

DETERMINANTS OF FERTILIZER USE AMONG SMALL-HOLDER FARMERS IN WETLAND REGION OF CROSS RIVER STATE.

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ABSTRACT

The study modelled and estimated the fertilizer demand function for wetland farmers in Cross River State. Stratified random sampling method was used to collect cross sectional data from 130 wetland farmers with the help of a well structured questionnaire and personal interview schedules. Ordinary Least Squares Method was used to estimate the specified equation. The results reveal that household size, household consumption expenditure, number of poultry birds kept by farmers, number of goats owned and perceived price of fertilizer have negative effect on fertilizer demand. Education of the farmer, farm size, extension agent contact, farm income, ability to predict rainfall, modern communication facilities, output of maize and mixed cropping in combination with maize have positive influence on fertilizer demand. Also policies that reduce production constraints and household size were recommended. In addition, policies that strengthen the present extension programme and improve rural infrastructures would help to reduce production cost while increasing fertilizer demand and farmers wellbeing.

KEY WORD: Fertilizer, Wetland, Farmer, Demand, Policy

INTRODUCTION

Nigeria depends so much on the agricultural sector. The sector employs more than 70% of the active population, provides raw materials for agro-based industries; it is also a good source of fuel and, most important, reliable source of food to our teeming population (Okunneye 2003 and Lawal 2008). The present government has identified the immense contribution of the agricultural sector to Nigeria's economic development. Though in recent years, the country has witnessed a remarkable improvement in the growth rate (about 5%) of agricultural sector compared to less than 2% growth rate of the 1980's (Falusi, 2008), Nigeria is yet to adequately feed its citizens. The country relies mostly on heavy food importation, especially the grains. Growth in the agricultural sector has remained unsatisfactory given the low level of innovations among our farmers (Abdulahi, 1999 and Uwatt, 1997). Therefore, for the country to successfully satisfy the increasing food demand of her population, agricultural productivity must increase. In Nigeria, the recent improvement in agricultural growth rate has been attributed to hectareage expansion rather than actual improvement in farm management techniques (Falusi, 2008). With increased population pressure, farms in upland and wetland regions of the country are under intense usage (Kelly, 2006). This has altered some of the farming practices such as fallowing system, shifting cultivation and crop rotation. Rather farmers now adopt intensive land cultivation technique and drastic reduction in the fallowing period, which has a declining effect on soil fertility, especially in soil erosion prone southern part of the country.

To tackle this problem of decreasing soil fertility and unsatisfactory agricultural output, there is an overwhelming need to intensify the use of fertilizer

technology among our farmers. Empirical studies have shown that chemical or mineral fertilizer is one of the most powerful productivity enhancing inputs available (Naseem et al 1999; Byerlee et al 1997; Heisey 1997). Nigerian farmers consumed on the average 11.8kg per hectare of fertilizer between 1991 and 1995. The figure declined to 8.9kg per hectare in 1996 and later increased to 9kg/ha in 2002 to 2003 (Gruhn et al 2000; FAO 2004 and FAO, 2004b). The government subsidy programme on fertilizer input did not significantly affect fertilizer consumption among smallholder farmers (Smith et al 1994; Daramola 1986 and Nwosu, 1995).

At the state level, various state governments have mapped out several strategies to increase fertilizer consumption among her farmers through direct procurement and extension services. In Cross River State, in particular, government has been involved in direct distribution of fertilizer to farmers through Local Government Liaison Offices. The state has two distinct ecological zones: the dry inland area and the coastal wetland region. The wetland area stretches from Akpabuyo Local Government Area through Calabar South and Calabar Municipality to Odukpani Local Government Area. Also there are some spotted wetlands along Ikom River and Calabar River. The wetland stretches inland for a distance of 25km from the Atlantic Ocean and comprising inshore waters, coastal lagoons, estuaries and mangrove swamp (Awosika et al 2001). The rainy season spans the period, April to October, with an annual rainfall of 3000mm to 4000mm. The dry season lasts between November and March (Awosika, 2001b). This unique demarcation makes farming more lucrative in the upland area during rainy season. The wetland region offers an opportunity for all-year crop farming including the dry season.

