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Adoption of Inorganic Fertilizer by Resource Poor Cassava Farmers in Niger Delta Region, Nigeria

Nsikak-Abasi A. Etim and Glory E. Edet
Department of Agricultural Economics and Extension,
University of Uyo, P.M.B 1017 Uyo, Akwa Ibom State, Nigeria

Abstract – **Modern fertilizers use based on the chemical concept on plant nutrition have contributed very widely to the immense increase in agricultural production. This study shows empirical relationship between adoption of inorganic fertilizer and resource poor cassava farmers in Uyo, Niger Delta, Nigeria. Specifically, the study estimated the determinants of adoption of fertilizer by resource poor cassava farmers using Tobit model. Through the multistage random sampling procedure, 120 cassava farmers were selected and primary data were obtained using questionnaire. The result of the Tobit regression analysis reveal that farm size, population pressure on land, and farmers' age were directly and significantly related to adoption and use intensity of inorganic fertilizer whereas average walking time to the farm, sex of the farmer and availability of labour related inversely with adoption and use intensity of inorganic fertilizer. These result underscore the need for appropriate policy intervention that will encourage access to productive resources, such as land, investment in education and rural road infrastructure development.**

Keywords – **Adoption, Cassava, Farmers, Nigeria.**

I. Introduction

Nigeria produces the largest amount of cassava in the world, followed in descending order by Brazil, Thailand, the Democratic Republic of Congo (DRC), Ghana, Tanzania, Mozambique, Uganda, and Madagascar [1]. Although Nigeria's cassava products are still of low value and quality, available data suggests that Nigeria will continue to expand its output of cassava during the 2000s. Over five hundred million people live on cassava throughout the world, eating its roots or tubers due to their high energy content and its leaves that are an abundant source of protein and vitamins A and B [2]; [3]; [4].

By Zone, the North Central zone produced over 7 million tonnes of cassava a year (1999 to 2002). South South produces over 6 million tonnes a year while the South West and South East produces just less than 6 million tonnes a year. The North West and North East are small by comparison 2 and 0.14 million tonnes respectively [5]. On a per capita basis, North Central is the highest producing state at 0.72 tonnes per person in 2002, followed by South East (0.56), South South (0.47), South West (0.34), North West (0.10) and North East (0.01). National per capita production of cassava is 0.32 tonnes per person. In Nigeria, the consumption pattern varies according to ecological zones. Gari, a roasted granule is the dominant product and is widely accepted in both rural and urban areas. It can be consumed without any additives or it can be consumed with a variety of additives such as sugar, groundnut, fish, meat and stew. Fufu and Akpu, a fermented wet paste from cassava is another product that is widely consumed throughout the country especially in the Southern zones. In Niger Delta Region of Nigeria, mostly in Akwa Ibom and Cross River States gari and fufu are consumed with some indigenous soups as Edikang-ikong, Atama, Editan, Ikon, and Mbukpab uyo.

Nigeria has witnessed a growing demand for cassava and its products as propelled by rising per caput consumption. The country is facing twin challenges of reforming economy and reducing poverty [6]. With the increasing population of 141,000 million people [7], the pressure does not only limit land resource available for agricultural purposes but also causes a decline in food supply. According to [8]; [9] pressure on population does not only increase food demand but affect resource use and indirectly decreases food supply. Some factors which are responsible for the limitation in the adoption of fertilizer amongst farmers include risk preferences, credit constraints [10], low knowledge and literacy level [11] unprofitability of fertilizer use [12]; [13], inaccessibility to market [14] as well as limited or untimely availability of farm resources [15] and [16] have also emphasized the relevance of the households limited ex-post consumption coping capacity. Farms size and labour availability were also reported by [17].

Fertilizers are substances that supply plant nutrients or amend soil fertility. They are the most effective means of increasing crop production and improving the quality of food and fodder. Poor soil health and low use of inorganic fertilizers have been identified as two major factor limiting productivity growth of Agriculture in Africa [18]; [19]; [17]. Fertilizer has been a major component of the cultivation of improved cassava varieties being promoted by extension packages. It is therefore imperative that research in agriculture and policies/ programmes should be designed to understand the reasons responsible for slow fertilizer adoption by subsistence farmers in rural communities of the state. This study therefore attempts to identify the determinants of fertilizer use by resource poor cassava farmers in Akwa Ibom State, Niger Delta Region.

II. Methodology

This study was conducted in Akwa Ibom State, Niger Delta, Nigeria. The state is located at latitude $4^0 33^1$ and $5^0 53^1$ and longitude $7^0 25^1$ and $8^0 25^1$ East and occupies a total land areas of 7,246km^2. With an estimated population of about 3.9 million [20], the state is bounded to the North by Abia State, to the East by Cross River State, to the West by Rivers State and to the South by the Atlantic Ocean. Administratively, the state is divided into 31 Local

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Government Areas and has 6 Agricultural Development Project (ADP) Zones viz: Oron, Abak, Ikot Ekpene, Etinan, Eket and Uyo. The study area is in the rainforest zone and has two distinct seasons viz: the rainy and the short dry season. The annual precipitation ranges from 2000 – 3000mm per annum. Most of the inhabitants of rural communities in the study area are farmers and the crops commonly cultivated include cassava, oil palm, yam, cocoyam, fluted pumpkin, okra, waterleaf, bitter-leaf, etc. In addition, some micro livestock are usually raised at backyards of most homesteads [21]. The study employed multi-stage sampling procedure. The first stage involved the random selection of 4 Local Government Areas in the state. The second stage involved the random selection of 30 respondents from each Local Government Area. The participatory research involved 80 males and 40 females totaling 120 farmers. With the aid of questionnaire, primary data such as farm size, sex, soil fertility status, quantity of fertilizers applied, education, age, labour were obtained in 2012 cropping season.

