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A CASE STUDY

Analysis of adoption and risk perception in innovation system in Kwara state Nigeria : A case study of improved rice

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Abstract : The critical issues associated with the Nigerian agriculture is that of low productivity and also what the farmer's perceive as risk involved in adopting innovative and improved technology. Although rice is a leading staple food crop in Nigeria, domestic rice production has not increased sufficiently to meet the increased demand. This study, therefore, focused on determining the risk perception of farmer's on improved rice and consequently the adoption of new technology, a case study of improved rice. Farmers were classified into risk classes using the multi-item scale approach and probit model was used to determine the relationship between socioeconomic characteristics and adoption status. A relatively large group of farmers exhibit a risk taking attitude with only few exhibiting risk indifference attitude. The study revealed high rate of adoption of improved rice. Farming experience, amount of credit available, co-operative membership and risk co-efficients have significant effects on the adoption status of the new rice variety. Inadequate capital, disease and pest, climate change and inadequate input were perceived as a risk situation affecting improved rice production. Consequently the study recommends among others that risk situation and behaviour of farmers should be considered in innovative technology to achieve sustainable development via agricultural development.

Key Words : Innovation, Multi-item scale, Probit, Rice, Risk, Uncertainty, Perception

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INTRODUCTION

Agriculture holds the key to rapid economic development, social transformation and poverty alleviation (Bello, 2004). It accounts for 40 per cent of Nigeria's Gross Domestic Product and offers employment to about 80per cent of the population (Omotesho *et al.*, 1995). In spite of this, agricultural production has failed to meet the food needs of the country's rapidly growing population. This has led to constant food shortages, rising farm product prices and huge importation of food by the government. The nation currently spends about N1.3 trillion on the importation of basic food items such as wheat, sugar, rice and fish (Daily independent, 2012). Rice is one of the major cereals that have been imported in huge quantities into the country over the years despite the fact that the commodity is cultivated in virtually all the agro-ecological zones (Ojehomon *et al.*, 2009). During the last two decades, rice has moved from a ceremonial to a staple food in many Nigerian homes. Nigeria consumes 5.4 million MT of rice annually, out of which 1.6 million MTs are imported excluding the huge quantity smuggled through the porous borders (USAID, 2009). Nigeria is currently the largest importer of rice in the world, spending N356 billion yearly or about N1 billion daily to import the food item (Daily Independent, 2012).

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Yet Nigeria's fertile land and rich agro-climatic conditions could easily produce rice to feed the entire country and generate surplus for the region.

Nigerian rice farmers are not able to produce enough to feed the country because they lack some key resources available to farmers in more developed nations. Presently, Nigeria's rice sub-sector is dominated by weak and inefficient producer-market linkages due to poor infrastructure including lack of improved processing facilities low rice productivity, poor post harvest handling and storage, expensive and poor access to inputs (high quality seed, fertilizer and crop protection products), inadequate market information, lack of transparency among players, low capacity to meet quality standards and limited efficiency of distribution networks. Area expansion and irrigation have already become a minimal source of output growth at a world scale. Agricultural growth will depend more and more on yield-increasing technological change (Datt and Ravallion, 1996; Hossain, 1989). It is believed the adoption of new agricultural technology, such as the high yielding varieties (HYV), that led to the Green Revolution in Asia could lead to significant increases in agricultural productivity in Africa and stimulate the transition from low productivity subsistence agriculture to a high productivity agro-industrial economy (World Bank, 2009). In recent years, rice production has been expanding at the rate of 6 per cent per annum in Nigeria, with 70 per cent of the production increase due mainly to land expansion and only 30 per cent being attributed to an increase in productivity (Fagade, 2000; West AfricaRice (WARDA), 2005; Okoruwa *et al*., 2007). Lack of high yielding varieties with good grain qualities, competition with imported rice, and inadequate post-harvest processing facilities are some of the factors that have been attributed to the low output in rice production.

