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Effect of Household Endowment on Fertilizer Use in Rice Production in Kwande, Benue State, Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

This study investigated the effect of household endowment on the use of fertilizer by rice farmers in Kwande Local Government Area of Benue State, Nigeria. Primary data were collected from 100 randomly selected rice farmers through the use of structured questionnaires. Logit regression was used to analyze the data. The Logit results show that age, household size, education and credit were significant factors affecting fertilizer use among rice farmers in the study area. While household size, education and credit increased the probability of adoption of fertilizer, age decreased the probability. This emphasises the need for the relevant policy intervention to encourage technology adoption in the study area. Specifically, the government is recommended to enact and implement policies that will raise the physical, human and social capital of the households in the Benue State, Nigeria.

Keywords: Social capital; human capital; physical capital; fertilizer; adoption; rice.

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1. INTRODUCTION

Agriculture plays significant role in the social and economic activities of many countries of the world. Agriculture in Sub Saharan Africa has continued to be important for sustainable development, rural poverty eradication and reliable source of food for the region [1,2]. However, the productivity of agriculture has witnessed continuous declining trend while poverty increased in the region over the last ten years [2]. Agriculture contributes or accounts for 39.5% of Nigeria's Gross Domestic Product (GDP) and employs 70% of active population [3]. It provides food for the teaming population and raw material for growing industry [4] with the bulk of the food being provided by smallholder farmers with small land sizes and use of obsolete technologies. However, prior to oil discovery in Nigeria, agriculture contributed over 60% to its GDP as well major source of foreign exchange. During the oil boom period, the sector was neglected in the policy arena. Given that agriculture is the main stay of major population of Nigeria especially in the rural areas, poverty and insufficiency of basic food have characterised the economy since then [5]. This is due in part to the demand-supply gap arising from low agricultural productivity.

Low soil fertility has been recognized as one of the major constraints to higher productivity and this is basically related to low nutrient status of the soils and continuous cultivation without planned replenishment of depleted soil nutrients [6]. Therefore since the economy of the sub Saharan region and especially Nigeria depends heavily on agricultural production, agricultural productivity has to be improved through the introduction and optimal use of improved agricultural technologies such as inorganic fertilizer, improved seeds, soil and water management technologies, expansion of irrigation and water resource and increased provision of extension services. This study focuses on the fertilizer technology. Despite the expected impact of inorganic fertilizer, the African continent consumes less than 3% of world fertilizer use per annum and sub Saharan African account for only 1 percent of this amount [7]. Fertilizer use rate or intensity in Nigeria has been far below the Food and Agriculture Organization (FAO) recommended 200kg/ha for the sub Saharan African countries. For instance, [8], report on fertilizer use rate intensity among Nigerian farmers reveals an increasing fertilizer use rate from 1970 to 1993. The intensity dropped from 11.8kg/ha in 1995 to 8.90kg/ha, further increasing to 9.0kg/ha in 1996 and 13kg/ha in 2003. As at 2009, fertilizer use in Nigeria was estimated at 13kg/ha by Federal Ministry of Agriculture and Rural Development [9].

This figure varies across the different states of the nation. Technology adoption in Benue State has proven not to be very effective due to the challenges faced by household which could be due to the expensive nature of the technology and difficulty in use of the technology. In Benue State for instance, fertilizer is always scarce, farmers (especially small holders) hardly gain access to the fertilizers, even when access is finally gained, it is most times too expensive for them to purchase. Sometimes due to low income, farmers are only able to purchase fertilizers when the time for application of fertilizers for maximum use by the plant has already past. Subsidy is claimed to have been placed on fertilizer price for small holder farmers, yet Benue State farmers still complain of the non-availability of fertilizer [10,11]. Therefore, the major challenge is to promote efforts to increase the supply and use of inorganic fertilizer alongside other technologies. Although, the state produces a wide range of crops, rice is selected for this study given its prominent position.

