ANALYSIS OF SOCIO-ECONOMIC FACTORS INFLUENCING FARMERS' ADOPTION OF RICE VARIETIES WITH HIGH YIELDING AND WEED SUPPRESSING ABILITIES IN KANO RIVER IRRIGATION PROJECT (KRIP)

BY

[1]Nandi, J. A., [2]Haruna, S. K. and [1]Abudu, S.

[1]Department of Agricultural Economics and Rural Sociology, Ahmadu Bello University, Zaria
[2]National Agricultural Extension and Research Liaison Services, ABU, Zaria
E-mail for Correspondence: jamesanandi@yahoo.com

ABSTRACT

This study analysed the socio-economic factors influencing the adoption of rice varieties with high yielding and weed suppressing abilities in Kano River Irrigation Project (KRIP) Multistage random sampling technique was used to select 135 rice farmers for the study. Descriptive statistics, logit regression analysis and likert scale rating were used to analyse the data. The results show that the respondents were mostly males (67 percent) with average age of 43 years and had one form of education or the other, implying that the respondents were young and literate. Farming experience, household size, farm size and extension contact averaged 13 years, 7 persons, 1.7ha and 6 times respectively. Respondent's adoption decision was influenced by credit availability, gender, market availability, education, extension contact, labour availability and farm size. The respondents were in agreement with all the stated advantages of rice varieties with high yielding and weed suppressing abilities. Average adoption intensity was 47 percent and respondents disagreed with most of the perceived constraints of the technologies. The study therefore recommends that extension services should be adequately funded, monitored and evaluated intermittently by government to guarantee effective dissemination of the improved technologies. Also, farmers should form cooperative groups to strengthen their capital base.

Keywords: adoption intensity, irrigation, logit, perception, rice varieties, weed suppressing
http://dx.doi.org/10.4314/joafss.v10i1.4

INTRODUCTION

Agricultural growth is essential for fostering economic development and feeding growing populations in most less developed countries. Agriculture supplies food and raw materials and generates household income for the majority of the people. Nigeria's domestic economy is partly determined by agriculture, which accounts for about 41% of the Gross Domestic Product (GDP) and two-thirds of the labor force (NBS, 2012). Nigeria is endowed with 74 million hectares of arable land and additional 2.5million hectares of Irrigable land. Fundamentally, Nigerian environment is characterized by fair to good soils but poor and unreliable rainfall and low quantity as the case in arid and semi-arid regions. However, technological development has given the opportunity to tap the two important natural resources (water and soil) for cultivating the land all year round through irrigation (Oriola, 2009). Irrigation involves artificial or conscious effort to augment soil water supply during a period of deficit or in areas of deficit. However, irrigation is not restricted to application of water to soil alone; it extends further to the management and the distribution of water and drainage problems arising from irrigation activities. Irrigation projects are therefore designed to help reduce the dependence of crop growth on precipitation, which to a large extent is uncontrollable by man. In other words, irrigation system is aimed at increasing and improving agricultural yield, particularly in semi-arid and arid environment. This is why Worlf (1995) reported that irrigation has made higher and more reliable yield possible, as crops can be planted more than once in a year within the tropics.

Rice is a unique crop grown virtually all over the country, because it requires a wide range of temperature between 20 and 38°C during growth and a long period of sunshine and can be grown over a wide range of ecological conditions (Odoemenem and Inakwu, 2011). Rice has become an important economic crop and the major staple food for millions of people in sub-Saharan Africa in general and Nigeria in particular (WARDA, 2006). Rice is perhaps the world's most important food crop being the staple food of over 50 percent of the world population, particularly of India, China and a number of other countries in Africa and Asia. Rice is one of the major cereals, which have assumed cash crop status in Nigeria, especially in the producing areas, where it provides employment for more than 80% of the inhabitants as a result of the activities that take place along the distribution chains from cultivation to consumption (Ogundele and Okoruwa, 2006). The prevalent types of rice production systems in Nigeria are the rain fed upland; rain fed lowland and irrigated lowland (Singh *et al*., 1997). Average yield of upland and lowland rain fed rice in Nigeria is 1.8 tonnes/ha, while that of irrigation system is 3.0 tonnes/ha (PCU, 2002). Studies conducted in various places like Cote d'Ivoire and Senegal indicates that 3.0 tonnes/ hectare from upland and lowland system and 7.0 tonnes/ hectare from irrigation system is obtained (WARDA and NISER, 2001). Over the past three decades, the various governments in Nigeria have put constant efforts in promotion and development of modern irrigation scheme, as a way to increase food production and meet an ever increasing demand (Balmisse *et al*., 2002).