Rice production requires an integrated quality management along the entire network from rice production, through processing and marketing. Moreover, actors along the network are key players in rice innovation and are important in the development of behavioral patterns that make organizations and policies sensitive to stakeholders (Ashley and Carney, 1999). Rice production requires a radical shift from traditional thinking and approaches to complementary technologies such as rice innovation (WARDA, 2005). Innovation involves using knowledge to find new ways to create and bring about change. It may require the creation of new knowledge but inspired application of knowledge to create additional value (Evans, 2004). Innovation system embraces not only the *science suppliers* but also the totality and interaction of actors involved in innovation (Hall and Dijkman, 2006). It extends beyond the creation of knowledge to encompass the factors affecting knowledge in useful ways. Biggs and Matsaert (2004) observed that an effective innovation system facilitates flow of information and mutual partnerships between actors.

Therefore, successive Nigerian governments came up with policies including the presidential initiative on rice and a proposed ban on imported rice in 2009. The presidential initiative on increased rice production was designed to reverse the rising import bill which stood at N96. 012 billion in 2002 to meet domestic demand by 2006 and export by end of 2007. In order to achieve this, the Federal Government resulted into inviting companies that can assist in increasing rice production in the country hence, brought in Olam International. Olam International distributes a package which contains improved rice seedlings, herbicide and fertilizer to the farmers. They also serve as a marketing channel to the farmers. They absorb the farmer's produce, process it and release it into the market.

These market failures can be severe and leave small farmers in a poverty trap from which they struggle to escape; even when the technology that allows them to produce more exists. These market failures may be overcome by institutional innovation, but in some cases stronger state intervention may be needed including the use of input subsidies. Incremental production from improved inputs will not necessarily result in surpluses since Africa agricultural problems are complex with such problems as weak institutions, inefficient markets, weak policies and governance and cannot be resolved by technological fixes only. The complexity of African agricultural systems coupled with poverty and food insecurity has led to a shift in global agricultural research systems towards an innovation research systems. However, another critical issue associated with the Nigerian agricultural system is what the farmer's perceive as risk involved in adopting new innovations and improved technology. Risk perceptions and risk preferences are widely recognized by economist as the major factors influencing risky behavior. Risk perceptions characterize the likelihood of chance outcomes usually framed in economies in terms of subjective probabilities. A dimensional analysis of perceived risk is not new to the literature on risk perception. Researchers (Slovic *et al.*, 1980, Slovic *et al.*, 1987, Johnson and Tversky, (1984) have identified several persistent dimensions to risk perception across different populations. Cunningham (1967) defined risk perception as a consumer's subjective feeling that there is some probability that a chance may lead to an undesirable outcome. Perception is influenced amongst other situations by, emotional state of the individual, personal experiences with the same similar risks and socio-demographic background like age, gender and location. Adoption on the other hand is regarded as a decision to make full use of an innovation or technology as the best course of action available (Rogers, 1995). In Sub Saharan Africa, innovation in agriculture is a powerful means to address relatively low production and add value. Higher agricultural productivity is a precondition for growth and development, and higher yields are a way to raise incomes and reduce poverty, particularly in rural areas, either directly through enhanced smallholder incomes or indirectly through increased

employment and wages. Understanding how innovation takes place and developing policies and institutions that facilitate enhanced innovation are thus central to the process of agricultural development on the African continent (World Bank, 2009). Every new technology comes together with benefits and also risks. Every new technology comes together with benefits and also risks and according to Ebbersen and Pedersen (2007), risks refers to a possible future harm.

Knight (1921) with his concept of measurability of uncertainty provided the basis for the classic distinction between risk of which information was available about the relative chances of the different outcomes and uncertainty in which this information was not available. This means that risk is distinguished from uncertainty on the basis of the amount of information available about the likelihood of the outcome of actions. Akande (1998) described risk as a situation where the probability of an event occurring can be predicted. That is risk refers to a situation where probability distribution exist and can be estimated through objective or subjective procedure. On the other hand, uncertainty is used to descried situation where the probability of an event occurring cannot be predicted. This implies that unlike risk, uncertainly can neither be measured nor quantified

The more a person dreads an activity, the higher its perceived risk and the more that person wants the risk reduced. The more the risk is reduced, the more the innovation is likely to be adopted. However, there's little or no literature about risk perception and adoption of Olam rice in Kwara State, Nigeria. The study seeks to identify farmer's perceived risk of improved rice, determines what farmers perceive as risk involved in adopting innovative and improved technology, elicit the risk attitude of the farmers and evaluate the effect of farmers' socio economic characteristics on their adoption status of Olam rice.

