IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 8, Issue 11 Ver. II (Nov. 2015), PP 01-07
www.iosrjournals.org

Comparative Analysis of Fertilizer Use among Small-Scale Irrigation Farmers in North-Western Nigeria

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Abstract: *The study analyzed the comparative fertilizer use amongst some sampled small-scale irrigation farmers in North-western Nigeria. A total of 240 irrigation farmers were selected from four States namely Kebbi, Sokoto, Zamfara and Kano. Descriptive analysis was used to explain the socioeconomic characteristics while a Probit analysis was carried out to identify the determinants of fertilizer use among the households.The results of the Kebbi's Probit analysis indicated that the variables that played significant roles in determining fertilizer use were Cultivation intensity, Education, Market distance, Non-farm activities, and Association membership. For Sokoto, the variables were Cultivated area, Cultivation intensity, Age, Market distance and wage. For Zamfara, they were Cultivation intensity, Demonstration trial, Crop choice and wage while that of Kano State included: Cultivated area, Cultivation intensity, Demonstration trial and Crop choice. The study revealed a lot of factor differentials in the use of fertilizer amongst the sampled households of the four states. Although about 86% of the farmers in all the four States used fertilizer, this use can generally be said to be in moderate doses as revealed by the mean quantity of fertilizer in the descriptive analysis. Improvement of this can be achieved by policy targets that could address those factors wherever applicable.*

I. Introduction

For minor irrigation investments to deliver its purposes of increasing food security and poverty alleviation amongst others, there is the need for Complementarity of such investments with adequate use of fertilizer. This is due to the fact that irrigation farming which is practiced along river floodplain or already established water sources has the tendency of quickly using up the soil nutrients than the rain-fed farming due to the possibility of cultivating these irrigation lands more than once annually. Because In rain-fed farming, there is more ample chance to increasing hactarage to virgin or fallow lands and hence encourage nutrients re-mining than these irrigation areas. Hence there is the need to focus more attention towards the reversal of the declining soil fertility especially in the irrigated portions of the country. According to research findings, there is a downward spiral of declining soil fertility, low crop yield and increasing poverty in the less-favoured areas of sub-sahara Africa Tsegaye et . al (2006).The northern agricultural climate of Nigeria which are the most irrigated zone in the country share similar episode. These regions are typically drought prone and hence more irrigation-dependent than all the other agroecological zones of the nation. The need to stay nearby a fixed water source had increased the tendency of the northern soils to be cultivated over and over with a little period of natural nutrient re-mining. In order to break down this spiral, there must be promotion of sustainable use of inorganic fertilizers and this is a policy challenge. Land degradation was a significant global issue during the 20th century and remains of high importance in the 21st century as it affects the environment, agronomic productivity, food security, and quality of life (Eswaran et al., 2001). Soil degradative processes include the loss of topsoil by the action of water or wind, chemical deterioration such as nutrient depletion, physical degradation such as compaction, and biological deterioration of natural resources including the reduction of soil biodiversity (Lal 2001). In Nigeria, human-induced soil degradation is a common phenomenon. Its severity is light for 37.5% of the area (342,917 km2), moderate for 4.3% (39,440 km2), high for 26.3% (240,495 km2), and very high for 27.9% (255,167 km2) (UN FAO, 2005).It is the concern to trigger the improvement of soil fertility in Africa as a whole that made some African leaders gathered together for a fertilizer summit in Abuja in 2009. In the summit, it was noted that a move toward reducing hunger on the continent must begin by addressing the issue of irrigation and its severely depleted soils. Due to decades of soil nutrient mining, Africa's soils have become the poorest in the world. It is estimated that the continent loses the equivalent of over $4 billion worth of soil nutrients per year, severely eroding its ability to feed itself. Yet farmers have neither access to nor can they afford the fertilizers needed to add life to their soils. And no region of the world has been able to expand agricultural growth rates, and thus tackle hunger, without increasing fertilizer use. (African Fertilizer summit, 2009). It is against this backdrop that this paper aims at analyzing the comparative fertilizer use decision of the irrigation farm households in four selected states of north-western Nigeria.

