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Adoption of agricultural innovations among rice farmers in federal capital territory, Nigeria

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Abstract
The study accessed rice farmers' adoption of innovations in the Federal Capital Territory, Nigeria. The FCT has six area council; Abaji, kuje, Municipal, Kwali, Bwari and Gwagwalada. The study area covers a land mass of 8,000 kilometers (km^2). It is bordered by four states Kaduna, Nassarawa, Kogi and Niger, it lies between latitude 80 251 and 90 251 North of the equator and longitudes 60 451 and 70 451 east of the Greenwich meridian. Abuja is located in the middle belt of Nigeria, its size is equivalent to 0.8% of Nigeria. There exist expansive fertile marshy plains good for rice production. The multistage sampling method was used to sample a total of 120 rice farmer using structured questionnaires as instruments in Gwagwalada council, 20 farm cells were selected, 6 farmers were then randomly selected from each cell. The data were analyzed using simple descriptive statistics. Most of the farmers (87.5%) were male. 6-11 persons (33.3%) per household constituted the largest household size of the total farmers sampled. Majority of the farmers (26.76%) earned only between N 21,000 and N 60,000 annually. Adoption rate of some agricultural innovation in rice were rated as Fertilizer (60.2%), herbicides (60.2%), improved seed (30.8%), use of agricultural extension services (3.3%) use of farm machinery (2.1%) and silos (1.1%). Constraints faced by farmers in the study area were inadequate capital (80%), inadequate extension services (85.8%) poor market price (30.8%), high cost of agro chemicals (98.3%), inadequate storage and processing facilities (92.5%), No access to loans and credits (95.0%). The research recommended public private partnership (PPP) to sensitize and educate farmers to enable them to benefit from the new innovations and technology that abound in rice farming.

Keywords: Adoption, farmers, innovation and constraints

Introduction

Adoption of good innovations by rice farmers is central to boosting the production of rice International Rice Research Institute IRRI, (2022) [16]. Rice is an important cereal crop of a large monocotyledonous family of some 600 genera and around 10,000 species called Graminae (FAO, 2013) [11]. It is considered as one of the most important staple foods for over half the population and third after wheat and maize in the world (Sennuga, *et al.*, 2020; Jegede**,** *et al*, 2021) [27, 17]. According to FAO (2013) [11], more than half of the world's population feed on rice, majorly *Oryza sativa* and *Oryza glaberrima*. As one of the major staple food crops consumed by more than half of the world population, rice then, is seen as central to the food security of the ever-growing population especially in Africa and Asia. The areas where rice is cultivated in Nigeria are classified into five ecosystems namely: rain-fed upland, rain-fed lowland, irrigated lowland, deep-water and mangrove (Oyewole and Sennuga 2021) [17]. Rain-fed lowland accounts for 50% of the total area under rice cultivation followed by rain-fed upland (30%) and irrigated (16%) system. Deep-water and mangrove swamp systems constitute the remaining 4% of the total land area. Rice is cultivated in about 32 States in Nigeria with a total land area of about 2.43 million hectares and annual production of over 4.47 million metric tons of milled rice thus giving an average of 1.84 metric tons per hectare and the major rice producing States in Nigeria includes Taraba, Kaduna, Niger and Kano. (Abubakar, *et al.*, 2016; Ojo, *et al.*, 2021) [1, 24].

According to Mustapha *et al.*, (2012) [20], Taraba State also in the northeast of Nigeria has the largest land area under rice cultivation with 375,670 hectares representing 15.4% of the total land area, followed by Kaduna State with 344,890 hectares (14.17%). Niger State has 330,670 hectares (13.59%) while Kano contributes 219.060 hectares or 9% of the total land area under rice cultivation in Nigeria (Fadiji and Sennuga, 2020) [10]. Demand for consumption of rice is on the increasing side, especially with the deliberate policies created by the government to encourage speedy adoption of innovations by rice farmers in recent years and it has now become a food security and cash commodity crop with states like Lagos, Kebbi, Ebonyi and Cross River in the front line (Abubakar *et al.*, 2016; Lai-Solarin *et al.* 2021) [1, 19]. In 2007, the Federal Government of Nigeria raised the tariff on rice importation to 75% to "Protect local producers against massive imports of rice". This policy is stimulating interest in the domestic production of Rice (Hassan, 2014; Ebisike, *et al.*, 2021) [32, 8]. It is estimated that home-grown

rice yield is at about 5 million tons annually in Nigeria with the possibility of increasing if innovations required for growing the crop are properly adopted by rice farmers (Idu, *et al*., 2013; Egboduku, *et al.*, 2021) [14, 9].

