Research Article
Open Access
CrossMark

Factors influencing adoption of rice improved production practices by farmers in adopted villages, Niger state, Nigeria

Abstract

The study was conducted to assess factors influencing adoption of rice improved production practices by farmers in adopted villages of the National Cereals Research Institute (NCRI) Badeggi, Niger state, Nigeria. The study employed a simple random sampling technique to select 150 respondents for the study. A structured questionnaire was used for data collection. Both descriptive and inferential statistics were used for analysis of the data. The results of a 3-point perception rating scale (Likert ratio) indicated that method-cum-result demonstration, farmers' participation in On-Farm Adaptive Research (OFAR) trials, Management Training Plot (MTP) and use of contact farmers were the very effective extension delivery methods. The results of binary logit regression model revealed farmers' training and extension contact as highly significant ($P \leq 0.01$) factors influencing adoption of the rice production practices, while the household size, land owned and years of farming experience were significant at 5% level of probability. The study therefore concluded that extension delivery methods were effective; farmers' adoption decision was influenced by range of factors, and therefore, these should be focused by research and extension organizations for policy formulation and development of extension strategies for technology delivery.

Keywords: cereals, development, productivity, adoption, households, innovation

Volume 9 Issue 1 - 2019

Abubakar HN,[1] Garba Y[2], Gana AK,[1] Jocob IA[3]

[1]National Cereals Research Institute, Badeggi PMB, Nigeria
[2]Crop Production Department, Ibrahim Badamasi Babangida (IBB), Lapai, Nigeria
[3]National Agricultural Extension and Liaison Services, Ahmadu Bello University, Nigeria

Correspondence: Gana AK, National Cereals Research Institute, Badeggi PMB, Nigeria, Email andrewgana2@yahoo.com

Received: October 31 2017 | **Published:** January 31, 2019

Introduction

A well developed agricultural research systems with a policy thrust of generating and disseminating improved technologies capable of boosting farmers' output and enhancing economic development of the rural populace is one key focus of Nigeria agricultural policy and program.[1] Broad-based adoption of improved production technologies was established to be the most effective way to increase productivity.[2] Continuous adoption of improved technologies will improve food security and reduce poverty if barriers to their continued use are overcome.[3] As recognized by Doss,[4] one way of improving agricultural productivity, in particular and rural livelihood in general, is through the introduction of improved agricultural production technologies to farmers. Most importantly, adoption of improved technologies remain the viable means to increase the productivity of small holder agriculture, thereby fostering economic growth and improved wellbeing for millions of the poor households.

As result of myriad of research on adoption behaviour, several terminologies have been associated with the adoption concept. Adoption of innovations, according to Rogers[5] refers to the decision to apply an innovation and to continue to use it. This is closely followed by the main options of active rejection, which occurs when farmers consider adoption of innovation (including its trial) but then deciding not to adopt it, and passive rejection (also called non-adoption), which consists of never really considering the use of the innovation. The concept of sustainable adoption was highlighted as the degree to which an innovation continues to be used over time after a diffusion program ends.[5] This is contiguous to the term continued adoption which is the persistent use of an innovation. Adopted village concept is an extension model designed to disseminate new technologies to rural areas within 50 km radius from a research station to potential adopted villages or Technology Outreach Centres (TORCs) in order to objectively increase farmers' productivity as well as a large scale adoption of modern production practices. National Cereals Research Institute (NCRI) is using the adopted village concept to strengthen the outreach system for promotion of improved farming systems and improved practices on its mandate crop inclusive of rice within Niger state. There is always strategic links between the technologies and farmers' adoption decision. Factors responsible for farmers' decision in explaining technology adoption behaviour mostly cited by literatures[1,6] includes socio-economic factors such as land own, labour force, income status etc. Demographic and personal characteristics, institutional factors, economic factors and technology related factors. The National Cereals Research Institute (NCRI) Badggi has been in the forefront in its effort to undertake the mandate of improving the genetic constituents of rice crop and release of same through effective outreach systems using different dissemination pathways.[6] The Institute has developed and promoted rice production technologies that are ecology specific which include lowland production systems: use of improved seed, nursery practices, land preparation and Levelling, Transplanting and spacing, Water management, Fertilizer rate, use of herbicide to kill weeds, use of chemical to control insects and pests, use of chemical to control diseases, harvesting techniques and drying. These practices are usually extended to the rice farmers using the institute outreach systems and dissemination platform including the use of On-farm Adaptive Research (OFAR), Management Training Plot (MTPs), on farm Research (OFR) and adopted village. Similarly, field demonstration, field days, interpersonal contact (individual and group) and mass contact among others are universal and conventional techniques employ by extension agencies for effective delivery.