Irrigated rice cultivation in Nigeria has a long history dating back to the colonial era, but it was not until the droughts of the early-to-mid seventies that concerted efforts were paid to irrigation development in the country. Irrigated rice systems account for 10-16% of the total rice area in the country (Fagade, 2000). As a result of FAO and US Bureau of Reclamation studies in the early 1970s, three pilot public irrigation schemes were developed, all in the sub-arid and dry sub-humid agro-ecological zones, namely: Bakolori Scheme, the Kano River Irrigation Scheme and the Chad Basin Scheme. Currently, the schemes occupy 974,900 hectare of land under cultivation as reported by the Nigerian National Committee of ICID (NINCID) (In: Ojo *et al.*, 2010). Although, irrigation schemes in developing countries especially in sub-Saharan Africa (SSA), Nigeria inclusive, suffer from very low water use efficiency, resulting in water logging and salinity problems (Ojo *et al*., 2010). However, adequate and efficient irrigation provides a reliable employment, increase cropping intensity, increase yield per hectare and eventually generate more income, hence, high standard of living for the farmer (Jamala *et al.*, 2011). Irrigated production can buffer the impacts of drought where it can draw on groundwater or stored surface water or a mixture of both. In addition, these systems encompass varying levels of water control, ranging from partial water control in intensive lowland systems to full water control with possibilities for double cropping.

Total rice production has increased over the last two decades. Falusi (1997), Fagade (2000), Okoruwa *et al*. (2007) and AfricaRice (WARDA) (2008) noted that rice production has been expanding at the rate of 6% per annum in Nigeria, with 70% of the production increase due mainly to land expansion and only 30% being attributed to an increase in productivity. Due to rice increasing contribution to per capita calorie consumption (Ogundele and Okoruwa, 2006) and growing population in the country, the demand for rice is growing faster than production, thus, making the country depend on imported rice to meet the high demand. The annual demand for rice in the country is estimated at 5 million tonnes, while production is 3 million tonnes, resulting in a deficit of 2 million tonnes (Chinma, 2004). The supply gap is being met through rice imports which represent over 25 percent of all agricultural imports and more than 40 percent of domestic consumption (Main Report and Working Papers, 2006). The inability to meet rice consumption needs through local production has resulted in high cash outlays for importation. In 2010 alone, importation of rice was ₦356 billion, about ₦1billion per day (Izeze, 2011). Recent policies have placed emphasis on increasing local rice production in order to reverse import trends and free up limited foreign reserves for use in other sectors.

To reduce the dependence on imported rice as well as develop the local rice industry and enhance the adoption process of high yielding varieties and also increase the production level of rice, Nigeria adopted several development initiatives, some of which include the African Rice Initiative (ARI) which was established in 2002 to promote the dissemination of high yielding varieties (NERICA) in SSA. The Federal Government of Nigeria launched the Presidential Initiative on Accelerated Rice Production in 2003. Government also banned milled rice imports and put a 50 percent duty on parboiled rice. In addition, a levy of ten percent was imposed on rice imports to create a dedicated fund for the development of the local rice industry, including processing and marketing (Main Report and Working Papers, 2006). Notwithstanding the various policy measures, domestic rice production has not increased sufficiently to meet the increased demand. The existing rice production potential has not yet been realized, as smallholder (small-scale, subsistence and *fadama* farmers) output is inadequate and paddy processing is substandard. To meet this shortfall, government recognizes the potential of irrigated agriculture, using improved technologies and wishes to promote further expansion of rice production.

Access to improved varieties, good quality seed and availability of good quality seed have been reported as the principal constraints in rice production. A report by Fagade (2000) showed that the rate of utilization of certified seed is 5-15 percent, 10-20 percent, and 30 percent among producers at Badeggi, Bende and Kano areas respectively. Results obtained by WARDA in the Sahel suggest that use of poor quality seed contributes to low yields in irrigated rice production. As a result, agricultural growth will depend more and more on yield-increasing technological change (Ravallion and Datt, 1996).

Opportunities exist for addressing these problems. For instance, high yielding short duration varieties adapted to Sahelian conditions are already extensively used in Senegal, Mauritania, Mali and Burkina Faso. In 2006, a conservative estimate of area grown to NERICA varieties in SSA was about 200,000 hectares (WARDA, 2008). Amount of certified seed produced in Nigeria rose to 5,785 tons in 2006. According to NASC, an agency responsible for seed certification, extension rate for NERICA 1 and NERICA 2 in rain-fed upland fields is 32% (2005 - 2006). Overall extension rate for improved varieties of rice is estimated at 10% (www.jica.go.jp/english/operations/thematic_issues/agricultural/pdf/nigeria_en.pdf). This low rate is due to use of local varieties by rice farmers resulting in low crop yield. In recent years, improved seed is being extended in both rain-fed upland areas (mainly NERICA) and rain-fed lowland areas (mainly WITA 4 and SIPI varieties).

