African Journal of Agricultural Research Vol. 5(18), pp. 2497-2503, 18 September, 2010
Available online at http://www.academicjournals.org/AJAR
ISSN 1991-637X ©2010 Academic Journals

Full Length Research Paper

Farmer's response to adoption of commercially available organic fertilizers in Oyo state, Nigeria

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Accepted 22 June, 2010

The objective of this study is to identify and analyze the socio-economic factors influencing farmers' response to adoption and use intensity of commercially available organic fertilizer by non-users of fertilizer in Oyo State, Nigeria. A total of 139 respondents selected by multi-stage random sampling technique were interviewed with the aid of structured questionnaires augmented with personal observations on the farmers' farm. Data were analyzed using descriptive analysis, test of difference between means and proportions, and Tobit regression analysis. Result of the Tobit model estimates showed that number of years spent in acquiring formal education, household size, and number of extension visit received during last cropping season positively influenced adoption decisions, while farming experience, farm size, and distance from source of supply of commercial organic fertilizer negatively influenced adoption decisions. The result confirms the importance of information dissemination and ability to process such information, availability of labour and nearness to the source of technology in adoption decisions.

Key words: Farmers' response, organic fertilizer, incidence, use intensity, relative use, status.

INTRODUCTION

Literature is replete with the importance of adopting appropriate technological improvement in land – augmenting forms to sustain agricultural growth and increase agricultural productivity especially in developing countries. This is premised on the observed low use of such technology in most developing countries, Nigeria inclusive, (Bumb, 1994) resulting in soil nutrient mining and thus creating widening gap in meeting food self-sufficiency bids in such countries. However, the success of adopted technology is closely linked with favorable government policies and institutions (Todaro, 1989).

In general, the adoption of a new technology may be influenced by many factors. According to Rogers (1983), these factors include the socio-economic characteristics of the households (education, social status, attitude, social influence estimated skills, resource endowments), its objectives, together with the characteristics of the technology, relative advantage of the technology, its profitability, compatibility, complexity, triability and observability. Many attempts have been made by economist and sociologists to explain the importance of these factors in adoption decisions especially in the area of agriculture. Sequel to these, three groups of paradigms for explaining adoption decision can be found in the literature; the innovation – diffusion, economic constraint, and adopter perception paradigms (Adesina and Zinnah, 1993).

These paradigms differ in emphasizing factors that condition adoption decisions. For example, while the innovation – diffusion model holds access to information about an innovation as the key factor determining adoption decisions (Argarwal, 1983), economic constraint model contends that economic constraints reflected in asymmetrical distribution patterns of resource endowments are the major determinants of observed adoption behaviour (Aikens et al., 1975). For the adopter perception paradigm, it is the perceived attribute of a given innovation that conditions adoption behaviour. Various attempts have been made to ascertain the superiority of the economic constraint model over the

Abbreviations: EXPER, Farming experience; **FSIZE,** farm size; **OFFI,** off farm income; **RELUST,** relative use status; **HHS,** household size; **LEDUC,** literacy level;

innovation model (Hooks et al., 1983), although such assertion has been challenged (Nowak, 1987), also the adopter perception although well established is the least quantitatively developed in adoption literature (Adesina and Zinah, 1993).

As a result of the observed inconsistencies in adoption studies, as regard the importance and relationships among different socio-economic factors, it is pertinent to conduct specific technology adoption studies. Therefore, the objective of this study is to quantitatively determine the socio-economic factors that influence farmers' adoption and use intensity of commercial organic fertilizer among non-users of fertilizer in Oyo state, Nigeria. The commercial packaged organic fertilizer is relatively new in the study area, hence, no study has been specifically conducted to quantitatively examine the determinants of commercial organic fertilizer use among farmers in the study area. The identification and understanding of such factors will enhance better targeted commercial organic fertilizer – based soil management interventions.

METHODOLOGY

Data for this study were collected from a randomly selected sample of 139 farming households in 20 villages located in four Local Government Areas (LGAs) of Ibadan/Ibarapa Agricultural Development Programme (ADP) zone in Oyo State, Nigeria. The sampled population, which is mainly smallholders who depend primarily on agriculture for their livelihood, comprises 100 users of commercial organic fertilizer (UCOF) and 39 non-users of any fertilizer (NUFE).

Data were collected by personal interview of respondents with the aid of structured pre tested questionnaires. The questionnaire contains questions on socio-economic characteristics of farmers (age, genders, literacy level, etc.), resource and production characteristics as well as institutional and technology attributes. These were supplemented with personal observation on the farmer's plot. Data were analyzed with descriptive statistics, test of differences between mean scores and proportions, and Tobit regression techniques.

