# Adoption and Productivity of Improved Rice Varieties in Osun State, Nigeria

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**Abstract**

In addressing the problem of food insecurity in the country, improved rice varieties were introduced into the country but the adoption rate and productivity of the technologies have not been analyzed in Osun State, Nigeria. This study used a multi-stage sampling technique to select 100 farmers involving adopters and non-adopters of improved rice varieties in the rice growing areas of the State. The results showed that the yield of an average non-adopter was 325.50 kg/ha while that of adopter was 548.80 kg/ha. Budgetary analysis showed that farm income for an average adopter and non adopter were N52, 000 and N27,000, respectively, the benefit-cost ratio was 1.80 for the former and 1.30 for the later. The probit model revealed that frequency of extension visits and non-involvement in off-farm enterprises were the significant factors determining the farmers' adoption decisions. The study recommended that there is need for great emphasis on the use of extension agents and a critical assessment of farmers' operational methods in order to increase production, productivity and farm income in the area.

***Key words:*** Adoption, Productivity, Improved rice, Probit

## INTRODUCTION

The food sub-sector of Nigerian agriculture parades a large array of staple crops, made possible by the diversity of agro-ecological production systems. The major food crops are: cereals (sorghum, maize, millet, and rice); tubers (yam and cassava); legumes (groundnut and cowpeas) and others (fruits and vegetables). These commodities are of considerable importance for food security, expenditures and incomes of households.

Of all the staple crops, rice has risen to a position of pre-eminence. At independence in 1960, rice was merely a festival food consumed mostly in affluent homes during the Christmas and other religious festivals. However, since the mid-1970s, rice consumption in Nigeria has risen tremendously, (10.3% per annum) as a result of accelerating population growth rate (2.8% per annum) and increasing per capita consumption (7.3% per annum) due to changing consumer preferences (Akpokoje *et al.*, 2001). Rice production in Nigeria has expanded during the same period (9.3% per annum), particularly as a result of vast increases in rice area (7.9% per

annum) and to a lesser extent through yield increases (1.4% per annum). However, the production increase was insufficient to match the consumption increase, with rice imports making up the shortfall. Quantities imported have oscillated widely over this period, but lately have surged from 300,000 metric tons in 1995 to about 1,000,000 metric tons in 2001 (Akpokoje *et al.*, 2001).

Aderibigbe (1997) also observed that studies on rice production in Nigeria have shown that increase in rice production, although rapid, are not keeping pace with consumption requirement, WARDA (2001), also noted that even though the rice consumtion per capital in Nigeria (59Kg) was lower than in most other West Africa countries in 1989, the total consumption was highest, almost doubling that of Cote D'ivore which was next to Nigeria. According to 2006 Census result, Nigeria is said to have about 140 million people and this is a worrisome Statistics vis-à-vis the food demand and supply trend in the country.

In recent years (2001-2005) in Nigeria, rice production has been expanding at the rate of 6 percent per annum, with 70 percent of production increase due to an increase in productivity (Akpokodje, *et al.*, 2001; Africa Rice Centre, 2007). Much of the expansion has been in the rain fed systems particularly the two major ecosystems that make up 78 percent of rice land in West and Central Africa (WCA). Nonetheless, demand for rice in WCA (including Nigeria) has far outstripped the local production (Africa Rice Centre, 2007). Thus, rice has become a critical commodity in the Nigerian economy and this has compelled the Nigerian government to continually intervene in the rice sector over the past few decades. Recent initiative in rice production is the introduction of improved rice variety (R-Box). The R-Box is the initiative of a private agro-chemical company called Candel Company Limited, in collaboration with public and private collaborators. The technology is to improve the productivity of small-scale rice farmers through reduction of drudgery and high labour cost while increasing yield.

This study becomes necessary because ever since the presidential initiative on rice has been implemented in Osun State, the field performance of the initiative (from the adoption point of view) has not been properly assessed judging from available literature (Africa Rice Centre, 2007). Since improved technology remains the only way to substantially have optimum output from rare and minimum resources, the rate of local farmers' adoption

of this improved technology would be of interest. Hence this study seeks to intrinsically assess the extent of and determinants of such adoption as well as the eventual effects of the use of the new variety on farmers' incomes. Therefore the broad objective of this study is to evaluate the determinant of adoption and the productivity of the improved rice varieties in Osun State. The specific objectives are to:

(i) Examine the socioeconomic characteristics of adopters and non-adopters of the improved rice varieties;
(ii) Determine factors influencing adoption decisions of farmers; and
(iii) Determine and compare the incomes of adopters and non-adopters in the study area.