Lack of high yielding varieties with good grain qualities and problem of weeds have impeded the growth of rice sub-sector. Weed competition is the most important yield-reducing factor in rice farming (Johnson *et al*., 1997); and further reduces labor productivity which is already generally limited by labour availability during the main cropping season (WARDA, 2008). Therefore, high yielding varieties with weed suppressing abilities are required for adoption to boost rice output. It is believed that the adoption of new agricultural technologies, such as the High Yielding Varieties (HYV), like NERICA 1, NERICA 2 and other improved varieties produced and distributed by agencies such as National Agricultural Seed Council (NASC), West Africa Rice Development Association (WARDA) and National Cereals Research Institute (NCRI); and rice with weeds suppressing ability varieties which yield 4-8 MT/ha such as FARO 52 (WITA 4), FARO 4 (Sipi), Jamila (unnamed variety) are influenced by socio-economic factors of the farmer. According to Ekong (1988) adoption is influenced by so many factors such as socio-economic characteristics of the adopters.

The adoption of more efficient farming practices and technologies that enhance agricultural productivity and improve environmental sustainability is instrumental for achieving economic growth, food security and poverty alleviation in sub-Saharan Africa (Ersado *et al*., 2003). Despite the fact that adopting high yielding and weed suppressing varieties of rice could result to higher income due to increased output and consequently better standard of living of the farmers, there is no research work or comprehensive information regarding the socio-economic factors influencing farmers' adoption of rice varieties with high yielding and weed suppressing abilities in KRIP. Even though it has been observed that low yield of rice is mainly due to local varieties and weed competition (WARDA, 2008). Thus, this study was designed with the general objective of analyzing the socio-economic factors influencing farmers' adoption of rice varieties with high yielding and weed suppressing abilities in KRIP. The specific objectives were to:

i. describe the socio-economic characteristics of rice farmers in the area;
ii. analyse the effect of factors influencing farmers' adoption of rice varieties with high yielding and weed suppressing abilities;
iii. ascertain farmers' perception on the advantages of growing rice with high yielding and weed suppressing abilities;
iv. analyse the intensity of adoption of rice varieties with high yielding and weed suppressing abilities in the study area;
v. ascertain farmers' perception on constraints encountered in growing rice with high yielding and weed suppressing abilities

METHOLOGY

Study Area

The Kano River Irrigation Project (KRIP) is located at Kadawa, about thirty-five kilometers south of Kano city. According to Kebbeh *et al.* (2003), the Kano River Project was initiated with the construction of the Tiga dam between 1970 and 1974 to irrigate a total area of about 62000 ha in two phases. The first phase with a potential of 22,000 ha irrigated area was completed in 1974 (Kadawa scheme) and continues to be largely operational. The second phase of the project has not been completed, though; it is operational with sprinkler irrigation sparingly functional in few hectares. The KRIP is situated in the Sudan Savanna agro-ecological zone, which is characterized by a mono-modal rainfall distribution averaging 550 to 1000 mm per annum. The length of the growing period is 90 to 165 days (for rainfed crops), with most rains occurring between May and September. Air humidity is high during the wet season and very low during the dry season. Minimum temperatures occur from November to February, and highest temperatures occur in March and April. Daily temperature variation is high during the dry season and low in the wet season. The main soil type of the KRIP is the reddish-brown to brown regosols, with mainly sandy to clay loam texture. The soils tend to be slightly alkaline, and soil organic matter content and cation exchange capacity are low (Kebbeh *et al.*,2003).

Sampling procedures and Sample size

The respondents (farmers) interviewed were selected using multistage random sampling technique to select a sample size of 135 rice farmers among the villages around the Irrigation Project. The area constitutes of three Local Government Areas, namely; Bunkure, Garun-Mallam and Kura. Three villages were selected from each Local Government Area of which 15 rice farmers were randomly selected from each village in 2011.

Analytical Techniques

Descriptive statistics (frequency, mean and percentages) was used to achieve objectives i and iv, while logit regression analysis was used to achieve objective ii. Likert scale ratings were used to achieve objectives iii and v.

Empirical Model

Logistic Regression Analysis (LRA) extends the techniques of multiple regression analysis to research situations in which the outcome variable is categorical. The model for logistic regression analysis assumes that the outcome variable, is categorical, example dichotomous, but LRA does not model this outcome variable directly. Rather, LRA is based on probabilities associated with the values of the output. Generally, logistic regression is well suited for describing and testing hypotheses about relationships between a categorical outcome variable and one or more categorical or continuous predictor variables (Peng *et al.*, 2002). The logit model, which is based on cumulative logistic probability functions, is computational easier to use than other types of model and it also has the advantage to predict the probability of farmers adopting any technology. Unlike the Multiple regression and Discriminant analysis which pose difficulties when the dependent variables have only two values, 1 if the event occurs and 0 if it does not (Karki and Bauer, 2004). The Binary Logit Regression Model (BLRM) is considered appropriate in such a situation (Polson and Spencer, 1992). It requires far fewer assumptions than the other two models mentioned above, and even when the assumptions required for Discriminant analysis are satisfied, it still performs well (Hosmer and Lemeshow, 1989; kleinbaum 1994).