Nigeria's rice production rose from 3.7 million metric tonnes in 2017 to 4.0 million metric tonnes in 2018. For the record, the major rice producing states in Northern Nigeria are Kebbi, Borno, Kano, and Kaduna. Currently, most of the farmers producing rice rely on traditional technology with low use of improved input technologies. Average rice yields per unit area in the country are low and range between 2.0 and 3.0 t / ha compared to yields of 6-8 t / ha reported on research plots. It is important for farmers to adopt improved varieties and have a good knowledge of rice agronomy to increase rice production and productivity in the various states in Nigeria. (Kamai, *et al.,* 2020; Aluko, *et al.,* 2021) [18, 6]. Significant improvement in rice production in the FCT started in 2002 and continued steadily it is cultivated in Abaji and also along the flood plains of River Gurara in the western part of the FCT. Of the total land area in the FCT, 20.605,000 Ha is used in cultivating Rice (Hassan, 2014; Adangara, *et al.*, 2022) [32, 2].

The adoption rate of any agricultural technology can be measured in terms of the number of farmers who adopt the technology or in terms of the total area on which the technology is adopted depending on the objective of the study (Ogeneve, 2017; Oduwole, *et al.,* 2022) [23, 22]. In a study on the adoption of improved rice varieties among smallholder farmers in Kogi State Nigeria. Adisa, *et al.*, (2019) [5] applied the logit regression model to both adopters and non-adopters to identify factors influencing the farmers' decision to adopt or not adopt the improved rice varieties while the linear regression was applied only to adopters to identify factors that influence the intensity of use after farmers might have decided to or adopted the improved rice varieties. They found that a substantial proportion of land area grown to rice was cultivated with improved rice varieties with an adoption rate of 68.7% while the adoption rate for local varieties was 31.3% and income, farm size, age, use of fertilizer, storage facilities, availability of extension services also influence farmers adoption of innovations in rice farming.

In another study on the adoption of innovation on productivity of NERICA rice farming, AKinnagbe and Akinbola (2022), analyzed data obtained from sample survey of NERICA rice farmers in Ekiti State, tobit regression indicated that farmers' technology score was affected significantly by farmers‟ level of education, extension visit, farming experience, land ownership status, credit use and level of rice commercialization.

In an assessment of the adoption improved technologies by the rice farmers in Kogi state, using the Tobit model to unravel the decision to adopt or not to adopt the use of fertilizer. Tobit model estimates of factors affecting adoption and use intensity of chemical fertilizer in rice production showed that farm size, type of ecosystem, tillage type, education, population pressure on land, farmers age and non-farm income to be positively and significantly related to adoption and use intensity of chemical fertilizer while field distance to the village, gender, access to credit and labour availability had indirect relationship with adoption and use intensity of chemical fertilizer. Adisa, *et al.,* 2019; Oyetola, *et al.,* 2022) [5, 26].

Objectives of the study

The purpose of the study is to assess the Farmers' Adoption of Innovation in Rice Farming in Federal Capital Territory, Nigeria. The specific objectives of the study are to:

1. Describe the socio-economic characteristics of rice farmers in study area;
2. Investigate some of the innovation adopted by rice farmers;
3. Ascertain the constraints of rice farmers in the adoption of innovations in rice farming.

