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Abstract

This study assessed the determinants of intensity of improved rice varieties adoption using the Tobit model and also employed. The Heckman Two-stage model was used to identify the determinants of market participation and its potential impact on farming households' welfare in three states selected from the three notable rice producing ecologies in Nigeria. A cross-sectional data of 600 rice farmers from the three states were used in the analysis. The Tobit model revealed that the gender of household head, wealth status, distance to sources of seed, household size, membership of any organisation, and educational background positively and significantly influence the intensity of improved rice varieties adoption. Gender of household head, contact with extension agents, educational background, area cultivated to improved rice varieties, and access to seed were positively and statistically significant in determining market participation. Also, the estimated ordinary least squares (OLS) part or the second step of the Heckman model revealed that how peanut acreage, number of bicycles owned, and the dependency ratio could influence the income from farming as a result of improved variety adoption. Therefore, it is recommended that formation of associations among the rural farmers should be encouraged. Access to seed and information about the improved rice varieties are also essential to increase the intensity of its adoption. Programmes that would improve contact with extension agents, educational background and the proportion of area cultivated to improved rice varieties should be promoted in order to increase market participation and generate improvement in rural households' welfare.

Keywords: Adoption, Market, Farming, Welfare, Nigeria

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1.1. Introduction

Agricultural sector will for a very long time continue to play a strategic role in the development and growth of most developing nations of the world. Most importantly, its role in employment generation cannot be overemphasised. For example, across the globe agriculture employs about 40% of the active labour force. In sub-Saharan Africa, Asia and the Pacific, the agriculture-dependent population is over 60%, while in Latin America and high income economies the proportions are estimated at 18% and 4%, respectively (World Bank,2006). Therefore, agriculture has a great potential to influence growth and contribute significantly to poverty reduction. However, this could only be achieved through increase in productivity of smallholder farmers as emphasised in the 2008 World Development Report.

Therefore, boosting agricultural productivity has been an issue of paramount importance to development oriented organisations across the globe. Based on the success stories that emanated from the Green Revolution in Asia, which led to increase in productivity and poverty reduction through the development and dissemination of improved agricultural technologies, efforts to increase agricultural productivity in developing countries have also targeted the development and dissemination of improved agricultural technologies such as fertilizer and improved seed varieties. More importantly, improved agricultural technology adoption is expected to increase the market share of agricultural output through which the small holder farmers input utilization decisions and output combinations would be progressively guided by their profit maximization objectives. According to Omiti et al. (2006), this process can lead to the systematic substitution of non-traded inputs with purchased inputs, the gradual decline of integrated farming systems, and the emergence of specialized high-value farm enterprises. The ensue commercial orientation of smallholder agriculture could lead to a gradual decline in real food prices due to increased competition and lower costs in food marketing and processing (Jayne et al.,1995).

In Nigeria for instance, due to the fact that rice is the most important staple food crop, several improved rice varieties have been developed, and disseminated through different programmes in order to encourage its adoption and therefore move food production from the subsistence level to the commercial level for improved household and national well-being . Although, evidences abound in the literature on the positive impact of improved rice varieties adoption on yield, poverty reduction and welfare (Dontsop-Nguezet et al., 2011; Awotide et

al., 2012,Mendola, 2007; Diagne et al., 2009), however, it is also recorded that in Nigeria in spite of the adoption of improved varieties and the consequent positive impact on yield, poverty among the rural farmers is still highly endemic and the rural areas are still characterised by deplorable living conditions. The World Bank (2007) posited that one important route to reduce poverty in rural areas is to enhance the market participation of rural farmers, as this can increase the net returns to agricultural production.

However, evidence suggests that currently smallholder farmers do not often participate much in staple food markets and their overall market share is still very low (Jayne et al., 2005). For instance, Jayne et al. (2005) found that the top 2% of commercial farmers sold about 50% of observed marketed maize in Kenya, Mozambique and Zambia. Ellis (2005) also shows that farmers in semi-arid areas of Africa have very low proportions of output marketed.

The above scenario therefore, generated some important questions that required urgent answers. For instance, if indeed improved agricultural technology adoption generated increase in yield, then why is poverty still prevalent generally in the rural areas, and in particular among the rice farmers. Could it be that the increase in yield is not translated into increase in income through market participation, and if yes what are the factors that hinder farmers from participating in the market and if they do participate in markets, what is the effect of the market participation on poverty and welfare. These are some of the vital questions that this study intends to answer.

