Fertilizer use and measures for increased sustainable consumption by peasant farmers: food security approach in rural Nigeria

Augustine J Udoh[1]* and **Emmanuel Umoh[2]**

1. Department of Agricultural Economics and Extension, University of Uyo, Akwa Ibom State, Nigeria
2. Department of Agricultural Economics and Extension, Cross River State University of Technology, Calabar, Cross River State, Nigeria

*Corresponding author: augtine@yahoo.com

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Abstract

A study was conducted to develop practices that would increase in fertilizer usage by the farmers in Akwa Ibom State of Nigeria. Three zones out of six of the Akwa Ibom State Agricultural Development Programme (AKADEP) were randomly selected. The target population was contact and non-contact farmers of AKADEP. One hundred and seventy farmers were randomly selected from the farm cells to take part in the study. The relationship between the quantity of fertilizer used and factors that affect it was determined by using multiple regression analysis. The results show that most farmers were old. While 18.82% had no formal education, about 34% had just primary school education. Their farm size and income were extremely low. Educational status, farm size and income level of the farmers had direct impact on the quality of fertilizer consumed. High cost of fertilizer, late arrival of fertilizer, distance between farmers and fertilizer sales centers and land fragmentation were some of the constraints to fertilizer use. The following measures were suggested to alleviate the problems. They are: close location of fertilizer purchasing centers at the farm level, timely distribution of fertilizer to farmers, reduction in fertilizer price through subsidy and packaging of fertilizers in 5, 10 and 20 kg bags to enable farmers to buy and use in their smaller plots.

Introduction

The role of fertilizer has long been recognized by farmers in Nigeria. Consumption of fertilizer had increased remarkably within the last forty years. Between 1953 and 1985, consumption of total nutrients rose from 603 to 389,540 t. In 1987, about 680,599 t of potassium fertilizer (K_2O) was consumed in the country. In 1990, for example 2.2 billion naira (N) was spent on procuring 1.3 million t of fertilizers. In spite of this, the level of fertilizer consumption (about 23 kg ha^{-1}) in Nigeria is considered low.

The proportion of the world population living in the developing countries has been estimated at about 72%; this no doubt means that the developing countries will have to step up their agricultural production. Consequently, according to Chianu et al. (2008) the African Heads of State declared support for increase in quantity of fertilizers used by farmers from about 8 to 25 kg ha^{-1}. Nigerian farmers like most farmers in Africa have recognized the need to improve soil fertility but despite farmers' awareness on the usefulness of fertilizer, its consumption has been very low. Several reasons have been advanced for the low fertilizer consumption in Nigeria. These include among others high cost of fertilizer, transportation costs and inadequate personnel. Similarly, high cost, poor distribution systems and lack of manufacturing abilities has compounded the problem of fertilizer use in African countries. A case study of the Mambilla Plateau Area of Nigeria indicated that the greatest problem of farmers in this area as regards fertilizer utilization is transportation due to poor infrastructure. According to Wallace and Knausenberger (1997), lack of credit, poor marketing structures, high cost of transportation and weak extension services are some of the constraints that affect fertilizer use in Ethiopia and other African countries.

The major objective of the study was to enhance fertilizer utilization in Akwa Ibom State. The specific objectives were: (a) to assess the socioeconomic characteristics of farmers in the study area; (b) to examine the relationship between the quantity of fertilizer utilized and factors that affect its use; and (c) to identify the constraints associated with fertilizer utilization in the study area. The study is of prime importance in determining better ways of ensuring increase in fertilizer utilization and hence the sustainable agricultural production in the rural area. It will help the government considerably to enhance planning of agro-developmental policies as well as implementation. It aims at increasing the awareness of farmers about fertilizer utilization and the provision of

materials to the researchers for further research and by which food security will be further strengthened.

