware (2), and not aware (1) of each improved rice production technology (IRPT). The responses were counted with respect to the weights. The score for each variable was multiplied by the corresponding weight to obtain a weighted score. Further, the weighted scores were summed to obtain a weighted sum. The weighted sum was further divided by the number of respondents to obtain a weighted mean for each variable. Finally, the weighted means were sorted in descending order against the decision rule. The mid-point values of the scale were summed up and further divided by 4 to obtain a mean of 2.5. Any variable with a weighted mean value equal to or above the cut-off mean of 2.5 was considered to have high awareness, while any variable with a weighted mean of less than 2.5 was considered to have low awareness. Similarly, a four point Likert scale was used to analyze the level of adoption of improved rice production technologies (IRPT) among farmers. Adoption is the decision of farmers to make full use (application) of specific recommended practices of improved rice production technologies on a continuous basis (for at least 5 years) as the best course of action available. A list of eleven recommended improved rice production technologies was drawn thus:

i. Land preparation by machines (tractors)

ii. Improved seed varieties

iii. Seed treatment

iv. Appropriate planting dates

v. Recommended plant spacing

vi. Nursery practice and transplanting

vii. Application of recommended fertilizer

viii. Recommended time of weeding

ix. Use of herbicides for weed control

x. Use of pesticides for pest and disease control

xi. Appropriate time for harvesting

Responses were rated on a 4-point Likert type scale. Thus: fully adopted (4), adopted (3), seldom adopted (2), and not adopted (1) for each improved rice production technology (IRPT). The responses were counted with respect to the weights. The score for each variable was multiplied by the corresponding weight to obtain a weighted score. Further, the weighted scores were summed to obtain a weighted sum. The weighted sum was further divided by the number of respondents to obtain a weighted mean for each variable. Finally, the weighted means were sorted in descending order against the decision rule. The mid-point values of the scale were summed up and further divided by 4 to obtain a mean of 2.5. Any variable with a weighted mean value equal to or above the cut-off mean of 2.5 was considered adopted, while any variable with a weighted mean of less than 2.5 was not considered adopted. These weighted means were used to determine the relationship between the dependent variable (level of adoption of IRPT), and the independent variables. The weighted score was used as the dependent (Y) variable in the regression.

Logit Regression Model

The logit regression model was used to determine the factors that influence the adoption of improved rice production technologies in the study area.

Theoretically, the logit model is expressed as

$Y = \beta o + \beta_1 X_1 + \beta_2 X_2 + \text{-----} \beta n\, Xn$

Where Y = Adoption (1 = adoption for weighted score equal or above 2.5, 0 = otherwise)

βo = Intercept

β_1 - - - - n = estimated parameters

X_1 - - - - n = set of independent variables
X_1 = Age (years)
X_2 = Gender (male 1, female 0)
X_3 = Marital status (married 1, single 0)
X_4 = Educational status (years spent in school)
X_5 = Household size (number of persons in the household)
X_6 = Farming experience (years)
X_7 = Farm size (ha)
X_8 = Extension contact (number of visit)
X_9 = Annual income (N)
X_{10} = Co-operative membership (if yes, 1, 0 if no)

Results and Discussion

Socio-economic Characteristics of Farmers

According to Table 1's results, 47% of farmers were between the ages of 31 and 40, 26% were between the ages of 41 and 50, 16% were over 50, and 11% were between the ages of 21 and 30. The Farmers were 40 years old on average. This suggests that the majority of farmers were of working age and, thus, would have been more open to new scientific discoveries and far more willing to take chances when implementing novel concepts and spreading cutting-edge methods than older farmers. This result is consistent with that of Abubakar *et al*. (2019), who in a study on analysis of factors influencing the adoption of rice improved production practices by farmers in adopted villages of Niger state, Nigeria, found that young people are more likely to accept and act as better agents of innovation transfer. According to the respondents' gender, 33.0% of farmers were women and 67.0% of farmers were men. Because land is a more productive resource than other resources, men have the right to own it, which may explain why there are more male farmers in the study area. This is accurate given that the majority of the women engaged in commerce and marketing, including the sale of firewood, fruits, and vegetables. Men get more involved in farming as a result, freeing up women to engage in other livelihood activities that augment the additional income. This is in line with the research done by Onyeneke (2017), who discovered that most rice growers in Imo State, Nigeria, were men. Table 1's result also shows that 90% of farmers were married. Farmers who are married might be more committed and perhaps feel more pressure to increase productivity to satisfy the needs of their families among other things, the need for food and money. Similar findings were made by Chekene and Chancellor (2015) when they investigated the factors influencing the adoption of improved rice varieties in Borno State, Nigeria, and discovered that married farmers made up the majority of the farmers.

