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Farmers and the Adoption of Modern Fertiliser: A Case of Irrigational Farming in Auyo Local Government Area, Jigawa State, Nigeria

Ahmad Abdullahi*[a], Abubakar Hamid Danlami[b],
*[a]*Registry Department, Sule Lamido University Kafin Hausa, Jigawa State*
[b] *Department of Economics, Faculty of Social Sciences, Bayero University Kano, Nigeria*
**Corresponding author email: *ahmadhja@gmail.com*

Abstract
The study examines the determinants of fertiliser demand among irrigation farmers in Auyo Local Government Area of Jigawa State, Nigeria. Data for the study was sourced using structured questionnaire, a two-stage sampling technique was used to select the respondents. Logit regression model was estimated to analyse the factors that influence modern fertilizer adoption, the result of the estimated model shows that, marital status, farm size, farming experience, contact with extension workers, membership of association were statistically significant in determining fertiliser adoption in Auyo local government area, Jigawa State. The result further shows that the major obstacles to fertiliser adoption and use intensity include: high cost of fertilizer, lack of credit facilities, inadequate supply, untimely supply, hoarding of fertilizer by agents, hoarding of fertilizer by agents and supply of undesired type. The work recommends that, government should enhance the services of extension workers, offer micro finance services, provide credit facilities, skills and training programmes on some off – farm jobs for farmers in the study area.

Keywords: Fertilizer, Adoption, Logit-Model, Constraints

1. INTRODUCTION

Agriculture is the main livelihood for over 70 percent of households in Nigeria (Banful, Nkonya, Obon, 2009). An estimated 65% of the population resides in the rural areas where agriculture is predominantly the occupation. It is estimated that about 70% of the rural population engage in agriculture yet cannot produce cheap adequate food the country (Kofarmata & Danlami, 2019; Manyong et al., 2005). Nigeria has a total land area of about 71.2 million hectares of cultivable land, out of which only about 34.2 million hectares or 48% of the total cultivable land are, actually cultivated (Amaza, Olayemi, Adejobi, Bila, Iheanacho, 2007). In Nigeria, agriculture remains a significant sector in the nation's economy despite the extensive role of the oil sector in the economy. It serves as the economic mainstay of the majority of households in the country (Amaza, 2000; Udoh, 2000). It contributes about 45% of the GDP, employs two-third of total labour force and provides livelihood for over 90% of the rural population. The sector is dominated by smallholder farmers accounting for over 90% of the total output while more than half of the farmers produce only food crops (Tsauni & Danlami, 2016; IFAD, 2010).
Land fragmentation as imposed by increasing population density and urbanization has resulted in increasing land use intensification which resulted to the collapse of the traditional fallow system of cropping, increase soil depletion and low crop yield among farmers (Azagaku & Anzaku, 2002) the pressure necessitated the need for a better way of

increasing soil fertility, hence, the adoption of fertilizer for enhanced productivity (Makinde, Agboola & Oluwatoyinbo, 2001). Fertilizer is known to be a powerful productivity enhancing input. Indeed one-third of the increase in cereal production worldwide has been attributed to fertilizer related factors FAO (1999). Anderson (1976), argue that "fertilizers contributed 55-57% of the rise in average yield per hectare" (as cited in Danlami, 2014a). Also, practical experiences have shown that chemical fertilizer is one of the most reliable productivity enhancing inputs available to farmers (Ezeh, Onwuka, & Nwachuku, 2006). However despite the vital role played by fertilizer in agricultural production, farmers in Sub-Saharan Africa (SSA) still lag behind other areas in terms of fertilizer use compared to the recommended level (Danlami, 2014b). The application of fertilizer improves the soil fertility in view of the continuous cropping of the fragmented land available to farmers. Experiences have shown that chemical fertilizer is one of the most reliable productivity enhancing inputs available to farmers (Onwuka, 2005).

Fertilizer in broad sense includes all those organic and inorganic materials that are added to the soil to provide elements essential for the growth of plants (Danlami, 2014b; Fayaz, Ali, Jan & Jan, 2008). Fertilizer is known to be a powerful productivity enhancing input, indeed one-third of the increase in cereal production worldwide has been attributed to fertilizer related factors. In the same vein, Pinstrup – Anderson (1974), argued that fertilizers contributed to 55 - 57% of the rise in average yield per hectare (cited in Danlami, 2014b).

Fertilizer use was estimated at 13 kg/ha in 2009 by the Federal Ministry of Agriculture and Rural Development (FMARD), far lower than the 200 kg/ha recommended by the FAO thereby resulting to declining soil fertility which is one of the major reasons for slow growth rate in food production in the country (Ogunmola, 2007). Consequently, low fertilizer use has been identified as a major challenge that must be overcome in order to increase Nigeria's agricultural productivity. It is in this light that this study seeks to examine fertilizer use and its determinants among food crop farmers.