Although, many studies have been conducted to assess the determinants and intensity of agricultural technology adoption (Adesina and Seidi, 1995; Adesina, 1996; Awotide et al., 2012) and its impact on poverty reduction (Diagne and Demont, 2007; Diagne et al., 2009; Dontsop-Nguezet et al.,2011; Awotide et al., 2011) . This is based on the premise that the use of modern technologies can result in higher productivity and production entering markets However, studies that have analysed the relationship between improved agricultural technology adoption, market participation and overall welfare among the rural farming households in Nigeria is scanty, therefore creating a gap in the literature that needed to be filled. This study intends to identify the physical and socioeconomic factors affecting the intensity of adoption of improved rice varieties and also the determinants of market participation and its effect on rural farming households' welfare in Nigeria. Through the

results that would emanated from this study, the policy makers would be enlightened on why there has been increase in yield without a commensurate improvement in rural farming households' welfare , and consequently shed more light on the socio-economic variables that influences market participation in order to encourage farmers to shift from subsistence farming to commercial production.

The rest of the paper is organized as follows: Section two presents the literature review. The analytical framework and estimation techniques are presented in section three. Section four contains the data and descriptive statistics. The results and discussions are presented in section five. Section six contains the summary, conclusion and policy recommendations.

2.0. Literature Review

Since the much publicised achievement of the Asian Green Revolution as a result of improved agricultural technology adoption, and the replication of that efforts in developing countries, several studies have focused on assessing the determinants of adoption and intensity of adoption (Adesihina. Awotide, Ouma et al.2002). More recently, the attention has shifted to assessing the impact of adoption on these high yield increasing technologies on poverty and welfare (Mendola, 2007; Nkonya et al., 2007; , Dontsop-Nguezet et al., 2011; Awotide et al., 2011).

However, beyond adoption and the attached benefits of increase in yield, it has been discovered that smallholder farmers in a bid to participate in markets face two decision problems after production, the first being whether to sell or not to sell their produce and the second being how much to sell into a market (Goetz, 1992; Heltberg and Tarp, 2001; Boughton et al., 2007).Therefore, in view of the importance of smallholder farmers' market participation to the growth and development of any nation and more specifically to poverty reduction and improve welfare among the rural farming households, the concern has also shifted to empirical examination of the determinants of market participation and further assessment of the effect of market participation on welfare or poverty reduction.

Omiti et al. (2009), assessed the factors influencing the market participation of smallholder farmers in rural and peri-urban, Kenya. Results showed that farmers in peri-urban areas sold

higher proportions of their output than those in rural areas. Distance from farm to point of sale is a major constraint to the intensity of market participation. Better output price and market information are key incentives for increased sales. These findings demonstrate the urgent need to strengthen market information delivery systems, upgrade roads in both rural and peri-urban areas, encourage market integration initiatives, and establish more retail outlets with improved market facilities in the remote rural villages in order to promote production and trade in high value commodities by rural farmers.Jagwe (2011) using a two-stage Heckman and probit model found that belonging to a farmer's group, size of the household, distance to the market and ownership of transport means significantly influenced extent of farmers' participation in banana markets.

Drawing on a sample of 360 households situated in the highlands, midlands, and lowlands of two provinces in northern Viet Nam, Tung and Costales (2007) assessed market participation of smallholder poultry producers. The study revealed that market access is largely determined by the geographic location of the households in relation to main market centres. Choice of main market outlets is also heavily influenced by proximity to market centres, with itinerant village traders gaining in importance as market outlet as scale of smallholder production increases. Itinerant traders are the main link between smallholder producers and consumers in larger urban centres, largely through informal market chains.

Heltberg and Tarp (2002) and Benfica et al. (2006) assessed market participation in Mozambique by estimating a reduced form equations for market participation and value sold of food crops (as a group), cash crops (as a group), and total value of crops sales, using data from a 1996-97 Living Standards Measurement Survey (LSMS). The study revealed that the important factors that significantly affected market participation included farm size per household worker, animal traction, mean maize yield, age of household head, climatic risk, transport ownership and infrastructure.

Onoja et al. (2012) conducted a study to investigate the determinants of market participation in the small-scale fishery sector of the Niger Delta region in Nigeria. The study noted that the probability of participating in fish marketing was significantly determined by household size, distant to the nearest marketing channel, price of the commodity and sex of the fish farmer/marketer. Market infrastructure development, provision of marketing incentives to

women and development of an institutionalized marketing information service are recommended. From the foregoing, it is obvious that the issue of market participation and its effect on welfare among the smallholder rice farmers in Nigeria is still an important area that has not been adequately researched.

3.0. Analytical Framework and Estimation Techniques

3.1. Intensity of Improved Rice varieties Adoption: Tobit Model

Rogers and Shoemaker (1971) have defined adoption as the decision to apply an innovation and to continue using it. The theory of utility maximization is generally used to explain farmers' responses to new technology (Adesina and Seidi, 1995; Adesina, 1996). According to this theory, a farmer will adopt a given technology such as improved rice varieties if the utility obtained from it exceeds that of the traditional varieties. If U_{i0} is the utility derived from the use of the traditional variety, while U_{i1} is the expected utility from the adoption of new improved varieties, then, although not observed directly, the utility of farmer i from adopting a given measure of the improved varieties (j) can be expressed as:

$$U_{ij} = X_i\beta_j + \tau_{ij} \qquad j = 1,0; \qquad i = 1,.....,n \qquad 1$$

Where X_i is a farm –specific function, β_j is a parameter to be estimated, τ_{ij} is a disturbance term with mean zero and constant variance.