Methodology

The research was conducted in the six agricultural zones in Akwa Ibom State: Abak, Etinan, Eket, Oron, Ikot Ekpene and Uyo. The area is located (latitude 4°30' and 5°53' N and longitude 7°25' E) in the southeastern zone of Nigeria. One hundred and seventy farmers were randomly drawn from a list of 500 contact and non-contact agricultural development program farmers selected in the Primary Fertilizer Distributing Points and Farm Service Centres with an even distribution in the six zones of AKADEP.

The instrument employed in the collection of data was structured questionnaire consisting of thirty-three items all based on fertilizer utilization. Section A of the questionnaire was concerned with demographic characteristics of the farmers, Section B dealt with quantities and distribution of fertilizer while Section C dealt on the constraints to fertilizer utilization and possible solution.

The independent variables that were used in the study include the following:

1. Age: measured in actual number of years of respondent.
2. Income level: measured in Nigerian naira and kobo.
3. Educational status: measured by the level of education.
4. Farm size: measured in ha.
5. Farming experience: measured in actual number of years spent in farming.
6. Extension contact: measured by the number of visits by the extension agents.

Method of data analysis used in this research includes descriptive statistical methods such as tables, frequency and simple percentages and pie charts. Analysis was carried out on data collected in 2010. Also regression analysis was performed to observe the relationship between the quantity of fertilizer utilized and factors that affect it.

Production function was estimated by method of ordinary least square (OLS) as follows in implicit form.

$Y = f(X_1, X_2, X_3, X_4, X_5, X_6)$

where

Y = Quantity of fertilizer utilized;

X_1 = Age; X_2 = Income level; X_3 = Educational status; X_4 = Farm size; X_5 = Farming experience; X_6 = Extension contact.

To obtain estimates for the parameters in the relationship, four common functional forms of the OLS method namely linear, semi-log, double log and exponential were applied.

The four functional forms can be expressed explicitly as follows:

Linear: $Y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + u$

Semi-log function (Cobb-Douglas):

$Y = 1nb_1 + b_1 1nx_1 + b_2 1nx_2 + b_3 1nx_3 + b_4 1nx_4 + b_5 1nx_5 + b_6 1nx_6 + u$

Double log function (Cobb-Douglas):

$LnY = 1nb_0 + 1nb_1 + b_1 1nx_1 + b_2 1nx_2 + b_3 1nx_3 + b_4 1nx_4 + b_5 1nx_5 + b_6 1nx_6 + u$

Exponential function:

$LnY = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + u$

where Y = Quantity of fertilizer;

b_0 = Constant parameters representing the intercept;

b_1 = Coefficient of the variable;

x_1–x_6 = Same as X_1 to X_6 as described earlier;

u = Error term (either affecting the utilization but not included in the model).

Results and discussion

Socioeconomic characteristics of respondents.

Age: Age plays a very important role in agriculture. In Nigeria, fertilizer application is mainly practiced by the old people due to rural urban drift of youngsters in search for white collar jobs and the reluctance of youth after school education to work on the farm due to drudgery and low farm prices. Table 1 shows that 21.2% of the respondents fall between 20 and 30 years of age. Next are those in the range of 31–40 years with 17.6% followed by those between 41 and 50 years with 26.5% and lastly 51 years and above with 34.7%. This implies that the farming population is aging since the old people have the greatest percentage. Therefore, fertilizers should be made available at the farm gates to enable the old people to acquire the product with less stress and cost.

Sex: It is generally believed that women contribute the greatest percentage in farming occupation; ie, women

engage more in crop farming than their male counterparts, who are mostly involved in fishing, hunting and in land clearing. Table 1 also shows that the rate of fertilizer utilization would be low because women have smaller farm sizes which require less quantity of fertilizer. Besides, their farm income is low and they would prefer to use household waste thereby paying little attention to chemical fertilizers. A policy to assist women to acquire more land and increased income should be instituted.

