WEALTH STATUS AND AGRICULTURAL TECHNOLOGY ADOPTION AMONG SMALLHOLDER RICE FARMERS IN NIGERIA

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Abstract: Due to the high cost and risk associated with adoption, the wealth of a household may be an important factor in the decision to adopt Improved Rice Varieties (IRVs) in Nigeria. This study assessed the role of household wealth in IRVS adoption. The study employed the Principal Component Analysis (PCA) to generate the wealth index which was used to partition the respondents into wealthy and non-wealthy households. The logit and the Tobit models were adopted to assess the determinants and intensity of adoption of IRVs among 600 randomly selected smallholder rice farmers from the three major rice producing ecologies in Nigeria. Data were collected using well-structured questionnaire. Results indicated that factors determining the adoption and intensity of adoption of IRVs varied between the wealthy and non-wealthy households. Farmers organization, access to credit, access to seed, education, wealth index, contact with extension agents were some of the variables that had positive and significant influence on the farmers decision to adopt IRVs. Farm size, wealth and income positively and significant affected the intensity of adoption. The cost of seed had negative and significant effect on both the decision to adopt and the intensity of adoption. Hence, if the desired adoption rate and intensity of adoption of IRVs is to be achieved, it is important to embark on wealth group specific policies, adopt programs and policies that can lead to improvement in wealth and households income, encourage formation of farmers' organization and ensure the price of IRV seeds are affordable to the rural farmers.

Keywords: Adoption, Farmers, Nigeria, Rice, Wealth

INTRODUCTION

The development and dissemination of improved agricultural technologies particularly in Africa came as a result of the need to improve the well-being of the rural poor farmers and also to enhance national income (Phiri et al., 2004). Consequently, several improved varieties of agricultural technologies such as seed, fertilizer and improved land management techniques have been developed through the joint and concerted efforts of national and international research institutes in developing countries particularly, Sub-Saharan Africa (SSA) with the financial supports of multilateral organizations such as the World Bank . In Nigeria for example, at least 57 different Improved Rice Varieties (IRVs) have been developed and disseminated to the rural farmers through different programs and policies. All these efforts were geared toward increasing rice productivity to encourage the attainment of national and household food security. This is based on the premise that the adoption of new agricultural technology such as the High Yielding Varieties (HYV) that led to the Green Revolution in Asia could also lead to significant increases in agricultural productivity in Africa and also stimulate the transition from low productivity subsistence agriculture to a high productivity agro-industrial economy (World Bank, 2008).

It is widely reported that the extensive growth in Asia's green revolution created welfare effects beyond the adopting farmers and villages (Despite an array of reports and findings on the impact of agricultural technology adoption on yield increase and poverty reduction (Just and Zilberman, 1988; Binswanger and von Braun, 1991; de Janvry and Sadoulet, 1992; Rosegrant and Hazell, 2000; Renkow, 2000; De Janvry and Sadoulet, 2001; Bourdillon et al 2002 ; Evenson and Gollin, 2003; Hossain *et al* 2003; Mendola 2006 ; Bellon et al. 2006; Kijima et al. 2008; Becerril and Abdulai, 2009), majority of farmers in Africa particular in Nigeria still plant the traditional varieties and some that have at one time adopted have discontinued adoption, hence the observed adoption rate and intensity of adoption have been minimal (Oladele, 2005). While the green revolution benefitted many farmers, the adoption of promising agricultural technologies has been far from global, and has remain particularly low among the poor (Jack, 2011). In SSA adoption of new technologies has lagged behind that of Asia (Gollin et al. 2005). Similarly, Dixon et al. (2006) observe that despite the release of nearly 1,700 improved wheat varieties in developing countries during the period 1988–2002, only a relatively small number have been adopted on a substantial scale by farmers. Production and price risks that could render input use unprofitable sometimes prevent rural households from benefitting from input technology change.

The households' ability to cope with such risks and hence benefit from input technology change is often positively related to its wealth or stock of productivity assets (Langyintuo and Mungoma, 2008). Although a number of studies (see: Voh, 1982; Rao and Rao, 1996) have identified households' socio-economic and demographic characteristic that influence farmers decision to adopt or not to adopt an improved technology, Langyintuo and Mungoma (2008) among many others investigated the effect of household wealth on the adoption of improved high yielding maize varieties in Zambia. However, the influence of wealth status has not been adequately studied in the adoption literature particularly in SSA and in relation to rice in Nigeria; none exists to the best knowledge of the authors. Therefore, this study was conducted to fill the gap in the literature and to complement other studies on technology adoption in SSA by examining the effect of households' wealth on the adoption of IRVs in Nigeria.