Data

Feder et al. (1985) stated that socio- economic factors are generally thought of as influencing farmer's adoption of intensification technologies. Specifically, Erenstein (1999) claimed that socio-economic factors are determinants of land and technology use. However, factors influencing the adoption of new agricultural technologies can be divided into three major categories: farm and farmers associated attributes (Mussei et al., 2001), attributes associated with the technology (Adesina and Zinnah, 1992; Misra et al., 1993) and the farming objectives (CIMMYT, 1988). Factors in the first category include the farmer's education level, age, and household and farm size. The second category, according to Mussei et al. (2001), varies with the type of preferred technology, e.g. the characteristics a farmer prefers to adopt in commercial organic fertilizer. The third category assesses how different strategies used by the farmer, such as commercial versus subsistence farming, influence the adoption of technologies. For this study, based on extensive review of empirical adoption studies (Bamire et al., 2002, Adejobi et al., 2004), data were collected on personal characteristics of the farmers, resource use and production characteristics, institutional and technological attributes. The choice of variables of instruments was based on the extensive review of factors affecting adoption of agricultural technologies in low income countries by Feder et al. (1985) and Heisey and Mwangi (1993).

Personal characteristics of the farmers considered in this study include age (AGE), gender (GENDER), literacy level (LEDUC), farming experience (EXPER) and household size (HHS) of the farmer. Earlier studies indicated that the age of an individual affects his mental attitude to new ideas and influences adoption in several ways (Bamire et al., 2002). They went further to claim that younger farmers have been found to be more knowledgeable about new practices and may be willing to bear risk and adopt a technology because of their longer planning horizons, while older farmers may have more experience, resources or authority, which may give them more possibility for trying a new technology. Although there was no agreement on the direction of this variable as regard commercial organic fertilizer in adoption literature, age was expected to be negatively related to adoption because of the need for extra physical labour needed to handle the product. Age was measured in year. GENDER was measured as a dichotomous variable with male farmers scored as one and female farmers as zero. Olayemi and Ikpi (1995) stated that out of 95% of Nigerian farmers who practice small scale farming, that is, cultivating not more than 2 ha of farmland, about 55% of them are women whose activities have socio-cultural restrictions as against men. These restrictions often limit the female farmers in their ability to accumulate assets, and access productive resources such as credit and land. Consequently their demand and supply of technologies to improve their productive capacities are negatively affected. Exposure to education has been found to positively affect fertilizer adoption decisions (Awe, 1997; Bamire et al., 2002). Based on these earlier empirical adoption studies, the variable was expected to be positively related to adoption of commercial organic fertilizer. LEDUC was measured as total number of years spent in acquiring formal education.

Farming experience (EXPER) can generate or erode confidence in new technology. With more experience, a farmer can become more or less risk-averse when judging new technology (Mussei et al., 2001). The variable could thus have a positive or negative effect on farmers' adoption decision. EXPER was measured as number of years spent in active farming and is expected to be positively related to adoption of commercial organic fertilizer. This was because of the problem often associated with inorganic fertilizer distribution and inconsistence pricing (Bamire et al., 2002). Household sizes (HHS) was measured as number of individuals living under the same roof and eating from the same pot with the farmer. There is no agreement in adoption literatures as regard the direction of influence of this variable. Manyong and Houndekon (1997) found HHS to be positively related to technology adoption decisions while Owu (1995) claimed that the variable had a negative relation with technology adoption. However, the variable was predicted to be positively related to commercial organic fertilizer as it will serve as additional labour required in adoption of the technology.

Farm size (FSIZE) and off farm income (OFFI) were the resource and production characteristics considered in this study. FSIZE was measured as the total hectare cultivated by the farmer and has been found to be positively related to technology adoption (Manyong and Houndekon, 1997). The variable is often taken as an indicator of wealth and perhaps a proxy for social status and influence within a community (Mussei et al., 2001). However, the variable was expected to be negatively related to adoption of commercial organic fertilizer because of large quantities required for soil fertility maintenance. Previous empirical work on adoption found that access to off farm income enhances farmer's ability to purchase inputs (Mussei et al., 2001) and thus is positively related to adoption. Following earlier empirical findings, the variable was predicted to have a positive relationship with adoption of commercial organic fertilizer. OFFI was measured in Naira/month.

The institutional and technological attributes considered in this study include membership of the socio-cultural associations (MASS), the extension visit received during the last cropping season (NEXT), availability of commercial organic fertilizer (AVAIL) and distance of farm from the nearest source of commercial organic fertilizer (DIST).