III. Analytical Technique

To model the effect of adoption decisions, Tobit model is used. This model [22] and [23] has found several empirical applications in the adoption literature [24]; [25], [26, [27]; [28]; [17]. The dependent variable is level of use of inorganic fertilizer, which is censored at zero. To avoid the censoring bias that ordinary least squares could generate, a Tobit censored at zero was used because level of fertilizer use less than zero was not observed and most respondents reported zero application. As reported by [27] and [17], a bias to the parameter estimates is also imparted even when a Tobit procedure is incorrectly used assuming that the true point of censoring in the sample is zero. Other estimation approaches, such as the Heckman's model also generate unbiased results [28]. But the Tobit approach conserves degrees of freedom and is relevant in this case where the explanatory variables have a continuous effect on the dependent variable.

Since the level of fertilizer use cannot be negative (the threshold is zero), the dependent variable can be written using an index function approach as:

$$I^* = \beta^T X_i + e_i \qquad (1)$$

$$Y_i = O \text{ if } I_i^* = T \qquad (2)$$

$$Y_i = 1 \text{ if } I_i^* > T \qquad (3)$$

Where Y_i represents a limited dependent variable, which simultaneously measures the decision to use fertilizer and the use intensity.

I_i^* is an underlying latent variable that indexes adoption.

T is an observed threshold level

X is the vector of independent variables affecting adoption and intensity of use

β^T is a vector of parameters to be estimated

e_i is the error term. If the non-observed value of I* is greater than T, the observed variable T, becomes a continuous function of the independent variables, and O otherwise. For the generalized case, the value of the log likelihood function is given as

Empirical Model:

The model is presented as

$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}, X_{11}, X_{12}, e)$

Where Y = Total quantity of fertilizer used on cassava farm (kg/ha)

X_1 = Sex of the farmer (Dummy 1 if male, O if otherwise)

X_2 = Age of the farmer in years

X_3 = Education of the farmer in years

X_4 = Farm size in hectares

X_5 = Average Walking time to nearest farm in minutes

X_6 = Soil fertility status (Dummy; 1 if good, O if otherwise)

X_7 = Population pressure on available land (number of persons per hectare)

X_8 = Average walking time to nearest market in minutes

X_9 = Access to credit (Dummy; 1=yes, O if no)

X_{10}= Tenancy status (Dummy; 1 = tenant, O if landlord)

X_{11}= Labour in mandays

X_{12}= Membership of Social Organization (Dummy; 1 = member, O = Non-member)

e = Error term

IV. Results and Discussion

The summary statistics of the dependent and some explanatory variables are presented in Table 1. The average farm size used in the cultivation of cassava was 2.15 hectares. This is an indication and confirmation that farming in the area is on subsistence level with intercropping of maize and fluted pumpkin most prominent. This result is consistent with earlier empirical findings by [29] in their study of sources of technical efficiency among subsistence maize farmers in Nigeria. The smallness in farm sizes may be attributable to the prevalent tenural arrangement which encourages small holdings of farmland in southern Nigeria. Farm practices in cassava production include land clearing, construction of mounds or ridges, planting, fertilizer application, weeding and harvesting. The fact that labour is as high as 327.02 mandays is an indication that these practices require substantial amount of labour and greatly imply the labour intensive nature of cassava production. The results of the analysis on age and educational attainment are indications that cassava farmers are within an active and productive age group and have acquired and attained considerable level of formal education. The average walking time of 20 minutes to the nearest farm is an indication that most farms were not famer from homesteads and therefore were intensively cultivated. The average walking time of 15 minutes to the nearest market implies that farm products which are very perishable were readily marketed and therefore less likely to spoil.

V. Tobit Model Estimate Results

The land (Farm size) variable is positive significant at 1% level of probability. This implies that increase in this variable will lead to increased adoption and intensity of chemical fertilizer use. The effect of farm size has been variously documented to be positive. [30; [31]; [25] and [17]. Adoption costs, risk perceptions, human capital, credit constrants, labour requirement and tenural arrangements are affected by farm size. Reference [30] argued that large fixed costs in small farms are constraints to technology adoption and farmers, total land holding may serve as a good proxy for wealth status and income levels [32].

The variable age could have either positive or negative effects on adoption. Older farmers are less likely to adopt innovations. In this study, age has a positive sign and significantly impacts on adoption. Age indexes experience and services as evidence for human capital revealing that farmers with more years of experience in farming obtained from accumulated years of observation and experimentation with various technologies are more likely to adopt innovations faster than farmers with less experience. References [33]; [34]; [29] argued that increased experience in cultivation may also enhance critical evaluation of the relevance of better production decisions, including efficient utilization of productive resources.