Wetland crop farming in Cross River State has been going on for ages. This practice has turned up

several tons of agricultural output especially the short-live crops like okra, maize, rice, improved hybrid of cassava, cucumber, cocoyam, pumpkin among others. Due to encroachment of human development the area has been under intensive year to year cultivation with a corresponding reduction in farms size and soil fertility. To cope with increasing demand for food especially during the dry season and rapidly increasing population of the state there is an overwhelming need to improve on the existing manure based soil improvement technique of the wetland farmers in the state. Mineral fertilizers technology is crucial to such efficiency. With the current effort by the Cross River State Government towards fertilizer distribution and extensive publicity on the use of mineral fertilizer, farmers are ready to buy and use mineral fertilizers in the wetland region. Since these fertilizers are not free; the pertinent question becomes; what factors affect wetland farmers in buying this farm input? The identification of these factors would help to address the constraint wetland farmers have in consuming mineral fertilizer. This, it is hoped, would help to lessen the food problem and reduce the scourge of urban and rural poverty among the citizens of the state.

The study will therefore specifically attempt to identify the determinants of fertilizer use or demand among wetland farmers of Cross River State. The study will also assess the socio-economic characteristics of the wetland farmers as well as highlight policy implication of our findings for appropriate recommendations.

LITERATURE REVIEW

Kelly (2006), while studying factors affecting demand of fertilizer in sub-Saharan Africa, identified price of fertilizer, output price of crops, and prices of other inputs that substitute for fertilizer including parameter of fertilizer production function as factors affecting fertilizer demand in the region. Staal et al (2003), identify education, extension service, number of adults per acre, cash crop plot, pasture plot, idea or prediction of rainfall pattern by farmers, population density and various soil textures (clay, loamy and sand) as important determinants of fertilizer demand decision in Kenya. Fufa et al (2006) on their empirical research on determinants of fertilizer use on Maize farms in eastern Ethiopia found out that age and farmers perception and the current price is high have a negative significant effect on fertilizer demand among farmers. They also highlighted farmer's expectation of good rainfall season to have positive significant effect on fertilizer demand. On the other hand, Croppenstedt et al (1996) in their work on the determinants of demand of fertilizer among cereal farmers in Ethiopia found plot size, previous experience with fertilizer, supply of fertilizer, liquidity, oxen owned by household, and the ratio of price of main crop to cost of fertilizer and credit availability as important factors constraining fertilizer demand. Naseem et al (1999) also identified factors affecting fertilizer use in sub-Saharan Africa to include farm size, amount of rainfall, density of road infrastructure, household size and percentage of land devoted to cotton. Minot et al (2000) studied demand of fertilizer among farmers in Benin Republic and Malawi and found out in Benin Republic that education of

household head, size of farm plot, and household head expenditure have a positive significant effect on fertilizer demand, while farm size squared, maize plot, rice plot, number of cattle owned, and number of oxen have a negative significant effect on fertilizer demand among farmers. In Malawi, however, they inferred that unit household size, education of household head, ethnicity, price of maize, farm size, number of pigs owned, household head expenditure, club membership, vegetable plot, tobacco plot and maize plot have positive significant effect on fertilizer demand. Plot ownership, regions and size of the plot on the other hand have negative significant effect on fertilizer demand.

THEORETICAL AND MATHEMATICAL FRAMEWORK

The study is based on the concept of profit (π) maximization. We assume that a farmer is a rational producer and decision maker. A wetland farmer is assumed to face an optimization problem such that profit is maximized with respect to the cost of variable production inputs. Let us consider a farmer that wants to maximize profit of Y output crop given inputs X_1 , X_2 , and input normalized prices of r_1 and r_2 respectively. Also the output price is given as P.

$$\text{Then } \pi = PY - r_1x_1 - r_2x_2 \dots\dots\dots (1)$$

To optimize equation (1) involves maximizing π subject to cost constraint.

$$\text{Maximize } \pi = PY - r_1x_1 - r_2x_2 \dots\dots\dots (2)$$

Subject to

$$C^0 = r_1x_1 + r_2x_2 \dots\dots\dots (3)$$

C^0 is a constant cost of inputs used in producing Y. This cost is a constraint that limits the farmer's ability to obtain more inputs. Hence $Y=f(x_1, x_2)$ and the relationship is ideally concave. Following the above condition we can specify various forms of production technology models. We consider Ordinary Least Squares method (OLS) instead of Maximum Likelihood Method. This is because we assume that the error term exhibits all the characteristics assumed by OLS method. Through extensive publicity, the farmers are assumed to have good knowledge of the availability of the fertilizer but are constrained by certain factors in purchasing the input. Therefore the shape of the error distribution is assumed to be symmetry as only few farmers would be expected to have no idea of the availability of fertiliser. The normal or symmetry shape of the error term validates the use of OLS instead of the Maximum Likelihood Method. In addition, we considered linear and exponential forms of OLS. These forms give better predictive estimates when used to estimate demand function (Carreira et al, 2006).