The membership of associations (MASS) such as the cooperative societies and farmers organization has been found to enhance the interaction and exchange of ideas among farmers (Awe, 1997). This will influence the adoption of technology positively. The variable was measured as dichotomous with membership attracting 1 and non-membership attracting zero.

The extension visits represent the major source of information on importance of technology adoption to production activities on the farmers' farm. Although, the effect of information on adoption decisions has been linked with the channel, source, content, motivation, and frequency of extension visits (Brown 1991). Keregero (1991) stated that visits by extension agents are expected to positively influence the adoption of technologies. Therefore NEXT was predicted to influence adoption of commercial organic fertilizer positively.

The variable was measured as number of extension visits received in immediate past production season. Availability of commercial organic fertilizer in adequate quantity and right time (AVAIL) determines whether the product is supply constrained. Efficient and prompt delivery of a given technology or innovation tend to promote the adoption. Hence, the variable measured, as dichotomous variable with prompt supply attracting one and delay in supply attracting zero, is expected to positively influence adoption of commercial organic fertilizer. Distance of farm from the nearest source of commercial organic fertilizer (DIST) measured in kilometer is expected to influence adoption negatively. This is because proximity to the source of technology has some cost implications (Nwosu, 1995). These costs according to Bamire et al. (2002) include transportation and risks, which increases as distance traveled by farmers to purchase fertilizer material increases.

Analytical model

The Tobit Regression Model was used in empirical analysis because the dependent variable (relative use status of commercial organic fertilizer RELUST) is measured as the proportion of total farm land cultivated with commercial organic fertilizer and has censored distributions. RELUST is zero for non-adopters; hence the use of ordinary least squares (OLS) would yield inconsistent estimates (Amemiya, 1984). An alternative would be to include only observations for which dependent variable is greater than zero in the analysis. However this will lead to sample selection bias in the estimated coefficient of the OLS model. Equally, the use of linear probability model (LPM) may end in predicting values that may fall outside the 0 – 1 interval, thereby violating the basic tenets of probability. Moreover, the use of probit-logit methodology forgoes valuable information of variables under consideration because of the use of a dummy instead of a continuous variable, and does not provide information on the use intensity on adoption of a given alternative.

The Tobit regression model used in this study (McDonald and Moffit, 1980) was that of Ephraim et al. (1997). Where V = intensity of adoption of an improved technology, V^* = the solution to utility maximization problem of intensity of adoption subject to a set of constraints per farming household and conditional on above a certain limit . V_o = the minimum technology adoption per farming house hold. Here V_o = O hectare cultivated with commercial organic fertilizer.

Therefore:

$$V = V^* \text{ if } V^* > V_o \quad (1)$$

$$= O \text{ if } V^* \leq V_o$$

Equation (1) represents a censored distribution of intensity of adoption since the values of V for all non-adopters equal zero. Following Tobit (1958), the expected intensity of adoption of a given technology E (V) is:

$$E(V) = X\beta F(Z) + \sigma f(z) \quad (2)$$

Where X is a vector of explanatory variables, F (z) is the cumulative normal distribution of z, f (z) is the value of the derivative of the normal curve at a given point (that is, unit normal density), z is the z-score for the area under normal curve, β is a vector of Tobit maximum likelihood estimates, and σ is the standard error of the error term. McDonald and Moffit (1980) noted that the marginal effect of an explanatory variable on the expected value of the dependent variable is:

$$E(V)/\delta X_i = F(z)\beta_i \quad (3)$$

Also, the change in the probability of adopting a technology as independent variable X_i changes is:

$$\delta F(z)/\delta X_i = f(z)\beta_i/\sigma \quad (4)$$

And, the change in intensity of adoption with respect to a change in an explanatory variable among adopters is:

$$\delta E(V^*)/\delta X_i = \beta_i (1 - zf(z)/F(z) - f(z)^2/F(z)^2\} \quad (5)$$

The Tobit model coefficient do not directly give the marginal effects of the associated independent variables on the dependent variable, rather it gives a vector of maximum likelihood estimates which can be decomposed into two parts, change in probability of adoption and the marginal intensity of adoption as the respective explanatory variables changes (Amemiya, 1984; Goodwin 1992).

