Determinants of Fertilizer Adoption by Rice Farmers in Bende Local Government Area of Abia State, Nigeria

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DETERMINANTS OF FERTILIZER ADOPTION BY RICE FARMERS IN BENDE LOCAL GOVERNMENT AREA OF ABIA STATE, NIGERIA

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ABSTRACT

This study presents empirical evidence to show how socio-economic factors affect adoption and use intensity of chemical fertilizers in Bende local Government Area of Abia State by using the Tobit model. A multi-stage random sampling technique was used to select 100 rice farmers in the L.G.A in 2007. The result of the analysis found farm size, type of ecosystem, tillage type, education, population pressure on land farmers' age and non-farm income to be positively and significantly related to adoption and use intensity of chemical fertilizer, while field distance to the village, gender, access to credit and labour availability had an indirect relationship with adoption and use intensity of chemical fertilizer. There were no significant relationship between adoption and soil fertility status, field type, village distance to market and membership of social organizations. These results call for policies and measures for more security of tenure to land, education, access to tractor services, good rural road networks, access to credit, and programs that target both gender groups to ensure equitable adoption of chemical fertilizer by male and female farmers.

Key Words: Fertilizer Adoption, Tobit Model and Rice Farmers

INTRODUCTION

Rice is the staple food in many countries of Africa and constitutes a major part of the diet in many others. During the past three decades, the crop has seen a steady increase in demand and its growing importance is evident given its important place in the strategic food security planning policies of many countries (Norman and Otoo, 2002). Nigeria is the 17th world producer of rice. The average production figure for Nigeria is 1,779,000mt which accounts for about 40.8% and 0.6% of total West Africa and World output of rice respectively (FAO, 2008).

In the West Africa sub region, Nigeria has witnessed a well established growing demand for rice as propelled by rising per caput consumption and consequently the insufficient domestic production had to be complemented with enormous import both in quantity and value at various times (Erenstein *et al*., 2004 and Daramola, 2005). Recent global trend in the rice industry however shows that there is a growing import demand for the commodity in Africa, as evidenced from pressure on world supply and the steady increase in the world price of the commodity in the last five years (FAO, 2006).

Studies (Oyekanmi *et al*., 2008; Nwite *et al*., 2008) from research stations (based on their on-station and on-farm trials) showed that the adoption of the technologies and improved management practices should lead to substantial yield increases in rice production. Modern input use, including fertilizer, is an important determinant of agricultural productivity, and continuing low agricultural productivity is an important contributor to poverty persistence especially in agriculture based countries such as in Africa (Christiaensen and Demery, 2007).

A host of demand and supply side factors have been invoked to explain the limited adoption of fertilizer including limited knowledge and education (Asfaw and Admassie, 2004), risk preferences, credit constraints (Croppenstedt *et al*., 2003), limited profitability of fertilizer use (Dadi *et al*., 2004; World Bank, 2006b), lack of market access (Abrar *et al*, 2004) as well as limited or untimely availability of the inputs themselves. Carlsson, *et al*. (2005), the World Bank (2006a) have also highlighted the importance of the households' limited ex-post consumption coping capacity.

Soil infertility and low use of chemical fertilizers have been cited as two major factors limiting productivity growth of agriculture in Africa (Bationo and Mokwunye, 1991; Vlek, 1990). Fertilizer has been a major component of

improved rice production technologies being promoted by the extension package. It is therefore of critical importance for agricultural research and policy design to a better understanding of the reasons behind the persistence of low fertilizer adoption by farmers in the zone. This study makes an attempt to analyze determinants of fertilizer use by rice producers in Bende Local Government Area of Abia State.

METHODOLOGY

A multi-stage random sampling technique was used for the study. Four communities were randomly selected from the LGA under study in the first stage. In the second stage, 25 respondents were randomly selected form each community. The farmer participatory research involved 100 farmers, 80 males and 20 females. Primary data were collected in 2007 with the aid of a well structured questionnaire and included such variables as quantity of fertilizers applied, farm size, fertility status, field type, tillage type, gender, education, age, non-farm income and labour etc.