The variable population pressure on available and indicates the relevance of maximum output as a consequence of fertilizer application. The coefficient is positive and significant at 10%. According to [25] and [17], farmers have greater incentive to intensify land use by applying land saving technology in order to meet higher household food needs, given the relatively inelastic supply of good quality land. The elasticity of average walking time to farm, sex and availability of labour and were negative and significant. This means that increasing these variables would lead to a decrease in the adoption of fertilizer and use intensity. The fact that the locational variable, average walking time to farm is negative significant is an indication that cassava farms located farther away from the homes are less intensively cultivated and thus require lesser fertilizer than farms located nearer to homes. The negative sign of the sex elasticity implies that males are less likely to adopt and intensively use fertilizer than females. The negativity of elasticity of labour may imply decreasing returns due to excessive and intensive labour use on cassava farms. The variable soil fertility status is negative significant. This implies that farmers whose soils have poor fertility status would be more likely to increase their rate of adoption and use intensity of fertilizer. This finding is consistent with earlier empirical study by [17] on the determinants of fertilizer adoption by cassava farmers in Nigeria.

VI. CONCLUSION

The study estimated the determinants of adoption of inorganic fertilizer and use intensity by cassava farmers in Akwa Ibom State, Niger Delta Region, Nigeria. Results of the study reveal that cassava was mostly grown on subsistence level and the most critical determinants of adoption of chemical fertilizer by farmers were land, age of the farmer, population pressure on land, average walking time to farm, sex of the farmer and labour. These findings underscore the need for appropriate policy intervention to stimulate cassava production by encouraging farmers particularly women through timely accessibility to productive resources such as land and chemical fertilizer. Rural road infrastructure should be developed to ensure accessibility to market and ready disposal of farm products.

Table I: Summary Statistics of variables of Cassava Production

Variables	Unit	Mean value	Minimum value	Maximum value
Land	Hectares	2.15	1.27	2.92
Education	Years	12	4	16
Age	Years	25	18	48
Labour	Mandays	162.08	90.58	327.02
Walking time to nearest farm	Minutes	20	14	28
Walking time to nearest market	Minutes	15	12	30
Population pressure	Persons/ha	6	2	14
Fertilizer use on cassava farm	Kilogram	121.52	50	200

Source: Field survey, 2012.

Table II: Tobit model estimates for determinants of adoption and use intensity of chemical fertilizer in cassava production

Variables	Coefficients	Standard error	t-ratio
Intercept	-0.686	0.298	-2.302**
Sex X_1	-0.441	0.215	-2.051**
Age X_2	0.621	0.309	2.010**
Education X_3	0.351	0.086	4.129***
Farm size X_4	0.082	0.026	3.154***
Walking Time to nearest Farm X_5	-0.063	0.029	-2.172**
Soil Fertility Status X_6	-0.016	0.006	-2.667***
Population Pressure on Land X_7	0.518	0.282	1.837*

Walking time to nearest market X_8	-0.812	0.634	-1.281
Access to credit X_9	-1.007	0.432	-2.331**
Tenancy Status X_{10}	0.028	0.081	0.346
Labour X_{11}	-1.531	0.634	-2.415**
Membership of social organization X_{12}	-0.081	0.218	-0.372

Source: Computed from Tobit Regression Results,2012
***, **, * Asterisk indicate significance at 1%, 5%, and 10% respectively.

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AUTHOR'S PROFILE

Nsikak-Abasi A. Etim
graduated from the University of Uyo, Nigeria with First Class Honours in Agricultural Economics and Extension. He obtained his M.Sc.in Agricultural Economics and Ph.D. in Resource and Environmental Economics from the University of Ibadan, Nigeria and Michael Okpara University of Agri-culture, Umudike, Nigeria respectively. He teaches Agricultural, Environmental and Resource Economics in the Department of Agricultural Economics, University of Uyo, Akwa Ibom State, Nigeria. He is a member of many professional bodies including the Agricultural Society of Nigeria. His areas of research are development and environmental economics with foci on poverty and efficiency issues in the contexts of production and environ-ment. He has published widely on these areas in both on-shore and off-shore journals.

Glory E. Edet
graduated from the University of Uyo, Nigeria with Second Class Honours (Upper Division) in Agricultural Economics and Extension. She obtained her M.Sc.in Agricultural Economics and Ph.D. in Resource and Environmental Economics from the University of Ibadan, Nigeria and Michael Okpara University of Agriculture, Umudike, Nigeria respectively. She teaches Agricultural, Environmental and Resource Economics in the Department of Agricultural Economics, University of Uyo, Akwa Ibom State, Nigeria. She is a member of many professional bodies including the Nigerian Economic Society and Agricultural Society of Nigeria. Her areas of research are welfare, development and environ-mental economics with foci on poverty, social capital and efficiency issues in the contexts of production and environment. She has published widely on these areas in both on-shore and off-shore journals.