Rice is valued as the most important staple food for over half of the world's population [12]. Asia accounts for more than 90% of world rice area and a comparable fraction of production [12]. In Nigeria, Benue state as the food basket of the nation ranks one among the highest producers of rice and contributors to the total output of rice production in Nigeria. Benue state in 2000 accounted for 61% rice production in Nigeria [12]. Between 2007 to 2010, the Benue State ranks 3rd in rice production and together with other six states accounted for 67% of rice production in Nigeria while the remaining 29 states accounted for only 23% [13]. A most current report indicates the state as the largest rice producer in Nigeria [14]. Rice is a cash crop which can be grown on upland and lowland and from all references; lowland rice has proven to be more profitable than upland rice. Rice production has declined over the years due to inadequacy of irrigation system, inorganic fertilizer application and none use of other improved technologies [13,15-17]. This is most times due to the challenges faced by the smallholder households with limited resources. Rice producing farm household are primarily smallholder with limited capital resources. They cultivate an average of 8ha with crop per year of which 3.3ha are

devoted to rice [8]. Crop farming typically is the main sources of household income but household variously supplement their income with livestock and off-farm sources of income.

Despite all the policy measures and programmes established by federal government towards ensuring that fertilizer gets to the farmers at the grass root, it is still unclear why fertilizer use intensity remains low among these smallholder farmers. Against this background, this study intends to quantify the effect of fertilizer for rice production in Kwande Local Government Area (LGA) of Benue State, Nigeria and the role of household endowments in fertilizer adoption decisions. Household endowments are different assets households own and they are classified into physical assets (e.g. land, livestock), human assets (e.g. education, extension contact, farming experience) and social assets (e.g. membership in a farmer group).

2. MATERIALS AND METHODS

The survey was conducted in Kwande local government area of Benue State, Nigeria. The local government is bordered on the West by Vandeikya and Ushongo local governments on the South by Cross River on the North-East by Taraba State and Republic of Cameroon. It has an area of 2,891km², The postal code of the area is 982. It is located latitude 6º, 31' to 7º, 18' North and longitude 9º, 45' to 8º, 45' East. The area has an average minimum and maximum temperature of 21ºC to 32ºCrespectively. Annual rainfall ranges from 1500mm and over 2500mm meteorological station Adikpo. Kwande local government covers a land mass of 870km square [18]. The population of Kwande Local Government Area is predominantly made up of Tiv-speaking people; rice is generally cultivated at least twice in a year in the area. Its headquarters are in the town of Adikpo and a population of 248,697 based on the 2006 census [18].

Kwande local government is divided mainly into four districts, Nanev, Turan, Ikurav-ya and Ishangev-ya. This study interviewed twenty five (25) rice farmers randomly selected from each of the four (4) main districts making a total of 100 rice farmers for the study. This study made use of primary data collected using structured questionnaire. Data collected for this study include: if farmers used fertilizer last farm season, the quantity of fertilizer used last farm season by the farmers in kg. Also information on the physical, social and human capital status of the farmer was collected. These include data on farm size in total owned by the farmers, livestock ownership, the size of the household and the hired labour employed, membership of a farmer organization, access to extension services, access to market, age, rice farming experience, formal education, gender.

For investigating the impact of household endowments of fertilizer adoption, the Logit model is selected because the dependent variable is dichotomous. The model is specified as:

$$\frac{P_i}{(1-P_i)} = \frac{1+\exp(Z_i)}{1+\exp(-Z_i)}$$

Where $\frac{P_i}{(1-P_i)}$ is the odds ratio in favour of adopting fertilizer. i.e. the ratio of the probability that a farmer will adopt fertilizer to the probability that a farmer will not adopt fertilizer. Hence, the dependent (endogenous) variable is binary and its value is 1 for a farmer who used fertilizer and 0 for a farmer who did not use fertilizer. Z_i is a linear function of the explanatory variables with values ranging from $-\infty$ to $+\infty$.

Because the above equation is nonlinear, one can linearize the model by taking the natural log. This gives the following linear Logit model:

$$Li = \ln\left[\frac{P_i}{(1-P_i)}\right] = Z_i = \beta_0 + \beta_1 X_1 + ... + \beta_{14} X_{11} + e$$

That is, the log of the odds ratio is not only linear in X but it is also linear in the parameters. L is called the Logit.