The adoption variable is defined as a dummy, with 1 indicating adoption and 0 otherwise. A farmer would adopt an improved rice variety, i.e. j=1, if $U_{i1} > U_{i0}$. Although, studies that had assessed the adoption of improved agricultural technologies have utilised either probit, Logit or Tobit model. In order to analyse the intensity of adoption, measure by the average proportion of farmland devoted to improved rice production by the respondents in the different 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 (see, Taha, 2007; Rahimato, 2007; Dereje, 2006;)

The Tobit model is a statistical model proposed by James Tobin (1958) to describe the relationship between a non-negative dependent variable y_i and an independent variable (or

vector) X_i.The Tobit model supposes that there is a latent unobservable y_i^*. This variable depends linearly on x_i via a parameter vector β. In addition, there is a normally distributed error term u_i to capture random influence on this relationship. The observed variable y_i is defined as being equal to the latent variable whenever the latent variable is above zero and to be equal to zero otherwise.

$$y_i = \begin{cases} y_i^* if y_i^* > 0 \\ 0 if y_i^* \leq 0 \end{cases} \quad 2$$

Where y_i^* is a latent variable:

$y_i^* = \beta x_i + u_{i,} \quad u_i N(0, \sigma^2)$

If the relationship parameter β is estimated by regressing the observed y_i on x_i, the resulting Ordinary Least Squares (OLS) regression estimator is inconsistent. It will yield a downwards-biased estimate of the slope coefficient and an upwards-biased estimate of the intercept. Amemiya (1973) has proven that the maximum likelihood estimator suggested by Tobin for this model is consistent. Following Chebil et al. (2009), the likelihood function of the model (2) is given by L, and presented as follows:

$$L = \prod_0 F(y_{0i}) \prod_1 f_i(y_i) \quad 3$$

$$L = \prod_0 [1 - F(x_i\beta / \sigma)] \prod_1 \sigma^{-1} f[(y_i - x_i\beta)/\sigma]$$

Where f, and F are the standard normal density and cumulative distribution functions, respectively. Then we can write the lo-likelihood function as:

$$LogL = \sum_0 \log(1 - F(x_i\beta/\sigma) + \sum_1 \log\left(\frac{1}{(2\prod\sigma^2)^{1/2}}\right) - \sum_1 \frac{1}{2\sigma^2}(y_i - \beta x_i)^2 \quad 4$$

The parameters β and σ are estimated by maximizing the log-likelihood function

$$\begin{cases} \frac{\partial LogL}{\partial \beta} = -\sum_0 \frac{x_i f(x_i\beta)/\sigma)}{1 - F(x_i\beta/\sigma)} + \frac{1}{\sigma^2}\sum_1 (y_i - \beta x_i)x_i = 0 \\ \frac{\partial LogL}{\partial \sigma^2} = \frac{1}{2\sigma^2}\sum_0 \frac{\beta x_i f(x_i\beta/\sigma)}{1 - F(x_i\beta/\sigma)} - \frac{n_i}{2\sigma^2} + \frac{1}{2\sigma^4}\sum_1 (y_i - \beta x_i)^2 = 0 \end{cases} \quad 5$$

Since the two equations (5) are non-linear, the maximum likelihood estimators must be obtained by an iterative process, such as the Newton-Raphson or Davidson-Flecher-Powell (DFP) or Berndt-Hall-Hall-Hausman (BHHH) algorithm (Greene, 2003). To study the explanatory power of the model, a statistic based on likelihood ration (LR) is appropriate. This ratio is defined as follows:

$$LR = 2(\log L_r - LogL_u) \quad 6$$

Where $LogL_u$ is the log-likelihood for the unrestricted model and $\log L_r$ is the log-likelihood for the model with k parametric restrictions imposed. The likelihood ratio statistic follows a chi-square distribution (χ^2) with k degrees of freedom. The dependent variable indicating the intensity of adoption is the proportion of area of farm land cultivated to the improved rice varieties.

3.2. Determinants of market participation and its Effect on Welfare: Heckman Selection Model

A farmer is adjudged to participate in the market if he or she sells part of the rice output. Given that the focus of this study is to identify the determinants of market participation and how it affects rural farming households' welfare we stated the basic relationship of the effect of market participation on welfare as a linear function of vector of explanatory variables (X_i) and market participation dummy variable (D_i). The linear regression can be specified as:

$$G_i = X_i^{'}\lambda + \gamma D_i + \varepsilon_i \quad 7$$

Where:

G_i = is the per capita consumption expenditure

ε_i = is a normal random distribution term

D_i = is a dummy variable representing market participation. It takes the value of 1 if the farmer sold part of the rice output and 0 otherwise.