According to data on educational attainment, 44% of farmers had completed secondary education, 27% had completed primary education, 18% had completed higher education, and 1% had not completed any formal education. Education plays a significant role in enabling farmers to accept new technologies by raising their level of knowledge and comprehension of innovative farming techniques that increase food output. This effectively demonstrates that the majority of the farmers in the research region were educated to some degree. Obasi *et al*. (2012) state that an individual's educational attainment improves both his output on the farm and his capacity to comprehend and assess novel agricultural technologies. This is in line with the findings of Henri-Ukoha *et al*. (2011), who highlighted the importance of education in enabling farmers to adopt new technologies by enhancing their knowledge and comprehension of these practices and helping to increase food production. Approximately 48% of the farmers had households with between six and ten people, 24% had households with one to five people, 20% had households with eleven to fifteen people, and the remaining 8% had households with more than fifteen people. The farmers had nine (9) people living in their homes on average. These unusual circumstances exist in rural areas because the majority of farmers think that having more children who will work on the farm is preferable to hiring outside assistance. This result bears a strong resemblance to that of Dontsop-Nguezet *et al*. (2011), who discovered that the average household size of rice producers in Nigeria's three main rice ecologies was ten members. Table 1 also shows that 61% of the farmers have been farming for duration of one to five years. 31% of farmers have been in the business for six to ten years, and 8% have been in it for eleven to fifteen. Eight years was the average amount of farming experience. This suggests that the majority of farmers have been engaged in farming for a reasonable amount of time. Farmers may be able to employ productive resources more effectively thanks to their years of knowledge. This is consistent with the findings of Bamire *et al*. (2010) and Mignouna *et al*. (2011), who maintained that farmers ought to be able to evaluate the advantages of new technology and hone their production abilities with sufficient experience.

The findings also indicate that 72% of the farmers had farms that were between 1-3 hectares in size, 17% had farms that were between 4-6 hectares in size, and 11% had farms larger than 6 hectares. The rice farmers in the study area own an average of 3.1 hectares of land. This suggests that the majority of the farmers were subsistence and small-holder farmers, a situation which may have prevented them from participating in large-scale production and from having access to huge financing institutions. This result bears close comparison to that of Onyeneke (2017), who found that rice farmers in Imo State, Nigeria, had an average farm size of 1.8 hectares. The bulk of respondents (64.0%) engaged in agriculture as a major source of livelihood. This is followed by business (28.0%) and civil servants (12.0%). The implication is that farming is a primary source of income and survival for most of the respondents. According to Chukwu *et al*. (2016), 50.8% of rice farmers in Ebonyi State made farming their primary full-time job. These findings are consistent with their findings. The annual income of farmers in the study area reveals that 38% of the farmers earned between N101, 000 – 150,000. About 24% of the respondents earned between N151, 000 - 20,000. The result further revealed that 20% of the farmers earned between

201,000 – 250,000, 14% earned above 250,000 while the remaining 4% earned between N50,000 – 100,000 as annual income. The mean annual income of the farmers was N 202, 356. This finding shows that farmers in the study area have fair annual incomes that allow them to embrace new methods for producing rice. Given the significance of income in the adoption process, this outcome suggests that the adoption of enhanced rice production technology will probably be positive.

The findings show that while 39% of the farmers claimed to have access to agricultural credit, the bulk of farmers (61%) did not have any credit available for their farming operations. Ceteris paribus, farmers who have access to financing facilities are more likely to embrace enhanced production technology than those who do not. This is not surprising, considering that farmers' primary justification for not implementing new technologies was their high cost. Farmers who have access to financing will be able to buy better equipment for their operations. Acquiring and using credit for agricultural purposes increases production, which improves community food security (Vihi *et al*., 2018). Furthermore, the results indicate that 56% of the farmers said they had no contact with extension agents in the previous year. About35.0% of them received one visit, while 9.0% of the farmers had extension visits twice in the past year. Given that most respondents received only yearly visits from extension agents, which was deemed insufficient, it appeared that the extension services in the study area is limited. Several farmers expressed concerns during oral interviews that there doesn't seem to be enough government extension agents to support farmers on a regular basis and that they are underfunded. Extension workers faced difficulties in providing services on a regular basis, including a lack of facilities and incentives. This is consistent with the findings of Kiptot *et al*. (2011), who found that many public extension organizations lack resources and, as a result, are unable to provide farmers with timely and appropriate advice. According to Orisakwe and Agomuo (2011), farmers who regularly engage with extension agents receive encouragement, exposure to new ideas, and guidance on how to use the technologies.