According to Karki and Bauer (2004) logit is applicable to a broader range of research situations and is able to predict the presence or absence of a characteristic or outcome based on values of a set of predictor variables and it is similar to a non-linear regression model but is suited to models where the dependent variable is dichotomous. There is flexibility in the model where independent variables can be interval level or categorical; if categorical, they should be dummy or indicator. Farmers' adoption of rice varieties with respect to high yielding and weed suppressing ability was studied using logit model. The logit model assumes that the underlying stimulus is a random variable which predicts the probability of rice varieties with high yielding and weed suppressing abilities adoption. The relationship between the independent variable and probability is non-linear. The probability estimate will always be between 0 and 1 (Karki and Bauer, 2004), regardless of the value of Z in equation 5. This study utilized logistic regression model to empirically quantify the relative influence of various factors in the decision of the farmer in adopting these technologies. This was estimated by using the maximum-likelihood method. That is, the coefficients that make the observed results most likely were selected. The relationship of this dependent variable can be examined with the independent variables as:

$$Log_e\left[\frac{P(Y=1|X_1,\dots,X_p)}{1-P(Y=1|X_1,\dots,X_p)}\right]=Log_e\left[\frac{\pi}{1-\pi}\right]=$$
$$=\alpha+\beta_1X_1+\dots+\beta_pX_p=\alpha+\sum_{j=1}^{p}\beta_jX_j$$

- - - - - - (1)

Where; P is a conditional probability of the form P(Y=1| X_1,..., Xp). Hence, it is assumed that success is more or less likely depending on combinations of values of the predictor variables. The log-odds are known as the logit transformation of P. According to Dayton (1992) there are two basic reasons underlying the development of the LRA. First, probabilities and odds obey multiplicative, rather than additive, rules. However, taking the logarithm of the odds allows for the simpler, additive model since logarithms convert multiplication into addition. And, second, there is a (relatively) simple exponential transformation for converting log-odds back to probability. Farid *et al.* (2010) noted that the goal of logistic regression is to find the best fitting model to describe the relationship between the dichotomous characteristic of interest (dependent variable = response or outcome variable) and a set of independent (predictor or explanatory) variables. Logistic regression generates the coefficients (and its standard errors and significance levels) of a formula to predict a Logit transformation of the probability of presence of interest. Thus, the logistic regression model has been specified as

$$logit(P_i) = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \dots + \beta_nXn + e_i \quad (2)$$

Where, P_i is the probability of presence of the characteristic of interest. Therefore, the logit transformation is defined as the logged odds:

$$Odds = \frac{P_i}{1 - P_i} \quad (3)$$

$$\text{Probability}(\text{Technology Adoption} = 1) = \frac{1}{1 + e_j^{-z}} \quad (4)$$

$$Z = \beta_0 + \sum_{i=1}^{n} \beta_iX_i + e_j \quad (5)$$

Where:

P_i = Adoption of rice with high yielding and weed suppressing abilities
1 - P_i = Adoption of any other crop production
X_1 = Credit availability (Dummy variable, 1 = if Yes, 0 = No)
X_2 = Gender (Dummy variable: Male = 1, Female = 0)
X_3 = Market availability (Dummy variable: 1 = if Yes, 0 = No)
X_4 = Farming experience (Years)
X_5 = Household size (Number of persons in a household)
X_6 = Education (Number of years of formal schooling)
X_7 = Access to irrigation water (Dummy variable: 1 = Yes, 0 = No)
X_8 = Extension contact (Number of visit)
X_9 = Land availability (Dummy variable: Yes = 1, N0 = 0)
X_{10} = Labour availability (Dummy variable, 1 = if Yes, 0 = No)

X_{11} = Farm size (Hectare)
β_0 = Constant term
$\beta_1 - \beta_{11}$ = Coefficients to be estimated
e_i = Error term

Adoption intensity

Adoption is best defined as the deployment of technology *plus* the assimilation of all behaviours the new technology is intended to facilitate *plus* the abandonment of old behaviours that are to be eliminated (Holst, 2003). The adoption intensity is the ratio of land devoted to the cultivation of the new crop technology to the total cultivable land for the same crop. It shows the extent to which the farmer has committed his land for the cultivation of the new technology. Adoption intensity lies between 0 and 1. The closer the values to 1 the greater the adoption intensity, this means more land is devoted to the production of the new crop/technology implying higher adoption intensity.

$$\text{Adoption intensity}\ (A_i) = \frac{\text{Area of crop under variety (ha)}}{\text{Total Area under the same crop}} \ldots\ldots\ldots\ldots (6)$$

Perception: The perception of the rice farmer on the rice varieties with high yielding and weed suppressing abilities was measured by asking the respondents to rate in qualitative terms, their perception, using a five-point Likert type scale ranging from “strongly agree” (5), “agree” (4), “undecided” (3), “disagree” (2), to “strongly disagree” (1). This was used to assess respondents’ perception of the rice innovations introduced in the area. The mean perception was obtained by adding together 1+2+3 + 4 + 5 = 15 which was later divided by 5 to get a mean score of 3. The respondents’ mean score was obtained on each item. Any mean ($\overline{X}$) scores ≥ 3.0 indicate agreement, while scores < 3.0 indicate disagreement.