Furthermore, wealth index is a commonly used indicator of farmers' economic resources, yet there is no consensus in the literature on the relationship between wealth index and technology adoption. While some studies Mizher (2002), Salama (2001), Sakr (2001), Soma and Bali (1999), and El-Tantawy (1998)) found a significant positive relationship between the wealth index and adoption of agricultural innovations. The study by Abou El-Shahat (1990) indicates a significant negative relationship between the two variables. While only the studies by Ahmed (1994), Shibah and Abdel-Rahman (1990), and Yossef (1981)) found no relationship between them. Hence there is need for further study in order to clarify the exact effect of wealth index on improved agricultural technology adoption, particularly in Nigeria. In addition, in deviation from most studies on adoption in Nigeria and following Langyintuo and Mungoma (2008), the respondents were first stratified into wealthy and non-wealthy groups before modeling group-specific adoption decisions. In general, according to Moser (1998), Freeman et al. (2004), Ellis and Bahligwa (2003 and Langyintuo and Mungoma (2008) households are endowed with varying levels of different assets each of which could potentially contribute to their wealth statuses .Thus, this poses a potential problem in any efforts to stratify them based on wealth. Following Filmer and Pritchett (1998, 2001), Zeller et al. (2006), and Langyintuo and Mungoma (2008) this paper used the household assets to construct wealth indices by Principal Component Analysis (PCA) method.

The rest of the paper is organized as follows: section 3 presented the analytical framework and estimation techniques. Section 3 contains the data and descriptive statistics and in section 4 the results and discussion are presented and finally section 5, presented the summary of major findings, major conclusion from the study and some important policy recommendations.

ANALYTICAL FRAMEWORK AND ESTIMATION TECHNIQUES

2.0. Analytical Framework and Estimation Techniques

2.1. Determinants of Adoption: The Binary Logit Model

The decision to adopt an improved agricultural technology depends on a variety of factors (Nowak and Korsching, 1983; Wiersum, 1994; Mendola, 2005; Calatrawa-leyva et al., 2005), including farm households' asset bundles and socio-economic characteristics, characteristics of the technology proposed, perception of need, and the risk bearing capacity of the household. This study recognized the influence of wealth and other households' socio-economic characteristics on farmers' decision to adopt or not to adopt an improved rice variety. The respondents were classified into wealthy and non-wealthy farmers and the factors influencing adoption decision for each category were examined using the Logistic regression model. The use of the logit model is consistent with the literature on adoption (see Griliches, 1957; Lionberger, 1960; Rogers, 1983 and Alson et al. 1995) which described the adoption process as taking on a logistic nature. The Logit model have also been applied in several adoption studies by Green and Ng'ong'ola (1993); Kato (2000); Boahene et al. (1999); Nkonya et al. (1997); Shakya and Flinn (1985); Feder et al.(1985) and Rogers (1995).

The binary dependent variable was defined as 1 if the farmer had been planting at least one IRV for 5 years and 0 otherwise. Hosmer and Lemeshew (1989) pointed out that the logistic distribution (logit) has advantage over the others in the analysis of dichotomous outcome variable. It is extremely flexible and easily used model from mathematical point of view and results in a meaningful interpretation. The binary logistic model does not make the assumption of linearity between dependent and independent variables and does not assume homoskedasticity (CIMMYT, 1993). Hence, the logistic model is selected for this study. The probability that a farmer will adopt IRV was postulated as a function of some socioeconomic, demographic characteristic and institutional factors. Therefore, the cumulative logistic probability model is econometrically specified as follows:

$$P_i = F(Z_i) = F(\gamma + \sum \lambda_i X_i) = \frac{1}{1+e^{-Z_i}} \quad (1)$$

Where P_i is the probability that a farmer will adopt IRV or not given Xi; e denotes the base of natural logarithms, which is approximately equal to 2.718; X_i represents the ith explanatory variables; and γ and λ are parameters to be estimated. Hosmer and Lemeshew (1989) pointed out that the logit model could be written in terms of the odds and log of odds, which enables one to understand the interpretation of the coefficients. The odds ratio implies the ratio of the probability (P_i) that a farmer will adopt to the probability (1-P_i) that the farmer will not adopt IRV:

$$(1-P_i) = \frac{1}{1+e^{Z_i}} \quad (2)$$

Therefore

$$\frac{P_i}{1-P_i} = \frac{1+e^{z_i}}{1+e^{-z_i}} = e^{z_i} \quad (3)$$

The natural log of equation (3), will give:

$$Z_i = \ln\left(\frac{P_i}{1-P}\right) = \gamma + \lambda_1 X_1 + \lambda_2 X_2 + ... + \lambda_m X_m \quad (4)$$

If the disturbance term (U_i) is taken into account, the logit model becomes:

$$Z_i = \gamma + \sum_{i=1}^{m} \lambda_i X_i + U_i \quad (5)$$

Equation (3) was estimated by maximum likelihood method. This procedure does not require assumptions of normality or homoskedasticity of errors in predictor variables.