X_i = is the vector of household and farm characteristics

Market participation by the smallholder farmers is a function of farmer and farm characteristics. By deciding to participate in the market, the farmer has self-selected to Participate in the market instead of a random assignment. Therefore, following Becerril and

Abdulai (2009), we assume that the farmer is risk–neutral. The index function used to estimate market participation by the farmers can be expressed as:

$$D_i^* = X_i'\alpha + \nu_i \qquad 8$$

D_i^* = is a latent variable denoting the difference between utility from market participation U_{iA} and the utility from not participating in the market U_{IN}. The farmer will participate in the market if $D_i^* = U_{IA} - U_{IN} > 0$. The $X_i'\alpha$ provides an estimate of the difference in utility from market participation ($U_{IA} - U_{IN}$) using the household and farm-level characteristics X_i, as explanatory variables, while ν_i is an error term. In estimating equations (7) and (8), it needs to be noted that the relationship between the market participation and welfare could be interdependent. Specifically, the selection bias occurs if unobservable factors influence both error terms of the welfare (per capita consumption expenditure) equation (ε_i) and the market participation choice equation (ν_i) thus resulting in the correlation of error terms of the outcome and market participation specifications. Thus, estimating equation 7 using the ordinary least squares (OLS) will lead to biased estimates. To address this problem, a two-step Heckman's procedure was used to analyse factors affecting the probability of market participation. The model is appropriate because it addresses simultaneity problems.

The Heckman (1976) two stage procedure has been used to address selection bias when the correlation between the two error terms is greater than zero (Hoffman and Kassouf, 2005; Adeoti, 2009; Johannes et al., 2010; Siziba et al., 2010). The approach depends on the restrictive assumption of normally distributed errors (Wooldridge, 2002). The procedure involves, first, the estimation of the selection equation using a probit model (parket participation equation (8)) and second, the estimation of the per capita consumption expenditure equation (7). The market participation equation (8) is estimated as:

$$D_i^* = X_i'\alpha + \nu_i \qquad 9$$

D_i^* is a latent variable representing the propensity of market participation by a farmer. X_i is the vector of farmer's asset endowments and household characteristics that influence market participation decision. The probit model predicts the probability of market participation and also obtains the inverse Mill's ratio (IMR). The inverse of the mill's ratio, (λ) , which is the ratio of the ordinate of a standard normal to the tail area of the distribution, can be computed (Heckman, 1980) as shown below:

$$\lambda_i = \frac{\phi(\rho + \alpha X_i)}{\Phi(\rho + \alpha X_i)} \quad \textbf{10}$$

Where ϕ and Φ are, respectively the standard normal density function and standard normal distribution functions. λ_i is the calculated IMR term to provide OLS selection corrected estimates (Greene, 2003).

4.0. Data and Descriptive Statistics

This study used primary data collected in 2010 through multistage random sampling technique. In the first stage, three major rice producing ecologies were purposively selected. This led to the selection of upland, lowland and irrigated rice ecologies. The second step involved the random selection of one state from each of the rice growing Systems. Hence, Kano, Osun and Niger states were randomly selected to represent irrigated, upland and lowland rice ecologies, respectively. In the third stage, two Agricultural Development Programmes (ADP) zones that were basically rural were purposively selected from the ADP zones in each state. The fourth stage involved the random selection of five LGAs from the two selected ADP zones in each State. The random selection of 3 villages from Niger state and 2 each from Kano and Osun state constituted the fifth stage. The last stage involved the random selection of rice farming households from each of the village. The number of rice farming households selected from each village was proportionate to size of rice farming households in each village. Hence, 20 rice farming households were selected from each of the selected villages in Niger state and 15 each from Kano and Osun States. This sampling design generated a total of 600 rice farming households. Data were collected on a wide range of variables using well- structured questionnaire. The description of the variables used in the analyses and their descriptive statistics is presented in Table 1. The result showed that about 76% of the respondents participated in markets. The average household was 8 people per household. The average age of the respondents was 45 years, and about 81% of them were male. About 88% of the respondents obtained additional income from off farm participation. Majority of the respondents (68%) had formal education. The proportion of the respondents that had contact with extension (36%) and those that belong to any organization (31%) were very low and this could negatively influence market participation, as the two variables are both very vital to information access.

5.0. Results and Discussion

5.1. Relative Frequency Distribution of Major Socio-economic Characteristics of the Respondents

The results of the relative frequency of major socio-economic characteristics of the respondents s presented in Table 2 showed that about 76.2% of the respondents were below 50 years of age, while 24% of the respondents were above 50 years of age. This implies that the majority of the respondents were still young and in their productive age and this could positively influence market participation. In terms of household size; about 98% of the respondents had less than 20 persons. This predominantly large household size could be responsible for the small and fragmented farm size, such that a large percentage of the population (75%) had a farm land of less than 4 ha. Majority of the respondents (70%) also had less than 4 tons in terms of rice output; this could however, positively influence market participation since farmers might not be able to consume all that is produced within the households.