## RESEARCH METHODOLOGY

### Study Area

Osun State is primarily an agrarian community. It has an estimated land area of 8,882.55sq km. Rice production is limited to Ilesa zone comprising Erin Ijesa, Erin Oke, Erinmo and Obokun. The popular upland varieties of rice in Nigeria are IITA 150 and R-Box (Nerica, Nerica 3). The lowland varieties include Farro 44, Farro 52 and Wita to meet up with local demand. In the zone, upland rice is planted from April 1 to June (savannah Zone), March to April (forest zone) while the lowland rice is planted between July and August.

The climate of Osun State is good for rice production. There are two distinct geographical seasons in Osun State; they are the rainy season starting in late March and ending in October and the dry season starting from November to early March. The mean annual temperature varies between 21.1 0C and 31.1 0C and annual rainfall is within the range of 800mm in the derived savannah agro-ecology to 1,500mm in the rainforest belt.

### Sampling technique and data collection

A multi-stage sampling technique was used to select respondents in the sate. The first stage involved purposive sampling of the three communities where rice farmers were mostly located. The communities were Erin-Ijesa, Erinmo and Erin Oke communities. The second state was a random selection of a total of 100 respondents in the communities based on population. At least 25 respondents were selected from each community. Staff of Osun State Agricultural Development Programme (OSSADEP)'s Extension offices and the Rice farmers association of Nigeria (RIFAN) assisted in data collection. Data were collected through the use of structured interview schedules between June and September 2007. The interview schedules were

broadly drawn to cover information about the farmers' socio-economic characteristics, inputs and output, farm operations, credit, technology awareness and adoption status.

**Data Analysis**

Data were analyzed using descriptive statistics, budgetary analysis and probit model.

**Budgetary analysis**

Farm enterprise budget approach was used to estimate costs and returns accruing to each of the farmers. According to Alimi and Manyong (2002), a budget is the quantitative expression of total farm plan summarizing the income, cost and profit (a residue of total cost from total revenue). Gross margin is the difference between the total revenue and the total variable cost. The total cost component is expressed as;

(TC) = (TFC) + (TVC),

Where (TC) = Total cost, (TFC) = Total fixed cost, (TVC) = Total variables cost.

The gross margin was calculated as

(TR) – (VC)

Where (TR) = Total revenue and (VC) = Variable cost

**The Probit Model**

The probit model was used to analyze factors that influenced the decisions of farmers to adopt the improved rice variety in the study area. The probit model uses the Cumulative Distribution Function (CDF) to explain the behaviour of a dichotomous dependent variable. Given the assumption of normality, the probability that $I_i^*$ is less than or equal to $I_i$ can be computed from the normal CDF as

$P_i = P(Y = 1/X)$

$= P(I_i^* < I_i)$

$= P(Z_i < B_1 + B_2X_i)$

$= F(B_1 + B_2Xi)$

Where I* = critical or threshold level of the index, such that if Ii exceeds I*, the family will adopt, otherwise it will not. P(Y=1/X) is the probability that an event occurs given the values of the X, or explanatory variable(s) and where $Z_i$ is the normal variable i.e. Z~ N(0,Q2)

The log-likelihood function for probit is

$\ln L = \Sigma w_j \ln \theta(x_j b) + \Sigma w_j \ln(1 - \theta(x_j b))$

Where $w_j$ denotes optional weights.

The model relating to the adoption is specified as follows:

$P_i = F(B_0 + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + B_5X_5 + B_6X_6 + B_7X_7 + B_8X_8 + B9X9)$

Where,

$Pi$ = adoption status measured as dummy(1=adoption,0=non-adoption)

$X_1$ = Sex of the respondents; $X_2$ = Age in year; $X_3$ = marital status; $X_4$ = Literacy level (number of years of formal education), $X_5$ = Household size; $X_6$ = Farm size (ha); $X_7$ = Social capital (1=yes, 0=no); $X_8$ = Extension visits (1=yes, 0=no); $X_9$ = Engagement in off-farm activity (1=yes, 0=no).