X1 = Age of household head in years
X2 = Household size (#)
X3 = Farm size in hectare
X4 = Livestock (Number of livestock owned)
X5 = Off farm income (dummy variable 1 for off farm income, zero otherwise)
X6 =Extension (access to extension services by farmer, dummy variable)
X7 = Member (membership of an organization, dummy variable)
X8 = Credit (access to credit, dummy variable);
X9 = Market (distance to the nearest fertilizer dealer)
X10 = Gender (sex of the household head, dummy)

X11=Education (level of formal education in years)
β0 = intercept term
B1 - β11are the coefficients
e = error term.

The summary statistics of all the variables used for analysis are presented in Table 1. Table 1 indicates that out of the 100 households sampled, 76% are male-headed households while the remaining 24% are female-headed households. The farmers are on average about 41 years of age which is an indication that they are mostly in their productive age bracket. They have mean household size of 9 persons. The mean level of education is 8 years showing that these farmers on average completed only primary school. About 87% had access to credit while 57% had access to extension services. The farm size is 1.6 hectares on average indicating that these are small scale farmers. The farm households have an average of 18 livestock. This is another form of physical capital in addition to land. The mean distance from house to the nearest market is about 10 kilometres. About 90% of the farmers are members of one farm group or another while 86% of the farmers are involved in one form of non-farm employment or the other. About 74% of the farmers adopted inorganic fertilizer. This is relatively high.

3. RESULTS AND DISCUSSION

To identify factors which influence the likelihood of adoption of fertilizer among farmers in the study area, the Logit model was estimated. The estimated coefficients of the Logit model, along with the standard error and z-values are presented in Table 2. The likelihood ratio statistics as indicated by the chi-square statistic is significant at 1%. This implies that all the variables included in the Logit model are jointly significant in influencing farmers' decision to adopt fertilizer. Therefore, the physical, human and social capital resource endowments of farmers have significant effect on their decision to use fertilizer. Table 2 shows that age, household size, credit and number of year of formal education were statistically significant. Age and education are human capital variables; credit is a physical capital and household size can proxy for social capital. However, the parameter estimates of the Logit model provide only the direction of the effect of the independent variables on the dependent (response) variable: estimates do not represent actual magnitude of change or probabilities. Thus, the marginal effects from the model, which measure the expected change in probability of a particular choice being made with respect to a unit change in an independent variable, are reported in Table 3 and discussed henceforth.

The results show that age is negatively related to the probability of fertilizer adoption and statistically significant at 5% level. The probability of fertilizer adoption decreases by 1% with an increase in age. This implies that younger farmers are more likely to adopt fertilizer for their rice production than older farmers. The importance of age in influencing adoption is also in agreement with several studies [19-23]. Young farmers tend to be more flexible in their decisions and adopt new ideas more readily because of anticipated life span within which investment in new technology will pay off [24]. According to [25], it could be that older farmers are more risk averse than younger farmers and have a lesser likelihood of adopting new technologies.

Table 1. Summary statistics of the variables used

Variable	Mean	Std. dev	Minimum	Maximum
Age	40.82	11.18	20	70
Household size	9.28	5.87	2	32
Farm size	1.61	0.85	0.4	4
Livestock	18.43	9.25	0	45
Off farm income	0.86	0.35	0	1
Extension service	0.57	0.50	0	1
Member	0.90	0.30	0	1
Credit	0.87	0.34	0	1
Market	6.97	3.77	1	15
Gender	0.76	0.43	0	1
Education	7.99	6.72	0	18
Adoption	0.74	0.44	0	1

The results reveal a positive and significant relationship between household size and the likelihood of adoption of fertilizer in the study area. This variable is significant at 1% level. The probability of adopting fertilizer increases by 3% with an increase in the household size. Family size has been recognized [26] to play a vital role in the adoption of any particular technology or farm practice. Household members provide the human labour and management inputs. This can affect the adoption and level of use of technologies. Family size can also create certain demand which may motivate the adoption of new practices or technologies that would increase the farmers' income as a means of meeting these demands. Furthermore, having large household size may encourage a pool of family resources into investment in improved technologies that will consequently increase the family earning capacity. This is because some family members would tolerate certain levels of unfavourable conditions is as much as it is aimed at creating more financial resources for the family. This therefore puts such families in a financially advantageous position to have more resources for investment in improved farm practices and technologies [27].

