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Farmers' Evaluation of NERICA Rice Varieties and Adoption Determinants in Nigeria

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Abstract: Farmers' evaluation and analysis of the factors determining the adoption of improved farm technology are essential to elicit what varietals characteristics motivate farmers to adopt or reject improved varieties and the technology. The main objective of the study was to elicit farmers' criteria for selecting rice varieties and the factors determining adoption of NERICA varieties in the study areas. The data used for this study were collected from 600 farmers in Ekiti, Kaduna, Nassarawa, Ogun, Ondo, and Taraba States of Nigeria through farming household survey conducted from August to September 2009. The main instruments for data collection were well-structured questionnaires administered in each state. This study utilized descriptive statistics, such as means, frequency and percentages; and Tobit regression model were used to analyze the data collected. The results revealed that field days attendance was very low in the study areas and was similar across states; and this may limit their participation in exchange of ideas and in sharing of knowledge and experience of improved technology. The small farm size and subsequently low output could adversely affect rice production in the country and thus prevent the country from attaining self-sufficiency in rice production. Farmers grow an assortment of both local and improved rice varieties and the most important criteria across the states were high yield, tillering and logging resistance. There was progressive increase in the proportion of land given to NERICA rice cultivation since 2004. This suggests that there is increase in the adoption rate of NERICA varieties across states. Level of formal education, farm size, access to credit, rice income, farm income and level of awareness of NERICA varieties positively and significantly determined NERICA rice adoption. Base on these, we recommend that government should aim at policies geared towards providing incentives to encourage all stakeholders to improve productivity in rice production. Incentives, such as provision of micro credit and implementation of subsidy on inputs like fertilizer and seed, would go a long way in boosting rice production in the study area.

Key words: Adoption, evaluation, NERICA rice varieties, Nigeria.

1. Introduction

Rice is the most important staple food for about half of the human race [1, 2]. It ranks the third after wheat and maize in terms of indigenous production. Ladebo [3] established that rice contributed about 12%-14% of the food requirement of the Nigeria populace. However, rice production in Nigeria has not been able to meet the consumption demand of the rapidly growing urban population [4] and this situation has led to acute demand for imported rice. Rice is one of the crops, in which the gap between potential and actual output in terms of area cultivated is wide [5]. In line with this, research work at the West Africa Rice Development Association (WARDA) has led to a major success with the development of improved upland rice varieties from interspecific cross between *Oryza sativa* and *O. glaberimma*. These varieties give reasonably high yields under low input systems, which predominate in the upland rice systems and are effective in weed suppression—a major problem for upland rice systems [6].

Analysis of the factors determining adoption of improved farm technology is essential to discover what categories of farmers have benefited from the adoption of improved varieties and to know what varietals characteristics motivate farmers to adopt or reject improved varieties. According to Lee et al. [7], the development, testing and promoting of agricultural innovations require several level and types of

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activities, which are not likely to exist within any organization. Most times, agricultural research and innovation suffer lack of connection between the scientists who devise innovative materials and practices and the extension agents that should promote them in the field.

In a study of the adoption of improved technology, Morris and Shabman [8] highlighted three sets of factors affecting the adoption. These are characteristics of the technology, characteristics of the farming environment and characteristics of the farmer [9, 10]. The adoption of technology will also depend on the particular agro-ecological zone in which the farmer lives. In addition, variations between zones may make adoption difficult. Village location and expenditure in hiring labour were positively and significantly related to the adoption of improved soybeans varieties [11].

Several studies have shown that certain characteristics of the farmers influence the adoption of improved farm practices. These characteristics include: age, education, farming experience, income level, market-related factors, access to credit facilities and extension visit, etc.. It is against this backdrop that the study seeks to elicit farmers' criteria for varieties evaluation and factors determining the adoption of NERICA varieties in the study areas.