Perception on constraints to high yielding and weed suppressing rice seed/ varieties

The perceived constraints were itemized and measured by asking respondents to indicate their perception on each of the constraint on a 4-point Likert-type scale, ranging from strongly agree = 4; agree = 3; disagree = 2 and strongly disagree = 1. A midpoint of 2.50 was obtained by dividing 10 by 4. The respondents’ mean ($\overline{X}$) score was obtained on each of the items. Any mean ($\overline{X}$) scores ≥ 2.50 was regarded as agreement, while any mean ($\overline{X}$) scores < 2.50 was regarded as disagreement.

RESULTS AND DISCUSSION

Socio-economic characteristics of the respondents

The result revealed that the total sample of the study is composed of 67 percent males while the females were 33 percent (Table 1). Similarly, education plays a key role for household decision in technology adoption. It creates awareness and helps for better innovation and invention. It was observed that 69 percent of the farmers had one form of formal education or the other with average schooling years of 5, implying that the respondents are literate. The result shows that 57 percent of the respondents had farming experience of more than 10 years with average of 13 years. This implies that rice is one of the major crops cultivated by the people in the area and farming is their predominant occupation as a result of their long stay in the enterprise. The average household size was found to be 7 persons. This indicates that the farmers had fairly large family sizes which can serve as a source of labour. About 70 percent of the respondents have received credit in different forms for rice cultivation.

Age of the respondents ranged from 19 to 72 years with mean of 43 years. Respondents within the age range of 13-50 years were 77 percent. This indicates that most of the farmers were still within the productive age. They are young and energetic which show a virile farming population. About 36 percent of the respondents indicated that they have had contact with extension agents between 1 to 4 times in the last cropping season, whereas about, 39 percent of the respondents have had 5-8 times visit by extension agents with a mean of 6 times per year. This indicates inadequate extension services for fast technological adoption in the area. The result on farm size show an average of 1.7 hectare, though, majority (51 percent) of the respondents had between 1.1 and 3.0 hectares of land while 36 percent had less than or equal to 1 hectare of land for farming. The International standard judgment for farm sizes stated that all farms less than 10ha are classified as small scale farms (Ozowa, 2005). This implies that all respondents in the study area were small scale farmers.

Table 1: Socio-economic characteristics of the Respondents

Variable	**Frequency**	**Percentage** (%)	**Mean**
Gender			
Male	91	67.41	
Female	44	32.59	
Educational Attainment (Years)			
None	42	31.11	
1-6	53	39.26	5.34
7-12	31	22.96	
13-18	9	6.67	
Farming Experience			
1-5	23	17.04	
6-10	35	25.93	13.02
>10	77	57.03	
Household size			
1-5	57	42.22	
6-10	61	45.19	7.13
>10	17	12.59	
Credit availability			
Yes	94	69.63	
No	41	30.37	
Age (Years)			
≤ 20	2	1.48	
21-30	23	17.04	
31-40	47	34.81	
41-50	44	32.59	43.32
51-60	13	9.63	
≥ 61	6	4.44	
Extension contact (No)			
1-4	48	35.56	
5-8	52	38.52	5.73
9-12	24	17.77	
>12	11	8.15	
Farm size (ha)			

≤ 1	48	35.56	
1.1-3.0	69	51.11	
3.1-5.0	18	13.33	1.7
Total	**135**	**100**	

Source: Field survey, 2011.

Empirical model result

Logit regression analysis (LRA) using Shazam software package shows that most of the coefficients are not consistent with hypothesized relationships and their tests of significance help to indicate their importance in explaining adoption decisions of the rice farmers in the area (Table 2). The positively significant coefficient of credit availability was as expected. It implies that availability of credit encourages farmers to adopt improved technology. The farmers who received credit were found to adopt improved technology by 8.18 percent for every naira received. If production credit is invested into an enterprise it is expected that it should lead to higher levels of output, but in case the credit is not accessed on time, it may, more often than not, lead to misapplication of funds. Hence, the expected impact of such funds will not be felt on the enterprise. The results of the econometric model proved that gender of the respondent is an important variable influencing adoption decision. The coefficient of gender indicates that the probability of adopting rice varieties with high yielding and weed suppressing abilities by a male farmer increase 1 time higher compared to a female farmer, given other variables constant. This could be attributed to the cultural barriers in the area which impedes women from free association especially to male gender or extension agents.

The coefficient of market availability was found negatively significant at 10 percent probability level, which implies that proximity to market could enhance the rate of adoption of rice varieties with high yielding and weed suppressing abilities. The presence of market can guarantee increased prices which can bring about high income to the farmer resulting from increased output. Education (Years of schooling) had positive coefficient and was significant at 1 percent probability level, which implies that adoption increases with increase in years of schooling. The results revealed that on the average, 54 percent of the farmers would adopt rice varieties with high yielding and weed suppressing abilities as years of schooling increases, ceteris paribus. Risk aversion decreased with positive coefficient of education which was as expected to increase the rate of adoption. This result is consistent with the findings of Karki and Bauer (2004). Extension service popularizes innovation by providing necessary information, knowledge and skills in order to enable farmers to apply innovation (Karki and Bauer, 2004). Majority of the farmers in KRIP have not been able to acquire much knowledge about the technology due to lack of technological know-how, transportation facilities, access to communication media and technical training. Farmers who adopted rice varieties with high yielding and weed suppressing ability had a higher probability of applying the adopted innovation. It was presumed that they were privileged with material and managerial support from the extension agents, followed by timely availability of knowledge and skills, which apparently helped them to apply the new technology. The positive significant coefficient of the variable indicates positive impact on technology adoption.