Therefore, agricultural productivity growth in Sub-Saharan Africa lags behind that of other regions in the world, and is well below that required to achieve food security and poverty goals. Many farmers in the region are facing declining crop yields, which have adverse effects on the region's economic growth (Hassan, 1998). A prominent constraint to higher productivity among farmers in the region is "soil infertility" related mainly to low nutrient status of the soils and continuous cultivation without planned replenishment of depleted soil nutrients (Wanyama *et al.,* 2009). Increasing agricultural productivity in the Sub Saharan Africa especially in Nigeria is an urgent necessity; and one of the fundamental ways of improving agricultural productivity is through introduction and optimal use of improved agricultural technologies.

Reduced rate of fertilizer application in Nigeria (especially rural areas) may have adverse implications on soil fertility, agricultural productivity and rural poverty reduction. For instance Oke et al. (2009), argue that more than all other inputs, access to fertilizer and inadequate farming and storage facilities remain the key drawback to the growth of agriculture in Nigeria. Lack of fertilizer means low yield and low yield result to low income, and low income further keeps fertilizer economically out of reach of local farmers (cited in Danlami, 2014b). Moreover, Nwagbo and Achoja (2001) as cited in

Ezeh, Onwuka and Nwachuku, (2006), argued that various factors and constraints are at play in the microeconomic environment of the farmers which results to low consumption or application of inorganic fertilizer despite its vital role in enhancing productivity. However, as there is a strong correlation between crop yield and the volume of fertilizer utilisation (consumption), so is between fertilizer consumption of the farmer and selected socio-economic indicators. This condition motivates the need to analyse and assess the factors that influence small farm holders` fertilizer demand in rural areas using socioeconomic variables, as this will contributes towards the designing of policies that will stimulate fertilizer consumption in the rural areas.

1.1 Objectives of the Study

The main objective of the study was to assess the determinants of demand for fertilizer in Auyo Local Government Area. The specific objectives of the study are:

I. to examine the factors influencing the adoption of modern fertilizer among irrigation farmers in the study area;
II. to identify the various constraints to modern fertilizer adoption in the study area.

2. METHODOLOGY

2.1 Description of the study area

Auyo is a Local Government Area (LGA) in Jigawa state with its headquarters in Auyo. This LGA is occupied by the Auyo people and had Auyokawa as the dominant language (dialect) in the Local Government Area. At the moment, Auyokawa is extinct and Hausa language is the new adopted language in this Local Government Area. Auyo has a landmass of 512km² and has 731 as its postal code. Auyo has 132,268 at its population based on 2006 population census which is projected to rise to 176,800 by the year 2018 (NPC, NBS). The population of farmers under irrigation scheme is estimated to be 9,654 (FMA- GESS 2015). Auyo Local Government Area is surrounded by five other Local Government Areas; they are Hadejia, Malam Mandori, Kafin Hausa, Kaugama and Miga Local Government Areas

2.2 Method of Data Collection

Kothari (2004) defined data collection as the process of gathering empirical evidence to gain fresh insight into the situation and to answer research questions. For the purpose of this study, a structured questionnaire was used as an instrument for the collection of data. This research adopted questionnaire method because; it is more practical and economical than most of the other data collection techniques. Moreover, information can be solicited easily from many respondents within a short period of time. It also provides the researcher with high degree of flexibility by providing different alternative ways of administering questionnaire. The information generated from the respondents based on questionnaire is easily comparable. Additionally, it offers greater anonymity which makes respondents to provide more responses easily. Large samples that often considered in a questionnaire method makes results to be more reliable and dependable (Danlami, 2017; Kumar, 2011; Mackey & Gass, 2005; Kothari, 2004).

2.3 Tools of Data Analysis

Mugenda and Mugenda (2003) define data analysis as the process through which the collected data is sorted, classified and coded to produce units of measure for analysis. It involves summarizing and grouping data based on the study theme and objectives to be fulfilled. For the purpose of the study in order to achieve the set objectives, Logit Model was employed.

2.3.1 Logit Model

The Logit Model was developed by David Cox in 1958 to estimate the binary response based on one or more predictor variables. This study employed the Logit model to assess the significance of different variables in determining the binary response with regards to adoption of fertilizer as a farming input among irrigation farmers in the study area.

2.3.1.1 Specification of the Logit Model

This study employed the Logit Model to estimate the significance of different variables in determining the adoption of fertilizer as a farming input. Here the dependent variable (Y_i) takes value 1, if the sampled farmer adopts modern fertilizer or 0 if otherwise. Let Pi be the probability that a farmer adopt modern fertilizer and (1- Pi) defines the probability that the farmer does not adopt the modern fertilizer.