The rationale for inclusion of

these factors was based on *a priori* of agricultural technology adoption literature. The effect of age (*AGE*) on adoption whether to adopt an improved technology may be negative or positive. Previous studies (Feder *et al.*, 1985; Nkonya *et al.*, 1997; Oluoch-Kosura *et al.*, 2001) show that the age of individuals affect there mental attitude to new ideas and influences adoption in several ways. Younger farmers have been found to be more knowledgeable about new practices and may be more willing to bear risk and adopt new technology because of their longer planning horizons. The older the farmers, the less likely he is to adopt new practices as he gains confidence in his old ways and methods (Bekele and Drake, 2003). On the other hand, older farmers may have more experience, resources, or authority that may give them more possibilities for trying a new technology. Thus for this study, there is no agreement on the sign of this variable as the direction of the effect is location-or technology-specific (Feder *et al.*, 1985; Nkonya *et al.*, 1997; Oluoch-Kosura *et al.*, 2001; Bekele and Drake, 2003). Education (*EDUCATION*) was hypothesized to positively influence the adoption of improved rice technology since as farmers acquire more education, their ability to obtain, process, and use new information improves and they are likely to adopt.

Education increases the ability of farmers to use their resources efficiently and the allocative effect of education enhances the farmer's ability to obtain, analyze and interpret information. Several studies reviewed by Feder *et al.*, (1985) indicate the positive relationship between education and technological adoption. Alene *et al.*, (2000), in the case of Ethiopia, reported that farmers with a higher level of education had a higher probability of adopting improved farming practices than those with lower level of education. Nkonya *et al.*, (1997), in the case of Tanzania, and Oluoch-Kosura *et al.*, (2001), in the case of Kenya, indicated that education is an important factor positively affecting the process of technical adoption.

Institutional factors of social capital (*SOCKAP*), extension contacts (*EXTENSION*) and access to credit (*CREDIT*) were hypothesized to positively influence adoption as these support services facilitate the uptake of new technologies. *SOCKAP* such as cooperative societies has been found to enhance the interaction and cross-fertilization of ideas among farmers. This in effect will positively affect adoption of technologies (Bamire *et al.*, 2002).

Farmers who are non-members of associations are expected to have lower probabilities of adoption and lower level of use of improved technologies. The extension contact variable incorporates the information that the farmers obtain on their production activities, affect adoption of innovations through counselling and demonstrations by extension agents on regular bases. The effect of this information on adoption varies depending on channel, source, content, motivation, and frequency. It is hypothesized that the respondents who are not frequently visited by extension agents have lower possibilities of adoption than those frequently visited (Adesina and Zinnah, 1993; Shiferaw and Holden, 1998; Oluoch-Kosura *et al.*, 2001; Bamire *et al.*, 2002). The variable is measured as dichotomous with respondents 'contact during the period scoring one, and zero for non-extension contact on the use of the technology.

*CREDIT* takes cognizance of farmers' access to credit to finance the expenses relating to adoption of innovations. Access boosts farmers' readiness to adopt technological innovations. It is hypothesized that the variable has a positive influence on the probability of the adoption and use of improved technology (Zeller and Sharma, 1998; Oluoch-Kosura *et al.*, 2001; Bekele and Drake, 2003). It is measured as a dichotomous variable with access being one, and zero for no access.

Measure of wealth, off-farm income *(OFFINCOME)* is hypothesized to positively influence adoption positively. It is generally considered to be capital that could be used either in the production process or be exchanged for cash or other productive assets. It is expected to influence the adoption of rice variety positively (Shiferaw and Holden, 1998; Zeller and Sharma, 1998; Negatu and Parikh, 1999).

To the extent that liquidity is a constraint to adoption, *OFFINCOME* will have a positive effect on adoption by relaxing the constraint. The level of off-farm income, however, may not be exogenous but be affected by the profitability of the farming operation that in turn depends on technology adoption decisions. Thus, the adoption of improved technology and the level of off-farm income may be determined simultaneously. The simultaneity arises due to the labour allocation decisions of the households between farm and off-farm activities. However, the off-farm income of the household surveyed is mostly derived from remittances of family members in non-farm business activities and from

employment in non-farm sector. As the skill requirements for these jobs are likely to be different from that of farming, the farm and non-farm employment may be considered as non-competitive activities. In this situation, the level of non-farm income would be largely exogenous to the adoption decision [Lapar and Pandy, 1999; Shiferaw and Holden, 1998].