Despite the accepted evidence of the contribution of improved technologies to agricultural productivity, there exist some problems including poor adoption of technologies, and sparingly available empirical evidences of the factors influencing the farmers' adoption behaviours in the adopted villages. Consequently, it is the objective of this study to ask some pertinent questions: what are the socio-economic characteristics of the rice farmers? How effective are the extension delivery methods employed by the NCRI for dissemination of the rice production technologies? What are the factors influencing farmers' adoption decision of the improved production practices of rice by the farmers in the NCRI adopted villages?

Objectives

The broad objective was to assess the factors influencing adoption of rice improved production practices by farmers in NCRI adopted villages, Niger state.

The study specifically sought to:

i. Describe socio-economic characteristic of rice farmers in the adopted villages.

ii. Determine the factors influencing adoption of improved production practices of rice among farmers in the adopted villages.

iii. Examine the effectiveness of extension delivery methods used by NCRI in dissemination of rice production technologies in the adopted villages.

Material and methods

The study area

Niger State is in the Guinea Savannah Zone of Nigeria. The state is bordered to the North-West by Kebbi State to the South by Kogi State to the South-West by Kwara State. Kaduna state and the Federal Capital Territory, Abuja borders the state to the North-East and South-East respectively. It lies between Latitude 8^0 10'N and 11^0 30'N, longitude $6^0$20'E and 9^0 03'E.[7] It has distinct dry and wet seasons and an annual rainfall of between 1,300 mm and 1,600 mm. The temperature occurs between 25°C and 38°C. The vegetation is Guinea Savanna with mixture of trees, shrubs, herbs, and grasses. The soils are of low to medium fertility levels and can be used for growing cereals, root and tree crops.[7] Niger State has a population of 3,954,772 people.[8] Using a population growth rate of 3.2% per annum, Niger state has a projected population of 5,966,367 people.

Sampling technique and data collection method

The basic information for the analysis was obtained from primary data collected with the aid of a structured questionnaire. The instrument was pre-tested in four different rice producing communities, and validated by group of three experts. Eight out of ten (10) adopted villages were purposively selected being the most prominent rice producing communities in the state. The selected adopted villages were Edozhigi, Ndagbachi, Dabarako, Jima-Doko, Loguman, Manima, Dwafu and Batagi. Twenty (20) rice farmers were randomly selected from each of the selected villages making a total of 160 rice farmers who constituted the sample size for the study. The classification of the rice farmers (adopters and non-adopters) was made possible based on their adoption decision of the production practices. This was done using technology adoption profile scoring adapted from Floyd (Table 1).[9]

Table 1 It shows the technology adoption profile

Technology adoption profile	Scoring*	Scoring**
Not aware	1	0
Aware, not tried	2	1
Tried, but dropped	3	2
Tried, undecided	4	3
Adopted	5	4

*Scoring by Floyd et al.[9] **Scoring modified by the author.

Respondent that marked '0 to 3' were classified as non-adopters, while 4 indicated the class of adopters. For binary dichotomous dependent variable, adopter=1, while non-adopter=0. The survey was conducted in February through April and May, 2017.