METHODOLOGY

Study Area

The study was conducted in southern part of Cross River State because it is the major wetland area in the State. Four local government areas were randomly selected for data collection. They were, Akpabuyo, Odukpani, Akamkpa and Calabar municipality. Stratified sampling technique with simple random selection was adopted in the study. Each local government area was divided into two sub-groups based

on the location and homogeneity of the wetland. Only farmers that grow cassava, maize and pumpkin in mixture or as a mono cropping system were considered for selection. In each of the sub-groups, 25 farmers were randomly selected in Akpabuyo, a total of 50 farmers were randomly selected from the 2 sub-groups in Odukpani. A total of 20 farmers were randomly selected from Akamkpa and 10 farmers from Calabar Municipality. In all, 130 farmers were used for data collection.

EMPIRICAL MODEL

Two forms of demand model were used, as they were expected to produce better estimates when used to estimate demand function (Carreira et al 2006). Ordinary Least Square method was used to estimate the selected functional forms.

Linear form:

$$Y = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + \dots + a_nX_n + e_1, \dots \quad (4)$$

Exponential form:

$$LNY = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + \dots + a_nX_n + e_2, \dots \quad (5)$$

Where e's are white noise or error terms, X's are vectors of explanatory variables. Details of X's are given below. Note that Y is the quantity of fertilizer bought in ₦/kg. The models specified, are used to investigate both income and non income determinants of fertilizer demand expressed in (₦/kg) by wetland farmers in Cross River State.

DESCRIPTION OF VARIABLES

Based on previous empirical work, we specify the following variables for investigation in the study area. The variables are listed and described as in Table 1 below.

TABLE 1: VARIABLE DESCRIPTION

VARIABLE	TYPE	DESCRIPTION
AGE	Continuous	Age of a farmer in years
HHS	Continuous	House hold size in number
SEX	Binary	Sex of respondent; 1 if male and 0 otherwise
AGE2	Continuous	Age of a farmer square in year square
EDU	Continuous	Formal education of a farmer in years
ETHNICITY	Binary	State of origin of a farmer; 1for indigenes 0 otherwise
FARMSS	Continuous	Farm size of respondent in ₦/hectare
FARMSS2	Continuous	Farm size square in ₦/hectare square
LANDOWN	Binary	Farm ownership: 1 for owner and 0 otherwise
CRD	Binary	Farm practice; 1for mixed cropping and 0 otherwise
DH	Continuous	House – farm distance cost in ₦/Km
DP	Continuous	Fertilizer purchase point – farm distance cost in ₦/Km
EXS	Continuous	Number of contact with an extension agent
MMA	Continuous	Membership of Association in years
HHC	Continuous	House hold consumption expenditure (₦)
OFI	Continuous	Off-farm income of farmers (₦)
PFER	Binary	Farmer fertilizer price idea; 1 for high price and 0 otherwise
FIN	Continuous	Farm income of a farmer in (AE) (₦)
NOPH	Continuous	Number of poultry kept by the farmers
NOGH		Number of goats kept by the farmers
PRF	Binary	Farmer ability to predict rainfall; 1 for yes and 0 otherwise
ART	Binary	Access to modern communication; 1 for yes and 0 otherwise
FPM	Binary	Soil practice; 1for bedding and 0 otherwise
OMM	Continuous	Output of maize in ₦/kg
OCC	Continuous	Output of cassava in ₦/kg
OTP	Continuous	Output of pumpkin in ₦/kg
MCP	Continuous	Output of maize, cassava and pumpkin in ₦/kg
FERT.	Continuous	Quantity of fertilizer purchase by farmer expressed in ₦/kg

Farm income (FIN) is expressed in adult equivalent (AE) ₦ where

$AE = 1 + 0.7(N_1 - 1) + 0.5(N_2)$ [Quartey (2005) in Ukoha et al (2007)].

N_1 = Number of adult aged 15 years or above

N_2 = Number of children aged less than 15years. Then the farm income per adult equivalent was derived as a total of farm income divided by the adult equivalent (AE).