Marital status: The marital status of the farmers could help in stimulating them to improve the conditions of their farm, for instance, by adopting improved methods of farming in order to produce more food for their families. Data showed that 60.6% of the respondents were married while the remaining 39.4% were single. This implies that a greater percentage of the farmers being married will tend to utilize more fertilizer for greater yields since they have more number of dependents to feed. This means that farmers will save money to acquire fertilizers in order to fend for the family. Therefore, fertilizer products should then be made affordable by farmers.

Occupation: About 31% of the farmers worked part-time thereby spending less time in the farm. However, their attention is focused on enabling to provide more food to the people. They are educated and innovative in ways of improving their farms though they have to do it through farm labor. Table 1 also shows that 68.82% of the respondents were full-time farmers, 4.71% were engaged in trading, 18.82% were civil servants while 7.65% did other jobs. This implies that the full-time farmers are more likely to adopt modern farming techniques, for instance, use of fertilizers. A more favorable environment for full-time farming will also encourage more people to become full-time farmers and with adequate availability of fertilizers will enable them to consume more for increased food production.

Educational status: Standard of education is another important factor in the adoption of modern agricultural technologies. Table 1 reveals that 34.12% of the respondents had no formal education and 18.82% only attended primary school. About 24.12% were able to reach secondary school level while 22.94% attended other educational levels like College of Education and Polytechnic. This shows that about 19% of the farmers were illiterate thereby having a negative effect on the use of modern farm input like fertilizer. Literate farmers can read and write and therefore can read extension leaflets, posters and magazines for more innovations and can communicate their experiences to illiterate farmers. Creating adult education centers for illiterate farmers to improve themselves will go a long way to encourage the consumption of fertilizers at the farm level.

Farming experience: It is imperative that a farmer acquires enough experience to enable them succeed in the farming because experience has shown that the longer one stays in an occupation the higher the skills derived. Experience therefore helps one to adjust to adverse farming conditions and to adopt modern farming technologies. From Table 1, it can be seen that 11.8% of the respondents had been involved in farming for less

Table 1. Demographic and socioeconomic characters and distribution of respondents.

	Respondents	
Character	No.	%
Age (years)		
20–30	36	21.2
31–40	30	17.6
41–50	45	26.5
51 and above	69	34.7
Total	170	100
Sex		
Male	62	36.5
Female	108	63.5
Total	170	100
Occupation		
Farming (full-time)	117	68.82
Trading and farming	8	4.71
Civil service and farming	32	18.82
Others	13	7.65
Total	170	100
Educational status		
No formal education	58	34.12
Primary	32	18.82
Secondary	41	24.12
Others	39	22.94
Total	170	100
Farming experience (years)		
<5	20	11. 76
5–10	82	48.24
11–16	40	23.53
17–21	22	12.94
21 and above	6	3.53
Total	170	100
Farm size (ha)		
<1	64	37.65
1–2	47	27.65
3–4	35	20.59
5 and above	24	14.12
Total	170	100

than 5 years, 48.2% for the past 5–10 years, 23.5% for 11–16 years, 12.9% had spent 17–21 years while 3.5% of the respondents had been in farming for more than 21 years. This shows that over 80% of the respondents had 5–21 years of experience, which will enhance benefits of fertilizer use. An intensive campaign program for the inexperienced farmers on adoption of improved farm technologies including the use of fertilizers will result in a greater quantity of fertilizer consumed by farmers and therefore higher production of tubers and roots, grains and vegetables.

Farm size: Farm size determines the quantity of inputs used. Small farm size requires less farm inputs such as fertilizer. Table 1 shows that 37.65% of the respondents had less than 1 ha farm, 27.65% had farm size of 1–2 ha, 20.59% between 3 and 4 ha of land, while 14.12% operate on farms of 5 ha and above. Most of the respondents' farm holdings are characterized by small size, which can be attributed to land acquisition and land fragmentation among family members. Because the farms are small, and the populations of crops planted are likely to be low, the quantity of fertilizer utilized would be reduced. To encourage farmers to consume more quantities of fertilizers, innovations on planting pattern and crop population should be intensified.