To estimate the factors influencing the incidence and intensity of adoption of commercially available organic fertilizer the following equation was specified.

$$Y_t = X_t\beta + \mu_t \quad (6)$$

Such that

$$Y_t = \begin{cases} O \text{ if } Y_i \leq T \\ Y_t^* \text{ if } O < Y_t^* < 1 \\ 1 \text{ if } Y_t^* > T \end{cases}$$

$$(t = 1, 2, \ldots\ldots, n) \quad (7)$$

Where Y_t is the observed dependent variable, e.g. RELUST; Relative use status that is, proportion of farm land cultivated with commercial organic fertilizer. Y_t^* is the non-observable latent variable representing the use of commercially available organic fertilizer. T is critical (cut-off) value which translate into $Y^* > T$, as farmer adopts and $Y^* \leq T$, as farmer rejects adoption and n is the number of observation.

RESULTS AND DISCUSSION

A summary of the socio- economic characteristics of the sampled respondents in the study area is presented in Table 1. From the table, a comparative analysis of the

Table 1. Distribution of mean and proportions of factors influencing adoption of commercial organic fertilizer.

Characteristics	Distributions		Mean/proportions in parenthesis		t-value
	UOFE	NUFE	UOFE	NUFE	
Age (years)					
21 – 30	6	-			
31 – 40	33	11			
41 – 50	44	18			
51 – 60	17	8	43.0	45.75	-2.70*
61 – 70	-	2	13		
Gender (%)					
Male	74	29	(0.74)	(0.29)	
Female	26	10	(0.26)	(0.10)	0.00
Literacy level (years)					
0 – 3	17	17			
4 – 7	36	17			
8 – 11	14	2	7.6	4.58	4.57*
12 – 15	3	3	4		
Farming experience (years)					
1 – 10	65	20			
11 – 20	32	17			
21 – 30	2	1			-0.91
31 – 40	1	1	9.5	10.58	
Household size (number)					
0 – 3	22	3			
4 – 7	73	35	4.5	5.28	-2.16*
8 – 11	5	1	7		
Farm size (ha)					
– 0.5	13	9			
0.6 – 1.0	46	21			
1.1 – 1.5	29	7	0.9	0.83	1.42
1.6 – 2.0	12	2	8		
Off farm income (naira)					
≤1000	7	6			
1100 – 2099	38	16			
2100 – 3099	21	11			
3100 – 4099	10	4	3029.50	2007.00	4.26*
4100 – 5099	13	2			
5100 – 6099	6	-			
6100 – 7099	3	-			
7100 – 8099	2	-			
Membership of association (%)					
YES	(88)	(28)	(0.88)	(0.28)	-1.86
NO	(12)	(11)	(0.12)	(0.11)	
Availability of organic fertilizer (%)					
YES	(100)	(32)	(1.00)	(0.32)	
NO	-	(7)	(0.00)	(0.07)	4.39*

Table 1. count'd.

Distance (km)					
1 – 5.9	22	-			
6.0 – 10.9	27	8			
11.0 – 15.9	41	24	10.	15.12	12.63*
16.0 – 20.9	10	7	88		
Extension visit					
0 – 1	28	31			
2 – 3	72	8	2.2	0.913	9.24*
4 – 5	-	-	5		

* Significant at 5% level of probability. Source: Date analysis, 2009.

mean and proportion of the socio-economic variables between users of commercial organic fertilizer (UCOF) and non-users of fertilizer (NUFE) showed that there exist significant differences between seven variables, these are age, literacy level, household size, off farm income, availability of commercial organic fertilizer, distance from source of commercial organic fertilizer and number of extension visit received. UCOF projects lower mean value in age and household size but have higher mean scores and proportion values in the remaining significant variables.

Tobit regression analysis

Tobit regression analysis was performed on primary data collected from the study area using LIMDEP (version 7) to obtain the maximum likelihood estimate (MLE) of Tobit coefficients, while SAS (version 8) was used to write the programme for decomposition of the MLE. The estimation result of Tobit regression analysis on adoption of commercial organic fertilizer (CAOF) by NUFE is presented in Table 2.

From Table 2, six variables were found to significantly influence the adoption of CAOF by NUFE. These are number of years spent in acquiring formal education (LEDUC) ($P<0.05$), farming experience (EXPER) ($P<0.05$), household size (HHS) ($P<0.01$), Farm size (FSIZE) ($P<0.01$), number of extension visits (NEXT) ($P<0.01$), and distance of farm from the source of CAOF (DIST) ($P<0.01$). The results showed that all the significant variables were of predicted signs except EXPER which was earlier predicted to be positively related to adoption of CAOF but was found to be negatively related.