Analytical techniques

The study employed both descriptive and inferential statistics. Data were analyzed using a simple descriptive statistic (Frequency count and percentage) in achieving objective i. Objective ii was analyzed using a 3-point rating scale (Likert ratio) to evaluate view point on effectiveness of the extension service delivery methods with regard to each of the extension method. Numerical scores were assigned thus: not effective=1, effective=2 and very effective=3. The mean was obtained using a 3-point rating scale, which was modified thus: >2.50=very effective, 2.0–2.50=effective, <2.00=not effective. A mean of 2.00 was used as cut-off point to determine level of effectiveness with respect to each of the extension methods. Thus, a 3-point rating scale of 1, 2 and 3 add up to 6, which gave 2 as mean, when divided by 3. Objective iii was achieved using binary logit regression model as result of binary response and dichotomous adoption decision choice by adopters and non-adopters.

Logit regression model

A binary logistic model is appropriate when the dependent variable to be evaluated is dichotomous.[10] The model is typically used when the dependent variable is dichotomous and the independent (explanatory) variables are either continuous or categorical variables. The coefficients are compared with probability of event occurring or not are bounded between 0 and 1. Logistic binary regression analysis examines the influence of factors on a dichotomous outcome by estimating the probability of the event's occurrence. This is done by examining the relationship between independent variables and the log odds of the dichotomous outcome by calculating changes in the log odds of the dependent as opposed to the dependent variable itself. The log odds ratio is the ratio of two odds and it is a summary measure of the relationship between two variables. The use of the log odds ratio in logistic regression provides a more simplistic description of the probabilistic relationship of the variables and the outcome.

For the purpose of this study, the binary logistic regression model was used to assess the influence of chosen parameters on probability of adoption of management practices by rice farmers occurring or not. If the coefficient of a particular variable is positive, it means that the higher values of such variable result in a higher probability of adoption, while at lower value of a particular variable implies a lower probability of adoption.[11] Such phenomena are generally modelled using the relationship:

$$Y_i = \beta X_i + U_i \quad (1)$$

Where Y_i=1 when decision is made to adopt and 0 if otherwise.

This means:

$Y_{i=}$1 if X_i is greater than or equal to a critical value, X^*

$Y_{i=}$0 if X_i is less than a critical value, X^*

$$Prb\ (Y_i = 1) = f(\beta X_i) \quad (2)$$

$$Prb\ (Y_i = 0) = 1 - f(\beta X_i) \quad (3)$$

Y_i is the observed response for the ith observation of the response variable (Y). This means that Y_i=1 for an adopter [farmer who marks '5' in adoption profile scoring of the rice production management practices (Table 1)] and Y_i=0 for a non-adopter (farmer who marks '0–4' in adoption profile of the management practices (Table 1)]. Xi is a set of independent variables associated with the ith farmer, which determine the probability of adoption, (P).

$$E\left(Y / X\right) = 1[F\left(\beta X_i\right)\ ] + 0\left[\ 1 - F\left(\mathrm{B}x\right)\right] = F(\mathrm{B}x) \quad (4)$$

The empirical model for the logit model estimation used in this study is given by.

$$AF = F(a + \beta X_i) = F\left(Z_i\right)$$

Where *AF,* is the discrete adoption choice variable, *F* is the cumulative probability distribution function, β is the vector of parameters, X_i is the vector of explanatory variables and **Z** is the Z-score of βX_i area under the normal curve.

For this study $Y_i = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots + \beta_9 X_9 + e$

Empirical model:

Y = adoption decision-ADPT (1 = adopt, 0 = otherwise). X_1 =Age of farmer-*AGE* (year). $X_{2=}$level of education- EDU (years of formal schooling). $X_{3=}$Household size-HHSZ (number of people). X_4 =land owned-LND (ha.). X_5=Farming experience-FMEXP (years). X_6=Training participation-TRNG (dummy). X_7=Extension contact -EXTCON (number). X_8=Membership of farmer's association-MFASS (years. X_9=cost of technology-COST (Naira) e=error term β_0=Constant term.