Income level: The level of income of a farmer determines his spending. Farmers with high level of income are likely to purchase large quantity of farm inputs. The higher the income level, the higher the response to the purchase of appropriate farm inputs. Figure 1 shows that 73.5% of the respondents had income level of N1,000–N2,000 while 15.9% earned between N3,000 and N4,000 and only 10.5% received N4,000 and above. This shows that majority of the farmers are low-income earners; consequently the rate of utilization of fertilizer is affected.

Cost of fertilizer: The cost of fertilizer may determine to a large extent the quantity to be used. Higher prices hinder the quantities of fertilizer purchased for use. Table 2 reveals that 28.2% of respondents were able to purchase fertilizer at N1500–N1700, 55.9% got it at

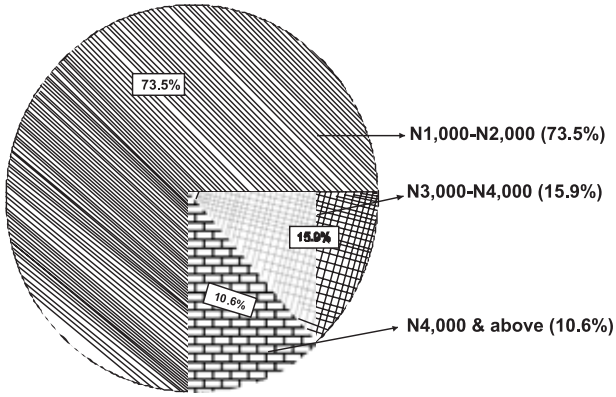

Figure 1. Distribution of respondents according to income level.

N1800–N2000 while 15.9% bought it at N2000 and above. This shows that the price of fertilizers is extremely high to allow for reasonable quantities by the low-income farmers for use on their farms. Besides high price, farmers have to travel long distance to and from the purchasing centers hence increasing their expenses.

Extension contact: Knowledge and experience about the existence of farm technology enables the farmer to make optimum use of it. Table 3 reveals that 37.65% of the respondents acquired knowledge about the existence and usage of fertilizer from extension agents whereas 62.35% from fellow farmers and friends. The percentage of those who acquired from fellow farmers is higher showing that farmers exhibit knowledge on the correct use of fertilizer thus demanding greater quantity of fertilizer utilized.

Place of purchase of fertilizer: The distance between the farm and the fertilizer purchasing centers determine the level of fertilizer utilization. Far distance attracts additional cost due to increase in transport fares, which add to the increase in the prices of the input. Table 4 shows that only 4.7% of the respondents were able to purchase fertilizer from AKADEP; 66.5% from open market and 28.8% purchase from Ministry of Agriculture. Majority of the respondents obtained

Table 2. Distribution of respondents by cost of fertilizer.

	Respondents	
Cost of fertilizer (N)	No.	%
1,500–1,700	48	28.2
1,800–2,000	95	55.9
2,000 and above	27	15.9
Total	170	100

Table 3. Distribution of respondents according to extension contact.

	Respondents	
Extension contact	No.	%
Extension agent	64	37.65
Other farmers	106	62.35
Total	170	100

fertilizers from the open market showing that the middlemen are very active in sale of fertilizers. This also created an opportunity for them to hike the price of the product. The use of cooperative societies by the farmers to purchase fertilizers at reduced rates for their members will enable farmers to use adequate amount of fertilizer in their farms.

