ESTIMATION OF INORGANIC FERTILIZER DEMAND AMONG SMALL HOLDER FARMERS IN DELTA STATE NIGERIA: IMPLICATIONS FOR POLICY GUIDELINE.

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ABSTRACT
The paper critically attempts to adopt quantitative techniques to estimate the responsiveness of sustainable fertilizer demand to some selected socio-economic variables among smallholder farmers'. One hundred and sixty (160) smallholder farmers in Delta State, Nigeria were randomly selected and studied. Primary data were collected, from respondents with the use of structured questionnaire. Collected data were analyzed with the aid ordinary least square of multiple regression model. Seven out the eight variables captured in the model were significant. The result the study showed that a amount of 73.95kg of fertilizer was demanded and used by smallholder farmers in the study area. The multiple regression model indicated that the quantity of fertilizer demanded by subsistence farmers was positively determined by farmer's income (0.005), farm size (13.88), farmer's previous experience in fertilizer consumption (5.33) and frequency extension contact (14.23). On the other hand, fertilizer price (-0.07), distance to the nearest fertilizer store (-16.32) and the associated cost of transportation (-0.57), negatively affected sustainable fertilizer demand of smallholder farmer. It was recommended that sustainable fertilizer utilization would ordinarily require that the significant socio-economic variables in the equation should form the major instruments for fertilizer policy for small scale farmers.

Keywords: Determinants, Fertilizer demand, Policy, Smallholder Farmers.

INTRODUCTION

In Nigeria, the role of agriculture in economic development has been very vital. Fertilizer, as a key input in crop production, can contribute significantly to the development of agriculture. Crop yields in some locations have been observed to be severely limited by suboptimal fertilizer use. Thus fertilizer utilization of the smallholder farmers ought to improve over time and spacer Fertilizer demand is defined as the quantity of fertilizer that farmers are willing and are able to purchase and use in crop production at a given price over a period of time. Fertilizer demand is a derived demand because it depends on the demand for the product it helps to produce. Greenwood (1981), investigated that no other single factor correlates so strongly with crop yields as does the quantity of fertilizer utilized in crop production. Smallholder farmers are those farmers who cultivated 1.5hectare and, below in a cropping season.

Just as there is strong correlation between crop yields and the volume of fertilizer utilization, so there is relationship between the fertilizer demand of the farmer and some socio-economic factors. But it is difficult to generalize about the economic variables that are responsible for the growth in fertilizer demand in any country. For instance variables which may correlate with fertilizer demand relate to price of farm produce, policy posture, market access conditions, farm income, farm size, fertilizer price per bag, etc. Each could have its own set of assumptions (Abbott. 1993: Akinola and Young 1991; Aluko; 1987; Brown 1961; Mbanasor: 1997 and Oji, 1997).

The detection and follow-up policy control of such critical variables would contribute to the assessment fertilizer demand. It is a research gap that has not received much attention of development economists. Sustainable fertilizer demand by farmers has remained a topical issue in the Nigeria's plan for self-sufficiency in food production (lbironke, 1997: Ogunfowora, 1993). This has necessitated the renewed interest of experts in situating studies n fertilizer demand by farmers. Such studies are only made possible when experts have a clear understanding of the dynamic behaviour of a set of socio-economic variables that underpin fertilizer demand. This is because they serve as policy instruments for an effective fertilizer programme. For instance, the plan for agricultural development 1990 - 2005, estimated fertilizer consumption at 1.1 million metric tonnes in 1995, 1.2 million metric tonnes in 1997 and about 1.4 million metric tonnes by the year 2000; assuming fertilizer is consumed in 20% of arable land in Nigeria (APMEU. 1990; Ibironke, 1997).

The estimated periodic rise in fertilizer demand was tar 1mm attainment because correlated variables were not studied and considered in the plan. Thus constructing fertilizer demand model around some correlate variables becomes an important research puzzle that is critical to an effective fertilizer policy. This paper essentially attempts to construct such model that best approximates the causal relationship between some selected socio-economic variables (exogenous variables) and sustainable iirtilii.er demand (endogenous variables).

The broad objective of the study is to estimate fertilizer demand equation for small holders in an economy. The specific objectives are to:

(i) assess the quantity of fertilizer demanded by smallholder farmers in the study area; and

(ii) estimate fertilizer demand equation of the smallholder farmers in Delta State, Nigeria.