Fertilizer's Potential Contribution to Agricultural Productivity

There is ample evidence from experience outside Africa that increased use of inorganic fertilizer has been responsible for an important share of world – wide agricultural productivity growth. Some argue that fertilizer was as important as seed in the green revolution as much as 50% of the yield growth in Asia (Hopper, 1993). Others have found that one – third of the cereal production world – wide is due to the use of fertilizer and related factors of production (Bumb, 1995, citing FAO). Early fertilizer research in Africa suggested that fertilizer can bring similar productivity gains to the continent. Pieri (1989), reporting on fertilizer research conducted from 1960-1985,confirmed that fertilizer in combination with other intensification practices, had tripled average cotton yields in West Africa from 310 to 970 Kg/Ha. Research summarized more recently shows numerous cases of strong fertilizer response for maize in East and Southern Africa (Byerlee and Eicher, 1997; Heisey and Nwang, 1997) .up till now, however fertilizer use in Africa has not led to increases in agricultural productivity on the scale observed elsewhere. Soil scientists are quick to point out that soils in Africa are inherently less fertile than in Asia where the green revolution took place (Weight and Kelly, 1999; and Townsend, 1999;). Low inherent fertility is exacerbated by less favourable climate (low, poorly distributed rainfall and high temperatures). Given SSA's less agro ecological conditions, plus lower investment in irrigation and much lower use of fertilizer (only 9kg of nutrients per ha compared with 73 Latin America, 100 in south and 135 in East and South East Asia (FAO, 2004), those slow productivity is not surprising. Hence, a key challenge is determining the relative importance of the various determinants of low fertilizer consumption and what can be done about it.

Theoretical framework for fertilizer Demand

According to Valerie et.al. (2005), in a competitive market economy, the level of fertilizer use is determined by the intersection of the fertilizer demand and supply functions. Using somewhat different terminology, fertilizer consumption can be viewed as the outcome of both the conversion of fertilizer's economic potential into farmers' effective demand and the fulfilment of the demand through fertilizer supply and distribution system (Desai, 1988). In developing countries, fertilizers economic potential – determined by the prevailing fertilizer responses and prices – is almost always much larger than actual use. (Desai, 2002). This fertilizer economic potential can be viewed as the amount of fertilizer that can be used profitably, based on an analysis of prevailing prices and response functions. Profitability may be benchmarked through a variety of indicators but value/cost ratios of 2 or more are most frequently used .Both descriptions of the process through which fertilizer consumption levels are established highlight the interaction of demand and supply factors. In this study, focus was on the demand side of the equation. The input demand function is often referred to as a derived demand, because it is determined to a large extent by consumers demand for the farm output. In general the demand for an input depends on the price of the output(s) being produced, the price of the input itself , prices of other inputs that substitute or complement the input and the parameter of production function that described the technical transformation of the input into an output. In the case of the fertilizer, this would be the fertilizer response function. (Debertin, 1986). Availability of funds to purchase the input can also influence the quantity demanded particularly for resource poor farmers in Sub-Sahara Africa, as can risk consideration.

Hypothesized Explanatory variables affecting fertilizer demand

Nicholas et al. (2000) and Reardon et al; (1999) submitted that in a world of certainly, complete markets, and perfect information, economic theory indicates that input demand will be determined by input prices, output prices, quasi – fixed factors of production and variables that influence the marginal product. In the context of the demand for inorganic fertilizer by small – scale farmers in developing countries, a wider range of variables than stipulated by theory may be considered relevant. The first variable that may prove relevant takes it root from the very nature of crop production. Since this is subject to random shocks brought about by weather vagaries which may influence the risk averseness of farmers, ability to bear risk (measured by income and ownership of assets is therefore stipulated as a variable that may affect fertilizer demand. Second, due to imperfect credit markets, cash constraint of the farmers (connected to the fact that individual peasants in developing economies do not always reap the full marginal benefit of their productive efforts). Membership in credit institutions and volume of cash income may also affect the use of fertilizer. Third, since farmers face transaction cost which is closely associated with transportation in buying fertilizer, factors such as distance of farmer's residence or farm to the local fertilizer markets may have an impact on fertilizer demand .Finally, because farmers sources of information varies with location and personality and that information at hand may be imperfect, education, literacy, and access to extension services may also affect the use of fertilizer.