Quantity and distribution of fertilizer: Quantity and distribution of fertilizer are related to the rate of fertilizer utilization, which in turn is determined by the price of fertilizer, income of the farmer, farm size, etc. Data recorded indicated that 48.8% of the respondents were not able to purchase fertilizers in 50 kg bags. However, 36.5% could purchase 5 bags of 50 kg, 12.5% purchased up to 3–4 bags of 50 kg and only 2.4% could purchase 5 bags and above of 50 kg of fertilizers. The farmers have not been able to purchase enough quantities for use on their farms and as such the level of usage is reduced. This can be attributed to income level of the farmers, price of fertilizers and availability of the input when needed. Since a greater number of farmers purchase less quantity of fertilizers due to the size of the bags, fertilizers packaged in smaller quantities should be made available for farmers' use.

Farmers' perception of fertilizer: Fertilizer has generally been perceived as being good for farming activities as it increases crop yield, improves soil fertility and increases income of farmers. Farmers' perception of the input determines the level of utilization. Table 5 reveals that 78.8% of the respondents accepted fertilizer as good input for farm activities. However, 17.1% of the respondents ascertained that it makes crops "watery" while 4.1% said it makes crops rot. The high percentage of those that accepted fertilizer as good input could be attributed to knowledge and experience about the correct use of fertilizer. Therefore, there should be more campaigns to dispel the wrong perception of fertilizer for optimum usage. The Ministry of Agriculture should therefore launch campaign in the rural areas to remove ignorance from the farming households in order to embrace the use of fertilizers whole-heartedly.

Table 4. Distribution of respondents according to the place of fertilizer purchase.

	Respondents	
Place of purchase	No.	%
AKADEP	8	4.7
Open market	113	66.5
Ministry of Agriculture	49	28.8
Total	170	100

Table 5. Distribution of respondents according to farmers' perception of fertilizer.

	Respondents	
Perception	No.	%
Good for farming activities	134	78.8
Makes crop 'watery'	29	17.1
Makes crop rot	7	4.1
Total	170	100

Constraints to fertilizer utilization: Factors such as high cost of fertilizer, late arrival, lack of knowledge about the correct use of fertilizer, distance between purchasing centers and the farms, land fragmentation, etc. were observed to have affected the level of fertilizer utilization. Figure 2 shows that 40.0% of the respondents complained of high cost of fertilizers as a constraint. This was followed by low income of farmers as indicated by 25.2% of the respondents. Fertilizers have been arriving in the state after the planting season. Late arrival of fertilizers also is a contributory factor to constraints in fertilizer consumption. This factor was identified by 14.1% of the respondents. Other factors contributing to constraints include far distance between purchasing centers and the farms; lack of knowledge about the correct use of fertilizers; land fragmentation; and lack of credit facilities. These were represented by 10.8%, 6.3%, 2.0% and 1.6% respondents respectively.

High price of fertilizers is the major constraint to fertilizer consumption (Fig. 2). Besides, farmers have to travel far distances (20–50 km) to purchase fertilizers thereby incurring high transportation cost. This then calls for availability of fertilizers in appreciable quantities in different sizes and in time. When fertilizers are used properly, crop productivity is enhanced, which

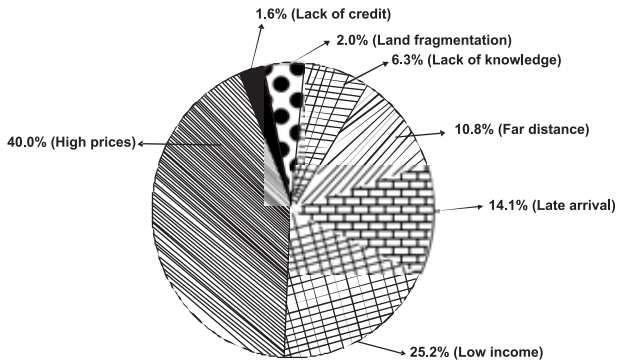

Figure 2. Distribution of respondents according to constraints to fertilizer use.

consequently, results in bumper harvest and therefore food security.