RESEARCH METHODOLOGY

Study Area and Sampling Procedure

The study was conducted in Delta state, Nigeria in 1999. The cross- sectional data used in this study were drawn from a comprehensive survey of fertilizer users (smallholder farmers). A sample of 160 fertilizer uses was randomly drawn from subsistence farmers in four Local Government Areas of the Delta State of Nigeria. These include Ethiope East, Ughelli North. Uvwie and Okpe Local Government Areas. Structured questionnaire was the main instrument used for the collection of primary data used for the study.

Analytical Framework

This study adopted econometric approach to estimate the fertilizer demand equation. Even where the form of estimation and tile relevant parameters are known, econometric model may sometimes be fraught by stochastic disturbance. In other words, error may arise from accurately estimating the behaviour of the endogenous variable from the behaviour of the exogenous variables. The reason being that there may be other variables that can affect the behaviour of the endogenous variable, which were not considered in the model. In economic theory, however, this error term is almost always suppressed.

Estimating sustainable fertilizer consumption equation is thus warranted once the basic premise embraces identifiable correlate variables of fertilizer demand in the past. This provides a minimum observed trend that is worthy of being translated into some specific future pattern necessary for fertilizer policy decisions over time. This can be achieved through econometric modeling. Thus interest in econometric approach to sustainable fertilizer consumption has been stimulated in part by the requirements for economic planners to make policy decisions on fertilizer consumption on the basis of reliable empirical information rather than mere intuitive-based-projections.

In this study, multiple regression analysis using the ordinary least square (OLS) technique was used to analyze the data collected.

Model Specification

The ordinary least square method of multiple regression and correlation model were employed in this study to determined the functional relationship between the quantity of fertilizer a farmer consumes and the correlate variables The essence of the use of these techniques is that once this functional relationship has been established, it is thin possible to predict fertilizer consumption on the basis of the coefficient of the "predictors". After trying other functional forms such as the semi-log and the double log functions, the linear multiple regression equation was chosen as the lead equation on the basis of R^2 value and number of significant variables. This takes the form:

$F_d = b_o+b_1X_1+b_2 X_2 +b_3X_3 + b_4X_4+b_5X_5+b_6X_6 +b_7X_7+b_8X_8 +\mu$

Where the variables and their expected behaviour are shown in Table 1.1

Tables 1.1 Description of Symbols in the Regression Model

Model Symbol	Description	Expected Sign	Measurement Unit
F_d =	Quantity of fertilizer demanded by farmers		Kilogram
X_1 =	Credit obtained	+	Naira
X_2 =	Farmer's income	+	Naira
X_3 =	Farm size	+	Hectare
X_4 =	Farmer's experience in fertilizer use	+	Years
X_5 =	Transportation cost to fertilizer store	-	Naira
X_6 =	Fertilizer price per 50kg bag	-	Naira
X_7 =	Distance to the nearest fertilizer selling centre	-	Kilometer
X_8 =	Frequency of extension contact	+	Number
b_o =	Intercept term		Number
$b_1 - b_8$ =	Regression coefficients		Number
μ =	Error term (unobservable factors)		Number

Test of Hypothesis

Durbin - Watson Test-for Autocorrelation in the Model

The test for autocorrelation is shown below:

The null hypothesis is H_0: P = 0

i.e. H_0: There is no auto-correlation with first order scheme. This hypothesis was tested against the alternative hypothesis

H_1: P≠0

i.e. H_1: The μ_s are auto-correlated with a first- order scheme.

RESULTS AND DISCUSSION

(i) fertilizer Demand of Smallholder Farmers

Table 2:1: Summary Statistics of Fertilizer Demand (kg)

Total	Mean	Minimum	Maximum	SD	CV	n
11,828	73.95	10	150	56.6	51%	160

The summary statistics of fertilizer demand is presented in Table 2.1. The result shows that total quantity of fertilizer demanded by smallholder farmers was 11,828kg, with mean of 73.93kg, minimum of 10kg and maximum quantity of 150kg. the average quantity 73.95kg/ha of' fertilizer demanded by smallholder farmers in 1999 was an improvement' over an average fertilizer consumption of 12kg per hectare by smallholder farmers in Africa (Ibironke, 1987). In spite of this, the mean quantity demanded by farmers was sub-optional. This falls short of 500kg/ha (based on average farm size of l.5hectare) need of the farmers in Delta State (Amantu, 1997).