Results and discussion

Table 2 shows that high proportions (87.5%) of the respondents were adopters of the rice improved production practices, while few (12.5%) were non adopters as indicated by the adoption profile of the respondents. Results in Table 3 show that majority (52.9%) of adopters fall between 41to 50 years of age, while 60% of non-adopters fall above 50 years of age. The finding implies that good number of the rice respondents were in their productive and economically active age ; therefore would be more receptive to new scientific findings, much willing to take risk in adopting new ideas and spread of innovative practices than the older ones in the non-adoption category. This agrees with the statement by Olowosegun;[12] Egbe & Eze[13] that young people are likely to accept and serve as better agents of innovation transfer; and is economically active age. The results further indicate that most (75%) of adopters of the rice production practices had more than 20 years of farming experience, while majority (70%) of non-adopters had between 16 to 20 years of rice production experience. This implies that rice production experience and ability to perceive effectiveness of improved practices over the traditional methods endear farmers to be receptive of innovative ideas. This is in line with Tiamiyu[14] who lamented that farmers who have more years of rice production experience are more likely to be innovators and technically skilful to demonstrate new technology with or without minimum assistance from extension agent.

Table 2 Summary of technology adoption profiles in classifying the respondents

Technology adoption profile	Modified score	Frequency	Percentage
Not aware	0	-	-
Aware, not tried	1	-	-
Tried, dropped	2	8	5
Tried, undecided	3	12	7.5
Adopted	4	140	87.5
Total		160	100

Source: survey data, 2016.

Table 3 Distribution of Respondent According to Socio-economic and Demographic Characteristics (n=160)

Characteristics	Adopters (n=140)		Non-adopters (n=20)	
	Frequency	Percentage	Frequency	Percentage
Age (years)				
<20	8	5.7	-	-
21-30	10	7.1	-	-
>31-40	18	12.9	3	15
41-50	74	52.9	5	25
>50	30	21.4	12	60
Mean household size				
10-Jan	30	21.4	13	65
20-Nov	46	32.9	5	25
>20	64	45.7	2	10

Table Continued....

Characteristics	Adopters (n=140)		Non-adopters (n=20)	
	Frequency	Percentage	Frequency	Percentage
Farming experience (years)				
<10	2	1.4	1	5
15-Oct	11	7.9	3	15
16-20	22	15.7	14	70
>20	105	75	2	10
Farm size (ha.)				
<1	16	11.4	4	20
5-Jan	72	51.4	2	10
10-Jun	32	22.9	9	45
>10	20	14.3	5	25

Source: survey data, 2016.

The results presented in Table 4 reveal that the use of field demonstration for showcasing method and result of improved rice production practices was very effective. The respondents rated method-cum-result demonstration as being high and very effective over the choice of a separate method demonstration or result demonstration. This is in line with Ayesha[15] who stressed that successful field demonstrations are very effective in convincing people and getting practices adopted by them. Field demonstrations may be regarded as the most effective tool in the hands of the extension worker for technology transfer. It involves the three important processes of learning: seeing, hearing and doing, so it is highly convincing. Organizing field day was averagely rated, considering both the green (organized at the vegetative stage of the crop) and brown (organized at the maturity stage of the crop) field day. The method was effective because it avails groups of farmers to meet together to observe new practices, and to prove that the new practice is superior to the one currently being used. This aligns with report by RTEP (2005) that field day organized at bloom phase or maturity phase was an effective extension tool for transfer of technologies, to a large extent, showcases the overall superiority of the new technology over the farmer practice. The findings further reveal that on - farm trainings including On-farm Adaptive Research (OFAR) and Management Training Plot (MTP) were rated very high as being very effective by the rice farmers. These are tools for absolute conviction for the farmers; strengthening of OFAR model is to ensure bottom-top demand driven approach to technology development (NCRI, 2013). The result is in contrast with the report by Egbe & Eze[13] that farmer' training programs and research-extension-farmer linkage were not very effective in extension delivery programs of Ebonyi state, Nigeria. Against this backdrop, there is obvious weak link in the overall farming system research and extension in the agricultural extension delivery in Nigeria. Furthermore, field visit is an important interpersonal (face-to-face) meeting with farmer in hi/her field to observe and identify field problem as well as to introduce new practices that are location-specific and advices on possible dimension of solving technical problems. Farmers' group meeting was discovered as effective tool for extension delivery service having a mean value of 2.01. Also found very effective were farm broadcast and use of contact farmers.