5.2. Mean Difference in some Welfare Indicators between Market Participant and non-participant

The difference in the mean of some welfare indicators between farmers that participated in the markets and those that did not was tested using the t-test and the result is presented in Table 3. The analysis revealed that there were significant differences in some of the variables between the farmers that participated in the markets and those that did not. The farmers that participated in market had higher and significant revenue from rice production, per capita consumption expenditure, and rice yield than the farmers that did not participate in markets, even though non-participating farmers cultivated large farm size than the participated farmers. This implies that market participation could positively influence the farmers' welfare.

5.3. Determinants of Intensity of Improved Rice Varieties Adoption

The factors that influence the intensity of improved rice varieties adoption was assessed using the Tobit model. The result of the analysis is presented in Table 4. The result showed that the estimated model has explanatory power as shown by the likelihood ratio which was significant at the 1% level. The results of the Tobit model showed that eight out of the 12 variables included in the model were statistically significant (positive and negative) in

determining the intensity of improved rice varieties adoption. The variables that positively influence the intensity of adoption included gender of household head, wealth status, distance to sources of seed, household size, membership of any organisation, and educational background. Those that negatively influence intensity of adoption were age of household head, and farm size. The positive coefficient of gender implies that the male headed household has higher intensity of adoption than the female counterparts. As wealth increases, the intensity of adoption also increases. In the same vein increase in household size also generate an increase in the intensity of adoption. This could be due to increase in the number of family labour available to the farmer as a result of the increase in family size.

The positive and significant coefficient of membership of any organization signifies the fact that farmers association which is regarded as one of the important components of social capital possesses the capability to increase the intensity of improved rice varieties adoption. This finding is also in tandem with other findings such as Bamire et al.(2002), and Ojiako et al. (2007), in addition it further substantiated the believe that it will be possible for agricultural development agencies to achieve great success when they work in collaboration with farmers' organisations (Verteeg and Koudokpon (1993).

The negative and significant coefficient of age of household heads was in agreement with other studies such as Hassan et al.,(1998), Itana, (1985) 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 (Awotide et al. 2012).

5.4. Market participation and its Effects on Welfare: Heckman Two-stage model

The first stage of the Heckman sample selection model in this study is the probit model and it assessed the determinants of market participation. The second stage examined the effect of market participation on welfare. This second stage is the outcome model (OLS) . The dependent variable of the market participation model was specified as binary, equal to 1 if the farmers sell part of the rice output and equal to 0 otherwise. The dependent variable of the second stage is welfare proxied by the per capita consumption expenditure. However, because of issues with identification, we need at least one independent variable that appears

in the selection equation but does not appear in the outcome equation i.e. we need a variable that affects selection, but not the outcome (Sartori, 2003). Hence, contact with extension agents, access to seed, and distance to sources of seed were used.

5.4.1. Determinants of Market participation: Probit Model

The first stage of the Heckman two-stage selection models is the probit model which investigates the determinants of market participation. The result of the probit model regression is presented in Table 5. The result showed that out of the 12 variables included in the model, six were statistically significant. The coefficients of gender of household head, contact with extension agents, educational background, area cultivated to improved rice varieties, and access to seed were those that positively determined market participation, while participation in off-farm activities negatively affected the probability that a farmer would participate in market. This implies that the probability to participate in market is higher among the male headed household than the female counterparts. This finding is however different from that of Onoja et al. (2012) which found a higher probability of fish commercialization if the head of the household is female. These finding according to Omoto (2003) could be an indication of the 'gendered' nature of local knowledge and its systems, since men and women usually have different and often complementary economically productive roles, different resource bases, and face different sets of social constraints. Hence, the finding from this study could be due to the fact that the male headed households tend to have larger output than the female headed households as a result of their better access to productive inputs.

Similarly, as contact with extension agents increases, the probability that a farmer would participate in the market would also increase. This is line with the findings of Bartha and Bauer (2007). Also, increase in access to seed would also lead to increase in the probability that a farmer would participate in market.

5.4.2 Effect of Market participation on Welfare: Outcome Equation- (OLS)

The result of the estimated ordinary least squares (OLS) part or the second step of the Heckman model is presented in Table 6. Among many findings, the result revealed that gender of household head, area cultivated to improved rice varieties, income from rice

production and vocational training were those variables that positively and significantly influence the rural farmers' per capita consumption expenditure as a result of market participation.