RESULTS

Table 2: SOCIO- ECONOMIC PROFILE OF WETLAND FARMERS

Characteristic	Frequency	Percentage
Sex		
Male	90	69.2
Female	40	30.8
Total	130	100.0
Age (year)		
<20	31	23.8
20-30	40	30.8
>30	59	45.4
Total	130	100.0
Education (year)		
No schooling	4	3.0
Primary school	81	62.4
Secondary school	35	26.9
Tertiary	10	7.7
Total	130	100.0
Family size		
<3	25	19.2
3 -5	60	46.2
>5	45	34.6
Total	130	100.0
Extension contact		
Zero contact	83	63.9
>3 contacts	29	22.3
>5 contacts	18	13.8
Total	130	100.0
Farm income (₦)		
<10,000	50	38.5
>10,000	80	61.5
TOTAL	130	100.0
FARM Size(Ha)		
0.1 -0.3	60	46.2
>0.3	70	53.8
Total	130	100.0
Membership of association (yr)		
<1	4	3.1
1 -10	70	53.8
>10	56	43.1
Total	130	100.0
Farming Experience (yr)		
<2	15	11.5
>2	115	88.5
Total	130	100.0

Source: Field survey, 2008

The result from Table 2 reveals that the majority of wetland farmers in Cross River state are males. This perhaps explains the high labour energy required to cultivate a wetland farm. Majority of farmers are relatively of youthful age and have few years of formal education. More than 40% of the respondents have moderate family size of 3 to 5 members and more than 60% have zero contact with extension agent. About 90% of the respondents have farm size less than one hectare and more than 60% made income of more than ₦10,000 in their farming activities.

DETERMINATIONS OF FERTILIZER DEMAND

Two functional forms of fertilizer demand function were estimated, namely; the linear and the exponential forms. The Linear form was picked as the lead equation because it exhibits better predictive value, and also contains more significant variables. For the lead equation, 89.16% of the variability in fertilizer demand was associated with the specified variables. The F- statistic (3.595) was highly significant at 1% level. This means the specified multiple linear regression model provides a better estimation to the fertilizer demand function of farmers in the study area.

TABLE 3: RESULTS OF REGRESSIONS.

VARIABLE	LINEAR (L)	EXPONENTIAL
AGE	-0.395(-0.420)	-0.027(-0.598)
HHS	-0.451(-1.712)*	-0.124(0.816)
SEX	15.083(-1.791)	0.512(0.842)
AGE2	-3.910(-0.820)	-2.83(1.287)
EDU	1.821(1.873)*	-0.115(1.758)*
ETHNICITY	18.995(1.541)	1.064(1.912)*
FARMSS	19.354(9.490)***	0.335(0.344)
FARMSS2	-7.502 (-7.117)***	-0.209(-0.068)
LANDOWN	-8.983(-0.759)	-0.434(-0.764)
CRD	4.279(0.244)	-0.073(-0.087)
DH	-1.175(-0.539)	0.015(0.140)
DP	-0.029(-0.480)	-0.001(0.404)
EXS	2.062(1.967)*	0.398(0.551)
MMA	1.156(0.808)	0.049(0.715)
HHC	-3.230(1.712)*	0.000015(1.690)*
OFI	0.001(0.689)	0.000089(1.914)*
FIN	0.0007(2.896)**	0.0000007(0.300)
NOPH	-0.081(-1.615)*	-0.022(1.269)
NOGP	-0.711(-1.710)*	-0.12(1.970)*
PRF	9.936(8.800)***	0.759(1.410)
ART	17.859(2.113)**	1.3414(1.705)*
FPM	9.949(0.508)	0.855(0.908)
OMM	1.66(1.799)*	-0.003(-0.057)
OCC	-0.096(-0.047)	-0.018(-0.184)
OTP	-0.530(-0.562)	-0.010(-0.254)
MCP	0.003(1.696)*	-0.0011(-1.401)
PFER	-0.913(-7.130)***	-0.193(-3.510)***
CONSTANT	3.648(1.500)	0.799(1.200)
R ²	0.891	69.91
-R ²	0.776	62.73
F-STAT	3.595***	3.012***

Note: *, **, and *** represent significant at the 10%, 5% and 1 percent (%) levels respectively. Variables are as defined in Table 1. Value in parenthesis is t-ratio. L= lead equation.

Household size has a negative significant (at 10% significance level) effect on fertilizer demand by wetland farmers. This suggests that as household size increases, more of the household income is channelled to household expenditure rather than to investment in buying fertilizer.

Educational level of the farmer has positive significant (at 10% significance level) impact on fertilizer demand. This means that as farmer's education levels get higher, the tendency for innovation adoption will also increase. This suggests that farmers will be exposed to current information on soil management as level of education increases. This in turn enhances their fertilizer demand. Steal et al (2008) had reported similar result.