Table 4 Mean Rating of Respondents' Perception of Effectiveness of Extension Delivery Methods (n=160)

Extension delivery methods	Very effective (FX3)	Effective (FX2)	Not effective (FX1)	$\overline{X}$
Field demonstration:				
Method	210	116	22	2.32
Result	294	104	-	2.65**
Method-cum-result	112	30	8	2.69**
Field day:				
Green	48	262	3	2.09*
Brown	141	188	9	2.25*
On farm training:				
On farm Adaptive Research	366	56	-	2.81**
Management Training Plot	312	56	20	2.59**
Interpersonal contact (face-to-face)				
Field visit	68	114	2	2.00*
Home visit	9	56	116	1.21

Table Continued....

Extension delivery methods	Very effective (FX3)	Effective (FX2)	Not effective (FX1)	$\overline{X}$
Group contact:				
Farmers' group meeting	36	128	10	2.01*
Exhibition	18	40	124	1.21
Workshops	12	10	141	1.08
Mass contact:				
Farm broadcast (radio)	23	84	160	1.78
Television programs	60	98	86	1.62
Technical guides & posters	12	54	124	1.27
Farmers' led delivery system:				
Contact farmer	330	56	12	2.65**

**Very effective and *Effective

Source: survey data, 2016

Table 5 presents the result of logit estimate of the selected factors influencing adoption of production practices by rice farmers. The model was grouped into personal, socio-economic and institutional factors. Of all the nine variables included in the model, seven indicated significant influence on the probability of adoption of rice agronomic practices. The R^2 value of 0.7895 which implies that the variable included in the model accounted for 78 percent of probability of rice farmers decisions to adopt rice production management practices. The Log-likelihood Ratio (LR) indicated a Chi^{-2} – squared value of 43.9655 significant at 1 percent level. This means all explanatory variables included in the model jointly influence framers' probability of adoption of improved rice production management practices. The model results also gave a predicted probability of 0.6845. This means there is about 69 percent probability of that rice farmers in the NCRI adopted villages, Niger state, Nigeria are willing to adopt improved rice production practices provided the personal, socio-economic and institutional constraints that hinder technology adoption are overcome. Given the above mentioned goodness of fit measures, it is conclude that the logit model employed had substantial integrity and hence appropriate. The maximum likelihood estimates of the Logistic model are presented in Table 4. The followings were statistically significant at 1%, 5% and 10%.

Table 5 Result of Binary Logistic Estimate of the Factors Influencing Adoption of Rice Improved Production Practices

Explanatory variables		Coefficient	Std. err	Z	P>|Z|	Odds Ratio
Age	X1	-0.3546	0.2522	-1.406	0.075*	0.3132
Level of education	X2	3.2517	6.4965	0.5005	0.623	0.2998
Household size	X3	2.3481	0.6423	3.6557	0.031**	0.5261
Land owned	X4	2.8437	0.8118	3.5029	0.024**	0.5681
Farming experience	X5	1.8924	0.7454	2.5387	0.012**	0.4624
Training participation	X6	4.4928	0.9264	4.8497	0.000***	0.8642
Extension contact	X7	2.4896	0.9411	2.6454	0.002***	0.5526
Farmers' association	X8	1.9543	3.6356	0.5375	0.894	0.3468
Cost of technology	X9	-0.4723	0.1443	-3.273	0.041**	-1.432

***(0.01); **(0.05) and *(0.1)

Source: survey data, 2016.