2.2. Intensity of Adoption: Tobit Model

The intensity of adoption can be measured by intensity of cultivation e.g. in terms of number of farmers, total area and area within farmers or harvest (CIMMYT, 1993). In order to analyze the intensity of adoption, measure by the average proportion of farmland devoted to improved rice production by the respondents in the different wealth categories this study adopted the Tobit model. The Tobit model which is a hybrid of the discrete and the continuous dependent variable originated from the work of Tobin (1958). Tobit model have been adopted in a number of studies (Taha, 2007; Rahimato, 2007; Dereje, 2006;). Following Maddala (1992) the basic Tobit model is specified as follows:

$$D_i^* = \lambda X_i + \mu_i$$

$$D_i = 0 \text{ if } D_i^* \leq 0 \quad (6) \qquad D_i = D_i^* \text{ if } D_i^* > 0$$

$$\mu_i \sim IN(0, \sigma^2)$$

I= 1,2…………..m

D_i^* = limited dependent variable, it is the intensity of adoption defined as the proportion of farm area devoted to improved rice varieties.

X_i = the socio-economic/demographic characteristics of the respondents.

The variables used in the empirical models are presented in Table 1. The selection of the variables is based on literature on adoption of improved agricultural technologies (Feder et al., 1985; Adesina and Zinnah, 1993; Adesina and Seidi, 1995; Marra et al., 2003; Kafle and Shah, 2012; Paudel and Matsuoka, 2008; Beke, 2011; Langyintuo and Mungoma (2008); Uaiene, 2011 and Lwelamira and Mzirai, 2010).

2.3. Household wealth indices

All the household assets which comprises of the physical, human, financial and social capital were used as the key indicators of wealth. The Principal Component Analysis (PCA) was adopted to compute the wealth indices for the respondents following the basic steps outlined by Langyintuo and Mungoma (2008). The procedure involved the identification of the relevant weight for each asset indicator by extracting from a set of variables those few with orthogonal linear combinations that capture the common information (Langyintuo and Mungoma , 2008). Given that the levels of endowment vary across the households and in order to ease comparison, there was the need to first normalize the assets by weighting to avoid distortions. Assets such as farm size and household size etc. which are measured in absolute values were also scaled from 0 to 1. Scaling was done as follows:

$$d = \frac{k_l - k_{\min}}{k_{\max} - k_{\min}} \qquad (7)$$

Where *d* represents the index, k_l represents the level, while k_{min} and k_{max} represent the minimum and maximum values of x, respectively, taken from the actual data collected. Once scaled (or normalized), it was easier to aggregate the indicators without distortion. Second, descriptive statistics (i.e., mean and standard deviation) and the component score coefficient matrix for the normalized variables were generated. With these, the wealth indices were computed as follows:

$$W_j = \sum_{i=1}^{m} [p_i (r_{ji} - k_i)] / z_i \qquad (8)$$

Where : W_j represents a standardized wealth index for each household 'j'; p_i is the weights (scores) assigned to the (m) variables on the first principal component; r_{ji} represents the value of each household 'j' on each of the *m* variables; k_i represents the mean of each of the *m* variables; and 'z'$_i$ the standard deviations.

DATA AND DESCRIPTIVE STATISTICS

A multistage random sampling technique was adopted to select a total of 600 rice farmers from the notable rice producing states in Nigeria. A well-structured questionnaire was used to collect data on socio-economic/demographic characteristics, income, expenditure, and household endowments from the household heads. As presented in Table 2, the average rice farmers are full time and male dominated and relatively young of about 46 years. This could be explained by the fact that in most African societies, the patriarchy system and male dominance in decision making is predominance and has engendered increase in the observed male headed households (Duze and Mohammed, 2006; Kisinza et al., 2008). The average rice farmer still keeps large family of about 10 persons with a small farm holding of about 0.5-2ha. Thus as the household size increases the tendency for the land to be continuously fragmented would be high leading to a reduction in yield as a result of excessive cultivation. The large household size could also implies that they have enough costless labour for farm activities (Okoedo-Okojie and Onemolease, 2009). Most of the respondents were of the middle age when they are still regarded as being energetic and therefore can be actively involved in production activities (Lupilya, 2007). About 53% of the respondents had no formal education. This is indicative of low literacy level; hence this will have the tendency to adversely affect their ability to process information.

3.1. Selected Socio-economic Characteristics Distribution of Respondents by Wealth Status

It has been attested to in the literature that farm households are not equally endowed. According to Langyintou and Mungoma (2006) farm households are endowed with varying levels of different assets each of which can potentially contribute to the wealth of the given household. Following Filmer and Pritchett, (2001) and Langyintuo et al., (2005) the principal component analysis was adopted to generate the wealth indices which was utilised to classify the respondents into two distinct categories. The respondents that had wealth index greater than 0 were classified as wealthy farmers and non-wealthy otherwise. Hence, about 42% of the respondents were classified as wealthy, while 58% were non-wealthy.