2. Methods

The study was conducted in six states in Nigeria, where NERICA II project is being implemented. The states are Ekiti, Kaduna, Nassarawa, Ogun, Ondo and Taraba. The data used for this study were collected through farming household survey conducted from August to September 2009. The main instruments for data collection were well-structured questionnaires administered on household by trained enumerators under the supervision of Agricultural Development Project (ADP) staff in each state. In all, a total of 600 questionnaires were administered. This database contains over 300 variables, which includes the information about household characteristics, cropping system, resource allocation and farmers' practices—rice varieties grown, husbandry practices, storage, marketing and constraints to rice production. The data used in our analysis came from a sample of about 600 farmers in 50 villages in six states. The villages were selected among the villages participating in NERICA II. This study utilized descriptive statistics such as means, frequency and percentages. In addition, Tobit regression model was used to analyze the data collected.

Tobit model specification: several studies have assessed the adoption of new technology using two-limit model [12, 13], but this current study used Tobit regression model by following Refs. [14-16]. The model framework used in this paper is given below using an index function approach:

$$V_i^* = \beta T X_i + e_i \quad (1)$$

if $V_i^* = 0$, $V_i = 0$;

if $V_i^* > 0$, $V_i = V_i^*$;

$i = 1, 2, \ldots\ldots n$;

where,

V_i^* = limited dependent variable; it is the depth of adoption of NERICA rice varieties measured by the area of land devoted to NERICA cultivation;

βT = vector of unknown parameters;

e_i = independently distributed error term;

X_i = vector of explanatory variables;

where,

X_1 = age of rice farmers in years;

X_2 = marital status (1= married, 0 = otherwise);

X_3 = level of formal education in years;

X_4 = household size (number of persons);

X_5 = rice farming experience in years;

X_6 = membership of association (1 = yes, 0 = no);

X_7 = field days attendance (number of times);

X_8 = farm size in hectares;

X_9 = access to credit (1 = yes, 0 = no);

X_{10} = fertilizer availability (1 = if a constraint, 0 = otherwise);

X_{11} = seed availability (1 = if a constraint, 0 =

otherwise);

X_{12} = rice income in Naira;

X_{13} = farm income in Naira;

X_{14} = awareness (1 = if exposed, 0 = otherwise).

3. Results and Discussion

3.1 Household Socioeconomic Characteristics

This study emphasized the socioeconomic characteristics of the respondents, such as sex, age, level of formal education, household size, membership of association, access to extension agents and attendance of field days on rice production, because they are important in farmers' evaluation of improved technologies. Ringe-Metzger and Diehl [17] classified the respondents into four categories: children (0-9 years), youth (10-15 years), adult (16-60 years) and old people (≥ 61 years) as the basis for explanation. The study revealed that majority sampled rice farmers were in the adult age bracket, implying that majority of the farmers were physically active. The age of the household head has been found to determine how active and productive a head of household could be. In addition, it has also been found to affect the rate of household adoption of improved technology. Table 1 showed that there was similarity of the average age of rice farmers across states. The minimum average age was 42 years in Nassarawa, while the maximum was 53 years in Kaduna with the mean value of 48 years for all states combined. The mean value for sex across the states revealed that rice production in the study areas is dominated by male, indicating that rice production is a male dominated environment. Table 1 revealed that the mean value for sex across states ranges from 0.69 to 0.97 with an overall average of 0.88 and standard deviation of 0.35. The importance of women farmers in the agriculture developing countries has been recognized for decades [18] and they has been recognized as primary producers of food crops [19]. Studies have shown that women also play major roles in farm-level decision [20]. Despite their importance, women farmers face daunting constraints to their productivity because of limited access to extension, capital markets and new technologies [19-24]. A number of wives were used as a proxy for household type. There was high level similarity in the number of wives per household; an average household head in the study area had about one wife. This implies that the livelihood of relatively small household size is with both negative effect (unavailability of labour force) and positive effect (possibility of reduced poverty and dependency).

As part of the basic socioeconomic characteristics of the respondents, information on the educational levels of the farmers was collected. Level of education in a particular society determines the level of exposure and sophistication in production as well as their perception of new innovations. The mean value of all the states was about eight years of formal education with a standard deviation of 5.5. Based on this result, it can be concluded that the literacy level in the study areas was relatively high. According to Azhar [25], education affects productivity in two distinct ways via the choice of better inputs and outputs (allocative efficiency effects) and through a better utilization of existing inputs (technical efficiency aspect). Studies have shown that farmers who have had exposure to formal education tend to adopt new innovations [26, 27].