Household size (*HHSIZE*) has been identified to have either positive or negative influence on adoption (Manyong and Houndekon, 1997, Zeller and Sharma, 1998; Oluoch-Kosura *et al.*, 2001; Bamire et al., 2002; Bekele and Drake, 2003). Larger family size is generally associated with a greater labour force being available to the household for the timely operation of farm activities. More labour hours will be spent on the use of improved technologies during labour slack seasons because of the low opportunity cost of labour in rural areas. The negative relationship of the variable with adoption has been linked to increased consumption pressure associated with large family. It is therefore difficult to predict this variable '*a priori*' in this study.

Previous studies have found a positive relationship between farm size (*FARMSIZE*) and technological adoption (Manyong and Houndekon, 1997; Negatu and Parikh, 1999; Oluoch-Kosura *et al.*, 2001; Bekele and Drake, 2003). Operators of large farms are likely to spend more on land-improving technologies. In many cases, large farm size is associated with increased availability of capital, which makes investment in new technologies more feasible. For this analysis, farm size is included as the total cropland available to the farmer. A positive relationship is hypothesized with adoption of rice technology. Availability of land and favourable land tenure positively affects adoption of new rice technology. Farmers with larger farm will readily accept new innovations than those with limited land.

**RESULTS AND DISCUSSION**

Results from the socio-economic characteristics of respondents showed that the mean age of farmers (both non-adopters and adopters) was 45.5 years. The major occupation was farming for 37% of the farmers. The remaining 63% farmers, consisting of non adopters and adopters, had some other non farm activities (e.g. tailoring plumbing, carpentry, trading in farm produce etc.). The farm size ranged from 0.3 to 5.0 hectares with a mean of 1.50 hectares. On the level of education, majority of the farmers were illiterates while those that were literate did not have more than secondary education. The cropping

pattern was mainly mono-cropping and most (more than 60%) of them practiced shifting cultivation. Use of fertilizer, chemicals, improved planting materials and other inputs was inadequate especially among non-adopters. The results showed that about fifty five percent of the respondents had adopted the improved rice variety. The mean household size for both adopters and non-adopters of improved rice variety was seven and about 80% of the respondents were married.

**Table 1: Socio-economic characteristics of respondents**

| | Non-adopters | | Adopters | |
|---|---|---|---|---|
| Age | No | % | No | % |
| | | Age | | |
| 21-30 | 4 | 11 | 5 | 9 |
| 31-40 | 8 | 22 | 11 | 21 |
| 41-50 | 15 | 41 | 22 | 42 |
| 51-60 | 6 | 16 | 9 | 17 |
| 61-70 | 4 | 11 | 6 | 11 |
| >70 | 0 | 0 | 0 | 0 |
| Total | 37 | 100 | 53 | 100 |
| | | Farm size | | |
| < 1.0 | 14 | 43 | 1 | 4 |
| 1.0-2.0 | 4 | 12.5 | 3 | 12 |
| 2.0-3.0 | 3 | 9.75 | 9 | 36 |
| 3.0-4.0 | 3 | 9.75 | 3 | 12 |
| >4 | 8 | 25 | 9 | 36 |
| Total | 32 | 100 | 25 | 100 |
| | | Literacy level | | |
| No education | 11 | 30 | 13 | 25 |
| Primary education | 11 | 30 | 18 | 34 |
| Secondary education | 13 | 35 | 18 | 34 |
| Tertiary education | 2 | 5 | 4 | 7 |
| Total | 37 | 100 | 53 | 100 |
| | | Marital status | | |
| Single | 6 | 16.2 | 6 | 14.3 |
| Married | 31 | 83.8 | 36 | 85.7 |
| Total | 37 | 100.0 | 42 | 100.0 |

Source: Field Survey, 2007

**Budgetary Analysis**

Results of the budgetary analysis revealed that labour (for non-adopters and adopters) constituted the major cost item.