These factors that may influence fertilizer demand are grouped into six categories, namely; family labour and human capital (which can be considered quasi – fixed factors for small farmers), land characteristics, market prices, factors that affect the marginal product of fertilizer, indicators of access and indicators of resources. Each of these is explained in full details below.

Labour and human capital variables: Under this category are household size and composition, sex and age of the head of household, education, literacy, and ethnicity. Ethnicity may be relevant if cultural norms and believes vary across groups, if it reflects language barriers if it influences social capital, or if it is correlated with missing geographic variables.

Land: Here, plot size, farm size, cultivation intensity, the sources of water for the plot and wether or not the plot is owned is examined. It is expected that the incentives for input use will be lower on share cropped land because not the entire marginal product of inputs accrues to the farmer. Those who rent land on annual basis may also face less incentive to use fertilizer than owners because fertilizer has benefit on land after the year of application.

Prices. This include the price of fertilizer (this include a weighted average of fertilizer price if more than one in-organic fertilizer are used) and wages for agricultural labour. To reduce the effect of price variation due to decisions by farmers (such as where to purchase or what type of activities to hire labour for, village level averages for all prices of labour were used.

Factors affecting the marginal product of fertilizer: One of the most important variables affecting the marginal product of fertilizer is the crop being fertilized. The decision of the farmer to grow a cereal or tuber crop will influence his decision regarding fertilizer use because cereals are generally more responsive to fertilizer. The types of crops grown by the farmers are represented by dummy variables.

Access: this category includes variable that reduce transaction cost in purchasing and using fertilizer. It includes the distance to the place where the fertilizer can be purchased, the distance from the house to the plot, measure of access to extension services, and membership in various organizations. It is assumed that the decision to purchase fertilizer and not the quantity purchases is affected by the distance to point of sales.

Resources: various measure of the resources of the household may reflect the ability to bear risk associated with fertilizer use and/or ability to overcome the cash constraints associated with purchasing fertilizer in the absence of well – functioning credit markets. Variables included under this are the sources of other livelihood activities.

II. Research Methodologies

The study was carried out in four states in North Western Nigeria. The region was chosen due to its agro climatic nature which predicated it as one in dire need of irrigation means for crop production than any other region in the country. The four states are: Kano ,Sokoto ,Zamfara and Kebbi. The basic data required for the analysis of this study was primary. The data was collected from farmers who practice irrigation in the study area between September and October of 2008.The data was sourced through the use of structured questionnaire which comprised various questions pertaining to the socio-economic characteristics, farming activities, value and volume of output of the participating farmers. A multi-stage sampling method which involved four stages was used. The sampling method involved a purposive selection of four states in the north western Nigeria, based on the predominance of irrigation farming in the region. A total of twelve local government areas, three in each state were selected for the interview and a village from each of the local government areas was systematically chosen followed by the selection of the farmers through a random sampling process. A total of 20 farmers were selected in each village. This amounted to a total of 240 respondents. Information were gathered on the irrigation schemes, household and enterprise characteristics, farm activities, quantities and costs of inputs used in production (capital, variable and overhead), quantities and values of output, the quantity of water consumed and irrigation practices. The data collected was analysed using descriptive tools and Probit model.