The notable factors associated with low productivity and production include dearth of modern inputs, inadequate machinery to reduce drudgery of farm work, poor management, poor infrastructural facilities to aid distribution of inputs, edaphic and climate instabilities [22], small and uneconomic units of agricultural enterprises, predominance of traditional techniques in production, limited use of agrochemicals, high dependence on rudimentary storage, inadequate credit supply and marketing facilities [28, 29]. Ironically, most of these problems can be solved with adequate credit supply either in cash or in kind. In addition, access to credit could influence or affect the adoption of new innovations, because new innovations

Table 1 Summary statistics of socioeconomic characteristics of the respondents.

Variables/State	Para meter	Ekiti	Kaduna	Nassarawa	Ogun	Ondo	Taraba	Pool
Age	Mean	48.14	53.45	42.24	51.33	48.91	45.41	47.94
	SD	11.39	8.45	9.22	10.56	12.01	10.56	11.10
Sex	Mean	0.90	0.97	0.69	0.92	0.92	0.92	0.88
	SD	0.30	0.36	0.46	0.28	0.27	0.32	0.35
No. of wives	Mean	1.22	1.23	1.08	1.12	1.12	1.39	1.19
	SD	0.91	0.85	0.00	0.63	0.76	1.95	1.10
Education	Mean	9.40	12.23	10.17	5.00	7.27	7.67	8.41
	SD	4.45	4.92	5.31	4.40	4.77	6.31	5.49
Credit	Mean	0.64	0.08	0.25	0.11	0.34	0.20	0.29
	SD	0.48	0.28	0.44	0.32	0.48	0.41	0.45
Household	Mean	8.00	12.45	8.44	5.91	7.71	10.68	8.59
	SD	3.90	6.73	5.20	2.70	4.66	9.24	5.95
Experience (L)	Mean	2.04	9.95	0.90	2.78	1.68	12.08	4.41
	SD	4.24	11.18	0.30	9.79	3.66	11.09	8.61
Experience (U)	Mean	14.50	7.65	0.70	18.59	4.30	4.04	8.38
	SD	9.22	7.07	0.88	13.87	5.20	6.04	10.39
Land area	Mean	15.72	14.60	9.27	10.56	7.33	12.77	11.48
	SD	35.64	23.80	10.84	10.30	7.82	19.95	20.44
No. of plots	Mean	4.27	5.18	2.24	3.50	2.34	4.44	3.70
	SD	2.41	4.16	1.05	2.39	5.43	6.12	4.02
Extension visit	Mean	19.98	5.19	5.98	7.66	25.28	19.82	14.71
	SD	6.15	4.78	9.87	8.65	61.21	59.76	36.62
Field days	Mean	1.55	0.71	1.91	1.40	1.41	1.88	1.48
	SD	1.77	1.52	2.53	2.16	1.27	0.93	1.79
Farm size	Mean	5.09	7.64	8.13	5.49	8.23	9.63	7.31
	SD	4.62	11.65	5.99	5.39	13.17	11.16	9.20
NERICA I	Mean	0.77	0.85	0.68	0.40	0.47	0.69	0.63
	SD	0.42	0.36	0.47	0.49	0.50	0.46	0.48
NERICA II	Mean	0.08	0.76	0.00	0.00	0.00	0.01	0.10
	SD	0.80	0.97	0.00	0.00	0.00	0.11	0.53

Source: field survey, 2009; L = lowland cultivation, U = upland cultivation; SD = standard deviation.

always come with additional cost. In line with this, rice farmers' access to credit was considered in this study. The farmers were asked whether they had access to credit during the last cropping season or not. The results in Table 1 showed that the majority of farmers did not have access to credit facilities. This could have implications for NERICA rice adoption in the study areas. This provides further explanation to the small farm size and the subsequently low level of output. Following from this, there is need for injection of credit and subsidy facilities to stem the vicious cycle poverty at least in the interim.