Access to credit was found to be important in influencing the likelihood of adoption of fertilizer by farmers in the study area. The variable is positively related to the probability of fertilizer adoption and statistically significant at 1% level. A one unit increase in credit access increases the probability of fertilizer adoption by 33%. The credit variable has the highest impact on fertilizer adoption in the area. Most farmers fear trying improved technologies or fertilizers because they do not have the necessary financial resources to adopt the technologies [28,29]. This is partly explained by the fact that most agricultural technologies require complementary inputs such as fertilizers and pesticides. These complementary inputs are difficult to come by due to the cash-stripped nature of farmers [30]. Access to credit reduces inefficiency as it enables farmers to adopt high yielding varieties and fertilizer and makes it possible for farmers to access information useful for increasing productivity and efficiency [31]. Oftentimes, cooperatives and farmer associations exist to fill the market failure caused by the absence of decent credit markets. Overall, access to credit helps farmers out of their financial predicaments thereby influencing them to adopt innovations.

Table 2. Parameter estimates of the Logit adoption model

Variables	Coefficient	Standard Error	Z-Statistic
Age	-0.076**	0.034	-2.250
Household size	0.254***	0.074	3.410
Farm size	-0.020	0.427	-0.050
Livestock	0.016	0.034	0.480
Off farm income	-0.290	0.852	-0.340
Extension service	-0.066	0.711	-0.090
Member	-0.272	1.098	-0.250
Credit	2.548***	0.851	3.000
Market	-0.109	0.103	-1.060
Gender	-0.223	0.694	-0.320
Education	0.080*	0.047	1.690
Constant	0.508	1.705	0.300
LR chi(2)	29.030***		
Log likelihood	-41.550		

Table 3. Marginal effects from the Logit adoption model

Variables	Marginal Effect	Standard Error	Z-Statistic
Age	-0.010	0.004	-2.340**
Household size	0.033	0.009	3.660***
Farm size	0.003	0.056	-0.050
Livestock	0.002	0.005	0.480
Off farm income	0.038	0.112	-0.340
Extension service	0.009	0.093	-0.090
Member	0.036	0.145	-0.250
Credit	0.334	0.108	3.100***
Market	-0.014	0.013	-1.090
Gender	-0.029	0.091	-0.320
Education	0.010	0.006	1.750*

*The asterisks *, **, and *** represent statistical significance at 10%, 5% and 1% levels respectively*

The result shows that the level of education of the respondents was a very important factor that influenced the likelihood of adoption of fertilizer in rice production in the study area. This is positive and statistically significant at 10% level. The positive and significant relationship between the level of education and likelihood of adoption of fertilizer in rice production in the study area agrees with earlier studies [32] that found that the literacy level positively influenced the intensity of use of fertilizer technology in South-western Nigeria and Berkeley, USA, respectively. This result suggests that higher educational level increases the probability of fertilizer adoption by 1%. This is also in line with [24] who reported that education correlates positively with adoption of improved practice. This is expected since the respondents in the study completed primary education on the average.

4. CONCLUSION

This study investigated the factors that determine the use of fertilizer by rice farmers in Kwande Local Government area of Benue state, Nigeria using Logit regression. This study interviewed twenty five (25) rice farmers randomly selected from each of the four (4) main districts making a total of 100 rice farmers for the study. This study made use of primary data collected using structured questionnaire. The results from the Logit model show that the age of the respondents, household size, access to credit and number of years of formal education were found to have significant effect on the adoption of fertilizer among respondents in the study area. While household size, credit and education increased the probability of fertilizer adoption, age decreased the probability of adoption. These findings emphasises the need for government to provide and improve on the relevant physical, human and social capital for farm households in the study area. Policies that will encourage the young people to participate in agriculture and improve the quality of farm household members as important labour supply is needed. Further, education policy needs to be revitalized to ensure greater access by the farm communities. In the future, this study may be extended to rather consider the intensity of fertilizer adoption rather than the use or non-use of fertilizer and attempt to link this to the farm households' livelihood outcomes.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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