Following Danlami et al. (2017) and Gujarati (2004), the general form of the probability that a farmer adopt fertilizer as a farming input is given as:

Pi=eiXi1+eiXi (3.6)

And the probability that the farmer does not adopt fertilizer is given by

1-P=11+eiXi (3.7)

Where:

i *Vector of unknown coefficient*

Xi *Vector of explanatory variables*

The binary choice model is specified in form of;

Li=ln Pi1-Pi =Y*=0+iXi+ i

Where Y*is a dichotomous dependent variable which can either assume a value of 1 or 0. It thus measures the determinant of fertilizer adoption as a farming input. In this study, QF is conceptualized as an observed dependent binary variable defined by:

QFi=i+1INCi+2FSi+3PXi+4ACi+5PFi+6MAi+7EXTi+8EDi+
9FEi+i (3.8)

Where:

QF = quantity of Fertilizer adopted

INC = Income of the farmer

FS = Farm Size

PX = Price of Output

AC = Access to Credit

PF = Price of Fertilizer
MA = Membership of Association
EXT = Extension Services
ED = Farmers Level of Education
FE = Farming Experience
1… β6 = represents the regression coefficient
μ = Error Term

2.4 Sample Size

The total sample size in the study was arrived at based on Dillman (2011). According to Dillman (2011), the formula for determining a good representative sample is as follows:

S=NP1-PBC2 N-1+P1-P

where S is the required sample size; N the population size = 9,654 the population proportion expected to answer in a particular way (the most conservative proportion is 0.50); B the degree of accuracy, expressed as a proportion (0.10); and C the Z-statistic value based on the confidence level (in this case 1.96 is chosen for the 95 per cent confidence level). This formula has been widely used in the studies of household behavior (Danlami & Islam, 2020; Danlami et al. 2019a; Danlami et al. 2018a; 2018b; Danlami et al. 2017).

The sample size was formulated as follows:

S=(9,654 x 0.5)1-0.50.051.962 9654-1+0.51-0.5
S=2413.56.53
S = 369.6

2.5 Sampling Technique

This study used two stage sampling technique. In the first stage, 4 ward community areas were selected using a convenience random sampling technique out of the total 9 wards in the local government area. In the second stage, 115 irrigation farmers were selected at convenience from each of the selected sectors, making a total sample size of 460 households to be used for the study.

3.1 Results and Discussion of Estimate of Logit Model

One of the objectives of this work is to examine the factors influencing the adoption of modern fertilizer among farmers in the study area. To achieve this objective, Logit Model was estimated based on the information obtained from the selected samples of the study. The result of the estimated logit model is shown in Table 1 as follows:

Table 1: Estimated Logit Model for Fertiliser Adoption

Variable	Coefficients	ME
Age	.0281699	.0006182
	(.020308)	(.00054)

m_status	1.533931 (.5753992)	.023335 (.01325)
income_f	-.0146231 (.0177979)	-.0003209 (.00041)
income_o	.0073785 (.0368496)	.0001619 (.00082)
Fsize	.4402044 (.127809)	.0096606 (.00302)
f_experience	.2568094 (.1189302)	.0056359 (.00401)
extension_~t	.314294 (.3384072)	.0068974 (.0086)
Education	-.0682031 (.1562912)	-.0014968 (.00341)
Assoc	1.543767 (.457044)	.0319423 (.01874)
_cons	-3.547299 (1.444255)	

Note: standard errors in parenthesis. *

Table 1 indicates the estimated coefficients and marginal effects of the probability of irrigation farmers' adoption of modern fertilizer based on the estimated logit model. Out of the total number of nine variables included in the model, five were found to be statistically significant in explaining the probability of adoption of modern fertilizer by irrigation farmers in Auyo Local Government Area of Jigawa State.

Farm Size: The coefficient for the variable farm size is .4402. This means for a unit increase in farm size, we expect a .4402 increase in the log odds of adoption of modern fertilizer by the farmers in the study area, This implies that when farmer's farm size increases, the possibility of such farmer to adopt modern fertilizer also increases, indicating that the more the acres of land is acquired for cultivation, the higher will be the possibility of farmer's decision to adopt modern fertilizer. In addition, the value of the coefficient of this variable was also found to be statistically significant at 1% level and positively related to the probability of modern fertilizer adoption, this tallies with a priori expectation of the study and is in conformity with the findings of Akpan (2014), and Thuo (2012).

However, the value of the marginal effect for farm size was found to have positive relationship with the probability of modern fertilizer adoption farmers in the study area. An increase in farmer's farms size will raise the probability of modern fertilizer adoption by 0.003.