Household size is the number of individuals in a household. It affects the amount of available farm labor, determines the food and nutritional requirements of the household and often affects household food security. Household size is very important in traditional agriculture. Table 1 showed that the household size varied across states. The minimum 6 persons/household was recorded in Ogun, while the maximum 12 persons/household was recorded in Kaduna State. The mean value of about 9 persons/household was recorded in the states combined. This may also have both negative and positive implication on rice farmers.

The summary statistics of farming experience for

both upland and lowland rice were presented in Table 1. The table shows that the mean rice farming experience for lowland rice was about four years, while that of upland rice was about eight years. This suggests that the most of the sampled farmers were more into upland farming. In most rural environment, access to and the quantity of croppable land could be used to determine the readiness of farmers to adopt new innovations. Table 1 reveals that on average, a farmer in the study areas had about 11 ha of croppable land with a standard deviation of 20.44. The wide disparity in the standard deviation across states suggests that there was wide inequality in the amount of land owned by the rice farmers. There is an evidence of large disparity in the farm land holding among the farming households in the six states. Generally in developing agriculture, literature is replete on the fact that farmers operate fragmented farmlands. This is clearly shown in Table 1 that an average rice farmer in the study areas had about four farm plots. The average farm plot numbers range from about two in Nassarawa to about five in Kaduna with a standard deviation of from 1.05 (Nassarawa) to 6.12 (Taraba).

Table 1 also provides information on rice farmers' access to extension services. The table shows that on average a rice farmer in the study areas met with the extension agent about 15 times in a production year. One thing to note is that the number of meeting with extension agents varied widely in the study areas. The highest number of visits was observed in Ondo State, followed by Ekiti State; while the lowest number of visits was observed in Kaduna, followed by Nassarawa State. This could also have implications for dissemination information or adoption of new technologies in rice production.

Field days are special events, which consist of a series of demonstration and speeches, and often the discussion focus on a central theme strung out over a course of a day to promote new technologies in a particular area. The purpose of the field day is to bring stakeholders to discuss, share technical knowledge and discuss problems encountered during the season. To this end, the number of field days attended by the rice farmers in the last production year, was considered in this report. Table 1 presents the attendance of field days by the maize farmers in the study areas. The table shows that field day attendance was very low in the study areas and was similar across states. This could have serious implication on the diffusion of NERICA varieties, as this may limit their participation in exchange of ideas and in sharing of knowledge and experience of improved technology. Therefore, NERICA II should intensify effort in this direction.

The output of rice like any other crop is limited by farm size. As a result, information on farm size was collected from farmers and is presented in Table 1. The mean farm size shows that a rice farmer cultivated a total of about 7 ha of land from about four small fragmented plots. These 7 ha of land may not be adequate, if the country is to be self sufficient in rice production. It is worth noting that the average farm size varied across states, with Ekiti rice farmers having about 5 ha while Taraba having about 10 ha. From this result, one can say that rice is being cultivated more in Taraba that Ekiti State. The small farm size explains the low rice output in states, like Ogun and Ekiti. The small farm size and subsequent low output could adversely affect rice production in the country, and thus prevent the country from attaining self-sufficiency in rice production. In the short run, government should aim at policies geared towards providing incentives to encourage all the stakeholders to improve productivity in rice production. In addition, incentives such as provision of micro credit and implementation of subsidy on inputs like fertilizer and seed should be provided. Finally, on socioeconomic characteristics, the NERICA varieties (NERICA I and NERICA II) grown by farmers were considered. The result in Table 1 shows that NERICA I is popular among the

rice producers than NERICA II. In states like Nassarawa, Ondo and Ogun, NERICA II was not planted at all.

3.2 Evaluation of NERICA Varieties with Other Varieties Planted

Farmers grow an assortment of both local and improved rice varieties, either on the same or different fields. Heterogeneity of the rice varieties grown across countries, was observed in the range of local and improved varieties. This might not be unconnected with the inability of the farmers to properly identify the various varieties. Experience has shown that farmers name new varieties after the source. Some local varieties are known by different names, and conversely, the same name might be used to different maize varieties. A major reason is the descriptive nature of local names, referring to certain key identifiable characteristics such as grain colour, appearance, growth habit and the perceived place of origin [30]. Farmers use many but similar criteria in selecting the rice varieties they grow. Table 2 shows the main criteria that farmers apply in choosing maize varieties and the importance of each criterion. The most important criteria across the states were high yield, tillering and logging resistance.

