Determinants of Rate of Adoption of Rice Production Technologies introduced by Agricultural Research Outreach Centres (AROCs) by Farmers in Niger State, Nigeria

Abstract

The study assessed the determinants of rate of adoption of rice production technologies introduced by Agricultural Research Outreach Centres in Nigeria. Data were collected using a multi-sampling technique. Data were analysed using simple descriptive statistics and multiple linear regression. Results revealed that respondents' mean age was 50 years; level of formal education of farmers was low and farm size was 2.5ha on the average. Age, farming experience, years of schooling and number of extension visits were the socioeconomic determinants affecting rate of adoption. It was recommended that more villages should be adopted with partnership between government and the private sector in order to cover more grounds and increase the rate of adoption of new technologies. Also, government and relevant stakeholders should prioritize establishment of the best extension teaching methods and systems as well as administration to help increase rate adoption of innovations and sustainability of the use of these technologies over time.

Keywords: Determinants, rate of adoption, rice production, technologies, farmers

Introduction

Rice is the most consumed staple in Nigeria with per capita consumption put at 32 kg per (PwC, 2018). In the recent decade, consumption is said to have increased by 4.7%, this increase is almost four times the global consumption growth, and reached 6.4 million tonnes in 2017 – accounting for c.20% of Africa's consumption. As at 2011, rice accounted for 10% of household food spending, and 6.6% of total household spending. Given the importance of rice as a staple food in Nigeria, boosting its production has been accorded high priority by the government in the past 7 years. Significant progress has been recorded; rice production in Nigeria reached a peak of 3.7 million tonnes in 2017 (PwC, 2018).

Although, the United States Department for Agriculture (USDA, 2018) report on Nigeria's import data has been reviewed downward from 3 million metric tonnes to 2.4 million metric tonnes there is still possibility that the country imports up to 3 million metric tonnes. This is due to illegal importations coming from Nigeria's porous borders. For instance, with data from the Thailand Rice Exporters Association and All India Rice Exporters Association a simple addition of exports from both countries shows 2.05 million metric tonnes of rice was exported to Benin in 2016. The USDA figure only represents 21 percent of what Benin imported from just Thailand and India; its total imports understated by at least 79 percent. Also, whereas exports to Benin in 2017 was at least 2.51 million metric tonnes from India and Thailand alone, the USDA stated the country had a total import of 525,000 metric tonnes (Ojewale, 2019).

Furthermore, India and Thailand alone recorded that 797,268.75 metric tonnes of rice were exported to Cameroon in 2017. Cameroon also shares a border with Nigeria. Both countries have imported parboiled rice which is not their preferred rice suggesting that they both target Nigeria's huge rice market. Several billions have been spent on improving productivity of rice in

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Nigeria. Nigeria's greatest resource as far as productivity increase is concerned are its smallholder farmers. Increasing their capacity, knowledge, skill and performance is requisite for productivity enhancement. It is the realization of this fact that has birthed the establishment of the Agricultural Research Outreach Centres.

The Agricultural Research Outreach Centre (AROC) is an established centre sited within each of the identified adopted village communities in an accessible location to the farmers. According to (ARCN, 2009) the main objectives of the AROC centres are to serve as a knowledge/resource centre for the contiguous farming communities, where all available relevant information on agriculture and other aspects of community livelihood would be displayed; serve the purpose of farm service centre where NARIs and FCAs will display available technologies and render services to the communities; serve as training venue where NARIs and FCAs will conduct training for the farmers; serve as a demonstration centre; and serve as outreach centre where feedback on technologies being promoted could be received.

Historically, adopted village/AROC concept is an approach introduced in 1996 under the World Bank assisted Project, National Agricultural Research Project (NARP) and recommended in the National Agricultural Research Strategy Plan of 1996–2010 (NARSP, 1996). The concept was introduced for developing and evaluating technologies emanating from the National Agricultural Research Institutes (NARIs) and to help in the early evaluation and dissemination of these technologies (NARSP, 1996). The scheme was initiated to facilitate the trial of new research findings by scientists under the farmer's environmental conditions. The scheme has the added advantages of involving the farmers in the trial either as observers, in the case of researcher managed, or executors in the case of farmer managed trials. The involvement of farmers will in turn speed up the rate of adoption of such technologies by neighbouring farmers, as the trial will also serve as demonstration plot. Also, technologies generated in the Institute are taken to the adopted villages for dissemination to farm families in the adopted villages (Adeogun*et al.*, 2017).