The study area

The study area, the Federal Capital Territory, covers a land mass of 8,000 square kilometers (km2). It is bordered by four states Kaduna, Nassarawa, Kogi and Niger, it lies between 80251 and 90 251. North of the equator and longitudes 60 451 and 70 451 east of the Greenwich meridian. It is located in the middle belt of Nigeria; its size is equivalent to 0.8% of Nigeria. The FCT has six (6) area councils namely, Kuje, Gwagwalada, Bwari, Abaji, AMAC, and Kwali. Nigerian Institute of Town Planners NITP (2019). The Federal Capital Territory is central to Nigeria in administrative, geographical, and lying just above the hot and humid low lands of the Niger / Benue trough but below the drier parts of the country lying to the north. It lies north of the wide alluvial plains formed by the confluence of the Niger and the Benue rivers. The Jema'a platform, a continuation of the Jos plateau extends well into the middle season is in the middle of March and ends in the middle of October in the north and early November in the south of the FCT. The mean annual rainfall ranges between 1,145mm to 1631.7mm, as a result of its location on the windward side of the Jos Plateau; this therefore gives rise to frequent rainfalls and a noticeable increase in the mean annual total from the south to the North (Adejoh, *et al.*, 2017) [3].

Sample and sampling techniques

On the multi-stage bases of sampling, a total of 120 rice farmers were randomly and purposively sampled for the study using structured questionnaires as instruments in Gwagwalada council. 20 farm cells as delineated by the Abuja Agricultural Development project FCTADP (2019) were selected, 6 farmers were then randomly selected from each cell, these constituted the total sample size for the study.

Method of data collection

Primary data were used for the study; the data was collected with the aid of well-structured questionnaire which were administered to the farmers with the help of an enumerator, three per cell of the FCTADP, (2018) [12].

Method of analysis

Descriptive statistics (frequency, percentage) was used for data analyses with aid of Statistical Package for Social Science (SPSS) to analyse the data. The descriptive statistics was used to present the results. Descriptive statistics was used to summarize data in an organized manner by describing the relationship between variable in a sample or population. Binary logit regression analysis was used to

analyze the effect of selected socioeconomic variables on the adoption of agricultural innovation as was adopted by Adejoh *et al*, (2017) [3] in a similar study. The logit modeled is specified below:

$Lny = Ln (p/1 - p)$
$Ln (p/1 - p) = f (\beta_i X_i) + e_i$

Where,
Y = adoption (1 = adopter, 0 = otherwise)
P = Probability of farmer adopting the technology
1 – P = probability of farmer not adopting the technology
Ln = Natural logarithm function.
Bi = vector of logistic regression coefficients.
Xi = vector of independent variables given as follows:
X1 = sex (male = 1, female = 0).
X2 = Age of the farmer (in years).
X3 = Household size (number of persons).
X4 = Level of education (years spent schooling).
X5 = Experience in rice farming (years).
X6 = use of pesticides (yes = 1, 0 otherwise).
X7 = use of herbicides (yes = 1, 0 otherwise).
X8 = use of fertilizer (Yes = 1, 0 otherwise).

Discussion of Results

Socio-economic characteristics of the respondents

Table 1.1 below shows the Socio-economic characteristics of rice farmers in the study. The table contained information on; gender, age, occupation, marital status, family size, literacy level and farming experience of respondents. The table further reveals that, most majority constituting about 87.5 percent of rice farmers numbering 85 were male, while the rest constituting about 12.5 percent attracting only 15 respondents were found to be female. This result indicates that, there were more males in rice production in the study area though female also participated in the farming. Similarly, the family size of the respondents shows that, 33.3 percent accounting for 40 respondents were at the majority and they have a family size that range between 6 and 10 persons per house hold.

The marital status of the respondents from the results obtained in table 1.1 also reveals that, 70.0 percent of rice farmers in the study area were married with only 30 percent was found to be unmarried. The contribution of marital status on agricultural production can be explained in terms of the supply of agricultural family labour. Family labour would be more where the household head is married and vise visa. majority of the respondents representing about 48.3 percent of the respondents constituting 58 had secondary school education, about 24.1 percent had at least primary school education while only 13.3 percent constituting 16 respondents had no formal education and these set of farmers hardly accept new innovation as asserted by Adenuga, *et al.*, (2016) [4], there exist a positive relationship between education and adoption of new innovation. While the remaining 13 percent attracting 16 respondents accounted for those with tertiary education. The implication of this is that, there is every likelihood that adoption of new innovations by the farmers in the study area would be very effective likely because education is one of the important factors that determines the ability of farmers to understand policies, programmes and innovations of their time. Education affects productivity through effective resource use, allocation and choice of inputs for production activities, all things been equal (Donkor, *et al.*, 2013; Indahgiju, *et al.*, 2022) [7, 15].