MATERIAL AND METHODS

Study area :

The study was carried out in Kwara State, Nigeria. The state comprises of sixteen Local Government Areas which have been divided into four Zones (A,B,C,D) by the Kwara State Agricultural Development Project (KWADP). The state has a population of about 2.37 million people (NPC, 2006), who individually consume about 24.6 kg of rice annually (IRRI, 2001).

Sampling technique :

Zone B was purposively selected for this study because 90per cent of rice production in Kwara State is from the zone. It comprises of Edu and Patigi Local Government Areas. The sample consisted of one hundred and twenty (120) rice farmers. Three villages were randomly selected from each local government and twenty (20) questionnaires were administered in each village; sixty (60) in each local government. For Edu LGA villages selected were Tsonga, Lade and Kpada and in Patigi LGA; Patigi, Liafiagi and Kpada were selected.

Method of data collection :

Primary data were used for the study. The primary data were collected from farmers through the use of well structured questionnaire administered randomly to farmers. The primary data reflects the socio-economic characteristics of the farmers, input and output data on rice production and general questions about views on risk perception and adoption of Olam rice.

Methods of analysis :

Descriptive statistics, like mean frequencies, percentage and standard deviation were used to identify farmers perceived risk of improved rice. Inferential statistics like, probit regression model, multi-item scale approach and chi-square were used to evaluate the effect of socio economic characteristics and risk level of the farmers on their adoption status of improved rice.

The multi-item scale approach is a measurement scale that gathers opinion about an object on a number of dimensions and the data can be collated to produce a combined rating. Multi-item scale approach involves; construct definition and scale design using likert scales, items validation, to measure farmer's risk attitude, testing the preliminary scale, risk attitude scale, construct validity testing, factor analysis and reliability testing and scale refinement.

To determine the effect of farmer's socioeconomic characteristics on their adoption status, the probit model was employed. The probit model is a statistical probability model with two categories in the dependent variable (Liao, 1994). Probit analysis is based on the cumulative normal probability distribution. The binary dependent variable y, takes on the values of zero and one. The outcomes of y are mutually exclusive and exhaustive. The dependent variable, y, depends on k observable variables X_k where k=1,…,K (Aldrich and Nelson, 1984). While the values of zero and one were observed for the dependent variable in the probit model, there was a latent, unobserved continuous variable, y*.

$$Y^* = X'\beta + \varepsilon$$

where $\varepsilon \sim n(0, 1)$

The dummy variable, y, was observed and was determined by y* as follows :

$$Y = 1_{\{Y^*>0\}} = \begin{cases} 1 \text{ if } Y^* > 0 \text{ i.e. } -\varepsilon < X'\beta, \\ 0 \quad \text{otherwise} \end{cases}$$

The Maximum Likelihood Estimation (MLE) technique was used to estimate probit model parameters.

The specification of the probit model was given as follows.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \text{-------} + \beta_n X_n$$

where, Y = Adoption of improved rice, X =Farming

experience (years), X_2=farm area (ha),

X_3=amount of credit available per farming season, X_4=co-operative membership (Yes=1, No=0), X_5=household size, X_6=risk co-efficients, β=co-efficients to be estimated.

RESULTS AND DISCUSSION

Table 1 shows the socio-economic characteristics of the respondents. It describes how the household socio-economic features are affected by their behaviour to risk and how their perception to risk determines their adoption.

The respondents had a mean age of 41.49 years with a modal group of 46-50 years where we had 28.3 per cent of the respondents. Most farm studies have highlighted the importance of age and its distribution in rural development, as it may influence the decision making of the respondents in terms of their adoption of any innovation as well as their risk attitude. From the Table 1, the mean years of farming experience was 12.98 years with a modal group of 5-10 years. Most of the respondents had between 5-10 years of experience in farming and a mean of 10.34 years of education. Furthermore, 15 respondents had no formal education, (12.5%). And, 92.5 per cent of the respondents were married, 6.7 per cent single and 0.8 per cent separated. Also, 7.5 per cent of the respondents had no spouse, 58.3 per cent had one spouse and 0.8 per cent had above 3 spouses. The mean number of spouses was 1 and 0.8 per cent of the respondents had a household size between 23-25 people. Large household size may reduce labour constraints faced during the peak of the farming season. The average yearly income is N171, 748.20 with 59.2 per cent of the total respondents earning N80, 000-160,000 and 2 per cent earned over N400, 000 yearly. Most of the respondents earn above the minimum wage of N96,000. It was also observed that majority of the respondents earn income from off farm activities such as, tailoring, bricklaying, commercial driving, carpentry, hunting and civil servants. Only one respondent had no secondary occupation.