According to Abubakar (2009) Agricultural Research Council of Nigeria (ARCN) believes in institutionally pluralistic extension delivery arrangement that would reach and respond to diverse farmers and farming systems. The linear system of passing research results to extension agents who then transfer them to farmers, in the opinion of Byerlee (2004), is regarded widely obsolete.

Adenike (2012) affirmed the need to seek greater understanding of alternative pathways for rural economic development, and redefining the role, mission, and strategies of the Agricultural Research Institutes and Agencies as facilitators of rural economic growth. This calls for the change in the mind sets of the change agents and greater flexibility and creativity in defining the agenda as well as new public-private-civil society partnerships on the basis of whatever is necessary to improve opportunities, productivity and income generation capacity of poor rural households. The Adopted Village/AROCs programme is in line with this assertion as confirmed by Chikwendu (2009) who opines that even if the impact of research and extension is not immediately self-evident elsewhere in easily quantifiable terms, it must be felt in quantifiable terms in Adopted Village Communities.

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Therefore, Since adoption of improved Agricultural technologies and modern farming techniques has been identified as an instruments of increase Agricultural Productivity of the farmers, poor adoption of modern farming techniques and new technologies by farmers would eventually lead to high cost of production with corresponding low yield and negative consequences such as poor standard of living, hunger, malnutrition, disease and unemployment. But, if farmers adopt and apply the improved techniques well, there would be increased productivity and food security.

Recently Agricultural Research Outreach Centres (AROCs) has been promoted and specifically in the Central Agricultural zone of Niger State, Nigeria to facilitate the dissemination of improved rice production technologies to farmers as an interventionist strategy to increase rice production. And since there has not been any empirical study on the assessment of the level of adoption of improved rice production technologies introduced and promoted by these AROCs in Central Agricultural zone 'A' of Niger State. It is against this background that this study intended to find answers to the following research questions:

i) What are the socio-economic characteristics of the rice farmers in the study area?

ii) What are the effects of respondent's socio-economic characteristics on their level of adoption of AROC's introduced and promoted rice production technologies?

Objectives of the study

i) describe the socio-economic characteristics of rice farmers in the study area;

ii) determine the effects of respondent's socio-economic characteristics on their level of adoption of AROC rice production technologies.

Research Hypotheses

The following hypotheses stated in null form were stated and tested

H_{01}: There are no significant relationships between the socio-economic characteristics of the rice farmers and their level of adoption of AROC's introduced Rice Production Technologies in the study area.

H_{02}: There is no significant relationship between the number of extension visits to farmer's farm and their level of Adoption of AROC's introduced Rice production technologies in the study area.

Methodology

Study Area

This study was conducted in the Central Agricultural zone 'A' of Niger State. Niger State has a population of 3,954,772 people (NPC, 2006). Applying the formular by Dotson (2018), the population of Niger State was projected to be 5,841, 121 persons at 2019. The study area is located in the North central zone along the Middle Belt region of Nigeria with coordinates of 100 00/N 60 00/E (Alamu, 2013). According to NSN (2013), the State was created on 3rd February, 1976 when the then North – Western State was transformed into Niger and Sokoto States.

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The State is classified as one of the largest States in the country spanning over 76,363 km^2 (29,484 sq ml) in land area with 80% of the land mass conducive for agriculture (Tologbonse, 2008). With 9.30% of the total land area of the country, Niger state is divided into three agricultural zones (Niger State Agricultural Mechanization Development Authority Central zone 'A', North zone 'B' & South zone 'C') under climatic features containing nearly all classes of soils of the savannah regions of West Africa (Tologbonse, 2008). The Central zone 'A' of which the study was carried out, comprises of eight (8) local government areas: Lavun, Gbako, Bida, Agaye, Makwa, Edati, Katcha and Lapai. A multi-stage sampling technique was used to select a sample size of 180 respondents.