The distribution of the respondents' socio-economic characteristics by wealth status is presented in Table 3. The result revealed that a higher percentage of the female-headed households (67%) were non-wealthy compared with the male-headed households (56%) and majority of the non-wealthy households were educated. Households that had farming as major occupation were wealthier than the non-farming households. In terms of agricultural technology adoption, 50% of the adopters were in the wealthy category, while 47% of the non-adopters belong to the non-wealthy households.

RESULT AND DISCUSSION

4.1. Test of Mean Difference of some selected variables by wealth status

The result of the test of mean difference of some selected variables by wealth status is presented in Table 4. As expected, the analysis showed that for all the selected variables there were significant differences between the wealthy and non-wealthy households except in agricultural expenditure. This means that both the wealthy and non-wealthy households expended almost the same amount on agricultural production. However, the wealthy households had larger farm size, more years of formal education and large household size than the non-wealthy households. In addition, due to the household endowments the wealthy households were also able to generate more income from the non-agricultural sources than the non-wealthy households. All these implied that wealthy farmers are better off in terms of well-being than the non-wealthy farmers and this could have implications on the adoption of improved agricultural technologies.

4.2. Determinants of adoption: Logit model

The analysis of the determinants of adoption was carried out in two different stages. First, the determinants of adoption were assessed in the total population of the respondents. We then proceeded to assess the determinants of adoption by wealth status. In addition, the marginal impacts of changes in the independent variables on the probability of adoption were also determined. The interpretation of these marginal impacts is dependent on the unit of measurement of the independent variables. The result of the analysis of adoption is presented in Table 5. The log-likelihood, the Pseudo R^2 and the LR (Chi^2) (significant at 1% level), implies that the overall models were well fitted and the explanatory variables used in the model were collectively able to explain the farmers' decision regarding the adoption of IRVs in the study area. Many of the included variables were highly statistically significant in determining the farmers' decision to adopt IRVs. The significant variables were however, not markedly different between the wealthy and the non-wealthy households. On the overall, for the total sample, wealthy and non-wealthy households the significant variables are discussed below:

The coefficient of age of the house head was negative but significant in all the models. This implies that as the age of farmers' increase the probability of adopting IRVS would reduce. This could be due to the fact that young farmers are more likely to adopt new innovations and bear more risk than older counterparts because they have more education and have been exposed to new ideas than older farmers. This is in agreement with findings of Ransom et al., (2003). However, this finding is contrary to the finding of Langyintuo and Mungoma (2008) who found that the probability of adopting improved high yielding varieties is positively influenced by age. The result of the marginal effects also revealed that an additional year to the age of the household head would reduce the probability of adoption by 0.7%. Similarly, an additional year to the age of farmers from the wealthy and non-wealthy households would reduce the probability of adoption by 0.4% and 0.6% respectively. The coefficient of gender was positive and statistically significant at 10%. This suggests that male headed households tend to adopt more than the female counterpart. It has been argued by some authors that women are generally discriminated against in terms of access to external inputs and information (Dey, 1981). Among the wealthy households however, gender of household head was not a significant determinant of adoption.

The coefficient of household size was positive and significant at 1% in the total sample and for the non-wealthy households. This suggests that farmers with large household size have the higher probability of adopting IRVS. According to Herath and Takeya (2002) if agricultural technologies increase the seasonal demand for labour, it would be less attractive to a household with limited family labour. Large household size could therefore serve as a source of labour and thus encourage improved technology adoption. The coefficient of access to credit was positive and significant in all the models. This implies that access to credit will increase the probability that a farmer would adopt IRVS. This is because according to Langyintuo and Mungoma (2006) input technology such as improved seed varieties is highly capital intensive and hence, cash is required to purchase the seed, which is normally more costly than the local ones, and complementary inputs such as fertilizer for optimal productivity. In addition, farmers who have access to credit can relax their financial constraints and therefore buy inputs. Thus, it is expected that access to credit will increase the probability of adopting technologies. This finding is in agreement with findings from other studies such as: Morris et al., (1999), Gemeda et al., (2001), Adesina and Zinnah, (1993), Langyintuo et al., (2005), and Langyintuo and Mekuria (2005).

The coefficient of membership of organization was positive and highly significant in all the three models. This suggests that participation in any social group will increase the probability of IRVS adoption. Member of an organization are in a privileged position with respect to other farmers, in terms of their access to information on improved technologies. Membership of any organization is expected to link the individual farmer to the larger society and expose the farmer to a variety of ideas. Indeed an overwhelmingly large proportion of studies found a significant positive relationship between the social participation and adoption (Getahun et al., 2000 and Sharma and Kumar, 2000). Extension contact had a direct influence on adoption behaviour of farmers. The greater the degree of contact of farmers with extension personnel, the greater is the possibilities of farmers being influenced to adopt agricultural innovations. The positive effect of contact with extension agents is explained according to Beke (2011) by the fact that farmers who have contacts with extension organizations are likely to hear about improved varieties and thus have more incentive to adopt new agricultural technologies. This finding is in harmony with the observation of Ouma et al. (2002), Igodan et al. (1988) and Paudel and Matsuoka (2008) who also reported positive and significant influence of access to extension agents on adoption of improved maize varieties.