Farm size has a strong positive significant (at 1% significant level) effect on fertilizer demand. Farm Size Square rather shows a negative significant impact. The result implies that total fertilizer demand increases with the farm size but at a decreasing rate. In other words, the unit per hectare demands of fertilizer declines with increase in farm size. Minot et al (2000) had similar result for Benin Republic.

The frequency of contact with an extension agent has positive significant (at 10% significance level) effect on fertilizer demand. This suggests that frequent extension agent- farmers meeting will promote awareness on the use of fertilizer by farmers. This will improve farmer's fertilizer demand.

The Household consumption expenditure has negative significant (10% significance level) effect on fertilizer demand by wetland farmers. This result suggests that farmer's fertilizer demand decreases with increased household consumption expenditure. This means that farmers prefer satisfying their domestic food demand to purchasing fertilizer.

Farm income, farmer ability to predict rainfall, and access to communication facilities have a positive significant (at 5%, 10% and 5% significance levels respectively) effect on fertilizer demand. As farm income increases, farmer's fertilizer demand also increases. Ability to predict rainfall affects positively the quantity of fertilizer used by the farmers. Also, the presence of modern communication facilities enhances fertilizer usage by the farmers. This actually reduces transportation cost and other variable costs. The

numbers of poultry birds and goats kept by the wetland farmers have a negative significant (at 10% significance level each) effect on fertilizer demand. The poultry litter and the animal dunes are good supplement to mineral fertilizer. The more the farmers have access to this manure sources, the more they reduce the consumption of fertilizer. Perhaps due to excessive deterioration of the wetland soil, the magnitude of the effect is relatively small; each manure source reduces fertilizer demand by less than 1kg per hectare.

The output of maize crop has a positive significant (at 10% significance level) response to fertilizer demand. The result reveals that maize crop responded better to fertilizer application than other crops in the wetland area. The result suggests that, farmers that planted maize have high demand for fertilizer than other crops. In other words, a farmer that plants maize crop is likely to increase fertilizer demand by 1.66kg per hectare. Minot et al (2000) obtained similar result in Malawi. Combined output of cassava, maize and pumpkin has positive significant (at 10% significance level) response to fertilizer demand. The maize content perhaps increases the fertilizer usage or demand.

CONCLUSION AND POLICY IMPLICATION

The study examined the socio-economic profile of the wetland farmers in Cross River State and identified the factors that affect fertilizer demand among the farmers. The study reveals that male farmers predominate the farming activities in the region. Majority of the farmers were of youthful age and had up to primary school education. Majority of respondents have 3 to 5 family size and zero contact with the extension agent while few made farm income less than ₦10, 000 and had farm size greater than 0.9 hectare.

On the other hand, the results of the regression indicate that household size, farm size square, household consumption, number of poultry birds, numbers of goats and farmer idea on fertilizer price have negative influence on farm level demand of fertilizer by wetland farmers. On the other hand, education of the farmer, farm size, extension service, farmer's ability to predict rainfall and output of maize have positive significant effect on fertilizer demand by the farmers. Based on the above results, we propose the following policy implications and recommendations.

- Policies, which reduce production constraints and household size, will increase wetland farmer's ability to increase fertilizer consumption. A reduction in agricultural production constraint will increase farm income through reduction in variable cost and subsequent increase in farm total revenue. Additionally, it will increase the number of farm plot, which has a positive significant effect on fertilizer demand.
- Education of the farmer and extension service have positive significant effect on farmers. Thus policies that are geared towards educational development of the rural people in Cross River State will also promote awareness on the use of fertilizer through exposure of the rural farmers to

current information on soil management techniques. Such policies will promote fertilizer demand among the farmers and are therefore strongly advocated.

- Farmer's ability to predict rainfall and access to modern communication facilities have positive significant influence on fertilizer demand. The result suggests that policies that are aimed towards rural development through provision of amenities and infrastructures such as metrological centre and modern global system of communication facilities will improve fertilizer demand. This is based on the premise that, farmers will reduce costs, risks and uncertainty while channelling the unspent or saved income to fertilizer purchase.
- Manure-fertilizer research programme should be set-up by institutions, NGO's, individual and government. The aim should include modality for optimum combination of manure and fertilizer inputs to achieve economic yield while maintaining soil fertility and sustainable environmental impact. This will promote fertilizer and manure demand as a complementary productivity enhancing input in the state.
- Maize output has a positive significant impact on fertilizer demand. The result suggests that farmers in the wetland region of the state should incorporate maize as one of their major crops as this will lead to increased fertilizer demand.

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