Food security. According to Jia (2009), "Rising agricultural productivity in developing countries is crucial to ease the tension of increased population and haunting concern on food security." But IRIN (2010) observes that farmers in Nepal face acute shortage fertilizers, which may impair food security programs. A similar situation is in Nigeria and other African countries. However, CTA (2000) states that despite the huge amounts of public funds from internal sources invested to increase productivity levels through improved product and processing technologies, sluggish growth in many countries still persists. Similarly, scientists have made more in-depth studies on most areas of food and agriculture to alert farmers, governments, policymakers, industries and financial houses and donor agencies to engage in food production to avert crisis of hunger and malnutrition. Charles and Bassey (2004) maintain that intensive vegetable farming by women in Calabar urban in the southeastern zone of Nigeria is associated with food security measures for their households. According to Lok Sanjh Foundation (2007), fertilizers play an important role in securing food supplies for the world. For example, commercial fertilizers contributed about 50% of the nitrogen taken up by the world's crops. This therefore implies that reducing fertilizer use may result in a threat to food security.

To enhance increase in the utilization of fertilizers by the rural farmers and therefore ensure food security, the following measures are pertinent. The provision of subsidy by the government, close location of fertilizer purchasing centers, timely distribution of fertilizers, price reduction and improvement in extension services are mandatory. Table 6 shows that 60% of the respondents suggested provision of subsidy by the government. Twenty-three respondents (13.5%) suggested close location of fertilizer purchasing centers of farms. About 5.9% maintained that there should be timely distribution of fertilizer while another 5.9% suggested improvement in extension services. Finally, 14.7% of the respondents suggested price reduction to ensure increase in fertilizer utilization. Subsidy alone will not save trouble if the farmers do not derive full benefit. Subsidy at times when provided by the government only ends in the hands of non-farmers. To avoid this, the activities of the middlemen should be checked. Hoarding and other practices should be kept under control. Government should involve Farmers' Association in implementing the subsidy so that the activities of the middlemen would be checked. The extension agents having close contact with the farmers would also ensure that they benefit from the subsidy. Moreover, the implementation should be done at the farm level and not at the Local Government Headquarters since this may involve the farmers traveling long distance thereby making it inaccessible to them. The women farmers in particular should be involved in the implementation since they will represent their group to receive the allocation.

Table 6. Distribution of respondents according to measures to enhance fertilizer utilization and food security.

Measures	Respondents	
	No.	%
Provision of subsidy by the government	102	60.0
Close location of fertilizer purchasing centers	23	13.5
Timely distribution of fertilizer	10	5.9
Improvement in extension services	25	5.9
Price reduction	25	14.7
Total	170	100

Regression analysis. The relationship between the quantity of fertilizer utilized and factors that affect its consumption was determined using Multiple Regression Analysis. Four functional forms that utilized OLS estimation methods were adopted for empirical purpose. These were linear, exponential, double log and semi-log equations. The equations showed the effect of the independent variables: age, income level, educational status, farm size, farming experience and extension contact on the quantity of fertilizer consumed. Results are presented in Table 7.

From the results in Table 7, linear equation was chosen as the lead equation. The choice of the equation is based on the parsimony of the estimated coefficients, the magnitude of the estimated coefficients, multiple determinations and the F-statistics and the number of statistical variables. The R^2 of 0.68% shows that 68% of the independent variables explain the total variation in the dependent variable. The remaining 32% were explained by other variables not included in the model.

$R^2 = 0.681$

The regression equation for the linear function is thus:

$$Y = 38.823 + 0.07106X_1 + 4.778X_2 + 0.307X_3 + 2.667X_4 + 0.357X_5 + 2.730X_6$$

The F-ratio = 12.43. This shows that the model was good and could be used for interpretation. Three of the estimated coefficients out of the six showed significance at different levels of probability. The coefficients are income level (X_2), education (X_3) and farm size (X_4).

The t-value of the coefficients of X_2, X_3 and X_4 were significant at 1% level. This implies that income level (X_2),

Table 7. Result of multiple regression analysis[1].