6.0. Summary, Conclusion and Policy Recommendations

This study assessed the factors that determined the intensity of improved rice varieties adoption using the Tobit model. Furthermore, the determinants of market participation and its effect on welfare were assessed using the Heckman two –stage selection model. The major findings from the study showed that the farmers that participated in market had higher and significant revenue from rice production, per capita consumption expenditure, and rice yield than the farmers that did not participate in markets. The results of the Tobit model revealed that the gender of household head, wealth status, distance to sources of seed, household size, membership of any organisation, and educational background were the variables that positively and statistically significant in influencing the intensity of improved rice varieties adoption. In addition, the probit model showed that gender of household head, contact with extension agents, educational background, area cultivated to improved rice varieties, and access to seed positively and statistically significant in determining market participation. Furthermore, the result of the OLS revealed that gender of household head, area cultivated to improved rice varieties, income from rice production and vocational training influence the rural farmers' per capita consumption expenditure as a result of market participation. In conclusion, increase adoption of improved rice varieties would generate increase in rice yield and consequently, rural farmers would have marketable surplus which through the participation in market would lead to increase in household income and by extension generate improvement in households' welfare. Therefore, it is recommended that formation of associations among the rural farmers should be encouraged. Access to seed and information about the improved rice varieties are also essential to increase the intensity of its adoption. Programmes that would improve contact with extension agents, educational background and the proportion of area cultivated to improved rice varieties should be promoted in order to increase market participation and generate improvement in rural households' welfare.

References

Alene, A.D., D. Poonyth, R.M. Hassan (2000). Determinants of Adoption and Intensity of Use of Improved Maize Varieties in the Central Highlands of Ethiopia: A Tobit Analysis. Agrekon, 39(4): 633-643.

Awotide, B.A., A. Diagne , A. N Wiredu , and Vivian Ebihomon Ojehomon (2012). Wealth Status and Agricultural Technology Adoption among Smallholder Rice Farmers in Nigeria. OIDA International Journal of Sustainable Development 05 (2), PP: 97-114.

Awotide , B.A., T.T. Awoyemi , A. Diagne, and V.T. Ojehomon (2011). Impact of Access to Subsidised Certified Improved Rice Seed on Income: Evidence from Rice Farming Households in Nigeria. OIDA International Journal of Sustainable Development 02:12 (2011)

Boughton, D., Mather, D., Barrett, C.B., Benfica, R., Danilo, A., Tschirley, D. and Cunguara, B. 2007. Market participation by rural Households in a low-income country: An asset-approach applied to Mozambique. Department of Agricultural Economics, 213 E Agriculture Hall, Michigan State University, USA.

Chebil, A., Nasr, H., and L. Zaibet (2009). Factors Affecting Farmers' Willingness to Adopt Salt-tolerant Forage Crops in South-Eastern Tunisia. African Journal of Agricultural and Resource Economics, Vol. 3(1), PP: 19-27.

Dereje, H. (2006) . Assessment of farmers' evaluation criteria and adoption of improved bread wheat varieties in Akaki, central Ethiopia. M.Sc. Thesis (Unpublished) Presented To School of Graduate Studies of Alemaya University.

Diagne, A., S. A. Adekambi, F. P. Simtowe And G. Biaou, (2009) The Impact Of Agricultural Technology Adoption On Poverty: The Case of Nerica Rice Varieties in Benin. A shorter version of the paper is being presented as contributed paper at the 27th Conference of the International Association of Agricultural Economists. August 16-22, 2009. Beijing, China

Ellis, F. (2005). Rural livelihoods and diversity in developing countries. Oxford University Press, Oxford.

Goetz, S.J. 1992. A selectivity model of household food marketing behaviour in sub-Saharan Africa. American Journal of Agricultural Economics 74:444-452.

Hassan, Rashid, Kiairie Njoroge, Mugo Njore, Robin Otsyula, and A. Laboso, (1998), Adoption Patterns and Performance of Improved Maize in Kenya., in Maize Technology Development and Transfer: A GIS Application for Research Planning in Kenya, ed. Rashid Hassan, CAB International, Wallingford, UK.

Heltberg, R. and Tarp, F. 2001. Agricultural supply response and poverty in Mozambique. Institute of Economics, University of Copenhagen: Studiestraede, Copenhagen, Denmark.

Heckman, J.J. 1979. Sample selection bias as a specification error. Econometrica 47:153-161.

Itana, A. (1985). An Analysis of Factors Affecting the Adoption and Diffusion Patterns of Packages of Agricultural Technologies in Subsistence Agriculture: A Case Study in

two Extension Districts of Ethiopia".Unpublished,M.Sc.thesis. Alemaya University, Alemaya

Jagwe, J.N. 2011. Impact of transaction costs on the participation of smallholder farmers and intermediaries in the banana markets of Burundi, Democratic Republic of Congo and Rwanda. A PhD Thesis (Agricultural Economics) submitted to the University of Pretoria, South Africa.

Jayne, T.S., D. Mather and E. Mghenyi (2005). Smallholder farming in difficult circumstances: Policy issues for Africa. MSU International Development Working Paper No. 86, 2006. Department of Agricultural Economics and the Department of Economics, Michigan State University, East Lansing, Michigan 48824-1039, U.S.A.

John Omiti, David Otieno, Timothy Nyanamba and Ellen Mc Cullough (2009). Factors influencing the intensity of market participation by smallholder farmers: A case study of rural and peri-urban areas of Kenya. Afjare Vol 3 No 1 March 2009.

