Factors Influencing Subsidized Fertilizer Access and Use Intensity on Small Holder Farmers in Trans Nzoia County

Augustine Wafula Barasa[1], Josephine Barasa[2], Paul Okelo Odwori[3], Kenneth Kisuya Malaba[1], Harrison Yego[4]

[1]*University of Eldoret, School of Agriculture and Biotechnology, Department of Agricultural Economics and Rural Development, Kenya*

[2]*University of Eldoret, School of Agriculture and Biotechnology, Department of Soil Science, Kenya*

[3] *University of Eldoret, School of Economics, Moi University, Kenya*

[4]*School of Business and Economics, Department of Agricultural Economics and Resource management, Moi University, Kenya*

Abstract: **- Low crop yields as a result of inadequate application of fertilizer remains to be a challenge limiting optimum crop production especially among smallholder farmers in Kenya. The government of Kenya, under The National Accelerated Agricultural Inputs Access Programme (NAAIAP), introduced subsidized fertilizersaimed at increasing crop productivity.Despite these initiative, there has not been much achievements as far as general increase in crop yields and especially maize crop yields in the country is concerned. This study therefore sought to investigate thefactors affecting the access and the use intensity of subsidized fertilizer among smallholder farmers in Western Kenya with the case of Trans Nzoia County.The specific objectives of the study were to establish the factors affecting the access to subsidized fertilizers and to assess the factors affecting the intensity of fertilizer used.This study employed cross-sectional survey using structured questionnaires to collect the data from 384 farmers who had been selected using multi-stage sampling technique. The data was analyzed econometrically using a double hurdle model which combined a probit model and a truncated regression model. The findings showed thatage, access to extension services, land size, distance to market, household size and non-farm income significantly affected the accessibility of subsidized fertilizer to the farmers while the intensity of subsidized fertilizer use was significantly determined by age, land size, access to extension services and non-farm income of household head. The study concluded that the government should target the smallholder farmers and consider their factors when formulating policies for distribution of subsidized fertilizers as they are the intended beneficiaries of the program.**

I. INTRODUCTION

Attaining optimum crop yields in smallholder farms of Western Kenya remains achallenge with most farmers recording low harvests. This is further translated to food insecurity and poverty especially in a country like Kenya where more than 70 percent of its population depend on agriculture- related farm and off-farm activities for their livelihoods(Ng'ang'a, Stanley Karanja, An Notenbaert, Chris Miyinzi Mwungu, Caroline Mwongera, and Evan Girvetz., 2017). A report by FAO (2018) indicates that 60 percent of the population are currently living below the 1 dollar-a- day poverty line. Since agriculture is a major contributor to the country's Gross Domestic Product and revenue, this declining trend is worrying and prompts for urgent response in terms of agricultural policies (FAO, 2018).

The causes of these lowcrop yields are diverse with factors such as declining soil fertility taking the center stage (Vanlauwe, et al., 2008). Soil infertility in Western Kenya smallholder farms is furthers caused by multifaceted factors such as of lack of /or inadequate use of inorganic fertilizers, high transport costs, weak market infrastructure and lack of institutional support (Druilhe, & Barreiro-Hurlé, 2012).In order to addresssoil infertility, the government of Kenya through The National Accelerated Agricultural Inputs Access Programme (NAAIAP) introduced subsidized fertilizers.This was aimed at raising fertilizer use to optimal levelsand increasing crop productivity from increased input use thereby raising land and labour productivity and food security for small holder farmers who form majority of households in Western Kenya (Ochola, & Fengying, 2015). Despite these initiative, there has not been a significant increase in yields in Kenya even after increasing the areas devoted to the targeted crops under the fertilizer subsidy by 15 percent(Druilhe, & Barreiro-Hurlé, 2012). This study therefore sought to investigate the invariably unavailable information on the associated factors that may affect the access and the use intensity of subsidized fertilizer in Western Kenya. Trans Nzoia was purposely selected as it has been predominantly been known in Kenya for its major role in maize production which is the major staple food in Kenya. This is attributed to its favourable climatic conditions suitable for maize farming (Mwongera, et al., 2017). The specific objectives of the study were to establish the factors affecting the access to subsidized fertilizers and to assess the factors affecting the use intensity of fertilizer.

II. MATERIALS AND METHODS

Study area

Trans-Nzoia is an agricultural county in the former Rift Valley Province, Kenya, located between the Nzoia River and Mount Elgon. Trans Nzoia covers an area of 2495.5 square kilometers.The county is largely agricultural with both large scale and small scale wheat, maize and dairy farming. The county is referred to as the basket of Kenya for its role in food production in the country.Situated in the slopes of the mountain, Trans Nzoia has a cool and temperate climate with average annual temperatures ranging between a minimum of 10°C to a maximum of 27°C. The county receives annual precipitation ranging between 1000 and 1200mm, with the wettest months being experienced between April and October. Trans Nzoia County's arable land makes agriculture the top economic activity, where maize farming is widely practiced, and mostly at a commercial level. The county has 5 sub counties: Saboti, Cherangani, Kwanza, Endebess and Kiminini.