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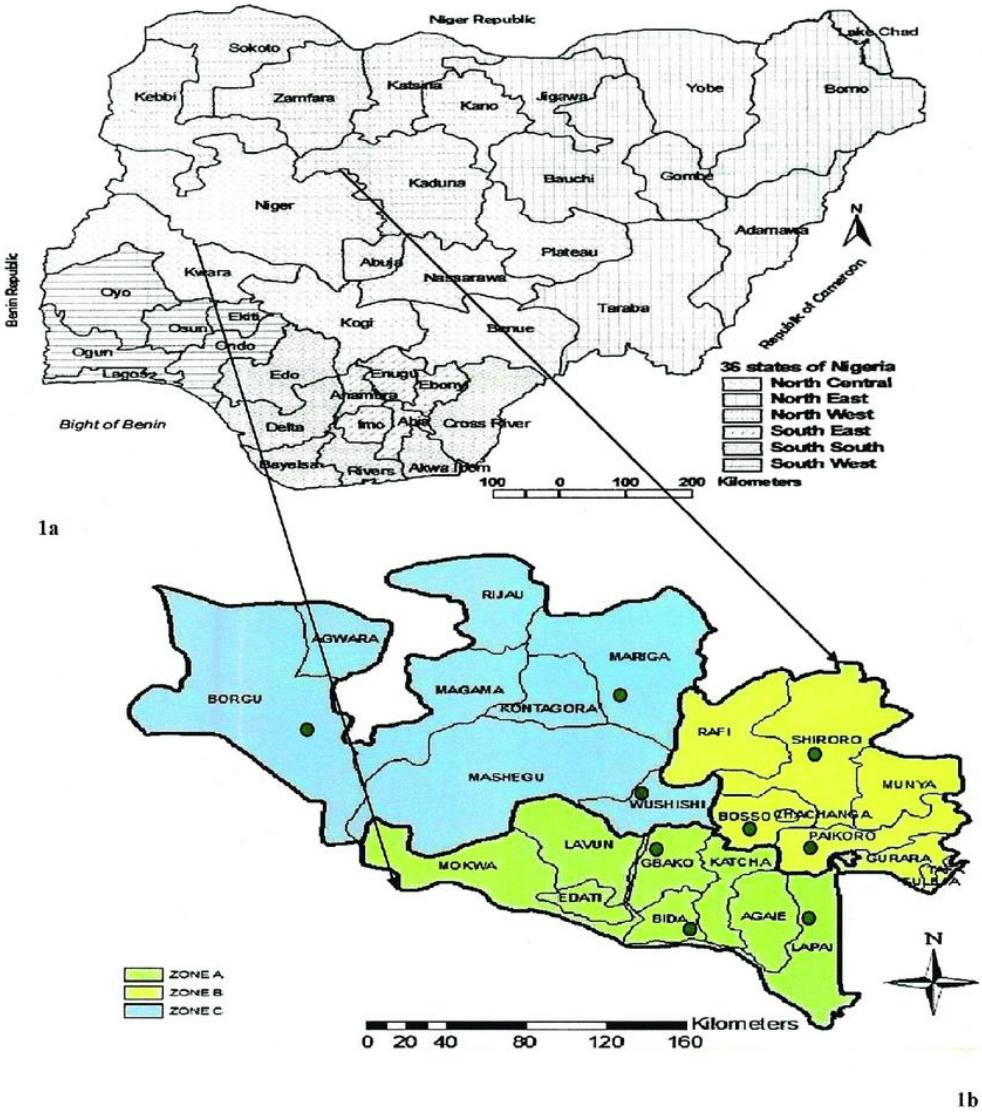

Source: Alhaji *et al.* (2018)

Fig.1. Map showing study location in Nigeria

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Analytical Techniques

Arithmetic mean was computed according the following formulae;

$\bar{X}=\Sigma\frac{Xi}{N}=\frac{x1+x2+x3+x4\ldots\ldots\ldots\ldots xn}{N}$ …… (1)

$\bar{X}$ = Mean
ΣXi = summation of the sample
N = Total number of observations
Σ= Summation
Xi = Individual observation
Percentage was mathematically expressed as:

Percentage (%) = $\frac{X}{N}$ x 100 …… (2)

Where,

X = Individual observation

N= Total number of respondents

Regression Analysis

The regression equation is expressed as follows:

$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + U$

Where;

Y = Level of adoption of AROC's rice production technology in percentage (%)

Therefore, Y = $\frac{\text{Number of AROC's technologies adopted by farmer}}{\text{Total number of technologies introduced by AROC}}$X 100

$X_{1\ldots\ldots\ldots}$ X_n= Explanatory/Independent variables
X_1 =Age of the farmer (years)
X_2 = Household size (number of persons in the household)
X_3 = Farming experience (years)
X_4 = Education (years of formal schooling)
X_5= Farm size (hectares)
X_6 = Marital status using dummy (if single = 0, married = 1)
X_7 = Membership of cooperatives (Member = 1, Non-Member = 0)
X_8= Training/AROC staff visits