Since we do not expect the relationship between education and adoption to be linear, hence following Croppenstedt et al. (2003) we included dummy variable for different levels of education. The coefficient of secondary education in the entire three models was positive and highly significant this showed that education of the respondents increases the probability of IRVS adoption. Generally, education is thought to create a favourable mental attitude for the acceptance of new practices, especially information and management intensive practices (Waller et al., 1998; and Caswell et al., 2001). Hence, many of the rural social literatures (e.g. Shoemaker, 1971) have suggested that adoption depends on the decision makers' education and information level. The finding of this study is also in agreement with other past studies on technology adoption. For example, Mittal and Kumar (2000) find a positive impact of rural literacy on the adoption of high yielding varieties of rice and wheat in India. Similarly, Doss and Morris (2001) indicate that education is a significant determinant of the adoption of modern varieties of maize in Ghana. This finding was also in harmony with the findings of Marufu et al., (1999), Asfaw et al. (2004), Feleke and Zegeye (2006) and Paudel and Matsuoka(2008). Furthermore, the ability to read and write would also imply greater access to formal sources of credit which can positively influence adoption. The influence of education on access to credit was corroborated by the observation made by Musebe et al. (1993) in which they reported that as the household head gets more formal education the probability of obtaining credit increase.

The coefficient of access to seed was positive and significant in all the models. This shows the important role of access to seed in IRVS adoption. Indeed, a farmer cannot adopt IRVS if access to the seed is denied (Dontsop-Nguezet et.al.,(2011). Kohli and Singh (1997) found that inputs played a significant role in the rapid adoption of HYVs in the Punjab. In the same vein, of Langyintuo and Mungoma (2008) also observed that seed availability in local retail outlets, which can facilitate easy access to seed have positive and significant impacts on the probability of adopting an IRV among the poorly endowed households but not among their well-endowed counterparts. The coefficient of cost of seed per kilogram was found to negatively affect the adoption of IRVS only among the wealthy farmers, while although it was negative in the whole sample and among the non-wealthy farmers it was not significant. This however, implies that as the cost of seed increases, the probability of adopting an improved rice variety decreases. This finding is in agreement with the finding of Akudugu et al. (2012) who discovered that the cost of modern agricultural production technologies was negatively related to the probability of adoption in Ghana. This implies that if the improved technology is costly to the farmer, there is low probability that the farmer would adopt it. Hence as noted by Oster and Morehart (1999), technologies that capital are intensive are only affordable by wealthier farmers and hence the adoption of such technologies will be limited to larger farmers who have wealth (Khanna, 2001).

Finally, Wealth index which is a commonly used indicator of farmers' economic resources had a positive and significant effect on the probability of adoption. This could be due to the fact that wealth makes households less averse to risk and makes it easier for them to get credit. This finding supported the finding of Langyintuo and Mungoma (2008) who also found a positive and significant relationship between the wealth status and improved high yielding variety adoption. For the wealthy sub-population of farmers, the coefficient of number of years of residence in the village was negative and significant. Implying that wealthy farmers who had stayed in the same village for less than 40 years tend to have a lower probability of adopting IRVS.

4.3. Intensity of Improved Rice Varieties Adoption

The results of the Tobit model estimates of the determinants of intensity of adoption are presented in Table 6. The negative and significant coefficient of age for the whole sample and wealthy households was in line with other studies such as Hassan et al.,(1998), Itana, (1995) Alene et al. (2000) and Kaguongo et al., (2010). This implies that as the age of farmers increase, the intensity of adoption decreases. This could be explain by the fact that old farmers are less receptive to new ideas and are less willing to take risks. An additional year to the age of the household head reduces intensity of adoption by 9% for the whole sample, 4% and 6% for the wealthy and the non-wealthy households respectively. As expected the coefficient of farm size was positive and significant in explaining the intensity of adoption in the whole sample and among the sub-population of wealthy farmers. It was positive but nit significant in explaining the intensity of adoption among the non-wealthy farming households. On the average, an additional hectare of farm land will increase the area devoted to improved rice production by 0.08 for the whole sample and 0.19 for the wealthy and non-wealthy households. This finding is in agreement with the finding of Alene et al. (2000).