(ii)Fertilizer Demand Equation

The linear function of the multiple regressions was accepted as the lead model on the basis of the value of R^2 and the number of significant variables in the model. An evaluation of' the frti1Izer consumption lead model shows that, it performed relatively well based on the values of R^2, R^2 (adj.) and F-ratio. The values of R^2 and R^2 (adj.) are 0.7589 (76%) and 0.7329 (73%) respectively. This indicates that approximately 76% of' the variation in the dependent variable (fertilizer quantity demanded) was due to socio-economic variables captured in the model. The values of the F^2 and F-test, thus provide reliable measures of the overall explanatory power of the regression model.

To test the null hypothesis of autocorrelation, Durbin - Watson statistics was adopted as follows: accept the null hypothesis of no autocorrelation if P = 0 and d = 2, otherwise accept the alternative hypothesis. Since P = 0 and d= 1.84 2, we accept that there is no autocorrelation in the function.

Using a one-tail at 1% level of significance, the F-computed is 59.7 and the theoretical F. (V_1 = 8, V_2= 151) is equal to 2.78. This shows that the model is significant.

The estimated regression equation is presented below:

$$\mathbf{F_d = .89.67 + 4.20X_1 + 0.005X_2 + 13.88X_3 + 5.33X_4 - 0.57X_5 - 0.07X_6 - 1632X_7 + 14.23X_8 + \mu^2}$$

(4.41) (0.93) (1.99) (4.69)* (6.06)** (350)* (11.85)** (470)* (3.98)***

R^2= 76%, R^2 (adj.) = 73%, F = 57, DW = 1:84, DF 8, 71,

Note: The figures in parenthesis immediately below, the regression coefficients are the corresponding t-values.

* = Significant at 1%

* * = Significant at 5%

Seven of the eight parameters included in the model were significant. These parameters relate to farmer income (X_2), Farmer size (X_3) Farmer's Fertilizer use experience (X_4), Transportation cost to the nearest fertilizer store (X5), Fertilizer price (X_6), Distance to the nearest fertilizer store (X_7) and Frequency of extension contact (X_8). The esu1ts obtained further indicate that all the explanatory variables enter the mode1 with expected signs, thus conforming with a priori expectation.

Test for Multi-collinearity in the Model

The correlation matrix showing the relationship between the diagnostic variables in the model indicated a low r-value. The component analysis seems to have taken care of the problem of multi-collinearity as the pair-wise correlations between diagnostic variables are generally low (**$r < 0.5$**).

At this point the results of the statistical significance of the individual explanatory variables in the model are discussed as Follows:

Credit

The fact that credit obtained is not statistically significant in the model, may suggest that smallholder farmers in the study area ct not depend strictly on credit for fertilizer purchasing. This could be perhaps due to the difficulties faced by them in obtaining credit for fertilizer purchasing in Delta State, Nigeria. This finding agrees with Abbott (1993) when he asserted that at high profitability from fertilizer use, the farmer may be less dependent on credit, but at less profitability level, access to credit becomes a major determinant of fertilizer demand.

Farmers Income

The coefficient of farmers' income is positive in conformity with a priori expectation that sustainable fertilizer consumption volume would increase as the resource holdings (income) of the farmer increases and sustained. Farmers in the rural areas would be more disposed to purchase and use more fertilizer when their income increases (Abbott. 1993 Mbanasor, 1997). Hence the smallholder farmers in the study area are indeed displaying rational behaviour.

Farm Size

A positive relationship between farm size and fertilizer consumption volume was evident. This implies that in the study area, small-scale farmers are more likely to purchase and consume fertilizer on the basis of farm size. This result agrees with Akinola and Young (1991) when they asserted that the larger the farm, the more the volume of fertilizer that would be consumed by the farmer. Also according to Oji (1997) economic theory stipulates that purchased input such as fertilizer can be regarded as normal input since its consumption increases with farm size. Thus land availability is an indicator of sustainable fertilizer consumption among farmers.

Farmers Previous Experience in Fertilizer Consumption

The results show that fertilizer consumption was sensitive to the farmer's experiences in fertilizer use. This variable gives an indication of both the length of farming experience and accumulation of capital. A long experienced farmer is more likely to have realized the importance of inorganic fertilizer and even where credit facilities are not available, such farmers are more likely to have accumulated enough capital resources to take advantage of fertilizer consumption (Oji, 1997). Thus experience would sustain farmers' interest in the use of fertilizer.