Age: Results of the analysis in Table 5 show negative relationship between age and adoption of production practices by rice farmers, and was found statistically significant ($P \leq 0.1$). 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 0.31 for older farmers. Hence adoption of improved practices for rice production is higher among youth than old farmers. In other word, the likelihood of adoption decreases with 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 word, the likelihood of farmers' adoption decision decreases as the farmers advances in age. This is in consonance with findings by Mamudu[16] on adoption of modern agricultural production technologies by farm household in Ghana that old farmers tend to be less productive, and usually conservative and abhorring innovation information. The younger farmers were more innovative and enthusiastic to venture into new way of doing things. In the same vein, age has also been

found to be negatively correlated with technology adoption level in studies on adoption of land conservation practices in Niger.[17] Older farmers, perhaps because of investing several years in a particular practice, may not want to jeopardize it by trying out a completely new method.

Household size: The variable is a proxy for the availability of labour to undertake farming activities, and was found positive and statistically significant (P≤0.05). The finding suggests that adoption probability was influenced by the bulk of number of people that constituted a household size. The positive coefficient is an indication of odds in favour of farmers' willingness to adopt the practices for rice production in the study area as influenced by the size of the household. Therefore, a unit increase in the household size would influence farmers' adoption decision by a factor of 0.5261. It can be inferred that availability of labour increases farmers' willingness to adopt the practices for rice production. Similar findings were reported by Adeniji[18] and Ani[19] who found positive relationship between household size and adoption of improved agricultural production technologies. The finding summarily implies that rice farmers were more inclined to adoption of modern tradition of rice production in relation to availability of labour force within a household. Households with large family size may readily adopt new agricultural production practices than those with smaller family size since labour force is available.

Land owned: hectares of farm land owned by the farmer and devoted to rice production. The variable was found to be positive and significant (P≤0.05). Being positive is indicative of influence in favour of the farmers' likelihood to adopt the improved management practices for rice production in the study area. The log odds ratio of 0.5681 gave simplistic probability description of relationship between the land owned and outcome. This implies that a unit addition of hectares of land owned by farmers would prompt farmers to adopt more number of rice production technologies. A farmer who is able to put additional farm land into rice production is more likely to try recommended practices and subsequently adopt them. This finding is consistent with Mustapha[20] who reported that land owned significantly and positively affect the decision to adopt improved production practices as an adaptation option to climate change and variability by smallholder farmers in northern Ghana. This presents a serious challenge to policy makers and implementers in promoting the adoption of modern agricultural production technologies.[16] This is because majority of farmers in the study area operate on small scale with average farm sizes hardly exceeding five hectares.

Farming experience: The coefficient of farming experience was found to be positive and significant (P≤0.05) in influencing the decision to adopt improved rice production management practices. The variable indicates log odds ratio of 0.4624 which predicts positive relationship and influence on farmers' adoption of the improved management practices in the study area. The positive influence is expected because more experienced farmers may have good advantage of acquiring better skills and access to innovative information about improved practices. The finding also implies that knowledge and experiences gained over time from working in an uncertainty production environment may help in evaluating the technologies thereby influencing their adoption decision. The fact that overwhelming majority (76.7%) of adopters having more than 20 years experience as rice farmers is indicative of likelihood that adoption would spread beyond the current production area. the finding agrees with Abubakar[6] who reported farming experience as being positive and significant determining factor influencing adoption and intensity of used of production technologies by lowland rice farmers in Niger state, Nigeria. Experience improves farmers' skill at production.