U = Error term
b_0 = Constant term
b_1 - b_8 = Regression Coefficients

Results and Discussion

Socioeconomic characteristics of respondents

The majority (74.4%) of respondents were between the ages of 41 and 60 years. Respondents between the ages of 21 and 40 years and those above 60 years of age both accounted for 12.7% respectively. The mean age of respondents was 50 years. This implies that the median age falls within 41 – 60 years suggesting that they are a workforce still energetic and productive. This finding is in line with those of Mustapha*et al.* (2012) and Matanmi*et al.* (2011) in their study in Kwara State Nigeria who reported that majority of farmers involved in rice production were within the middle age group who are energetic and highly productive. This finding agrees with that of Hayrol *et al.* (2009) who also revealed that the average age of farmers in developing countries is in excess of 46 years.

Most (54.3%) of the respondents had no formal education, 20.5% of the respondents had primary education while 17.7% and 7.2% had secondary education and tertiary education respectively. The results further show that even though the educational level of the respondents was low, there may be a likelihood of effective interaction amongst farmers with no formal education, those with formal education and AROC staff/extension agents which enhanced the level of understanding and bolstered the rate of adopting new farm technologies by farmers. The implication of this finding is that with proper advisory services and good follow up trainings farmers, notwithstanding their educational status, can access and incorporate necessary innovations into their agricultural practices.

Majority (76%) of the famers had between 1 and 10-years farming experience and 23.8% had 11 – 20 years. The mean years of farming experience was 7 years. The findings show that the smallholder rice farmers in the study area had relatively moderate experience in rice production which may likely to contribute to the awareness/familiarity and adoption of AROC introduced rice production technologies. Although, farming experience has been reported to improve adaptiveness of farmers the fact that the population is mostly young will contribute in increasing receptiveness of farmers to new technologies.

Further, majority (98.8%) of the respondents had between 1 – 5 hectares of rice farm land and only 1.2% had 6 – 10 hectares. The mean farm size was 2.5 ha. This shows that rice farmers in the study area were mainly smallholder/small-scale farmers. The finding might be connected with the fact that farm acquisition in the area was virtually through inheritance and continued fragmentation of big farms into small plots amongst the family members. This result corresponds with the findings of Mustapha *et al.* (2012) and Fakayode (2009) in which majority (61.25%) of the respondents of that study had 1-3 hectares of rice farms. It also agrees with Fasasi (2010),who reported that highest percentage of food produced in Nigeria was produced by small-scale farmers.

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Majority (71%) of the respondents acquired their farmlands through inheritance, 23.9 percent through rent/lease, and 3.4 through purchase while 1.7 percent of the respondents acquired their farmlands through communal effort. The result indicated that no change has taken place in method of land acquisition over the years. This also underscores the near absence of land markets in most states of Nigeria. The result also justified the consistent farm land fragmentation into smaller farms that exist in Nigeria. The findings agree with the known fact that Nigerian agriculture is dominated by ageing population who are small scale famers that largely acquired their productive farm lands through inheritance.

Majority of the respondents (about 63 percent) had a household size of 1–10 members and were mostly used for farm family labour. About 33.8 percent had family size within 11–20 households, 2.7 percent had within 21–30 household members. This shows that the respondents had fairly large households which could probably serve as an insurance against short falls in supply of farm labour. According to Olumba (2014) large family size could be as a result of polygamous nature of the rural farmers. He further opined that this could be linked to the fact that most rural farmers look at large household size as a good and economical way of maximizing farm returns by using family labour. The finding also agrees with Igbaji *et al.* (2015) who posits that married farmers with their households are usually better off to adopt labour intensive farming technologies and hence household size have a positive influence on the output of rice farmers.

A greater proportion of the respondents (46%) had an annual income between ₦201,000 – 300,000 and 40.5% of the respondents earned annual income of between ₦101,000 – 200,000. The mean annual income of the respondents was ₦250,000. The finding also revealed that the current annual income from rice production in the study area was as a result of adoption of improved rice production technologies introduced by AROC as income prior to adoption was markedly lower. This agrees with the findings of Ojo*et al.* (2013) which revealed that access and adoption to improved technologies, agronomic practices of staple crops will result to increase in the efficiency and income generation. This result was also in line with the findings of Johannes *et al.* (2010) and Mwambu*et al.* (2008) who opined that the adoption of improved varieties of crops and modern farming techniques had the potential of increasing incomes that will lead to stable income and poverty reduction.