Table 2: Logit regression result

Variable	Notation	Coefficient	Standard Error	t-value
Intercept	β_0	-4.4586**	1.9205	-2.321
Credit availability	X_1	.0818***	.0267	3.064
Gender	X_2	1.0265*	.5619	1.827
Market availability	X_3	-.0760*	.0399	-1.905
Farming experience	X_4	-3.0940	5.1746	-0.598
Household size	X_5	.0403	.0999	.403
Education	X_6	.5379***	.0821	6.552
Access to Irrigation	X_7	.8896*	.4668	1.906
Access to Ext. contact	X_8	1.8771	1.4257	1.317
Land availability	X_9	-.7113	.4585	-1.551
Labour availability	X_{10}	2.0059**	.8796	2.280
Farm size	X_{11}	.0159***	.0056	2.839
Log likelihood function		-56.32		
Number of observations		135.00		
McFadden R-squared		0.77		
Chi squared		12.08		
Degrees of freedom	10			

*** Significant at 1%; ** significant at 5% and * significant at 10%.

Source: Field survey, 2011.

The estimated coefficient of labour availability was found positively significant, which implies that there is possibility of the farmers adopting an innovation when labour is guaranteed. Farmers' adoption of rice varieties with high yielding and weed suppressing ability will increase 2 times more than those who do not have adequate labour for rice farming operations. This could be so because farming is generally labour intensive especially at the subsistence level. Households without adequate labour may be highly risks averse in adopting an innovation. Therefore, technological adoption is a function of labour availability. The positively significant coefficient of farm size indicates its positive influence on technology adoption which was as presumed. The adoption rate was found to be increased by 1.59 percent in every one unit increase in farm holding. Subsistence oriented small farmers are highly risk averse to apply innovation due to limited holding and uncertain outcome of technology.

The results of the logistic regression model also indicates that the fit of the data was good as indicated by the statistical significance ($P<0.05$) of the Chi-squared (χ^2). The Mcfadden R^2 explains the variation in the model attributable to the explanatory variables. It indicates that 77 percent of the variation is explained by the included independent variables in the model.

Respondents' perception on advantages of rice varieties with high yielding and weed suppressing abilities

Entries in Table 3 indicate that the respondents perceived advantages in the following areas were: weed suppressing abilities ($\overline{X}$=4.01), required less fertilizer ($\overline{X}$ = 3.99), high yielding (4-8MT/ha) ($\overline{X}$= 3.96), ease of thrashing ($\overline{X}$=3.56), high tillaring capacity ($\overline{X}$=3.59), large straw ($\overline{X}$= 3.24), consumer acceptability ($\overline{X}$=3.36), grows fast ($\overline{X}$=4.00), Moderate maturity time ($\overline{X}$=3.21). These findings indicate that the respondents were in agreement with all the stated advantages. This implies that these varieties could improve farmer's livelihood resulting from high yield, low cost of production, high demand and its early maturing nature.

Table 3: Farmers' perception on advantages of rice seed with weed suppressing abilities

Advantages	Weighted Mean	Overall Perception
It has weed suppressing ability	4.01	Agree
Required less fertilizer	3.99	"
High yielding (4-8MT/ha)	3.96	"
Ease of thrashing	3.56	"
It has high tillaring capacity	3.59	"
Large straw	3.24	"
Consumer acceptability	3.36	"
It grows fast	4.00	"
Moderate maturity time	3.21	"

Source: Field survey, 2011.

Intensity of adoption

Adoption intensity shows the ratio of farmland devoted to a particular technology given the farm size under cultivation for the same crop by the farmer. Table (4) depicts the adoption intensity distribution of the respondents. The result shows that the mean adoption intensity was 0.472. It implies that 47 percent of the respondents' rice land area was planted with rice varieties with high yielding and weed suppressing abilities. Majority of the respondents (43 percent) had their adoption intensity ranging from 0.41 – 0.60. This was followed by 33 percent respondents with adoption intensity interval of 0.61 – 0.80. The smaller percentage (24 percent) of the respondents had their adoption intensity between 0.21 – 0.40. This implies that adoption intensity of the farmers for these varieties of rice is still low.