ANALYTICAL PROCEDURES

To model the effect of adoption decisions, a Tobit model is used. This model (Chow, 1983 and Maddala 1983) has found several empirical applications in the adoption literature (Adesina and Forson, 1995; Adesina, 1996; Ransom *et al*., 2003; Holloway *et al*., 2004 and Nkamleu *et al*., 2007). The

dependent variable is level of use of chemical fertilizers, which is censored at zero. To avoid the censoring bias that Ordinary Least Squares could generate, a Tobit censored at zero was used because level of fertilizer use smaller than zero was not observed and many respondents reported zero application (Holloway *et al*., 2004) pointed out that even when a Tobit procedure is used, incorrectly assuming that the true point of censoring in the sample is zero also imparts a bias to the parameter estimates). Other estimation approaches, such as the Heckman's Model, could also generate unbiased results (Nkamleu, 2007). The Tobit approach conserves degrees of freedom and is relevant in this case where the independent variables have a continuous effect on the dependent variable.

Since the level of fertilizer use cannot be negative (the threshold is zero), the dependent variable can be written using an index function approach as;

$$I^*_i = \beta^T X_i + \varepsilon i \quad (1)$$

$$Y_i = 0 \text{ if } I^*_i \leq T \quad (2)$$

$$Y_i = 1 \text{ if } I^*_i > T \quad (3)$$

Where Y_i is represents a limited dependent variable, which simultaneously measures the decision to use fertilizer and the intensity of use. I^*_{i1} is an underlying latent variable that indexes adoption. T is an observed threshold level, X is

the vector of of independent variables affecting adoption and intensity of use, β^T is a vector of parameters to be estimated, and εi is the error term. If the non-observed value of I* is greater than T, the observed variable T_i becomes a continuous function of the independent variables, and 0 otherwise. For the generalized case, the value of the Log likelihood function is given as:

EMPIRICAL MODEL

The variables used in the analysis are presented below:

$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}, X_{11}, X_{12}, X_{13}, X_{14}, X_{15}, \varepsilon)$

Y=Total fertilizer use on rice field (kg/ha)

X_1= Farm Size (ha)

X_2=Type of Ecosystem (dummy variable; 1=upland, 0=lowland)

X_3=Tillage type (dummy variable; 1=tractor, 0=manual)

X_4= Field distance from village (km)

X_5= Soil fertility status (dummy variable; 1=good, 0=poor)

X_6=Tenancy status (dummy variable; 1=tenant, 0=owner)

X_7=Gender of household head (dummy variable; 1=male, 0=female)

X_8=Education of household head (yrs)

X_9=Population pressure on available land (person/ha)

X_{10}= Non-farm income (Naira)

X_{11}= Village distance to market (km)

X_{12}= Age of household head (yrs)

X_{13}= Access to credit (dummy variable;1=yes, 0=no)

X_{14}=Membership of social organization (dummy variable; 1=member, 0=non- member)

X_{15}= Labour (mandays)

ε = Error term

RESULTS AND DISCUSSION

The data in Table 1 show the average statistics of Rice farmers in Bende Local Government Area of Abia State.

Table 1: Average Statistics of Rice farmers in Bende Local Government Area of Abia State

Variable	Description	Mean	Std. Dev.	Min.	Max.
X_1	**Farm Size (ha)**	0.902	0.764	0.2	3
X_2	**Type of Ecosystem**	0.520	0.499	0	1
X_3	**Tillage type**	0.110	0.313	0	1
X_4	**Field distance from village**	1.813	0.839	0.3	5
X_5	**Soil fertility status**	0.700	0.458	0	1
X_6	**Field type**	0.590	0.458	0	1
X_7	**Gender**	0.700	0.458	0	1
X_8	**Farmer education**	7.890	4.463	0	12
X_9	**Population pressure on land**	5.090	2.005	1	12

X_{10}	**Non-farm income**	1150	3122	0	15000
X_{11}	**Village distance to market**	5.045	3.775	0.3	13
X_{12}	**Age of farmer**	39.900	10.104	23	63
X_{13}	**Access to credit**	0.220	0.414	0	1
X_{14}	**Membership of social org.**	0.130	0.336	0	1
X_{15}	**Labour**	157.490	98.609	35	500
Y	**Fertilizer use on rice field (kg/ha)**	109.920	48.125	50	250

Source: Field data, 2007

Table 2 shows the estimated results of the Tobit model. Eleven variables were significant in explaining the adoption of chemical fertilizer. The χ^2 was highly significant at 1% level of probability indicating goodness of fit.

Table 2: Tobit Model estimates of Factors affecting Adoption and Use Intensity of Chemical Fertilizer in rice Production, Bende Local Government Area.