The data presented in Table 1 indicates that the majority of respondents (71.0%) obtained their farmlands through inheritance, followed by 23.0% who rented their land and the remaining 6.0% who bought it. The drawback of most people using land they inherited is that it would cause farm land to become fragmented due to sibling sharing, which would lower the likelihood of mechanized agricultural practices. The majority of traditional communities do not hold their farmlands collectively, which causes fragmentation and leaves farmers with limited amounts of land. Because the ownership rights to inherited land are not formally documented, borrowers encounter difficulties when trying to complete transactions. Table 1's results further revealed that, 43.0% of the respondents belonged to cooperatives or farmers' organizations, whilst 57.0% of the respondents did not. According to Bamire *et al*. (2010), one way that innovation might spread among farmers is through their interactions with one another. Farmers may be able to access loans, inputs, and current and relevant information about their farming operations by becoming members of organizations, associations, or cooperatives. Salifu *et al*. (2012) claimed that farmers who are members of such organizations have easy access to loan facilities, extension services, and information on new technology.

Farmers' Level of Awareness of Improved Rice Production Technologies

The result in Table 2 displays how knowledgeable rice farmers are about enhanced rice production technologies. Eight (8) of the eleven (11) stated enhanced rice production technologies had mean values above the 2.50 cut-off mean, indicating that the farmers were familiar with them. They are: appropriate time of harvesting (3.44), land preparation by tractors (3.42), recommended time of weeding (3.41), appropriate planting dates (3.25), use of herbicides for weed control (3.24), improved seed varieties (3.11), application of recommended fertilizer (3.05) and Nursery practice and transplanting (2.73). The improved rice production technologies whose mean values fell below the cut-off mean (2.50) are; recommended plant spacing (2.08), use of pesticides for pest and disease control (2.01) and seed treatment (1.99). This suggests that the farmers in the research area are reasonably knowledgeable of the current methods for producing rice, which might be ascribed to the dissemination of knowledge through a variety of channels, including print and electronic media, fellow farmers, and extension workers. According to Olumba and Rahji (2014), demand drives awareness, and demand drives the quick uptake and dissemination of agricultural advances. This is also consistent with the findings of Mustapha *et al.* (2012), who discovered that the majority of rice farmers in Jeer LGA in Borno State were aware of the technologies used in rice production.

Level of adoption of Improve Rice Production Technologies

The level of adoption or utilization of improved rice production technologies is presented in Table 3. The result shows that appropriate time of harvesting (3.36), recommended time of weeding (3.21), appropriate planting dates (3.02), land preparation by tractors (2.86), use of herbicides for weed control (2.81), application of recommended fertilizer (2.63) and improved seed varieties (2.31) were the rice production technologies extensively adopted by the farmers in the study area. These improved technologies were above the cut-off point of 2.5, indicating high adoption. Similar finding have been credited to Mustapha *et al*. (2012) who found rice production technologies adopted by farmers in Jeer LGA of Borno State to include high yielding varieties, disease resistant varieties, early maturing varieties, use of weedicides, broadcasting method, manual harvesting and bagging method of storage. Similarly, Adeleye (2016) found in his study that the level of farmers' adoption of improved rice production technologies was mainly limited to use of tractors 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 fertilizer application and top dressing with urea. The result in Table 3 further showed that, use of pesticides for pest and disease control (2.08), recommended plant spacing (2.05), nursery practice and transplanting (2.02) and seed treatment (1.92) were below the cut-off point of 2.5, indicating low utilization. The low utilization of these technologies is probably due to technicalities related to their use, as well as costs associated with their use.