Table 4: Adoption intensity

Adoption intensity	Frequency	Percentage
0.0 - 0.2	6	4.44
0.21-0.40	27	20.00
0.41-0.60	58	42.96
0.61-0.80	45	33.33
0.81-1.0	9	6.67

Mean = 0.472
Source: Field survey, 2011

Perception on constraints to high yielding and weed suppressing rice seed/varieties

Result in Table 5, indicates that out of the 5 perceived constraints to the adoption of rice varieties with high yielding and weed suppressing abilities, the respondents agreed that the varieties requires more water than upland varieties ($\bar{X}$ = 2.53). On the other hand, constraints such as causes lodging ($\bar{X}$ =2.15), harbours pest and diseases ($\bar{X}$ = 1.75), has too many trash ($\bar{X}$ = 2.12), and causes shattering ($\bar{X}$ = 2.10) were all disagreed by the respondents. Due to the pest and diseases resistance nature of these varieties of rice hence, it could be adjudged that it can ensure food security because most of the crop losses stemmed from the activities of pests and diseases both on and off field.

Table 5: Farmers' perception on constraints to high yielding and weed suppressing rice seed/varieties

Effect	Weighted mean	Overall Perception
Causes lodging	2.15	Disagree
It harbours pest and diseases	1.75	”
It requires more water than upland varieties	2.53	Agree
It has too many trash	2.12	Disagree
Causes shattering	2.10	”

Source: Field survey, 2011.

CONCLUSION AND RECOMMENDATIONS

Conclusion

The study concludes that KRIP is comprised of young literate males with mean farming experience of 13 years, average household size of 7 persons, small farm holdings and had few contact with extension agents. Adoption of rice varieties with high yielding and weed suppressing abilities is significantly influenced by credit availability, gender, market availability, education, extension contact, labour availability and farm size. The respondents were in agreement with all the stated advantages with an average adoption intensity of 47 percent and disagreed to most of the perceived constraints. Therefore, to increase adoption of rice varieties with high yielding and weed suppressing abilities, extension service with males as target should be improved to boost the farmers' education and aid the farmers in credit acquisition in order to guarantee hired labour, means of accessing market and increased farm holdings. Also, due to the pest and diseases resistance nature of these varieties of rice, it could be adjudged that it can ensure food security and improve livelihood of the farmers.

Recommendations

From the findings of the research the following were recommended:

1. Extension services should be adequately funded, monitored and evaluated intermittently by government to guarantee effective dissemination of the improved rice varieties.
2. Farmers should form cooperative groups to strengthen their credit facilities.
3. Government and other concern organizations should encourage mechanization through provision of heavy equipment in order to increase labour availability.

ACKNOWLEDGEMENT

The authors would like to thank rice farmers in KRIP who availed us their time during field data collection for this study.

REFERENCES

Africa Rice Center (WARDA)/FAO/SAA (2008). *NERICA: the New Rice for Africa – a Compendium*. Somado, E. A., Guei, R. G. and Keya, S. O. (eds.). Cotonou, Benin: Africa Rice Center (WARDA); Rome, Italy: FAO; Tokyo, Japan: Sasakawa Africa Association. 210 pp. www.warda.org. Accessed date January 25th 2012.

Balmisse, S., Faure, G. and Ilu, I. Y. (2002). Integration of existing farming systems in Hadejia Valley Irrigation Project. In: Jamin J.Y., Seiny B. L., Floret C. (eds). 2003. Savanes africaines: des espaces en mutation, des acteurs face à de nouveaux défis. Actes du colloque, mai 2002, Garoua, Cameroun. Prasac, N'Djamena, Tchad -Cirad, Montpellier, France.

Chinma, G. (2004). Rice at Risk, Green Peace International Organization; Item ID 616740.

Dayton, C. M. (1992). Logistic Regression Analysis. file:///C|/Webpage/LRA/LOGISTIC REGRESSION ANALYSIS.htm. Accessed date March 10th 2012.

Ekong, E. E. (1988). *An Introduction to Rural Sociology*. Jumak Publishers, Ibadan pp 130-135

Ersado, L., Amacher, G. and Alwang, J. (2003). Productivity and Land enhancing Technologies in Northern Ethiopia: Health, Public Investments, and Sequential Adoption. *Environment and Production Technology Division, International Food Policy Research Institute, USA. EPTD Discussion paper* NO. 102. Accessed date March 27th, 2012

Fagade, S.O. (2000). Yield Gaps and Productivity Decline in Rice Production in Nigeria. Paper Presented at the Expert Consultation on Yield Gap and Production Decline in Rice, 5-7 September, 2000. FAO, Rome, Italy. 15 pp.

Falusi, A.O. (1997). Agricultural Development and Food Production in Nigeria: Problems and Prospects. In: Shaid, B., Adedipe, N.O., Aliyu, M. and Jir, M. (eds.) *Integrated Agricultural Production in Nigeria: Strategies and Mechanism (NARP) Monograph*, 5:151-170.

Farid, H., Silong, A. D. and Sarkar, S. K. (2010). Application of Logit Model in Innovation Adoption: a Study on Biotechnology Academic Researchers in Malaysia. *American-Eurasian Journal of Agriculture and Environmental Science, 9* (3): 282-287, 2010

Holst, W. (2003). Total cost of Adoption. PDF Adobe acrobat document at *www.gilbane.com/GRWP.merant.pdf*. Accessed date June 15th, 2011.