Analytical Method

The probit model represents another type of widely used statistical model for studying data with binomial distributions. Its employment in the social sciences goes back at least to econometrics in the early 1960s Probit models are generalized linear models with a probit link:

$$n = Ø^{-1}(\mu). \qquad (1)$$

The inverse of the normal CDF is in effect a standardized variable, or a Z score. As with the logit model, the probit model is used for studying a binary outcome variable. We may express probit models in probability,

$$\text{Prob}\,((y=1)) = 1 - F\left(-\sum_{k-1}^{k}\beta_k x_k\right) = f\left(\sum_{k-1}^{k}\beta_k x_k\right) = Ø\left(\sum_{k-1}^{k}\beta_k x_k\right), \qquad [2]$$

DOI: 10.9790/2380-081120107

Where the more general form of cumulative distribution function, F, is replaced by the standard normal cumulative distribution function, Ø. Unlike the logit model, which may take on two major forms---one expressing the model in logit (and a transformed version expressed in odds) and the other expressing the model in event probability ,the probit model takes on only one intuitively meaningful form because a probit model expressed in n is a linear regression of the Z score of the event probability. The equation for probability of non-event is then

$$\text{Prob }(y=0) = 1 - \text{Ø}\left(-\sum_{k=1}^{k} \beta_k x_k \right). \qquad [3]$$

The equation can be readily derived from equation 2 because the response is a binary outcome. This in our case is whether or not a farmer used fertilizer.

The variables that were included in the Probit analysis are: Cultivated area, Cultivation intensity, Age, Household size, Education, Market distance, Credit, Demonstration trial, Crop choice, Non-farm activities, Association membership and Wage. These are hypothesised as correlates of fertilizer use.

III. Results and Discussion

Table1: Descriptive Statistics of Sampled Farmers in the four States

Variables	**Mean**
Age (years)	**40.3**
Household size	**5**
Education (years)	**5.67**
Farm experience (years)	**14.13**
Market distance (km)	**1.22**
Farm size	**1.44**
Hired labour	**4**
Percentage that used fertilizer	**86.47**
Fertilizer Quantity	**124**
Pesticide	**5.04**

Table 1 shows that the mean age of respondents in the study area was 40 years; while an average farmer had a farm size of 1.44 Ha to show that the scale of operation was a small one. Years of formal education was approximately 6 which indicated that most of the farmers had an average of primary school education. The mean household size was 5 people, suggesting a not-too-large family size, which was indicative of the need for hired farm labour demand in the study area of which the mean size was 4. Farm experience was 14 years, indicating that the farmers were not new entrants and hence should have enough motivation to use fertilizer. Finally, market distance to farmers' homesteads was 1.4 Km which means that farmers should not have difficulty due to transportation in accessing fertilizer.

Table 2: Results of the probit analysis for the determinants of fertilizer use

Variables	Coefficients				T-Ratios			
	Kebbi	Sokoto	zamfara	kano	Kebbi	Sokoto	zamfara	kano
Constant	-2.71	1.79	-1.16	1.33	-1.72*	1.34	-0.54	0.89
Cultivated area	0.14	-1.58	1.80	-1.35	0.51	-2.25**	2.37**	-3.20***
Cultivation intensity	3.45	2.33	-2.96	2.45	1.79*	1.84*	-2.71**	1.77*
Age	-0.009	- 0.06	-0.001	-0.002	-0.25	-2.13**	-0.25	-0.05
Household size	0.08	0.12	0.26	0.17	0.41	0.81	1.13	1.26
Education	0.16	0.11	-0.13	-0.06	2.31**	1.53	-1.54	-1.36
Market distance	0.27	-0.22	0.14	0.03	2.72***	-1.98*	1.20	0.48
Credit	0.13	-0.23	0.61	-0.17	0.42	-0.52	1.34	-0.38
Demonstration trial	-0.61	0.77	-1.47	-0.73	-0.75	1.28	-2.34**	-1.67*
Crop choice	0.31	-1.07	3.64	-8.07	0.11	-0.82	1.85*	-3.18***
Non-farm activities	-0.97	0.68	0.55	0.62	-2.27***	1.48	1.12	1.26
Association membership	0.86	0.23	0.59	0.57	1.91*	-0.52	1.23	1.31
Wage	-0.002	0.0009	-0.001	0.0002	-1.40	1.72*	-1.65*	0.68
Log Likelihood	31.33	-31.20	-28.03	-27.61				
Chi Square	20.24	18.37	26.04	24.94				