The result of farming experience from the table further shows that about 28.3 percent accounting for 34 respondents had farming experience of 11 and 15 years, while 15.8 percent constituting 19 respondents had between 21 and 25 years farming experience, also about 8.4 percent accounting for 10 respondents were those that fell within experience years of between 1to five years, only 9 respondents, 7.5 percent had farming experience of 26 years and above. This indicates that most of the rice farmers in the study area have good knowledge of rice farming, signifying that, the respondents had adequate knowledge and experience in the production of rice and therefore, their long stay in the business indicates they usually had good returns that keep them in the cultivation of rice.

The result obtained on the farm size of the respondents shows that, majority constituting about 93.3 percent of the respondents numbering 112 had a land holding between 1 and 5 hectares, with about 4.2 percent constituting 5 farmers cultivated between 6 and 10 hectares, while, only about 2.0 percent with 2 respondent each cultivates between 11 and 15 hectares and only 0.8 percent accounting for only I respondent cultivated 16 hectares and above. From the analysis, it indicates that, majority of the rice farmers in the study area engage more in small scale rice production. This finding is in agreement with the findings of Idu, *et al.*, (2013) [14], that most farmers in the FCT cultivated crops on small and fragmented farm lands.

Table 1: Socio-economic characteristics of rice farmers in the study

Variable	Frequency	Percentage (%)
Gender		
Female	15	12.5
Male	85	87.5
Family Size		
1 -5 people	27	22.5
6 – 10 people	40	33.3
11 – 15 people	22	18.3
16 -20	26	21.7
21>	5	4.2
Marital Status		
Single	23	30.0
Married	84	70.0

Educational Level		
No formal education	16	13.3
Primary Education	29	24.1
Secondary Education	58	48.3
Tertiary education	16	13.3
Experience (yrs.)		
1 -5	10	8.4
6 -10	14	11.7
11 -15	34	28.3
16 -20	34	28.3
21 -25	19	15.8
26	9	7.5
Farm size		
1-5	112	93.3
6-10	5	4.2
11-15	2	2.0
16 and above	1	0.8
Income(N)		
1 -20,000	6	5.0
21'000 -40,000	12	10.0
41,000 -60,000	32	26.7
61,000 -80,000	32	26.7
81,000 >	38	31.6
Age (years)		
20 -30	28	23.3
36 -45	39	32.5
46 -55	26	21.7
56 -65	19	15.8
66 >	8	6.7
Education		
Pri. School	33	27.5
Sec. Sch.	56	46.6
Tertiary	17	14.2
No education	14	11.7

***Source*:** Field Survey, 2021

Adoption of rice innovation by the respondents

Adoption of innovation in study area as depicted from Table 1.2 shows that, about 90.4 percent accounting for 85 respondents adopted sprayers in their farming processes. 62.8 percent numbering 59 respondents each, applied fertilizer and herbicides when available. 49 percent and above adoption rate was considered as innovation adopted. The finding agrees with the findings of Yuguda, *et al.*, (2013) [30] that over, 70 percent of Nigerian farmers make use of fertilizer and herbicides in their farming practices when available.

Top among non-adopters were machinery and extension services at 97.7 percent each, constituting 92 numbers of respondents. This implies that, machinery and extension services were not adopted or made available to the farmers. This may possibly constitute a great impediment on output of rice in the study area. This is in line with the findings of (Oyeneye, 2017; Olorunniyi, *et al.*, 2022) [31, 25], that majority of farmers, over 90 percent, have not adopted use machinery in their farming practices which could be as result of absolutely no availability or introduction.