Following Mc Donald and Moffit (1980), the value of F (z) which is 0.3127 implies that 31.27% of the observations have non-zero willingness to use CAOF. In other words 31.27% of the respondents are willing to use CAOF. The expected RELUST is evaluated using Equation (8)

$$\alpha = 1 - z\, f(z)/F(z) - f(z)^2/F(z)^2 \qquad \text{……………..(8)}$$

$\alpha = 0.1744$

This implies that the expected proportion of land cultivated with CAOF is 0.17 ha. Against expectation, farming experience (EXPER) negatively influenced RELUST.

A year increase in EXPER reduced the probability of adoption of the CAOF by 0.75% while it reduced RELUST by 0.11 ha on the average for the entire sample and by 0.01 ha among adopters. This may be due to the fact that older farmers are probably the most experienced farmers. This category may not see any reason why they should invest in land quality development again.

As expected, household size (HHS) influenced RELUST positively. A unit increase in number of the household size increased the probability of adoption by 2.28% while it increased the RELUST by 0.03 ha on the average for the entire sample and by 0.02 ha among adopters. This might be as a result of the ability of the household members to provide additional labour needed in the use of commercial organic fertilizer. Farm size (FSIZE) negatively influenced RELUST. Each additional hectare of land cultivated reduced the probability of adoption of CAOF by 0.8% while it reduced the RELUST by 0.01 ha on the average for the entire sample and by 0.01ha among the adopters. This is probably due to the large quantity of the fertilizer needed to maintain soil fertility.

A number of extension visits received positively influenced the RELUST. Extension visits increased the probability of adoption of CAOF by 5.16% while it increased the RELUST by 0.08 ha on the average for the entire sample and by 0.04 ha among adopters. This confirms the importance of extension officers in support service for delivering improved agricultural information to the farmers.

Expectedly distance of farm from the source of CAOF negatively influences the RELUST. A kilometer increase in the distance between the farm and source centers

Table 2. Tobit model estimates for adoption of CAOF.

Variables	Coefficients	Standard error	P[/z/ >z]	Change in probability of adoption δF(z)/ δx	Total change δE(V)/δx	Change among adopters δE(V*)/δx
Constant	0.2015	5.9382	0.1699	0.0431	0.0630	0.0351
AGE	0.0125	0.0841	0.3601	0.0027	0.0039	0.0021
GENDER	-0.0284	0.0534	0.4138	-0.0061	-0.0089	-0.0049
LEDUC	0.2167*	0.0021	0.0135	0.0464	0.0678	0.0378
EXPER	-0.0352*	0.0278	0.0473	-0.0075	-0.0110	-0.0061
HHS	0.1067**	0.0518	0.0059	0.0228	0.0334	0.0186
FSIZE	-0.0360**	0.0088	0.0039	-0.0080	-0.0113	-0.0063
OFFI	0.1885	0.0195	0.1506	0.0403	0.0589	0.0328
MASS	0.0416	0.0293	0.02296	0.0089	0.0130	0.0073
NEXT	0.2409**	0.0036	0.0005	0.0516	0.0753	0.0420
AVAIL	0.0198	0.0447	0.3584	0.0042	0.0062	0.0035
DIST	-0.1769**	0.0875	0.0021	-0.0378	-0.0553	-0.0308

Log likelihood function = -187.46, Sample size = 139, Number of positive observations = 100, Proportion of positive observations = 72%, Z = 0.5601, f(z) = 0.2098, F(z) = 0.3127, σ = 0.98**, *Significant at 5%, **Significant at 1%, Source: Data analysis, 2009.

reduces the probability of adoption by 3.78% while it reduced RELUST by 0.06 ha on the average for the entire sample and by 0.03 ha among adopters. The reason is because proximity of the organic fertilizer source to farmer's farm has some cost implication. The farther the distance of procurement, the more difficult it is for farmers to procure them and the more difficult it is for farmers to transport to their farms.

Conclusion

The study showed that number of years spent in acquiring formal education, farming experience, household size, and farm size, number of extension visits received during the last cropping season and distance of farm from the source of commercial organic fertilizers are significant variables that influence farmers' willingness to adopt and use commercial organic fertilizer. Descriptive analysis showed that adopters of commercial organic fertilizer are slightly younger, have lower farming experience, spent higher number of years in acquiring formal education, have bigger farm size, earned higher off farm income, received higher extension visits and closer to the source of commercial organic fertilizer compared with non-users of fertilizers.

The results emphasize the importance of information dissemination channels and the ability of the farmers to process and make use of such information. This underscores the importance of human capital development in increasing the intensity and probability of the technology adoption. The result equally highlighted the importance of proximity to source of technology in adoption decisions.

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