The result displayed in Table 2 above is the outcome of the probit analysis for the determinants of fertilizer use in the four states. For Kebbi State, the result of the analysis showed that five of the variables hypothesized to be the determinants of fertilizer are observed to be significant. The variables that describe the labour and human capital are household size, age and education of the respondents. Out of these, only education was found to be statistically significant in determining whether a household would use fertilizer or not. Education was significant at 5% level, having a t-ratio of 2.31 and a coefficient of 0.16. This signifies that a household whose head is educated would likely use fertilizer. This result is contrary to what are obtained in the other three states. The reason might be probably due to the fact that the sampled irrigation household in Kebbi state had higher level of education than those of the remaining three states. Contrary to expectation, household size was found insignificant as a determinant of fertilizer use in the kebbi irrigation households. Perhaps the household members who suppose to serve as vital proxy for family labour are not in position to carry out their farming responsibilities probably due to dependency or religion believes as in the case of Muslim woen in the area. Among the variables categorized under the land characteristics, namely cultivated area and cultivation intensity; only the latter was statistically significant as a determinant of fertilizer use in the area having a r-ration of 1.79, a coefficient of 3.45 and positively significant at 10% level. Cultivation intensity measures the extent of land fallow and shifting cultivation. This result suggests that the heavier the land in the area is put into cultivation, the more is the likelihood for fertilizer to be used. This is due to the loss of the soil fertility associated with frequent cultivation with little space for fallow or shifting cultivations. Wage is the only variable hypothesized as a describer of price associated with fertilizer use.

The other variable that could have proved relevant under this category is the price of fertilizer, however there was a high multicollinearity problem between the dummy for fertilizer use and fertilizer price; hence this variable had been excluded from the analysis. Nevertheless, wage is also a very important variable in determining fertilizer use. Because of the problem of rapid weed growth in fertilized plots more than the unfertilized counterparts, the former tend to be more labour – intensive than the latter and this bear much on the farmers expenses. In the Kebbi state analysis of fertilizer use, wage was found insignificant and having a negative sign. This might be due to the fact that the household employed the use of family labour more than that of the hired labour and thus the implied cost of doing so did not directly add to the cost of employing hired labour. The next variable is the one that affect the marginal physical product of fertilizer. The only variable included here is crop choice which is a quantitative proxy of the particular crop being fertilized. Crop choice had a positive relationship with fertilizer use, although insignificant. The farmers probably did not chose to use fertilizer as a result of a prior knowledge that a particular crop responds to fertilizer more than a certain other and hence has more impact on the cash benefit accruing to the farmer as a result of this choice more than these other crops. The likelihood of using fertilizer among the sampled Kebbi irrigated based household was a random choice rather than predetermination.

Another variable included in the analysis is access. This is described by three sub-variables namely market distance, demonstration trial and association membership. Two of these three were statistically significant with the choice of fertilizer use among the farmers. Market distance is positively significant at 1%, having a t-value of 2.72 and a coefficient of 0.27. This is a perverse relationship and contrary to theory. The positive coefficient of market distance suggests that the further a fertilizer market was to a farmer's residence, the more would the farmer use fertilizer. This would definitely impact the transaction cost of using fertilizer in a negative way and hence farmers would be facing a disincentive. However, possible explanation that can be offered is that the farmers might be desperate in their need to procure fertilizer so that the additional cost incurred in the process was not high enough to constrain them. Some might even have avoided this extra cost by sending a family member or friend to purchase for them. Membership in farmers association was found to have a positive coefficient of 0.86 and statistically significant at 1% with a t-ratio of 1.91. Association membership is another factor that can influence a farmer to use or not use fertilizer. Farmers association can use their numerical strength to bring fertilizer in commercial quantity to the proximity of the member at a lesser cost than what is being sold in the market. Members also can enjoy the benefit of paying installmentally or even purchasing on credit till the time the farm produce is sold. The positive coefficient of association membership is expected. This implies that the involvement of the farmer in an association would increase the probability of fertilizer use among them. This result suggests that many of the households are well involved in farmers association. The third variable under this category is demonstration trial, which is statistically insignificant in determining the choice of using fertilizer. This implies that the farmer's decision other sources like friends, family members and the media.