Table 2 shows the percentage of respondents according to specified risk degree of cultivated crops. The perceived risk of the respondents on the production of improved rice was identified and respondents classified the other crops they plant in comparison to the improved rice according to the degree of risk involved in their cultivation. The respondents perceived inadequate capital and inadequate input as a risky variable affecting improved rice production. They also reported production risk in terms of bad weather (drought and untimely rainfall). This is reflected in the variation in yield of the crops over the years. The respondents also mentioned disease infestation, pest attacks and flood as part of the risk situation they face.

Nerica rice and beans were considered to be extremely risky with 50 per cent, respectively, while guinea corn was considered to be not risky with 50.8 per cent of the respondents. This may be because guinea corn can withstand

Table 1 : Summary statistics of selected socio-economic variables of respondents in the study area

Characteristics	Frequency
Age	
>25	0(0)
26-30	9(75)
31-35	15(12.5)
36-40	24(20)
41-45	33(27.5)
46-50	34(28.3)
51-55	4(3.3)
56-60	1(0.8)
Total	120(100)
Farming experience	
5 – 10	7(58)
11 -15	15 (12.5)
16 -20	21 (19.4)
>20	16(13.3)
Total	120 (100)
Number of spouses	
0	9(7.5)
1	70(58.3)
2	40(33.3)
Above 2	1 (0.8)
Total	120(100)
Gender	
Male	1118(98.3)
Female	2 (1.7)
Total	120 (100)
Marital status	
Married	11 (92.5)
Single	8 (6.7)
Separated	1 (08)
Total	120 (100)
Education level	
No formal education	15(12.5)
Quaranic education	13(2-12.3)
Adult education	16(13.3)
Primary education	3(2.5)
Post primary education	23(19.2)
University education	48(40.0)
Total	120(100)
Yearly income (N'000)	
80-160	71(59.2)
161-240	26(21.7)
241-320	15(12.5)
321-400	6(5.0)
401-450	1(0.8)
> 500	1(0.8)
Total	12(100)

Table 2: Percentage of respondents according to specified risk degree of cultivated crops

Crop	Extremely risk	Very risky	Moderately risk	Low risk	Not risky	Total percentage
Improved rice	-	-	15	85	-	100
Local rice	-	-	80.5	16.7	2.5	100
Nerica rice	50.0	0.8	40.8	5.8	2.5	100
Maize	-	47.5	8.3	43.3	0.8	100
Groundnut	-	-	46.7	50	3.3	100
Guineacorn	-	-	0.8	48.3	50.8	100
Beans	50.0	-	38.3	11.7	-	100

Table 3: Factor analysis

Eigen	Values	Per cent variance		Per cent total cumulative variation
1	2	1	2	
5.540	1.46	79.028	20.871	99.899

harsh and severe weather conditions 85 per cent of the respondents perceive improved rice as low risk and 15 per cent as moderately risky.

In terms of adoption of new innovation and technology, Tables 3, 4, 5 and 6 describe the attitude of the respondents to risk as measured using the multi-item scale approach. Explanatory factor analysis forms the scale items into two. The explanatory factor analysis on the scale items yielded Eigen values and percentage of its variation (Table 3). The Eigen values exceed one.

The result strongly supported a two-factor model where the first factor explained 79.028 per cent of variation in the data, the second factor explained 20.871 per cent of variation in the data. The total variation explained was 99.899 per cent. All the factor leadings of the items support a multi-model as the loadings are significant at 1 per cent.

On the basis of the questions the first four items make up scale 1 the last three items make up scale 2. The reliability of the scales is shown in Table 5. The reliability scale ranges from 0 to 1 with higher values indicating greater reliability. Scale 1 is more reliable with reliability co-efficient of 0.605 with scale 2 having 0.252.