Training participation: The results also indicate positive and significant (P≤0.01) relationship between the number of training attended and farmers' adoption decision of improved management practices for rice production. That is, training has a positively significant influence on the farmers' adoption of the recommended practices in the study area. This implies that adoption behaviour is positively influenced by the number of training farmers have participated which is increased by a factor of 0.8642. Therefore, by this finding, it can be inferred that farmers would be more willing to optimize compliance with the recommendation and specifications packaged for rice production in the study area, and would further be incline to spread the idea across the social system which could be used as a valid lead for organizing trainings through extension intervention programs and policies. Similar finding was remarked by Abubakar[6] that training participation in agricultural programs including On-farm Adaptive Research (OFAR) trials, Management Training Plot (MTP) demonstration techniques organized by the National Cereals Research Institute (NCRI) in Nigeria positively and significantly influence farmers' adoption level of lowland rice production technologies.

Extension contact: The coefficient of extension contact was found positive and significant (P≤0.01). This indicates positive relationship between the extension services and farmers' adoption probability of management practices. The variable reveals that extension contact has positive influence on the farmers' adoption decision with a log odds ratio of 0.5526. It could therefore imply that farmers would be more willing to adopt the management practices for rice production in the study area, if numbers of extension contacts are increased. Farmers who are not contacted by frontline extension agents are expected to have lower probabilities of adoption and a lower level of use of improved technologies.[21] Also, Brian[22] highlighted that number of extension visits has a positive impact on adoption and use of technologies. This is because farmers get exposed to new information which reduces information asymmetry that characterize a new technology and hence farmers are more aware about it and more willing to take the risk of trying the new technology. The policy direction shall therefore be focussed on effective delivery service methods with a view to sustain modern technology adoption among all the categories of farmers.

Cost of technology: The variable was negative and significant (P≤0.05). The negative relationship implies the lesser the cost of the technologies the more likely are the farmers to adopt the management practices. The finding portrays a true farmers' situation giving that they would have high probability of adopting the management practices into their farming systems, if the cost of obtaining such is low and affordable[14] corroborated the finding that the cost of technologies have a range of influence on the probability of adoption. The cost being within the reach of the end-user would stimulate interest for purchasing recommended quantities; and little would however be demanded, if the is above the purchasing power of the end-users.

Conclusion

Based on the findings, it could be said that integration of multiple extension delivery methods employed by the extension agencies proved promising and effective in dissemination of improved rice production practices in the study area. This stemmed from the field demonstration, farmer participatory approaches and on-farm

training programs. In addition, almost all of the selected parameters both socio-economic and institutional factors had exerted range of influences on farmers' adoption decision. The rice producers as a result of effective extension services had begun to integrate modern trend of rice production into their own farming systems. On the whole, this research work endorses the effectiveness of demonstration methods among others, therefore their continuation is recommended for assimilation of the rice production technologies as well as proliferation of improved practices and their benefits to larger number of farmers.

Recommendation

The study is policy focused; therefore the following recommendations were made:

- There should be a sustainable linkage systems between the research and extension;
- Farm broadcast should be emphasized for farmers to be abreast of new practices and production packages;
- Bottom-up approach and demand driven technology is thus recommended with a view to enhance the rate of adoption among end-users;
- Farmers' incentives and supports should be accorded top priority in the scheme of agricultural programs in the country.

Acknowledgments

None.

Conflicts of interest

The authors declared there is no conflicts of interest.