Membership of Association: The coefficient for the variable membership of farmers' association is 1.5437. This means for a unit increase in membership of farmers' association, we expect a 1.5437 increase in the log odds of adoption of modern fertilizer by the farmers in the study area. This might be attributed to the fact that farmers' participation in association activities enlightens them on the benefits associated with adoption and more ways of accessing the modern fertilizer. The value of coefficient of this variable was also found to be statistically significant at 1% level and positively related to the probability of modern fertilizer adoption, this conforms to a priori expectation of the work and was also in conformity to the work of Dube, (2016).

However, the marginal effect of the variable also shows that the higher the farmer's participation in farmers' association, the higher the probability of fertilizer adoption, implying that the adoption of modern fertilizer increases with more participation of farmers in the farmers' association in the study area.

Contact with Extension Agent: The coefficient for this variable is .3142. This means for a unit increase in contact with extension agents, we expect a .3142 increase in the log odds of adoption of modern fertilizer by the farmers in the study area. This is because agricultural extension workers are expert in farming activities that usually serve as free consultants to farmers. The variable was statistically significant at 1% level. This tallies with a priori expectation of the study and is in conformity to the findings of Danlami et al (2019b), and Nambiro (2012).
The marginal effect of this variable was also found to be positively related to the fertilizer adoption. This implies that the probability of fertilizer adoption increases with increase in the farmers contact with agricultural extension workers.

Marital Status: The coefficient for this variable marital status is 1.5339. This means for the married farmers, we expect a 1.5339 increase in the log odds of adoption of modern fertilizer by the farmers in the study area. This may be due to the fact that married farmers pay more attention to farming in a bid to produce for their families and also for additional income. The variable was statistically significant at 5% level. This tallies with a priori expectation of the study and is in conformity to the findings of Akpan (2014), and Nambiro (2012).
However, the marginal effect of this variable was found to be positively related to the fertilizer adoption. This implies that the probability of fertilizer adoption increases with marital status of the farmers.

Farming Experience: the coefficient of the variable is .2568 indicating a positive relationship between farming experience and the decision of a farmer to adopt modern fertilizer, which means that a unit increase in farming experience will increase the log odd of adoption of modern fertilizer by the farmers the variable is statistically significant at 5% level in explaining the relationship. Therefore, increase in farming experience has 60% probability of increase in adoption of modern fertilizer. The more experienced the farmer is the higher the tendency of their adoption of modern fertilizer as it was with apriori expectation. This is in line with the findings of; Danlami et al. (2016), Dramadri 2005 and Kaburu (2002).
However, the value of the marginal effect for farm size was found to have positive relationship with the probability of modern fertilizer adoption farmers in the study area. An increase in farmer's farming experience will raise the probability of modern fertilizer adoption.

Constraints to Fertiliser Consumption
The second objective of this study is to identify the obstacles of modern fertilizer adoption experienced by farmers in the study area. Table 2 shows the multiple responses on constraints to adoption of modern fertilizer by irrigation farmers in Auyo Local Government Area.

Table 2.0**:** Constraints to Fertilizer Consumption

Constraints	**Frequency**	**Percentage**
High cost of fertilizer	272	22.7
Lack of credit facilities	236	19.7
Untimely supply of fertilizer	230	19.2
Hoarding of fertilizer by agents	158	13.2
Inadequate supply of fertilizer	132	11.0
High cost of transportation	96	8.0
Supply of undesired type	72	6.0
Total	**1196**	**100**

Source: Field Survey, 2018

Table 2 indicates the collection of 1196 responses of the respondents on the various constraints to adoption of modern fertilizer in Auyo Local Government Area. The frequency shows that high cost of fertilizer is most constraining factor with 22.7% of the total responses followed by lack of credit facilities with 19.7%, untimely supply of fertilizer with 19.2%, hoarding of fertilizer by agents with 13.2%, inadequate supply of fertilizer with 11.0%, high cost of transportation with 8.0% and the least is supply of undesired type with 6.0%. This finding shows that all the factors have different level of constraining power to adopting modern fertilizer.

4. CONCLUSION

This study is centered on adoption of modern fertilizer and its influencing factors among irrigation farmers.

Empirical evidence from this study has revealed that majority of the farmers use (adopt) modern fertilizer on their farms. Marital status, farm size, farming experience, meeting with extension workers and membership of farmers' association are factors that significantly and positively determine the farmers' decision to adopt modern fertilizer in the study area.

5. RECOMMENDATIONS

i. As the study identified number of meeting with extension workers as one of the determinants of adoption of modern fertilizer, the government and other policy makers should increase knowledge and skills of farmers through avenues such as field days, extension agent contact with farmers or any other means of capacity building.

ii. Rural credit should be emphasized in order to mobilize savings and maximize the availability of credit to the farmers.

iii. The government and other stakeholders should establish institutions and encourage formation of cooperatives that offer micro-finances and loans to farmers.

iv. Other sources of income (non-farm) should be provided for farmers to complement their income from farming. This is because the study has found that the relationship between adoption of modern fertilizer and non-farm income is positive.

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