Transportation Cost to the Nearest Fertilizer Store

Transportation cost to the nearest fertilizer-selling center WS selected as a proxy for market access condition in the study area. This variable turned out to be a significant determinant of sustainable fertilizer consumption among smallholder farmers. The negative sign implies that a high transportation cost (which is a reflection of poor market access condition) would reduce the quantity of fertilizer a small-scale farmer would purchase and consume. On the other hand, a better market access would imply a reduced transportation cost to fertilizer selling centers. Oji (1997) had earlier noted that a better market access condition would give room for more demand. Therefore better rural road network would encourage sustainable fertilizer consumption by rural farmers.

Fertilizer Price

Fertilizer price per bag turned out to be one of the major determinants of sustainable fertilizer consumption by small holder farmers. The coefficient of this variable is negative in conformity with a priori expectation that the quantity of fertilizer consumed would ordinarily decrease as the price of fertilizer per hag increases. This is in consonance with the report of Aluko, (1987) that an increase in fertilizer price could lead to its under-consumption by resource-poor-farmers. Thus an affordable price of fertilizer per bag correlates SO well with sustainable fertilizer consumption by resource-poor-farmers.

Distance to the Nearest Fertilizer Store

The coefficient of this negative in the model in line with a priori expectation that fertilizer consumption volume would increase as the distance traveled by the farmer to the nearest fertilizer store decreases. This implies that relatively more distant farmers in the hinterland would purchase and utilize less quantity of fertilizer. Thus this variable captures the effect of' the location of fertilizer retail outlets on its consumption. Abbott (1993) had earlier recommended that where distance is a constraint to input (e.g. fertilizer) consumption, it should be sold and bought within area here its utilization will attract the greatest net economic return. In some situation farmers are able to use input only because of their proximity to the input selling station. The underlying policy objective should therefore be to strengthen the fertilizer linkage system through efficient marketing outlets to translate to advances in fertilizer demand and crop production in Nigeria.

Frequency of Extension Contact

The coefficient of extension contact is positive. This implies that fertilizer consumption rate by the small scale farmers depend on the information, in the form of technical advice they get through the extension agents. Even where extension agents are not involved in fertilizer marketing, it is possible that their frequent contact with small scale farmers would lead to sustainable fertilizer consumption. Thus a regional policy for strengthening the extension capacities through logistic support, and training programmes is critical to sustainable fertilizer consumption among smallholder farmers.

Implications for Policy Guidelines

The findings of this study have implications for policy implication for fertilizer demand and utilization among smallholder farmers. Of all the positive variables in fertilizer demand equation, the coefficient of the frequency of extension contact (14.23) exerted the highest influence on the fertilizer consumption among smallholder farmers in Delta State, Nigeria. The result implies that a 1 percent increase in frequency of extension contact will, all things being equal, lead to about 14 percent increase in fertilizer demand of the smallholder farmers in the study area. This is perhaps possible due to the technical support and input use advice that are embodied in agricultural extension package. The .policy option therefore is to improve the fertilizer distribution component of the extension services in Delta State, Nigeria.

On the other hand, of all the variables that negatively affected the demand for fertilizer of the Smallholder farmers in the study area, distance to nearest fertilizer store was outstanding with a coefficient of -16.32. This implies that a further 1 kilometer away from the nearest fertilizer store will discourage fertilizer demand by approximately 16%. The policy implication is to open up more fertilizer outlets (input delivery stations) in the farming communities. The cost of transportation (-0.56) also shows a negative re1atinship with fertilizer demand. A one percent rise in the cost of transportation, will all things being equal, lead to 0.6 percent drop in fertilizer demand among smallholder farmers in the study area. The deplorable road network should therefore be improved. Any macro -economic policy that continuously increases the pump price of petroleum products would have ripple effect on the ultimate price of the inputs. And this would discourage fertilizer demand among smallholder farmers in Delta State, Nigeria.

CONCLUSION AND RECOMMENDATIONS

This paper has attempted to estimate an equation for fertilizer demand among smallholder farmers. They have their peculiar characteristics of small farm size,

living in remote rural area, low income, low savings, small capital, low output and traditional method of farming. As a result of this separate fertilizer policy/plan should put in place so that they can benefit from government fertilizer programmcs in study area. The coefficient of multiple determination (R^2 = 0.7589), indicated that the model is efficient and can be relied upon in fertilizer policy formulation. Fertilizer policy/plan for smallholder farmers must therefore be based on farmer's income, credit, farm size, fertilizer price per hag, farmer's previous experience in fertilizer consumption, transportation cost lo fertilizer store, distance to the nearest fertilizer store and frequency of extension contact. The results further imply that fertilizer utilization would be optimized if policies are focused on complementary economic variable such as credit, income, subsidy and extension services that are critical to fertilizer demand of the smallholder farmers.

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