Based on this scale, all the sampled farmers were divided into risk averse, risk indifference and risk taker. The classification was based on the average sum of the score of the items of the more reliable scale farmers who had a negative sum score are risk takers those who had a sum score of zero are indifferent and those who had a positive sum score are risk averse

From Table 6, a relatively large group of farmers exhibited a risk taking attitude. 45.8 per cent (55 people) exhibited risk

Table 4 : KMO and Bartlett's test result

KMO	0.583
Bartlett's Test of sphericity	130.41
Significance	0.000

Note : KMO: Kaiser Meyer Ohlin statistics

Table 5: Reliability analysis result

Alpha	
Scale 1	0.605
Scale 2	0.252

Table 6 : Classification of respondents based on risk attitude scale

Risk averse	Risk indifference	Risk taking
38 (31.7)	27 (22.5)	55 (45.8)

Table 7 : Probit estimates

Y	*Co-efficients*	*Std Err*	*Z*	*P /z/*	*95* per cent *Conf.*	*Interval*
Farmers experience	0.0640084	0.0345588	1.85	0.064	-0.0037345	0.1317373
Farm area	0.3511831	0.1593488	2.2	0.28	-0.6634852	0.0388769
Credit	1.132.06	5.270.06	0.2	0.827	-9.18806	0.0000115
Co-operative member	0.0033622	0.0533138	0.06	0.95	-0.101131	0.1070553
Household size	0.008535	0.0492.56	0.17	0.867	-0.1045958	0.0883257
Risk co-efficient	0.7651147	0.4115852	1.83	0.063	-0.0415774	1.571807
Constant	1.334167	0.5080793	2.63	0.009	0.33835	2.329984

Log likelihood = -26.626.859 Presidio R02 = 0.1670
Probit Chi^2 = 0.0988 LR Chi^2 (6) = 10.68
No of observation = 120

taking behavior, 31.7 per cent (38 people) exhibited risk averse behaviour, 22.5 per cent (27 people) exhibited risk indifference behavior. This accounts for the high rate of adoption of improved rice.

Table 7 shows the analysis of the effect of socio-economic characteristics and risk level of the farmers on their adoption of new and improved technology (Olam rice).

The socio-economic characteristics used were farming experience, farm area, amount of credit available co-operative membership and household size. The risk co-efficients were obtained from the average sum of the score on the items of the more reliable scale. The parameters with positive co-efficients are those that have a significant effect on the adoption status of the farmers. Farming experience, amount of credit available, co-operative membership and risk co-efficients had significant effects on the adoption status. This implies that an increase in these parameters will lead to a positive effect on adoption status. The more experience a farmer has the higher the chances of him being on adopter when enough credit is available for farming activities the farmer tends to speedily adopt new innovations. It was observed in the course of the study that the down package was distributed to the farmers through their co-operatives and all non-adopters in this study belonged to no co-operative society.

Also risk co-efficient was positively significant to adoption status. Risk takers may readily adopt the new technology packages of Olam rice. The risk indifference partially adopts and those that are risk averse are non-adopters. This means, farmers with high risk co-efficient in the farming practice may likely adopt the new technology and innovation packages of Olam Rice. From the results of the probit regression analysis, it was observed that farm area and household size had no significant effect on the adoption status of the farmers. Their farm being large or small does not necessitate adoption likewise their household size. Farming experience, amount of credit available, co-operative membership and risk co-efficients were the determinant of the adoption status of the farmers.

Conclusion and recommendation :

The study shows that the farmers exhibited different risk attitudes and indicate that majority of the farmers were risk takers. Consequently the study recommends among others that risk situation and behaviour of farmers should be considered in innovative technology to achieve sustainable development via agricultural development. In view of this, policy for improved rice farmers should incorporate their risk preference, risk attitude and its relationship with their socio-economic characteristics. Doing these, may improve the adoption of improved rice by farmers. Also, there is need to group the farmers into co-operative societies as this will encourage risk sharing and facilitate dissemination of information as well as improve access to input and credit facilities. Most of the farmers that have not adopted improved rice attributed their non-adoption to the fact that they have no access to the seedlings. Therefore, there is need to increase the seedling package made available to the farmers and to ensure the timely delivery of the packages if possible well before the planting season.

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