The coefficient of membership of any organization was positive and significant for the whole sample and for the sub-population of non-wealthy farmers. This pointed to the fact that farmers association which is a form of social capital have the tendency to increase the intensity of improved rice varieties adoption. This finding also corroborated other findings such as Bamire et al.(2002), and Ojiako, (2007) and further corroborated the argument that agricultural development agencies have high rates of success when they work with farmers' group or associations (Verteeg and Koudokpon (1993). The cost of seed was found to negatively and significantly influence the intensity of improved rice varieties adoption in the whole sample and among the non-wealthy households. The marginal effect showed that a ₦1 increase in the cost of seed will result in 11.3% decrease in the area cultivated to improved rice varieties among the non-wealthy households. Langyintuo and Mungoma (2008) found that increasing improved seed price by a unit over the local ones would inevitably result in a 41% dis-adoption rate among the poor households.

The coefficient of the wealth index was as expected, positive in all the models but only significant in determining the intensity of adoption in the whole sample. This suggests that the area devoted to improved rice varieties cultivation would increase as the households become richer. This could be explained by the fact that wealthier farmers have greater access to resources and may be able to assume risk. Similarly, technologies that are capital intensive are only affordable by wealthier farmers and hence the adoption of such technologies would be limited to larger farmers who have the wealth (Khanna, 2001). However, Ojiako et al., ((2007) did not find any significant relationship between wealth status and intensity of adoption. The total household income was positive and significant in determining the intensity of adoption of improved rice varieties for the whole sample and among the non-wealthy households. This implies that farmers with high income will devote more land to improved rice varieties. Income is needed to purchase the seed and complementary inputs such as fertilizer for better yield. The coefficient of contact with agricultural Extension was positive and highly significant in all the models. This implies that farmers that have contact with extension agents are more likely to devote more area to improved rice varieties. Contact with extension agents has the potential to facilitate technology transfer and management at low cost to the farmers and can also relay farmers' need to innovators and policy makers to ensure that innovation meet local needs (Anderson and Feder, 2007). This findings supported other findings such as Nkonya et al. (2007), Polson and Spencer (1991) and Ojiako et al. (2007) among many others.

The coefficient of education which was measured as a dummy variable was found to be negative and significant in the whole population and among the wealthy farmers; meanwhile it was positive but not significant among the non-wealthy households. This signifies that farmers who lack formal education tend to devote more area to improved rice varieties than the educated counterparts in Nigeria. This could be due to fact that lack of education may not give them the opportunity to diversify their income sources and hence they focus more on farming. In relation to the wealthy households, it could be that it is the wealth rather than education that actually matter in determining the intensity of adoption and could be explained by the fact that lack of education would not enable a farmer to get other paid employment and hence, the farmer's source of income would be solely dependent on farming. However, this finding is contrary to some other studies that found education to significantly influence intensity of adoption. However, the number of years of experience in upland rice farming was discovered to positively and significantly determine the intensity of adoption in the whole sample and among the wealthy households, while it was not significant among the non-wealthy households. The coefficient of access to credit positively and significantly influenced the intensity of adoption in the whole sample and among the non-wealthy households and was not significant among the wealthy households. This further underscores the important role of credit in technology adoption, particularly among the resource poor farmers.

4.0. Summary, Conclusion and Recommendations

This study assessed the effect of wealth on improved rice varieties adoption in Nigeria. Using Principal Component Analysis (PCA), this study stratified the respondents into two distinct groups: wealthy and non-wealthy. The binary logit and the Tobit models were adopted to assess the factors that determine adoption and intensity of adoption respectively. The descriptive statistics showed that the wealthy households had significantly higher total income than the non-wealthy households. The per capita consumption expenditure which was also used as a proxy for welfare was also significantly higher among the wealthy households than the non-wealthy households. This implies that the wealthy households had a better well-being than their non-wealthy counterparts and this could encourage IRVs adoption.

In other to capture the difference in the determinants and intensity of adoption between the two groups, the two groups were assessed separately. On the overall, the result of the logit model revealed that many socio-economic characteristics of the farmers significantly influence their decision to adopt IRVs. Those variables which had positive and significant influence are: gender of household head, household size, access to credit, membership of any organization, contact with extension agents, access to seed, and wealth index. An improvement of these variables will therefore increase IRVs adoption in Nigeria. Efforts that will lead to improvement in these variables should be put in place. In particular, adequate and timely provision of good quality seed should be ensured, particularly in the rural areas, since it is impossible for any farmers to adopt without access to the seeds of the IRVs. However, it should be noted that a very large households can result into poverty and therefore excessive household size should not be encouraged. As had been revealed clearly, wealth of households is highly important in IRVs adoption, hence policies that can lead to accumulation of wealth in the form of productive assets among the rural framers should be encouraged.

The result also revealed that the age of the household head and the cost of seed had negative influence on the adoption of IRVs. Thus the cost of seed should be monitored to ensure that it is within the price farmers can afford. Given that the younger farmers tend to adopt than the older farmers, programs and policies that would make farming attractive to the younger people should be encouraged. This can also reduce the high unemployment rates among youths in the rural areas. The results of the intensity of adoption showed that farm size, membership of any organization, household income, and wealth index were the variables that significantly influence the intensity of adoption, while the cost of seed had a negative and significant influence on the intensity of adoption. It is recommended that membership of farmers associations should be encouraged, programs that would lead to increase in productivity and consequently increase household income should be put in place and the existing seed subsidy should be properly monitored to guarantee access to seed at reasonable prices in order to increase the intensity of IRVs adoption in Nigeria.