Functional forms	Constant terms	Age (X_1)	Income level (X_2)	Educational status (X_3)	Farm size (X_4)	Farming experience (X_5)	Extension contact (X_6)
Linear	38.823	0.07106	4.778	0.307	2.667	0.357	2.730
	(17.465)**	(0.444)	(0.945)***	(0.169)	(1.172)***	(0.856)	(9.305)
Exponential	3.492	0.003236	0.00005743	0.006425	0.03441	0.005082	0.0003051
	(0.363)***	(0.006)	(0.0001)	(0.009)	(0.036)	(0.011)	(0.123)
Double log	2.203	0.129	0.141	0.038	0.06066	0.09601	–0.00181
	(1.399)***	(0.214)	(0.04)***	(0.050)	(0.066)	(0.037)	(0.123)
Semi-log	–45.317	3.024	11.331	1.654	4.133	3.696	2.582
	105.947	(16.228)	(11.139)	(3.786)	(4.97)	(7.331)	(9.320)

1. Figures in parentheses are standard error values; ** = Significant at 5% level; *** = Significant at 1% level.

educational status (X_3) and farm size (X_4) contributed significantly to the variation in the quantity of fertilizer utilized. However, the age of respondent (X_1), farming experience (X_5) and extension contact (X_6) were not significant.

This could be discussed thus: as the income level of the farmers increases, the quantity of fertilizer utilized also increases. When farmers have enough funds at their disposal, there is the possibility that they purchase more of the fertilizers and hence increase agricultural productivity. When the income of the farmers is high, the farmers would not mind buying the input at any price. Level of education on the usefulness of fertilizer is an advantage, and thus farmers will apply more of the input to raise the yield of their crops bearing in mind its benefit.

Finally, farm size was shown to have been directly proportional to the quantity of fertilizer utilized. The larger the farm size the greater the quantity of fertilizer used. Farmers with larger farm size utilized more of the fertilizer to meet the requirement of the number of crops planted therein. A measure of strength of the relationship between the independent variables as well as the measure of the proportion of variance in the dependent variables that is explained by the independent variable is expressed by the F-statistics (12.43), which is significant at 1% level. This implies that the overall regression is significant.

Summary

The major objective of this study was to identify measures to enhance increase in fertilizer utilization. However, the results of the study revealed that most of the farmers in the study area were between 41 and 50 years. Their level of utilization of fertilizers was higher than other age groups probably because they were more experienced in the farm work compared to the younger farmers. The study showed that the majority were farmers with formal education. The literacy level of the farmers affected the adoption of fertilizer, which may have been closely linked to their awareness of the input. Most of the farms in the area were less than 1 ha in size. The study showed that most of the farmers were experienced in the farm work. It was also discovered that a greater number of the farmers used much of the fertilizers as these increased crop yields. Regression analysis showed that the quantity of fertilizer utilized is dependent upon the income level of the farmer and farm size.

Recommendations

Based on the findings of the study, the following measures are recommended to alleviate the problems that hinder fertilizer utilization and to enhance crop production and food security.

1. Regular training of farmers should be carried out to complement efforts of the extension agents.
2. Farmers' cooperative societies should be formed to enable farmers remove the negative impact of middlemen who add unnecessary cost to the prices of the products.
3. Timely delivery of fertilizers to the states should be encouraged.
4. Calabar Port should be used as a principal distribution center for Cross River, Akwa Ibom, Abia and Imo States to cut down transportation costs and therefore cost of fertilizers.
5. Efforts should be made to improve the existing storage facilities as well as build new ones.
6. Fertilizer promotion workshop and enlightenment campaigns should be intensified to enhance the efficient utilization of fertilizers to check their abuses and malpractices.

7. Government should exercise full supervisory role over fertilizer production and also make legislation, which will ensure sustainability of production level.
8. Ministry of Agriculture needs to ensure a thorough survey of the soils of this area and make fertilizer recommendation for the crops as deemed appropriate to avoid fertilizer wastage.

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