Hosmer, D. W. and Lameshow, S. (1989). *Applied Logistic Regression*. New York: John Wiley andSons.http//:www.jica.go.jp/english/operations/thematic_issues/agricultural/pdf/nigeria_en.pdf.

Izeze, I. (2011). PDP's N99 Trillion Food Imports and the struggle to eat. An Abuja-Based Consultant on Strategy and Communication. *Desert Herald Newspaper*. August 2nd – 8th, pp 32

Jamala, G. Y., Shehu, H. E. and Garba, A. T. (2011). Evaluation of factors influencing farmers' adoption of irrigated rice production in Fadama soil of North Eastern Nigeria. *Journal of Development and Agricultural Economics*, 3(2): 75-79. http://www.academicjournals.org/JDAE

Johnson, D. E., Riches, C. R., Diallo, R. and Jones, M. J. (1997). *Striga* on Rice in West Africa: crop host range and the potentials of host resistance. *Crop Protection, 16: 153-157*

Karki, L. B. and Bauer, S. (2004). Technology Adoption and Household Food Security. Analyzing factors determining technology adoption and impact of project intervention: A case of smallholder peasants in Nepal. http://www.tropentag.de/2004/abstracts/full/107.pdf Accessed 11th April, 2012.

Kebbeh, M., Haefele, S. and Fagade, S. O. (2003). Challenges and Opportunities for Improving Irrigated Rice Productivity in Nigeria. The Nigerian Rice Economy in a Competitive World: Constraints, Opportunities and Strategic Choices. *West Africa Rice Development Association (WARDA)*. Abidjan, Cote d'Ivoire

Kleinbaum, D. (1994). Logistic Regression. A Self-learning text. New York: Springer-Verlog.

Main Report and Working Papers, (2006). Federal Republic of Nigeria: Accelerated Rice Production in the Niger River Basin, TCP/NIR/3303

Nigeria Bureau of Statistics (NBS) (2012). Nigeria Poverty Profile 2010, January

Odoemenem, I. U. and Inakwu, J. A. (2011). Economic analysis of rice production in Cross River State, Nigeria. *Journal of Development and Agricultural Economics*, 3(9): 469-474. http://www.academicjournals.org/JDAE

Ogundele, O. O. and Okoruwa, V. O. (2006). Technical efficiency differentials in rice production technologies in Nigeria. *African Economic Research Consortium Research Paper 154*. Kenya. Accessed 11th October, 2010

Ojo, O. D., Connaughton, M., Kintomo, A. A., Olajide-Taiwo, L. O. and Afolayan, S. O.(2010). Assessment of irrigation systems for dry season vegetable production in urban and peri-urban zones of Ibadan and Lagos, Southwestern Nigeria. *African Journal of Agricultural Research,* 6(2): 236-243. http://www.academicjournals.org/AJAR

Okoruwa, V. O., Rahji, M. A. Y. and Ajani, O. (2007). Rice and Maize Stratification Project in Nigeria. Draft Report

Oriola, E. O. (2009). A Framework for Food Security and Poverty Reduction in Nigeria. *European Journal of Social Sciences 8(1):* 132-139

Ozowa, B. (2005). Making the most of agricultural investment. Retrieved at *www. ifad.org/agri_investment.pdf*. November 10th, 2011.

Peng, C.Y. J., Lee, K. L. and Ingersoll, G. M. (2002). An Introduction to Logistic Regression Analysis and Reporting. *The Journal of Educational Research,* 96(1):3-15

Polson, R. A. and Spencer, D. S. C. (1992). The technology adoption process in subsistence agriculture: The case of Cassava in South-western Nigeria. *Agricultural Systems,* 36:65-78

Project Co-ordinating Unit (PCU) (2002). Crop Area Yield Survey (CAY). Federal Ministry of Agriculture and Rural Development, Abuja.

Ravallion, M. and Datt, G. (1996). "How Important to India's Poor is the Sectoral Composition of Economic Growth?" *World Bank Economic Review*, 10, 1-25.

Singh, B.N., Fagade, S., Ukwunguwu, M.N., William, C., Japtap, S.S., Oladimeji, O., Effiisue, A., and Okhidievbie, O. (1997). Rice Growing Environments and Biophysical Constraints in Different Agro-ecological Zones of Nigeria. *Meteorology Journal*, 2(1): 35-44.

WARDA. (2006). *Africa Rice Center (WARDA) Annual Report 2005-2006: Providing What's Needed*". WARDA: Cotonou, Benin. 52pp

West Africa Rice Development Association and Nigerian Institute of Social and Economic Research (2001). *Report of the Stakeholders Workshop.* November 8-9, 2001. Ibadan, Nigeria.

Worlf, P. (1995). 'The Problem of Sustainability of Irrigation System'. Applied Geography. 45/46 pp 55-62.