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APPENDIX

Table 1: Definition of Selected Variables in the Empirical Models

Variable	**Definition and Measurement of variables**	Expected effect (Sign)
Dependent variables Adoption-Logit Proparea-Tobit	 1 if farmers planted at least one improved rice varieties for 5 years Proportion of area cultivated to improved rice varieties	
Gender	1 if house head is a male, 0 otherwise	+
Age	Age of household in years	+/-
Hhsize	Number of person in a household	+
Accredit	1 if household had access to cash credit, 0 otherwise	+
Secedu	1 if farmer had secondary education, 0 otherwise	+
Priedu	1 if farmer had primary education, 0 otherwise	
voctraindum	1 if house head had any vocational training, 0 otherwise	+
memorga	1 if household belong to any organization, 0 otherwise	+
Windex	Household wealth index	+
Resyeardum	1 if farmers had lived in the study area for more than 40 years, 0 otherwise	+
Costseed (N/kg)	Cost of a kilogram of improved rice seed in Naira	-
Farm size	Total area of farm land cultivated by the household	
Mrktdist(km)	Distance to the nearest sources of seed	-
seedaccess	1 if farmer readily had access to the improved varieties, 0 otherwise	+
relatsh	1 if farmer had contact with extension agents	+
Upland rice	Years of experience in upland rice production	
Lowland rice	Years of experience in lowland rice production	
Income	Total household income	

Table 2: Socio-economic/Demographic Characteristics of Respondents

Distribution	Number of respondents N=563	Percentage
Gender		
Male	442.00	92.00
Female	39.00	8.00
Household size		
<5	38.00	8.00
5-9	230.00	49.00
10-14	140.00	29.00
>15	69.00	14.00
Age (Years)		
20-29	27.00	6.00
30-39	91.00	19.00
40-49	210.00	44.00
50-59	101.00	21.00
>60	49.00	10.00
Farm size(Ha)		
0.5-2	230.00	48.00
2.5-4	130.00	27.00
>4	120.00	25.00
Educational level (Years)		
0	254.00	53.00
6	115.00	24.00
12	94.00	20.00
>12	14.00	3.00
Main Occupation		
Agriculture	403.00	84.00
Non-agriculture	78.00	16.00
Access to credit		
Have access	457.00	95.00
No access	24.00	5.00
Access to mobile Phone		
Have access	198.00	41.00
No access	283.00	59.00
Access to Media		
Have access	269.00	56.00
No access	212.00	44.00
Occupancy Status		
Owns house	307.00	64.00
Tenant	174.00	36.00

Source: Field Survey, 2010.

Table 3: Socio-economic Characteristics Distribution of Respondents by Wealth Status

Socio-economic Characteristics	Wealthy N=235	Non-wealthy N=328
	Percentage	**Percentage**
Gender		
Male	44.00	56.00
Female	33.00	67.00
Education		
Primary	31.00	69.00
Secondary	32.00	68.00
Higher education	40.00	60.00
Tertiary	40.00	60.00
Islamic	38.00	62.00
No education	53.00	47.00
Rice Ecologies		
Lowland	40.00	60.00
Upland	44.00	56.00
Irrigated	34.00	66.00
Occupation		
Farming	45.00	56.00
Non-farming	17.00	83.00
Adoption of improved varieties		
Adopters	53.00	47.00
Non-adopters	23.00	77.00
Vocational training		
Have vocational training	45.00	55.00
No vocational training	41.00	56.00
% that had access to credit	9.00	34.00
% that owned livestock	98.00	82.00
% that owns a house	99.00	78.00
% that are food insecure	40.00	48.00

Field Survey: 2010

Table 4: Test of Mean Difference of some selected variables by wealth status

Variable (Average)	Wealthy	Non-wealthy	Mean difference
Age (years)	47.00	44.00	2.7***
Years of Residence in the village	44.00	38.00	5.96***
Household size (Number)	11.00	7.00	4.46***
Years of education	5.00	4.00	0.09*
Farm size (ha)	2.89	2.00	0.85***
Output (Kg)	4052.49	2773.54	1278.95***
Agricultural income (₦/annum)	407948.10	227364.50	180583.60***
Non-agricultural income(₦/annum)	137617.10	69995.43	67621.72***
Total household income(₦/annum)	545565.20	297359.90	248205.30***
Agricultural expenditure(₦/annum)	63625.86	62654.40	972.00
Consumption expenditure(₦/annum)	216192.80	135462.90	80729.88***

Note: ***, **, * Significant at 1%, 5%, and 10% respectively.