3.3 Area Allocated to NERICA Varieties (2004-2008)

To show the potential adoption of NERICA varieties over years, the area cultivated to NERICA I and II from 2004-2008 was used. Table 3 reveals the year when NERICA varieties were adopted in the states. For example, rice farmers in Ogun and Kaduna states started planting NERICA varieties on or before 2004, while rice farmers in Ekiti and Taraba started in 2006. In terms of land area (ha) allocated to NERICA rice production, the table reveals that there was progressive increase in the proportion of land given to NERICA rice cultivation since 2004. This suggests that there is increase in the adoption rate of NERICA varieties across states.

3.4 Factors Affecting Adoption of NERICA Varieties

Tobit regression model was used to examine the factors affecting the adoption of NERICA varieties. The results are shown in Table 4. The sigma, which was significant at 1% level, implies that the model had a good fit. The results of the Tobit model showed that the age of the household head increases the probability of adopting NERICA varieties, though this effect was not significant in the study areas. Several studies have shown a significant relationship between age and the

Table 2 Reasons for the preference of NERICA over other varieties (percentage).

Reason/State		Ekiti	Kaduna	Nassarawa	Ogun	Ondo	Taraba	Pool
High yield	No	14.00	20.97	64.00	41.24	44.00	28.41	36.56
	Yes	86.00	79.03	36.00	58.76	56.00	71.59	63.44
Tillering	No	14.00	38.71	71.00	43.30	42.00	28.41	39.85
	Yes	86.00	61.29	29.00	56.70	58.00	71.59	60.15
Logging resistance	No	18.00	46.77	85.00	43.30	45.00	28.41	44.61
	Yes	82.00	53.23	15.00	56.70	55.00	71.59	55.39
Pest and disease	No	21.00	53.23	77.00	44.33	49.00	29.55	45.52
	Yes	79.00	46.77	23.00	55.67	51.00	70.45	54.48
Early maturing	No	13.00	25.81	68.00	49.48	52.00	29,55	40.76
	Yes	87.00	74.19	32.00	50.52	48.00	70.45	59.24
High market value	No	25.00	32.26	76.00	58.76	55.00	28.41	46.62
	Yes	75.00	67.74	24.00	41.23	45.00	71.59	53.38
Low fertilizer usage	No	20.00	35.48	80.00	54.64	45.00	32.95	45.52
	Yes	80.00	64.52	20.00	45.36	55.00	67.05	54.48

Source: field survey, 2009.

Table 3 Area allocated to NERICA I and NERICA II varieties.

Year/State	NERICA	Ekiti	Kaduna	Nassarawa	Ogun	Ondo	Taraba	Pool
2008	I	1.3	2.1	2.0	0.8	1.3	0.8	1.3
	II	0.1	0.5	0.0	0.1	0.3	0.0	0.1
2007	I	0.5	2.0	0.4	0.8	0.8	0.4	0.7
	II	0.0	0.5	0.0	0.1	0.1	0.0	0.1
2006	I	0.1	1.3	0.0	0.7	0.5	0.1	0.4
	II	0.0	0.1	0.0	0.1	0.0	0.0	0.0
2005	I	0.0	0.8	0.0	0.6	0.1	0.0	0.2
	II	0.0	0.1	0.0	0.1	0.0	0.0	0.0
2004	I	0.0	0.5	0.0	0.4	0.0	0.0	0.1
	II	0.0	0.1	0.0	0.0	0.0	0.0	0.0

Source: field survey, 2009.

Table 4 Tobit regression estimates of the factors affecting adoption of NERICA varieties.