Study Design

The study employed a cross sectional survey design in conducting the research. The collection of data was aided by use of structured questionnaires. A combination of purposive and random sampling methods were used in selecting the farmers where Saboti, Cherangani and Kwanza Sub counties of Trans Nzoia county were purposively selected before farmers were randomly selected on condition that the farmer had less than 2.5 hectare of land to meet the merit of being a small holder farmer.The required sample size was determined by formula developed by Cochran, (2007).

$$n = \frac{z^2.p.q}{e^2}$$

Where n is the sample size, z is the confidence interval (Z-value), p is the expected proportion and e is the acceptable margin of error. In this study, a 95% confidence interval was assumed and an expected proportion of 0.5 Therefore the sample size was calculated as

$$n = \frac{(1.96)^2.(0.5)(0.5)}{(0.05)^2}$$

Giving a minimum sample size of 384 households.

Data analysis

To analyze the two objectives, the study used a Cragg"s double hurdle model(Cragg, 1971)which has been common in analyzing adoption and intensity especially in agricultural economics (Noltze et al, 2011; Mal et al, 2012). Another alternative model that could beused is the Heckman's selection model although is too restrictive with respect to the interpretation of the sources of zeros (Mal et al, 2012).The Heckman model assumes that the non-adopters will never adopt under any circumstances while double hurdle model assumes that non-adopters are a corner solution in a utility-maximizing model and can adopt a technology if encouraged (Mal et al, 2012).

These two hurdles were estimated using a binary outcome model for the access to subsidizedfertilizer and a truncated normal model for the use intensity of subsidized fertilizer. To estimate the probability that a farmer would use subsidized fertilizer, a probit model was usedwhile a truncated normal model estimated the use intensity of subsidized fertilizer (Noltze et al, 2011).

First Hurdle –Subsidized fertilizer access

The first stage of the model determined the factors that influenced the probability of a household to access subsidized fertilizers using the following formula: An individual'saccess tosubsidized fertilizer is dichotomous, involving two mutually exclusive alternatives. The individual either has access or does not. The study used the probit regression model to estimate the factors influencing the probability of subsidized fertilizer use among smallholder farmers in Trans Nzoia. The Probit model was suitabledue to its ability to constrain the utility value of the dependent variable to lie within zero and one, and its ability to resolve the problem of heteroskedasticity (Asante et al., 2011).

$$Y\ (0,\ 1) = \beta_0+\beta_1X_1+\beta_2X_2 +\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6 +\beta_7X_7+\beta_8X_8+ \varepsilon$$

Where:

Y (0, 1) =Accessed Subsidized Fertilizer (1) or did not Access Subsidized Fertilizer (0)

β0 –intercept

β1… β8$_=$ coefficients of the independent variables

$X_{1=}$Gender	$X_{5=}$Access to Extension Services
$X_{2=}$ Age	$X_{6=}$Household size
$X_{3=}$Land Size	$X_{7=}$ Non-farm income,
$X_{4=}$Education level	$X_{8=}$Distance to market

Second Hurdle –Subsidized Fertilizer Use Intensity

The second stage of the double –hurdle model was used to assess the factors that influenced the use intensity of subsidized fertilizer with the quantity of the used subsidized fertilizer being the dependent variable. The following truncated regression model was used:

$$Y = \beta_0+\beta_1X_1+\beta_2X_2 +\beta_3X_3+\beta_4X_4 +\beta_5X_5+\beta_6X_6 +\beta_7X_7+\beta_8X_8 + \varepsilon$$

Where:

Y =Amount of fertilizer used ($kgha^{-1}$)

β0 –intercept

β1… β8$_=$ coefficients of the independent variables

$X_{1=}$Gender $X_{5=}$Access to Extension

	Services
$X_{2=}$ Age	$X_{6=}$Household size
$X_{3=}$Land Size	$X_{7=}$ Non-farm income,
$X_{4=}$Education level	$X_{8=}$Distance to market

III. RESULTS AND DISCUSSION

Factors influencing Subsidized Fertilizer Access and Use Intensity

The significant Wald chi-square value of 312.30 shows that the explanatory variables jointly influence the farmers' use of subsidized fertilizers. The accessibility of subsidized fertilizer to the farmers was significantly determined by the age, access to extension services, land size, distance to market, household size and non-farm income.

The intensity of subsidized fertilizer use was significantly determined by age, land size,access to extension services and non-farm income of household head. The non-farm income of the household head and land size were the most influential determinant of the intensity of subsidized fertilizer use. The significant Wald chi-square value of 312.30 indicates that the explanatory variables jointly influence the access to and fertilizer use intensity (Table 1).