Source: Field Survey, 2010.

Table 5: Logit Estimates of the Determinant of Adoption

	Total sample		Wealthy		Non-wealthy	
Variable	**Coefficient**	**Marginal Effect**	**Coefficient**	**Marginal Effect**	**Coefficient**	**Marginal Effects**
Age	-0.342** (0.158)	-0.007	-0.061* (0.037)	-0.004	-0.25 (0.019)	**-0.006**
Gender	0.516 * (0.285)	0.116	-0.801 (1.159)	-0.041	1.386*** (0.355)	0.327
Household size	0.114*** (0.041)	0.024	0.088 (0.074)	0.006	0.205*** (0.061)	0.051
Member of organization	1.714*** (0.319)	0.310	1.720** (0.763)	0.109	1.336*** (0.358)	0.305
Wealth index	0.295 *** (0.113)	0.063	0.931*** (0.310)	0.059	-0.473** (0.225)	-0.118
Access to seed	0.116 *** (0.028)	0.025	0.244** (0.101)	0.015	0.114*** (0.031)	0.028
credit	1.225 *** (0.263)	0.281	1.639** (0.661)	0.185	1.332*** (0.309)	0.320
Years of residence	-0.896 *** (0.288)	-0.184	-1.301** (0.622)	-0.075	-0.577 (0.366)	-0.143
Cost of seed	-0.001 (0.003)	0.000	-0.037** (0.015)	-0.002	0.002 (0.004)	-0.166
Contact with extension Agents	0.303 (0.302)	-0.066	0.102 (0.771)	0.006	0.672* (0.378)	0.066
Primary education	-0.075 (0.314)	-0.016	0.339 (0.672)	0.019	0.263 (0.379)	-0.273
Secondary education	1.107*** (0.388)	0.262	1.314* (0.786)	-0.135	1.157** (0.466)	0.001
Constant	1.038 (0.796		6.117*** (2.209)		-1.459 (1.001)	
Log likelihood	-259.93		-64.378		-172.062	
Number of observation	556.00		230.00		326.00	
LR Chi2 (12)	219.27		106.87		107.80	
Prob>Chi2	0.000		0.000		0.000	
Pseudo R^2	0.2967		0.4536		0.2388	

Note: ***, **, * Significant at 1%, 5%, and 10% respectively. Figures in Parentheses are the standard errors. Source: Field Survey, 2010.

Table 6: Maximum likelihood (MLE) Estimates of Tobit regression analysis

	Total sample		Wealthy		Non-wealthy	
Variable	**Coefficient**	**Marginal Effect**	**Coefficient**	**Marginal Effect**	**Coefficient**	**Marginal Effects**
Gender	0.175 (0.139)	0.175	0.153 (0.245)	0.153	0.185 (0.136)	0.185
Age	-0.096*** (0.036)	-0.096	-0.038 (0.075)	-0.038	-0.062** (0.031)	-0.062
Household size	0.004 (0.034)	0.004	0.011 (0.085)	0.011	-0.026 (0.042)	0.003
Farm size	0.075* (0.045)	0.075	0.185** (0.075)	0.185	0.003 (0.043)	0.191
Membership of organization	0.304*** (0.106)	0.304	0.121 (0.171)	0.121	0.191* (0.105)	0.003
Cost of seed	-0.004** (0.002)	-0.004	-0.005 (0.005)	-0.005	-0.003* (0.001)	-0.113
Windex	0.115* (0.059)	0.115	0.092 (0.107)	0.092	0.114 (0.088)	0.191
Income	0.213** (0.083)	0.213	0.302 (0.193)	0.302	0.191*** (0.066)	-0.559
Extension agents	0.959*** (0.180)	0.959	2.518*** (0.625)	2.520	0.559*** (0.147)	0.120
Education	-0.279** (0.116)	-0.279	-0.301* (0.176)	-0.301	0.120 (0.128)	0.023
Access to credit	0.446*** (0.139)	0.446	0.241 (0.309)	0.240	0.472** (0.112)	0.001
Experience in lowland rice farming	0.139 (0.262)	0.139	0.237 (0.899)	0.237	0.356 (0.243)	0.070
Experience in upland rice farming	0.197* (0.101)	0.197	0.647* (0.194)	0.647	0.070 (0.088)	0.125
Constant	0.005 (1.283)		-1.587 (3.23)		-1.614 (1.008)	
Log likelihood Number of observation LR Chi2 (12) Prob>Chi2 Pseudo R^2 Sigma	-596.755 535.00 220.60 0.000 0.1560 0.99		-302.848 226.00 90.02 0.000 0.1294 1.107		-247.005 308.00 126.89 0.000 0.2044	

Source: Analysis of 2010 field survey. ***, **, * Significant at 1%, 5%, and 10% respectively
Note: Figures in Parentheses are the standard errors.