Factors Influencing Adoption of Improved Rice Production Technologies

The Logit model was used in estimating factors that influenced the adoption of improved rice production technologies in the study area. The log-likelihood function (-12.3890) shows that the estimated model, including a constant and the set of explanatory variables, fit the data better. This suggests that all explanatory factors considered in the model collectively have an impact on how quickly farmers in the study area embrace new techniques for producing rice. The pseudo R-squared value of 65.3% implies that the variable included in the model accounted for 65.3% of the variation in adoption of improved rice production technologies. Each coefficient shows the extent to which the variable exerts an influence on the adoption of such technologies. According to the results presented in Table 4, six (6) out of the ten predictors, namely, age, educational status, farming experience, farm size, extension contact and annual income, were statistically significant. The regression coefficients, educational status, farming experience, farm size, extended contact and annual income were positive, which indicates that an increase in these variables holding others constant will lead to an increase in adoption of improved rice production technologies. The regression coefficient of age is negative, indicating that an increase in the age of the farmer will lead to a decrease in adoption of improved rice production technologies. Age (X_1) coefficient was significant and negatively (-2.4803) related to adoption of improved rice production technologies. The negative coefficient suggests a negative influence of the variable on the farmers' adoption decision. The finding implies that the probability of adoption decreases by a factor of 2.48% for older farmers. Hence, adoption of improved practices for rice production is higher among young people than with older farmers. In other words, the likelihood of adoption decreases with the increase in age of the farmers. This underscores the fact that older farmers are risk-averse and more conservative than the younger ones, who are more innovative and receptive to new technologies. In other words, the likelihood of farmers' adoption decisions decreases as the farmers advance in age. This is in consonance with findings by Mamudu *et al*. (2012) on the adoption of modern agricultural production technologies by farm households in Ghana that old farmers tend to be less productive, and usually conservative and abhorring innovation information. The coefficient of educational status (X_4) was positive (.0958) and significant at 10% level of probability. This indicates that a 9.58% increase in the farmers' years of formal education would result in a corresponding rise in the adoption rate of improved rice producing technologies. This validates the *apriori* expected positive sign. This suggests that adoption of such rice production technologies and education are positively correlated. The coefficient of farming experience (X_6) was positive (8.6964) and significant at 5% level, implying a direct relationship with the adoption of improved rice production technologies. This implies that the likelihood of adoption of improved rice production technologies increases with the increase in farming experience. Specifically, it shows that a unit increase in farming experience of the farmers would lead to an increase in adoption by 8.69 %. According to Balarebe (2012) and Mamudu *et al*. (2012), farmers become more proficient producers with experience. This suggests that a more seasoned farmer would be less apprehensive about the effectiveness of innovations and also be able to assess the benefits of any technology under consideration. Coefficient of farm size (X_7) was found to be positive (3.6930) and significant at 10%. This indicates that, in contrast to those without large farm sizes, rice farmers with larger farms adopted improved rice production technology (IRPTs). Put another way, a rise in the respondents' farm sizes will inevitably result in a rise in the degree at which improved rice production technologies are used. This is accurate and consistent with *apriori* expectations, as land ownership can facilitate the adoption of innovations. When they have enough land for the technology, they may try it out on their farm with ease. That is, compared to smaller agricultural land, farmers can use more technologies when their farm is rather vast. This result aligns with that of Abubakar *et al*. (2016), who likewise found that adoption of enhanced rice production technology in Lavun Local Government Area, Niger State, Nigeria, was positively and significantly correlated with farm size. The coefficient of extension contact (X_8) was positively signed (3.7360) and statistically significant at a 5% percent level of significance. It implies that farmers would feel more confident to continue using production technology packages if extension visits were conducted on a regular basis to provide information and advisory services. In actuality, the impact of extension contacts can raise knowledge of the possible benefits of improved agricultural advances and balance the detrimental effects of a lack of years of formal education on the decision to embrace particular technologies overall. Brian (2011) emphasized that the quantity of extension trips positively affects technology acceptance and utilization. This is because farmers are more likely to take the risk of testing new technologies, since they are exposed to new knowledge that lessens the information asymmetry that is characteristic of those technologies. The annual income of the respondents (X_9) was statistically significant at 1 percent and bore a positive

(2.0490) coefficient. This implies that a positive relationship exists between the farmers' annual income and their level of adoption of IRPTs. The a priori expectation was met because farmers with increased annual income are expected to adopt innovations more than those with lower annual income.

Test of Hypothesis

The result of the logit regression in Table 4 reveals that three socio – economic variables, namely; age, educational status and farming experience, had a significant relationship with the adoption of improved rice production technologies. We therefore reject the null hypothesis and accept the alternative hypothesis, thereby concluding that there is a significant relationship between the farmers' socio-economic characteristics and the adoption of improved rice production technologies.