Variable	Parameters	Coefficient	Std. Error	t-ratio
Intercept	b_0	-0.678	0.141	-4.799***
Farm Size (ha)	X_1	1.401	0.168	8.234***
Type of Ecosystem	X_2	0.237	0.048	4.900***
Tillage type	X_3	1.320	0.340	3.881***
Field distance from village	X_4	-0.146	0.030	4.892***
Soil fertility status	X_5	-0.152	0.060	-2.518**

Field type	X_6	0.071	0.047	1.499
Gender	X_7	-0.320	0.067	-4.774***
Farmer education	X_8	0.019	0.007	2.803***
Population pressure on land	X_9	0.080	0.015	5.388***
Non-farm income	X_{10}	0.002	0.001	2.490**
Village distance to market	X_{11}	-0.013	0.007	-1.837
Age of farmer	X_{12}	0.008	0.002	3.904***
Access to credit	**X13**	-0.399	0.079	-5.081***
Membership of social org.	**X14**	-0.165	0.238	-0.695
Labour availability	**X15**	-0.0021	0.0007	-3.204***
χ^2	0.00001***			
Log likelihood	-691.33506			
Total Sample	100			

Source: Computed from STATA 8A Trobit results/Surveys data, 2007, * and ** are significant levels at 1.0% and 5.0%.12.07048 -2.70**

The coefficients of farm size, type of ecosystem, tillage type, education, population pressure on land and age were positive and highly significant at 1% level of probability while that of non-farm income was positive and significant at 5%. This implies that increase in these variables will lead to increased adoption and intensity of use in chemical fertilizer. The significance of tractorization corroborates large farm size

suggesting that farmers with large farm holdings are more likely to use more (inputs) fertilizer. Farmers may likely use more fertilizer upland than lowland to mitigate leaching of fertilizer as a result of run-offs, environmental degradation, aquatic life and weed infestation. The effect of farm size has been variously found to be positive (Abara and Singh, 1993; Fernandez-Cornejo, 1996 and Adesina, 1996) Farm size affects adoption costs, risk perceptions, human capital, credit constraints, labor requirements, tenure arrangements and more. With small farms, it has been argued that large fixed costs become a constraint to technology adoption (Abara and Singh, 1993). Farmers' total land holding may serve as a good proxy for wealth and status and income levels (Bonabana-Wabi, 2002).

Generally education is thought to create a favorable mental attitude for the acceptance of new practices especially of information-intensive and management-intensive practices (Caswell *et al*., 2001). Age of the farmer can have a profound effect on technology adoption. The effect is thought to stem from accumulated knowledge and experience of farming systems obtained from years of observation and experimenting with various technologies. In addition, since adoption pay-offs occur over a long period of time, while costs occur in the earlier phases (Bonabana-Wabi, 2002). Population pressure on available land

signifies the importance of maximum output as consequence of fertilizer application. Farmers have a greater incentive to intensify land use applying land saving technology in order to meet higher household food needs, given the relatively inelastic supply of good quality land (Adesina, 1996)

The positive sign for non-farm income agrees with the evidence from earlier studies in West Africa by Kelly (1988), Reardon *et al* (1994) and Adesina (1996). Farmers in Bende L.G.A especially those that are close to markets, often rely on non-farm income generating activities to buttress returns from agriculture. Braun *et al*., (1994) has shown that such non-farm incomes could be substantial.

The coefficients of distance of field to village, soil fertility status, gender, credit access and labour availability were negative and significant. This implies that increase in these variables would lead to decrease in fertilizer adoption and use intensity. The negative value on the gender coefficient indicates that females are more likely to adopt fertilizer than males. Rice farms located further away from the village are less intensively cultivated and thus require less fertilizer than farms located near the village. The negative sign on access to credit may indicate lack of access to credit facilities for the purchase of inputs. The result of

labour availability may indicate diminishing returns due to excessive use of labour on rice fields. Non fertile lands would also increase adoption and use intensity of fertilizer.

The coefficient of field type was positive but non significant while those of village distance to market and membership of social organizations which were negative and non significant.

CONCLUSION

The results of this study indicate that important factors directly related to adoption of chemical fertilizers are farm size, type of ecosystem, tillage type, education, population pressure on land and age. Others are; field distance to village, gender, access to credit and labour availability. These results call for policies designed to improve farmer access especially women to more land, fertilizer, credit, more education and tractor services. There is need to put up adequate infrastructure especially good rural road network to reduce transport and communication costs.

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