Variable	Coefficient	*T* value	*P* value
Constant	-6.001*	-6.011	0.0000
Age of rice farmers in years	0.002	0.142	0.8872
Marital status (1 = married, 0 = otherwise)	-0.315	-1.279	0.2008
Level of formal education in years	0.066*	2.705	0.0068
Household size (number of persons)	-0.021	-0.913	0.3611
Rice farming experience in years	0.012	0.948	0.1189
Membership of association (1 = yes, 0 = no)	-0.494	-1.559	0.1189
Field days attendance (number of times)	0.091	1.225	0.2205
Farm size in hectares	0.100*	5.916	0.0000
Access to credit facilities (1 = yes, 0 = no)	0.515***	1.766	0.0774
Fertilizer availability (1 = if a constraint, 0 = otherwise)	-0.068	-0.176	0.8607
Seed availability (1 = if a constraint, 0 = otherwise)	0.313	0.900	0.3683
Rice income in Naira	0.753E-06***	3.539	0.0014
Farm income in Naira	0.428E-06**	2.346	0.0190
Awareness (1 = if exposed, 0 = otherwise)	6.790*	12.045	0.0000
Sigma	2.340*	23.884	0.0000
Log likelihood function	-714.99		

Source: field survey, 2009; *significant at 1%, **significant at 5%, ***significant at 10%.

adoption of improved farm practices [7, 13, 31-33]. The implication of the finding is that the older farmers have a higher adoption probability and use intensity of improved farm practices. Marital status was captured by a dummy variable, which represents one for married and zero otherwise. In this study, marital status was negatively related to adoption of NERICA varieties and the effect was not significant. The educational level of the maize farmers was significant at 5% but had the positive sign, suggesting that higher educational level increases the probability of adoption of NERICA varieties. Studies have revealed a positive significant relationship between education and the adoption of improved farm practices [26, 27, 33, 34]. However, the negative significant relationship between education and adoption of improved farm practices has been observed [13]. In addition, Ekong [10] studies revealed that there is no significant relationship between education and the adoption of innovation. The size of the farming households reduces the probability of adopting NERICA rice varieties and is not significant.

Rice farming experience was positively related to the probability of adoption but not statistically

significant. Faturoti et al. [34] revealed a positive and significant relationship between farming experience and adoption index. The membership of farmers' association was not statistically significant and negatively related to the likelihood of adoption. In like manner, field days attendance was not statistically significant but positively related to the likelihood of adoption of NERICA varieties.

Farm size was found to be significant at 1% level and showed positive relationship with likelihood of the adoption of NERICA varieties. Availability of capital can determine the extent of production capacity and this could influence the disposition of farmers to new ideas and innovation. Access to credit was positively related to the adoption of NERICA and the variable was significant at 5% level. Several studies have also reported positive and significant relation between access to credit and adoption improved technologies by farmers [35].

Unavailability of fertilizer and improved seeds were considered to influence the adoption of NERICA varieties. The variables were captured using dummy variable, indicating one if the input is a constraint and zero if not a constraint to rice production in the study areas. The study revealed that the unavailability of the two inputs had no significant effect on the adoption of NERICA varieties.

Farm income and income generated from rice production were also considered to influence the adoption of innovation in this study. Generally, new and improved innovations come with additional cost. Therefore, the higher income could positively influence adoption. The two variables were statistically significant and positively related to the likelihood of NERICA adoption. Finally, awareness was found to be statistically significant and positively related to the likelihood of NERICA adoption. The reason for the positive correlation between the awareness of farmers and the likelihood of adoption is very obvious. Farmers who are not exposed to the technology will not be predisposed to adopt the varieties.

4. Conclusions

This study evaluated farmers' perception of NERICA varieties and adoption of NERICA varieties, using Tobit regression model. And based on the evidence provided in the study, we conclude that field days attendance was very low in the study areas and similar across states. This may limit their participation in exchange of ideas and in sharing of knowledge and experience of improved technology. Therefore, government should intensify effort in this direction. The small farm size and subsequently low output could adversely affect rice production in the country, and thus prevent the country from attaining self-sufficiency in rice production. In the short run, government should aim at policies geared towards providing incentives to encourage all the stakeholders to improve productivity in rice production. Incentives, such as provision of micro credit and implementation of subsidy on inputs like fertilizer and seed, would go a long way in boosting rice production in the study area. Finally, level of formal education, farm size, access to credit, rice income, farm income and level of awareness of NERICA variety significantly determined NERICA rice adoption.

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