Constraints to Adoption of Improved Rice Production Technologies

The respondents were asked to state their major constraints on the adoption of improved seed rice production technologies. The various constraints are presented in a ranked order in Table 16. The result shows that the major constraints on the adoption of improved rice production technologies were high cost of technology with (69%), inadequate extension contact with (61%) and inadequate credit facilities with (48%) and lack of accessibility of some technologies (28.0). The high cost of the technologies could be a contributory factor to low adoption of technologies as many farmers would be unable to purchase the improved technologies as a result of high prices associated with them. This result is in line with that of Issa *et al.* (2016), who found that adoption of improved maize production technologies in Ikara Local Government Area, Kaduna State, have been hindered by high cost of the technologies. According to Akudugu *et al*. (2012), adopting new technology means that farmers have fewer options for where to invest. This implies that there is little chance that a farmer will adopt a technology if it is expensive for them. Affordably priced technologies must be developed, especially for impoverished rural residents, in order to promote the use of contemporary agricultural production technology. Inadequate extension contact ranked second amongst the constraints affecting adoption of improved rice production technologies. Inadequate extension contact can restrict farmers from becoming aware and subsequently adopting an innovation. Farmers who have contact with extension agents often tend to have more information to adopt technological practices and use these practices to increase their production, while those who have less contact with extension agents are less likely to adopt, and this could be due to the fact that farmers are conservative about certain ways of doing things and the tendency to adopt the innovation becomes difficult. Wekesa *et al*. (2003) found that extension agents assist in disseminating technology from researchers to local farmers, and Yu *et al*. (2011) found results that were similar, showing that extension agents encourage the use of more effective techniques and lessen farmers' aversion to taking risks. Poor access to institutional credit is often a critical constraint for farmers in Nigeria. Adopting new technologies in agricultural production often requires funds to purchase improved inputs such as seeds, fertilizer, herbicides etc. This may account for the reason that most of the respondents are small-scale farmers.This conclusion was corroborated by Mwangi and Kariuki (2015), who claimed that a lack of credit opportunities makes farmers less likely to adopt new technology, which will probably limit their ability to do so. All other variables being equal, rice farmers with greater access to credit are more likely to embrace modern techniques.

Conclusion

Findings from the study revealed that the majority of the farmers were young, married and had formal education. They had many years of farming experience, even though they operated on small scale holdings with low to moderate annual incomes. The farmers were highly conversant with improved rice production technologies, like appropriate time of harvesting, land preparation by tractors, recommended time of weeding, appropriate planting dates, use of herbicides for weed control. Improved seed varieties, application of recommended fertilizer and nursery practice and transplanting. Appropriate time of harvesting, recommended time of weeding, appropriate planting dates, land preparation by tractors, use of herbicides for weed control, application of recommended fertilizer and improved seed varieties recorded a high level of adoption among the farmers. Age, educational status, farming experience, farm size, extension contact and annual income were significant determinants of adoption of improved rice production technologies among the farmers. High cost of technology, inadequate extension contact and inadequate credit access were the major constraints to the adoption of improved rice production technologies. There is need therefore for subsidization of inputs (improved rice seeds, fertilizers, and agrochemicals) by government and input dealers may reduce cost of production and promote enterprise sustainability. Extension services should be strengthened by governmental and non-governmental organizations through recruitment of adequate extension workers in order to train farmers to apply these technologies for maximum output. One of the impediments affecting the adoption of improved rice production technologies is poor access to credit. Lending institutions with low interest rates should be brought closer to the farmers to enable them to obtain credit for rice production.

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Table 1: Socio-economic Characteristics of the Farmers