Kaguongo, W., G.F. Ortmann, E.Wale, M.A.G. Darroch and J. Low (2010). Factors Influencing Adoption and Intensity of Adoption of Orange Flesh Sweet potato Varieties: Evidence from Extension Intervention in Nyanza and Western Province, Kenya". Poster Presented at the Joint 3rd African Association of Agricultural Economics (AEASE) Confernce, Cape Town, South Africa, September, 19-23.

Mendola, M. 2007. Agricultural Technology Adoption and Poverty Reduction: A Propensity-Score Matching Analysis for Rural Bangladesh . Food Policy 32 (2007): 372-393.

Mkonya, E., P. Dayo., M. Tawodaj, Y. Kuta., G. Adewale., J. Pender., T. Arokoyo and E. Kato (2007). Beneficiary Assessment/Impact Evaluation of the Second National FADAMA Project. PCU/NFDO National FADAMA Development Office, Project Coordinating Unit. Federal Ministry of Agriculture and Rural Development.

Ojiako, I.A., V.M. Manyong and A.E. Ikpi (2007). Determinants of Rural Framers' Improved Soybean Adoption Decision in Northern Nigeria. Journal of Food, Agriculture and Environment Vol. 5(2): 215-223.

Onoja, A.O., B. B. Usoroh , D. T. Adieme, and N.J. Deedam Determinants of Market Participation in Nigerian Small-Scale Fishery Sector: Evidence from Niger Delta Region *Consilience: The Journal of Sustainable Development* Vol. 9, Iss. 1 (2012), Pp. 69 – 84.

Omoto, R. (2003). The context of gendered knowledge: a comprehensive minimum dataset on women in coastal communities. SPC Traditional Marine Resource Management and Knowledge Information Bulletin No.16.

Rogers, E.M. and F.F. Shoemaker, 1971.Communication of innovations: A cross culture approach. The Free Press, Collier Macmillan Publishing Inc. NY. pp: 11-28.

Sartori, Anna. 2003. An Estimator for Some Binary-Outcome Selection Models Without Exclusion Restrictions. Political Analysis 11:111–138.

Taha M. (2007). Determinants of the adoption of improved onion production package in Dugda Bora district, East Shoa, Ethiopia . M.Sc. Thesis (Unpublished) Presented To School of Graduate Studies of Haramaya University.

Tobin, James (1958). Estimation of relationships for limited dependent variables, *Econometrica* (The Econometric Society) 26 (1): 24–36.

Verteeg, M.N. and Koudokpon, V. (1993). Participatory farmer testing of four low external input technologies to address soil fertility decline in mono province (Benin). Agricultural systems 42: 265-276.

World Bank (2007). *World Development Report 2007: Agriculture for Development*, Washington D.C.

World Bank (2007). *World Development Report 2008: Agriculture for Development*, Washington D.C.

Appendix

Table 1: Variable Definition and their Descriptive Statistics

Variable	Description	Mean	Standard Deviation
Age	Age of respondent in years	45.000	8.620
Household size	Number of person living in the household	8.000	4.090
Market participation	1 if respondents sell part of produce, 0 otherwise	0.76	0.455
Education background	1 if farmer had forma education, 0 otherwise	0.683	0.465
Attend vocational training	1 if respondent attended vocational training, 0 otherwise	0.149	0.357
Gender	1 if respondent is male, 0 if female	0.809	0.395
Off-farm income	1 if respondents obtained income from non-farm sources, 0 otherwise	0.888	0.315
Total Farm land	Farm size in hectare (Ha)	2.390	1.590
Contact with extension agent	1 if farmer had contact with extension agents, 0 otherwise	0.361	0.481
House ownership	1 if respondent is the landlord, 0 otherwise	0.859	0.348
Access to seed	1 if farmer had access to seed, 0 otherwise	0.697	0.460
Membership of organization	1 if farmer is a member of any organisation, 0 otherwise	0.313	0.464
Wealth status	1 if farmer is wealthy, 0 otherwise	0.417	0.494
Cost of seed	The average cost of seed per kg (₦/kg)	100.609	36.926
Income from rice production	Income generated from rice (₦)	189231.70	111276.6
Area cultivated to improved rice varieties	The proportion of area cultivated to improved rice varieties	1.729	2.889

Table 2: Relative Frequency of some Demographic and Socio-economic Characteristics of the Respondents