Most of (56.7%) of the respondents had their farms visited 6 to 10 times per annum by the AROC staff or extension agents. The result revealed that majority of the farmers had their farms visited more often with an average mean of 7 times and such contacts afforded farmers the opportunity of sharing ideas and information on modern rice production practices which may likely lead to high level of adoption of these technologies. The finding corresponds with Jamilu*et al.* (2016) and Namwata*et al.* (2010) who reported that increased extension contact was positively and significantly associated with overall adoption of improved agricultural technologies among farmers. This is also a significant improvement on Nigeria's redundant public extension service where farmers rarely receive a single visit all-year round.

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Table 1: Socio-economic Characteristics of Respondents

Variables	Frequency	Percentage	Mean
Age (years)			
21 – 40	23	12.7	
41 – 60	134	74.4	50 yrs
Above 60	23	12.7	
Marital Status			
Single	6	2	1
Married	174	97	
Educational Qualification			
No Formal Education	98	54.3	
Primary Education	37	20.5	
Secondary Education	32	17.7	
Tertiary Education	13	7.2	
Farming Experience (Years)			
1 – 10	137	76	
11 – 20	43	23.8	7 yrs
Above 20	-	-	
Farm Size (Hectares)			
1 – 5	178	98.8	
6 – 10	2	1.2	2.5 ha
Above 10	-	-	
Farm Acquisition			
Inheritance	128	71	
Communal	3	1.7	
Purchase	6	3.4	
Rent/Lease	43	23.9	
Household Size			
1 – 10	114	63.3	
11 – 20	61	33.8	8
21 – 30	5	2.7	
Above 30			
Annual Income from Rice Production (₦)			
1,000 – 100,000	18	9.9	
101,000 – 200,000	74	40.5	250,000
201,000 – 300,000	83	46	
301,000 – 400,000	7	3.8	
401,000 – 500,000	-	-	
Above 500,000	-	-	
Credit/Loan for Rice Production			
Accessed/Collected	59	32.8	
Not collected	121	67.2	
Number of Extension visits/Year			
1 – 5	57	31.7	
6 – 10	102	56.7	7
11 – 15	21	11.6	
Number of Attendance of training/Year			
1 – 3	131	72.8	
4 – 6	48	26.7	3
7 – 9	1	0.5	
Membership of Cooperative Societies			
Member	169	90.6	1
Non-Member	17	9.4	
Years spent as Member of Coop Societies			
0 – 3	37	20.6	
4 – 7	139	76.7	4.5
8 – 11	4	2.2	

Source: Field survey (2018)

Respondents' Socio-economic determinants of level of Adoption of AROC's Rice Production Technologies

The analysis of the effect of respondents' socio-economic characteristics on the level of adoption of AROC's Rice Production Technologies is presented in Table 2. The R-squared (R^2) shows that 84.99% variation in the output was explained by variables included in the model; this shows the level of fitness of the model. The coefficients of Age (t= -3.88), Farming experience (t= -3.121), Education level (t = 8.20) and Extension visits (t = 5.074) were significant at 1% while Farm size was significant at 10% probability level. The result also indicates that marital status, family size and cooperative membership were not significant.

Number of extension visits to farmers' fields had a positive and significant relationship with the level of adoption of technologies introduced by AROC programme at 1%. This implies that the level of adoption of AROC introduced rice production technologies will be directly and significantly increased by number of extension visits. The number of extension visits to farmers' fields and visits by farmers to demonstration plots/AROC centres was observed to increase confidence and knowledge of farmers towards technologies that were offered, thereby increasing the level of adoption of new technologies. The result agrees with Ayoola (2012), Nyanga (2012) and Bello *et al.* (2012) who advanced that the increasing the number of contacts in an extension programme had a positive and significant effect on the application of agricultural technology. The finding further bears rich parallels to those of Okoruwa*et al.* (2009) who opined that extension (and advisory services), are not merely there to influence farmers physical input but more importantly to initiate a needed change in behaviour and attitudes towards the environment and relating modern inputs.

Years of formal education was observed to be positive and significant at 1% implying that adoption rate of AROC's rice production technologies was higher with higher levels of education of the respondents. This is evidenced by the fact that respondents with relatively higher number of years spent in school were more likely to have the attitude, behaviour and mindset that would induce higher levels of adoption of improved rice production technologies. The finding re-echoes findings of Oyedele (2016) who revealed that good education propels heads of households to adopt innovations and technologies that are vital for enhancing productivity. Furthermore, Xu and Wang (2012), Singha *et al.* (2012) and that of Abdullah and Samah (2013) posited that the level of education affects the type of decision farmers take in rice production and determines the level of opportunities available to improve livelihood strategies and managerial capacity in agricultural production. The result is contrary to the findings of Issa *et al.* (2016) that advanced that adoption of improved maize production practices in Ikara Local Government Area of Kaduna State is irrespective of level of education and farming experience.