References

1. Richard BA, Jones AD, Annor F. Socio-economic Factors Influencing Adoption of Codapec and Cocoa High-tech Technologies among snall holders farmers in Central region of Ghana. *American Journal of Experimental Agriculture.* 2013;3(2):277–292.
2. Minten B, Barrett BC. Agricultural technology, productivity, and poverty in Madagascar. *Elsevier*. 2008;36(5):797–822.
3. Oladele OI. A Tobit analysis of propensity to discontinue adoption of agricultural technology among farmers in Southwestern Nigeria. *Journal of Central European Agriculture*. 2005;6(3):249–254.
4. Doss CR. Analyzing technology adoption using micro studies: Limitations, challenges and opportunities for improvement. *Agric Econ*. 2003;34(3):207–219.
5. Rogers EM. *Diffusion of Innovations*. Fifth edition. USA: Free Press; 2003.
6. Abubakar HN, Kolo IN, Yabagi AA, et al. Adoption of production technologies by lowland rice farmers in Lavun Local Government Area of Niger state, Nigeria. *International Journal of Agricultural Extension*. 2016;4(1):7.
7. Ojohomon VET, Abo ME, Ojohomon O, et al. Adoption of Recommended Management Practices in the Lowland Rice Ecology of Niger State, Nigeria. *Journal of Tropical Agriculture*. 2006;2(24):82–89.
8. National Population Commission (NPC). *National Population Census Report*. Nigeria. 2006.
9. Floyd CN, Hardling AH, Paddle KC, et al. Adoption and Associated Impact of Technologies in the Western hills of Nepal. Overseas Dev. Inst. Network. *Journal of Agric Res and Ext*. 1999. 158p.
10. Amemiya T. Qualitative Response Models: A survey. *Journal of Economic Literature*. 1981;19(4):1483–1536.
11. Sarap K, Vahist DC. Adoption of Modern Varieties of Rice in Orissa: a farm level analysis. In: Al-Karablieh EK, Ahmed SA, editors. Logit Models for identifying the factors that influence the adoption of Barley production technologies in low rainfall areas. *Jordan journal of Agricultural Sciences*. 1994;9(3):251–265.
12. Olowosegu–Sani AO, Sule AM, Bwala RL. Contribution of Women to Fisheries Development in Kainj Lake Basin. Proccedings of 19th Annual conference of Fisheries Society of Nigeria. 2004.
13. Egbe BO, Eze SO. Farmers' perception of effectiveness of agricultural extension delivery towards Acquaculture development in Ebonyi state. Nigeria. *International Researchers*. 2014;3(3):1–15.
14. Tiamiyu SA. Technology adoption and productivity difference among growers of new rice for Africa in savanna zone of Nigeria. *Tropicultura*. 2009; 27(4):193–197.
15. Ayesha K, Pervaiz U, Khan NM, et al. Effectiveness of demonstration plots as extension method adopted by AKRSP for Agricultural technology dissemination in district Chitral. *Sarhad Journal of Agriculture*. 2009;25(2):4–18.
16. Mamudu AA, Guo E, Dadzie SK. Adoption of modern agricultural production technologies by farm households in Ghana: What factors influence their decission? *Journal of biology, agriculture and healthcare*. 2012;2(3):34–68.
17. Adesina AA, Baido-Forson J. Farmers' perception and adoption of new agricultural technology: evidence from analysis in Burkina Faso and Guinea, West Africa. *Journal of Agricultural Economics*. 1995;13(1):1–9.
18. Adeniji AA, Voh JP, Atala TK, et al. Adoption of improved cotton production technologies in Katsina State, Nigeria. *Journal of Applied Science*. 2007;3(7):39–42.
19. Ani AO, Kanya HT, Hassel UJ. Impact Study on the Adoption of Improved Agricultural Technology by Groundnut Farmers in Hauwul L.G.A. of Borno State, Nigeria. *Nigeria Journal of Rural Development Cooperation*. 2012;7:19–25.
20. Mustapha SB, Gwary MM, Samaila PA. Assessment of the effectiveness of Lake chard Research Institute "Adopted Scheme" in the dissemination of improved farm technologies in Borno state, Nigeria. *International Journal of Science and Technology*. 2012;2(12):837–920.
21. Bamire AS, Fabiyi YL, Manyong VM. Adoption pattern of fertilizer technology among farmers in the ecological zones of South-Western Nigeria: A Tobit analysis. *Austr J Agric Res*. 2002;53:901–910.
22. Brian C, Ugustine S, Patrick W. Adoption of conservation Agriculture Technologies by small holder farmers in the Shamva District of Zimbabwe: A tobit Application. *Ag Econ*. 2011.