Socio-Economic/Demographic Characteristics	Frequency	Relative Frequency	Percentage
Age of Household Head (Years)			
20-30	30	0.0533	5.33
30-40	147	0.2611	26.11
40-50	252	0.4476	44.76
50-60	116	0.2060	20.60
60-70	13	0.0230	02.30
70-80	5	0.0089	0.9
Household size (Number)			
1-10	429	0.7619	76.19
10-20	125	0.2220	22.20
20-30	9	0.0159	01.59
Farm Size (Ha)			
1-1.5	215	0.3819	38.19
2-3.5	206	0.3659	36.59
4-5.5	129	0.2291	22.91
5-6.5	13	0.0231	02.31
Mean Farm size	2.39		
Rice Output (kg)			
100-1000	67	0.1101	11.01
1000-2000	78	0.1385	13.85
2000-3000	90	0.1599	15.99
3000-4000	164	0.2913	29.13
4000-5000	109	0.1936	19.36
5000-6000	31	0.0551	05.51
>6000	24	0.0426	04.26
Mean output	3307.50		

Source: Field Survey, 2010

Table 3: Mean Difference in some Welfare Indicators between Participants and Non-participant

Variable	Market participants (N=398)	Non-market participants (N=165)	Difference	t-value
Average rice income	190469.10	186247.00	4222.09	0.409
Average Revenue from rice production	152182.70	119936.60	32243.02	3.266***
Average total household income	409870.50	397269.50	12601.01	0.395
Average household farm income	317256.10	296723.90	20532.19	0.811
Average Per Capita consumption expenditure	21670.28	18538.87	3131.41	2.79***
Average farm size	2.16	2.96	0.797	5.684***
Average rice Yield	1919.01	1442.63	474.00	5.03***

Source: Field survey, 2010. ***, **, and * implies significant at 1%, 5%, and 10% respectively

Table 4: Determinants of Intensity of Improved Rice Varieties Adoption: Tobit Model

Variables	Coefficient	Standard Error	t-value	P>|t|
Gender of household head	0.2311035	0.138589	1.67*	0.096
Age of household head	-0.0244303	0.006343	-3.85***	0.000
Wealth Status	0.6073626	0.133575	4.55***	0.000
Distance to source of seed (Km)	0.0350688	0.007886	4.45***	0.000
Cost of Seed (₦)	0.0012604	0.001775	0.71	0.478
Household Size	0.0437318	0.015022	2.91***	0.004
Contact with extension agents	0.0871802	0.133888	0.65	0.515
Membership of organization	0.5047024	0.125307	4.03***	0.000
Access to seed	-0.1395758	0.120274	-1.16	0.246
Total farm land (ha)	-0.0740151	0.024797	-2.98***	0.003
Education background	0.3414207	0.118486	2.88***	0.004
Off-farm income	-0.0661202	0.182038	-0.36	0.717
Constant	0.7961424	0.405167	1.96*	0.050
Sigma	1.045349	0.042672		
Number of Observation	534			
Log Likelihood	-626.733			
LR Chi^2 (12)	157.58***			
Pseudo R^2	0.1117			

Source: Field Survey, 2010. ***, **, and *, implies Significant at 1%, 5%, and 10% respectively.

Table 5: Determinants of Market participation: Selection Equation- Probit Model

Variable	Coefficient	Standard Error	Z-Value	P>|z|
Age	0.0109421	0.007928	1.38	0.168
Gender	0.6123779	0.18008	3.4***	0.001
Contact with extension agents	0.3906819	0.164889	2.37**	0.018
Educational background	0.5067316	0.159354	3.18***	0.001
Household size	-0.0246915	0.019149	-1.29	0.197
Off-farm income	-0.6777344	0.254484	-2.66***	0.008
House ownership	0.1765749	0.225744	0.78	0.434
Area cultivated to improved varieties	0.230302	0.037301	6.17***	0.000
Membership of any organisation	-0.1961994	0.174835	-1.12	0.262
Distance to sources of seed	-0.0118848	0.009879	-1.2	0.229
Access to seed	0.9644854	0.146911	6.57***	0.000
Attend vocational training	-0.2927403	0.185865	-1.58	0.115
Constant	0.0861119	0.419602	0.21	0.837

Source: Field Survey, 2010. ***, **, and *, implies significant at 1%, 5%, and 10% respectively

Table 6: Effect of Market participation on Welfare: Outcome Equation- (OLS)

Variable	Coefficient	Standard Error	Z-value	P>|z|
Gender	5374.431	2119.857	2.54**	0.011
Age	-57.07806	79.3446	-0.72	0.472
Household size	-86.68244	168.9217	-0.51	0.608
Off-farm income	-1947.948	2219.985	-0.88	0.38
Area cultivated to improved varieties	2404.277	547.3063	4.39***	0.000
House ownership	3203.826	2077.257	1.54	0.123
Membership of any organisation	1444.394	1552.681	0.93	0.352
Log of income from rice production	2057.448	849.3927	2.42**	0.015
Educational background	654.9839	1732.467	0.38	0.705
Attend vocational training	4645.92	1954.727	2.38**	0.017
Constant	38048.88	9513.106	4.00***	0.000
Mills lambda	-3003.944	2917.979	-1.03	0.303
rho	-0.26565			
sigma	11307.844			
lambda	-3003.9438	2917.979		

Source: Field Survey, 2010. ***, **, and *, implies significant at 1%, 5%, and 10% respectively