Another reason is that the extension agents might be too few to go round hence investment in extension agency should be a priority of the government of the state. The last category is the one that pertains to the resource endowment of the farm household. The variables that describe this are credit and non-farm or livelihood source. Livelihood source is significant at 5% level with a t-ratio of 2:27 and a coefficient of 0.97. This inverse relationship is also a perverse one as regards the choice of using fertilizer. A farmer that has more cash endowments as a result of access to other sources of income than from farming should have a higher likelihood of using fertilizer. Perhaps these categories of farmers spent these non- farm incomes on other contingencies they perceived more important than fertilizer procurement and or this income from non-farm sources might be too meager for them to have a left-over for the purchase of fertilizer. Credit was found to be statistically significant or among, the household.

The probit analysis of the Sokoto State irrigation households reports all the variables that are statistically significant with the choice of fertilizer use in the state. Only age was found to be significant, though having an inverse correlation with the choice of fertilizer use. This implies that as the farmer's age increased, the probability of using fertilizer by such farmers also reduced. This may be due to the loss of physical strength by the farmers which culminate in a reduction of the labour input. Moreover, this sets of farmers may be into farming mainly to attain food security objective and not to gain any primary direct cash benefit from their farming operations, hence they might not feel constrained to apply fertilizer on their plots. Education was found to be statistically insignificant, given that a handful of the farmers claimed to have attended formal schools in the previous years. The implication of this is that if learning is important in fertilizer use, it occurs primarily both at the informal education system and through oral demonstration method. This is consistent with the findings of Nicholas et. Al (2007) who found that educations and literacy variables were not significant in determining fertilizer use in northern Nigeria and some selected Africa countries respectively. Conversely Reardon et. Al (1999) suggested that education often influences fertilizer use through crop mix and the use of improved varieties. If the latter are controlled, education becomes insignificant.

Contrary to expectation, household size was also found to be statistically insignificant as in kebbi state. Both variables that were included as describers of land characteristics were found significant. Cultivated area has a negative impact of 1.58 with a t-ratio of 2.25 and is significant at 5% level. The inverse relationship of cultivated area and fertilizer use means that, other things being equal, smaller farms have more likelihood of using fertilizer than larger ones. This results reflect the attitude in the management of large farm holdings. Operators may not likely apply fertilizer to the entire farm. Cultivation intensity is positively significant at 5% with a t-value of 1.84 and coefficient of 2.33. This direct relationship implies that the more intense a land is being cultivated the higher is the probability of using fertilizer on such lands. Concerning the price variable, wage which is the only included describer of price is significant at 10% level with a t-value of 1.72 and coefficient of 0.0009. The positive and significant effect of agricultural wage on fertilizer use appears to justify the complementarity between fertilizer use and labour. The result indicates that when hired labour receives high wages, fertilization would also have a boost. The high wage may reflect off-farm employment opportunities or access to credit which makes it easier for the farmers to relieve the cash constraint that might have been imposed in using fertilizer as a result of this high wages. Because peasants are expected to turn off to family labour when hired labour become too expensive, but if they do not, it means an access is available for them to other sources of income.