Age had a1% statistically negative significance with the level of adoption of AROC introduced technologies. This implies that the older the farmers were less likely to adopt AROC's introduced rice production technologies. The result implies that older farmers in the study area were more reluctant to adopting new techniques, they were more prone to maintaining the customs that had existed previously and that they were used to. The result agrees with the findings of Paxton *et al.* (2011) and Moga *et al.* (2012) who showed that age was negatively correlated with the adoption and application of new agricultural technology. The finding also agrees with Afolabi *et al* (2012) that younger farmers adopt new technology faster.

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Farming experience was significant at 1% but negatively significant. The finding implies that as the farmers get older, they become more averse to risk taking. Therefore, the more the number of years in farming the less likely the adoption of AROCs introduced rice production technologies. The result agrees with Ajani (2009) who opined that farming experience is an important factor determining both the adoption, productivity and the production level in farming activities. The result is in line with the *apriori* expectation that rice farmers with high level of farming experience obtained increased production not necessarily because of higher adoption level of new technology but due to higher efficiency in resource utilization. This finding is contrary with that of Ainembabazi *et al*. (2014) who suggested that farming experience is useful in early stages of adoption of a given technology when farmers are still testing its potential benefits, which later determines its retention or rejection over time.

Further, the result shows that the coefficient of farm size was significant at 10%. This indicates that larger farm size justified the adoption of AROC's rice production technologies. As farm size increases, the probability of adoption of new technologies increases because the size of the farm can drive the investment into new technologies as a precursor to higher yields and more incomes. This finding is supported by previous studies of Ayoola (2012), Nyanga (2012) and Bello *et al.* (2012) who suggested that the Farm size has positive and significant effect on the adoption of new technologies. The result is also in line with the findings of Johannes *et al*., (2010) who asserted that farmers with more land may have easier access to new technologies and the capacity to bear risk in case of technology failure. However, this finding negates the findings of Idrisa *et al*. (2012) that farm size had nothing to do with adoption of new technologies.

Table 2: Socio-economic Effects on Adoption of AROC's introduced Rice Production Technologies

Variable	Coefficient	Std Error	t-statistic	Probability
Constant	0.598931	0.073543	8.143904	0.0000***
Age	-0.003081	0.000794	-3.881772	0.0001***
Coop. Membership	0.022148	0.016453	1.346150	0.1800^{NS}
Faming Experience	-0.006227	0.001995	-3.121843	0.0021***
Household Size	-0.005678	0.004531	-1.253169	0.2119^{NS}
Farm Size	0.013815	0.007032	1.964638	0.0511*
Marital Status	0.005116	0.033419	0.153096	0.8785^{NS}
Years of Schooling	0.010309	0.001257	8.201990	0.0000***
Number of Extension Visits	0.016251	0.003202	5.074713	0.0000***

R^2 = 84.99

Source: Field survey, 2018*** = Significant at 1% ** = Significant at 5% * = Significant at 10%^{NS} = Not significant

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Conclusion

It can be concluded that the rate of adoption of rice production technologies introduced by Agricultural Research Outreach Centres (AROCs) in Nigeria are determined by socioeconomic characteristics of farmers. Age, farming experience, years of schooling and number of extension visits were the socioeconomic determinants affecting rate of adoption.

Recommendations

1. As the findings showed that age is a key determinant of adoption rate indicate the fact that deliberate policy needs to be put in place to increase the influx of young people into agriculture as they are innovative, energetic and creative.
2. Clearly, farmers with exposure to extension services have proved to be able to accumulate more income due to greater productivity, this gives credence to the need to develop a better extension service delivery system in the country to reach more farmers over more visitation periods.
3. Incorporation of innovations and new technologies by farmers have proved to be the key to raising farmers' productivity levels, therefore government and relevant stakeholders should prioritize establishment of the best extension teaching methods and systems as well as administration to help increase rate adoption of innovations and sustainability of the use of these technologies over time.
4. More villages should be adopted with partnership between government and the private sector in order to cover more grounds and increase the rate of adoption of new technologies.

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