**Table 2: Budgetary Analysis per hectare of rice produced**

| NO | ITEMS | Non-adopter | Adopter | Pooled |
|---|---|---|---|---|
| | Variable Cost: | | | |
| 1 | Seed (₦) | 130.50 | 1220.23 | 583.70 |
| 2 | Fertilizer (₦) | 500.45 | 1629.00 | 778.70 |
| 3 | Chemical (₦) | 255.30 | 1616.20 | 773.3 |
| 4 | Labour (₦) | 20,504.57 | 25,428.06 | 12,226.500 |
| 5 | Total Variable cost/ha (₦) | 21,390.82 | 29,915.37 | 14,306.80 |
| 6 | Average yield (Kg) | 325.50 | 548.78 | 347.28 |
| 7 | Revenue/ha (₦) | 48,807.82 | 82,317.46 | 52,092.30 |
| 8 | Gross Margin (₦) (7-6) | 27417.00 | 52,402.09 | 37,785.50 |

Source: Field Survey, 2007

It accounted for over 80 percent of the cost of productions. This might indicate that the new technology has not achieved the objective of reducing labour cost. The results further revealed that the average total revenue for adopters was ₦82,317 while that of the non-adopters was found to be ₦48,807.82. The average total variable cost for both adopters and non-adopters were ₦29,915 and ₦21,391 respectively. Gross margin values were ₦52,402 and ₦27,417 for adopters and non-adopters while the benefit-cost ratios were 1.80 and 1.30, respectively. The cost to revenue ratio for average non-adopters and adopter was 0.43 while that of adopter was 0.37. This implied that total cost for an average adopter of rice technologies was 37 percent of total revenue. These findings showed higher productivity of improved rice varieties (548.78 kg/ha) compared with the local types (325. 50kg/ha).

**Data Analysis**

**Estimated probit regression**

The results of probit regression in Table 3 showed thatthe log likelihood was-45.98 and chi-square value was 17.24. This implies that the model as a whole is statistically significant at 1 percent

level of significance.

Extension service was significant at 1% level while off-farm variable was at 10% level. This indicates that both extension service and off-farm activity influenced the adoption of improved rice technology positively and negatively respectively. The estimate of extension coefficient indicated that a 1% increase in visit by extension agent will increase adoption rate by 1.3%. The positive coefficient of extension service conformed to the *a priori* expectation which implied that the farmers' contact with the extension agent increased the probability of adopting the R-BOX. On the other hand, the negative coefficient of off-farm activity implied that as the farmers got involved in non-farm activities, their probability of adoption decreased. Non-farm activities decreased the respondents' interests in adopting the technologies. Therefore and from the foregoing, age, sex, literacy level, marital status, household size, land size and the association which farmers belonged did not significantly influence the adoption behaviour of farmers towards R-Box technology.

**Table 3: Results of analysis of the adoption of rice varieties with probit model**

| Variables | Coefficient | T-Ratio |
|---|---|---|
| CONSTANT | -0.745 (0.884) | -0.837 |
| SEX | 0.906 (0.417) | 2.17 |
| AGE | 0.402E-03 (0.707) | 0.005 |
| MARITAL STATUS | 0.211 (0.180) | 1.172 |
| EDUCATION | 0.938E-03 (0.439) | 0.021 |
| HHSIZE | -0.234E-03 (0.437) | -0.006 |
| FARMSIZE | 0.519E-03 (0.440) | 0.013 |
| SOCKAP | 0.171 (0.400) | 0.428 |
| EXTENSION | 1.317 (0.394) | 3.343* |
| OFFINCOME | -0.726 (0.440) | 1.650** |
| CREDIT | -0.023 (0.413) | 0.056 |

Source: Data Analysis, 2007
Standard errors are in brackets.
Log likelihood = -45.98 Chi-Squared = 17.24
**Significant at 1% *Significant at 10%

## SUMMARY AND CONCLUSION

The farmers in the study area were mostly married, middle-aged with very few having secondary education as the highest educational level. An average farmer

cultivated less than four hectares of land. About 54 percent had already adopted the R-Box rice package. Budgetary analysis revealed higher productivity values of gross margin and benefit-cost ratios were recorded by adopters of the R-Box compared with non-adopters. The result of the probit model indicated that the major determinants of farmers' adoption decision were extension visit and non-involvement in off-farm activities.