The next variable is the one that affect the marginal physical product of fertilizer. This is statistically insignificant with the choice of fertilizer use. The same result was obtained among the sampled Kebbi state farmers. Concerning access, market distance is statistically significant though with a negative sign, unlike the result obtained in Kebbi state analysis. The reason may be due to the fact that fertilizer markets were near to the farmers' location in Sokoto state than in Kebbi. The t-value and the coefficient for market distance is -1.98 and -0.22 respectively. Association membership is insignificant though having a negative impact while demonstration trial is also insignificant but with a positive sign on the coefficient. The variable describing the farm household resource endowment are credit and engagement in non-farm activities. Credit is insignificant, reflecting a very poor access to credit by the farmers. Non-farm activities is also insignificant, meaning that income from non-farm activities are very small among the household and it reveals that a major source of the farmers' cash endowment derives from their farming activities and this sheds more light on the agrarian nature of these sampled farm households

In the Zamfara State probit analysis, none of the variables that describe the human and labour capital was found significant. Similar to the results obtained under the Sokoto state analysis, both variables categorized under land characteristics, namely, cultivated area ad cultivation intensity were significant. Cultivated area is positively significant at 5% with a t-value of 2.47 and a coefficient of 1.80. This implies that increase in the land hectarage put under cultivation would lead to increase in the probability of using fertilizer and that larger farms had higher tendency to use fertilizer than smaller farms. The reason for this are not clear, there might be some fixed costs associated with fertilizer application thus making it less worthwhile for smaller plots while larger ones enjoy economies of scale. Cultivation intensity is negatively significant with a t-value of -2.71 and coefficient of -2.96. This negative relationship shows that fertilized portions of the plots decreased with the additional increase in area cultivated. There is less incentive to offset the adverse effects of intense cultivation by the farmers. Demonstration trial, which is one of the variables that describe access, is negatively significant at 5%, having a t-ratio of -2.34 and a coefficient of -1.47. This also reflects the negative attitude of the farmers towards extension agency about the importance of fertilizer use. Crop choice measures the physical marginal products of fertilizer. The results shows that the farmers choose to fertilize their plots as a result of perceived benefits of doing so. This is explained by the positive sign on the coefficient. Crop choice is significant at 10%

with a t-value of 1.85 and coefficient of 3.64. Finally wage, the only describer of price characteristics is negatively significant at 10% with a t-value of -1.65 and coefficient of -0.001. This indicates that fertilizer use would be constrained upon an increase in agricultural wage. Instead of employing more hired labour for the extra farm operations as a result of fertilizer application, farmers switched to the use of family labour. This is the situation especially when the household comprises able men and women.

As shown in the table, four of the explanatory variables are statistically significant as determinants of factors to use fertilizer in Kano state. None of the variables that describe the labour and human capital was significant. Both variables that describe the land characteristics were significant, just like the situation under the Sokoto state fertilizer analysis. Cultivated area is negatively significant at 1% level with a t-value, but a different value of -0.49 for the coefficient. Cultivation intensity is significant at 10% with a t-value of 1.77 and a coefficient of 2.45. Demonstration trial is one of the variables categorized under access, the t-values and coefficients are respectively -1.67 and -3.73. Lastly, just like the result obtained under Zamfara State analysis demonstration trial has an inverse relationship with the choice of fertilizer use, suggesting probably the ineffectiveness of extension agencies which resulted in lack of willingness to use fertilizer. Lastly crop choice, the only describer of price characteristics is significant at 10% with the MLE having a t-value of -3.18 and a coefficient of -8.07. This inverse relationship stipulates that farmers' choice of using fertilizer was not a function of receiving the marginal cash benefits of doing so. Another objective that might have been more important to the household is that of attainment of food security, thus rendering the former a secondary issue.

IV. Conclusion and policy recommendation

Conclusively, it can be seen that an appreciable proportion of the irrigation households in the four states used fertilizer although with a lot of factor differentials which were perceived to be the determinants of this use. In any case, it is a justification of the fact that soil fertility in the area needed to be boosted by adequate use of fertilizer. Also, those who used fertilizer used it at sub-optimal doses which can be increased if farmers had adequate incentive for this use. Government should therefore continue to increase the subsidy on fertilizer and try as much as possible to make fertilizer available in smaller bags. Government-owned rural fertilizer market could also be put in place in each local government of the country in order to off – set the extortionary effects of merchants who make the demand for fertilizer somehow difficult for the peasants. The importation of fertilizer into the country should also be discouraged in order to reduce fertilizer costs at local markets and encourage domestic production.

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