Age	Frequency	Percentage	Mean
21-30	17	11.0	
31-40	76	47.0	
41-50	41	26.0	
>50	26	16.0	**40**
Sex			
Male	107	67.0	
Female	53	33.0	
Marital status			
Single	16	10.0	
Married	144	90.0	
Educational status			
Primary	44	27.0	
Secondary	70	44.0	
Tertiary	29	18.0	
Non formal	17	11.0	
Household size			
1-5	39	24.0	
6-10	77	48.0	
11-15	32	20.0	
>15	12	8.0	**9**
Years of farming			
1-5	35	22.0	
6-10	97	61.0	
11-15	28	17.0	**8**
Farm size			
0.5-1.0	27	17.0	
1.1- 1.5	36	23.0	
1.6 – 2.0	66	41.0	
2.1- 2.50	23	14.0	
>2.50	8	5.0	**1.6**
Occupation			
Farming	103	64.0	
Civil servant	19	12.0	
Business	38	24	
Annual Income (₦)			
50,000 – 100,000	6	4.0	
101,000 -150,000	61	38.0	
151,000 -200,000	38	24.0	
201,000 -250,000	32	20.0	
>250,000	23	14.0	**202, 356**
Extension contacts			
No contact	89	56.0.0	
Once in the last one year	56	35.0	
Twice in the last one year	15	9.0	
More than two times	-	-	
Land tenure			
Inheritance	113	71.0	
Hired	37	23.0	
Purchased	10	6.0	
Membership			
Yes	69	43.0	
No	91	57.0	

Table 2: Farmers' Level of Awareness of Improved Rice Production Technologies

Improved Rice Production Technologies	FA(4)	A(3)	SA(2)	NA(1)	Sum	Mean
Improved seed varieties	244	213	26	15	498	3.11*
Seed treatment	56	108	90	65	319	1.99
Use of tractors for land preparation	336	180	32	-	548	3.42*
Appropriate planting dates	244	234	42	-	520	3.25*
Recommended plant spacing	44	81	172	36	333	2.08
Nursery practice and transplanting	124	198	106	10	438	2.73*
Application of recommended fertilizer	224	201	64	-	489	3.05*
Recommended time of weeding	292	243	12	-	547	3.41*
Use of herbicides for weed control	256	213	50	-	519	3.24*
Use of pesticides for pest and control	48	69	162	44	324	2.01
Appropriate time of harvesting	284	267	-	-	551	3.44*

FA=fully aware, A=aware, SA=seldom aware, NA=not aware

Table 3: Farmers' Level of Adoption of Improved Rice Production Technologies

Improved Rice Production Technologies	FA(4)	A(3)	SA(2)	NA(1)	Sum	Mean
Improved seed varieties	84	129	122	35	370	2.31*
Seed treatment	44	51	162	51	309	1.92
Use of machines (tractors) for land preparation	184	150	122	3	459	2.86*
Appropriate planting dates	164	246	74	-	484	3.02*
Recommended plant spacing	40	93	152	43	328	2.05
Nursery practice and transplanting	52	81	142	49	324	2.02
Application of recommended fertilizer	124	138	15	6	422	2.63*
Recommended time of weeding	220	252	42	-	514	3.21*
Use of herbicides for weed control	168	153	126	4	451	2.81*
Use of pesticides for pest and disease control	56	69	170	38	333	2.08
Appropriate time of harvesting	284	246	8	-	246	3.36*

FA=fully adopted, A=adopted, SA=seldom adopted, NA=not adopted

Table 4: Logit Regression of Factors Influencing Adoption of Improved Rice Production Technologies

Variable	**Coef**	**Std Error**	**Z**	**P>|z|**
Constant	16.8951	6.6256	2.55	0.011
Age (X_1)	-2.4803	1.4309	-1.73	0.083*
Gender (X_2)	-.3138	.2302	-1.36	0.173
Marital status (X_3)	3.6509	2.3657	1.54	0.123
Educational status (X_4)	.0958	.0562	1.70	0.088*
Household size (X_5)	-2.0622	1.2290	-1.68	0.093
Farming experience (X_6)	8.6964	3.4680	2.51	0.012**
Farm size (X_7)	3.6930	2.1086	1.75	0.080*
Extension contact (X_8)	3.7360	1.6280	2.30	0.022**
Annual income (X_9)	2.0490	.6040	3.39	0.001***
Membership of coop (X_{10})	2.5581	1.6822	1.52	0.128
Number of obs	160			
LR chi2(10)	46.69			
Prob> chi2	0.0000			
Pseudo R2	0.6533			
Log likelihood	-12.389096			

Note: ***, ** and * Significant at 1%, 5% and 10%

Table 5: Constraints to Adoption of Improved Rice Production Technologies (n=160)

Constraints	***Frequency**	**Percentage**	**Rank**
High cost of technology	111	69.0	1st
Inadequate extension contact	97	61.0	2nd
Inadequate credit access	77	48.0	3rd
Non accessibility of the technologies	44	28.0	4th
Complexity of some technologies	11	7.0	5th

***Multiple responses**