The study had shown that farmers were responding to intervention programmes that promote the cultivation of low tillage high-yielding R-Box technology. The adoption of improved technology (R-Box) had been found to increase the income of rural farmers, thus improving the livelihood of smallholder farmers. However, there was need for aggressive awareness of the improved technology to rural rice farmers in other areas of the state through extension visits. More efforts should be given towards ensuring a wider and effective coverage for extension services. This might be in the form of recruitment of more extension agents complemented with regular routine training to update their technical skill.

**REFERENCES**

Aderibigbe, O.T. (1997) "An economic analysis of rice processing and marketing in Osun and Ogun State Nigeria" unpublished Ph.D. Thesis. Department of Agric. Econs. Obafemi Awolowo Universality, Ile-Ife.

Adesina, A. A and Zinnah, M. M (1993) Technology characteristics, farmers' perceptions and adoption decisions: A Tobit model application in Sierra Leone. *Agricultural Economics*. 9, 297-311.

Africa Rice Centre (WARDA) (2007) African rice trend: Overview of recent developments in the sub-saharan Africa rice sector. Africa Rice Centre Brief, Cotonou: WARDA, 8pp

Akpokodje, G., Lancon, F and Erenstein, O. 2001." Nigeria's Rice Economy: State of the Art" Draft Report, WARDA-NISER Collaborative Study.

Alene, A. D., Poonyth, D. and Hassan, R. M (2000) "Determinants of adoption and intensity of use of improved rice varieties in the central highlands of Ethiopia: A Tobit analysis". *Agrekon* (South African Journal of Agricultural Economics), 39(4), 633-643.

Alimi, T. and Manyong, V.M (2002) "Partial budget analysis for on-farm research". *Research Guide No.* 65. International Institute of Tropical Agriculture, Ibadan, Nigeria

Bamire, A.S., Fabiyi, Y.L and Manyong V. M (2002) Adoption pattern of fertilizer technology among farmers in the ecological zones of South-Western Nigeria: A Tobit analysis. *Australian Journal of Agricultural Research*. 53, 901-910.

Bekele, W. and Drake, L. 2003. Soil and water conservation decision behaviour of subsistence farmers in the Eastern Highlands of Ethiopia a case study of the Hunde-Lafto area. Elsevier Science Ltd. *Ecological Economics*, Vol. 46, No 3. pp 437-451.

Feder, G., Just, R. E. and Zilberman, D (1985) Adoption of agricultural innovations in developing countries: A survey. *The University of Chicago*. 255-299.

Lapar, M. L. A. and Pandey, S (1999) Adoption of soil conservation: the case of the Philippine uplands. *Agricult- ural Economics* 21, 241-256

Manyong, V. M., Houndekon, A. V (1997) "Land tenurial systems and the adoption of mucuna planted fallows in the derived savannas of West Africa". Paper presented at the workshop on property rights, collective action and technology adoption. ICARD. A. November 22-25. Aleppo, Syria.

Negatu, W. and Parikh, A (1999) The impact of perception and other factors on the adoption of agricultural technology in the Moret and Jiru Woreda (district), Ethiopia. *Agricultural Economics*. 21, 219-229.

Nkonya, E., Schroeder T. and Norman, D (1997) Factors affecting adoption of improved maize seed and fertilizer in Northern Tanzania." *Journal of Agricutu- ral Economics*, 4, 1-12.

Oluoch-Kosura, W. A., Marenya, P. P. and Nzuma, M. J (2001) Soil fertility management in maize-based production systems in Kenya: current options and future strategies. Paper submitted at the Seventh Eastern and Southern Africa regional maize conference, Nairobi. 350-355.

Shiferaw, B. and Holden S. T (1998) Resource degradation and adoption of land conservation technologies in the Ethiopian Highlands: A case study in Andit Tid, North Shewa. *Agricultural Economics*. 21, 241-256.

WARDA (2001) "rice: a valuable cash crop". Report of PRA diagnostic exercise in Iboro, Ogun State. Nigeria.

Zeller, M. and Sharma, M. (1998). "Rural finance and poverty alleviation". *Food Policy Report*, International Food Policy Research Institute, Washington, D.C. June 1998: 1-32.