Table 2: Distribution of Respondents According to adoption of innovations

Innovation	Frequency	Percentage (%) Adoption
Fertilizer		
Yes	72	60.2
No	48	38.8
Herbicides		
Yes	72	60.2
No	48	38.8
Pesticides		
Yes	85	70.1
No	45	29.1
Improved seeds		
Yes	37	30.8
No	83	69.2
Machinery of any kind		
Yes	2	2.1

No	118	97.9
Sprayers		
Yes	85	90.4
No	35	9.6
Extension services		
Yes	4	3.3
No	116	96.7
Silos / other modern storage facilities		
Yes	-	1.1
No	120	98.9

Source: Field Survey, 2021

Rice farmers' constraints in the adoption of innovations in rice farming

Adoption of innovations in rice farming in the study area is faced with numerous challenges which can also result to various levels of inefficiency in their farming practices. The result on Table 1.3 below shows the problems associated with Adoption of innovations in the study area. The problems highlighted include; inadequate capital (80%), accounting for 96 of the respondent are faced with the problem of in adequate capital, unfavorable market prices (80.7%), high cost of agro chemical (98.3%) indicating that 118 of the total respondent find it very difficult to access agro-chemicals among many others.

Table 3: Rice farmers' constraints in adoption of innovations

Constraint	**Frequency**	**Percentage** (%)
Inadequate capital		
Yes	96	80.0
No	24	20.0
Inadequate extension services		
Yes	103	85.8
No	17	14.2
Low level of education		
Yes	35	29.2
No	85	70.8
Poor market price		
Yes	37	30.8
No	83	69.2
High cost of Agro chemicals		
Yes	118	98.3
No	2	1.7
Inadequate processing and Storage facilities		
Yes	111	92.5
No	9	7.5
Delay in Supply of improved Farm Inputs		
Yes	118	98.3
No	2	1.7
No access to Agric. Loans and credits		
Yes	114	95.0
No	6	5.0

Source: field Survey, 2021

Table 4. Estimates of the binary logistic regression showing the effects of selected socioeconomic variables on the adoption of agricultural innovations among small scale rice farmers

Variable	**Marginal effect**	**S.E**	**t-value**
Sex (dummy)	-0.214	0.379	0.320
Age (years)	0.011	0.021	0.264
Household size (number)	-0.094	0.055	2.923***
Education (years)	0.006	0.026	0.051
Extension contact (dummy)	0.507	0.519	0.954
Use of pesticides (dummy)	0.681	0.371	3.372***
Use of fertilizers (dummy)	2.379	0.402	34.950***
farming experience (years)	0.042	0.032	1.721**
Constant	-2.874	1.074	7.158

Source: Computed from field survey data, 2021 Log-likelihood= 251.876, Lχ2 = 65.674, Prob >χ2 = 0.000; Pseudo R^2= 0.239 ***

**and = significant at 1% and 5% respectively

Table 4 above shows the model's log likelihood ratio of 251.876 and $\chi 2$ value of 65.674, by implication this indicate that all variables included in the model significantly influence the probability of adopting agricultural innovations among small scale rice farmers in the area at 1% and 5% level of probability.

Conclusion

The study therefore concludes that, the adoption rate of fertilizer, agrochemicals, sprayers were high. By implication effort should be made to reach out to the farmers to encourage them cultivate rice so as to fill the food shortage gaps in rice as a common staple food for all. Nevertheless, certain constraints such as high cost of agro-chemicals, inadequate access to extension agents, no access to loan facilities etc. greatly militated against the farmers' ability to cultivate rice in spite of the high level of adoption rate in most of the rice farming technologies. The study therefore recommends that, Public Private Partnership (PPP) should be explored by government so as to help in the more education and adoption of farmers with regard to new technology and innovations. Government should ensure better funding of the extension service (i.e., workers) in the FCT through more training through workshops and seminars, provision of mobility such as motorcycles and motivation so as to reach out more frequently to the rice farmers and to enable adequate and timely supervision by supervisors with a view to make them extend knowledge to farmers. Accessible, affordable and simple rice production machineries and equipment that will be easily adopted by rice farmers should be made available to the farmers. Agricultural Financial institutions should be mandated to give out loans to the farmers at low interest rate to the farmers to enhance their productivity.

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