The probability of a farmer accessing subsidized fertilizer was influenced positively by age of household head. This might have been caused by the fact that, the older a farmer gets, the more experienced he becomes in knowing the benefits and savings gained from using subsidized fertilizer with the assumption that the farmer is rational. The same case applies to intense use of subsidized fertilizer since an older farmer knows the benefits of applying intense fertilizer for higher crop productivity.These results are in agreement with studies by Mathenge and Olwande, (2010) who found that as farmers advance in age, they are more likely to participate in access of fertilizers and markets. However, these results contradict with Martey, et al. (2013) who found the probability of fertilizer technology adoption being influenced negatively by age of household head. They assert that normally younger household heads are more dynamic and innovative in terms of technology adoption as compared to older household heads.

As expected, non-farm income of households head had a positive effect on access and use intensity of subsidized fertilizer. This is attributed to the farmers' ability to purchase more fertilizer with ease and cater for the associated transport costs of delivery. These results are in agreement with Makau, (2016) who found that households who accessed income from non-farm activities bought 0.01kg more than those who did not. She attributed this to the fact that they had extra income which strengthened their spending power and ability to purchase fertilizer

Land size was also positively related to subsidized fertilizer access and intensity of use. There is usually a positive correlation between farm size and wealth status as large owners of land are deemed to be wealthier hence having the financial ability to access subsidized fertilizers and use more of it to cater for their large parcels of land. The marginal effect showed that a unit increase in the area under cultivation increased the probability of fertilizer adoption by 3.2. These results are in agreement with Akudugu, et al. (2012) who found farm size to be a positively related to the probability of adoption of modern agricultural production technologies such as use of subsidized fertilizers.However, these results contradict with Martey, et al. (2013) who advocates for farmers to own relatively manageable plots of farm lands after finding a negative relationship between area under cultivation and fertilizer adoption

.

Table 1: Double hurdle estimates of access and fertilizer use intensity

Variable	First Hurdle			Second Hurdle		
	Coefficient.	Std. Error.	z-value	Coefficient.	Std. Err.	z-value
Sex	0	0.17	-0.03	0.7004069	2.68	0.26
Education Level	0.05	0.02	0.24	0.30	0.35	0.87
Age	0.01**	0.01	2.12	0.20**	0.09	2.26
Land Size	0.29***	0.08	3.8	3.2***	1.17	2.74
Access to Extension Services	2.43***	0.18	13.19	8.73*	5.39	1.66
Distance to Agricultural Office	-0.14***	0.04	-3.27	0.55	0.707	0.79
Household Size	-0.10*	0.06	1.77	-1.531401	1.20	-1.27
Non-farm Income	0.00***	0.00	3.12	0.00***	0.00	2.97
No. of Observation	384			196		
Wald chi2(8) =	312.30			297.43		
Prob > chi2	0.0000			0.0000		

Distance to agricultural office had a negative outcome on subsidized fertilizer access as expected. This implied that increase in the distance to agricultural office was likely to decrease fertilizer access as distance has associated high costs of transport which might limit farmers from accessing the subsidized fertilizer. A unit increase in the distance to the agricultural office leads to a 0.14 decreases in chances of accessing subsidized fertilizer. This results tally with Makau, (2016) who found a negative relationship between distance and quantity of fertilizer used citing that longer distances attracted higher transport and transaction costs. However, contradictory results were found by Martey, et al. (2013) who reported a positive relationship between distance to agricultural office and fertilizer adoption and intensity of use. He argues that there was a likelihood of farmers depending more on neighbouring farmers for useful information on fertilizer use relative to most of the agricultural extension agents that are not accessible to farmers hence explaining the phenomenon.

Access to extension agents positively affected both the chances of accessing and the use intensity of subsidized fertilizer. This is due to the fact that extension services increases farmers' awareness on available subsidized fertilizers. These results tally with studies by Cavane, (2016) who found extension services being a significant factorfor adoption of fertilizers where the probability of adoption of NPK and urea increased 5 and 3 times more through learning from extension officers than learning from neighbours.

Household Size was found to negatively affect the chances of accessing subsidized fertilizer although it didn't significantly affect the use intensity. A larger household comes with higher obligations in terms of meeting the basic needs of a household. This burden usually constrains the household and might prevent them from harnessing the available subsidized fertilizers. These results however contradict with Makau,(2016) who reported a positive and significant relationship between household size and quantity of fertilizer purchased and used. She alludes this to the probability of a large household contributing to the labour during application hence acting as a motivation to access and use fertilizers

IV.CONCLUSION

The results showthat a significant number of farmers were not accessing subsidized fertilizers .This might have been attributed to flaws in the design and implementation of the program, fraudulent behaviours such assoliciting bribesto provide the product or diversion away from the intended beneficiaries (Dorward and Chirwa 2011).

The findings showed thatage, access to extension services, land size, distance to market, household size and non-farm income significantly affected the accessibility of subsidized fertilizer to the farmers while the use intensity of subsidized fertilizer was significantly determined by age, land size, access to extension services and non-farm income of household head.

The results suggest a collaborative approach where the government should consider socio economic factors of the farmers. The government should also target the smallholder farmers when formulating policies for distribution of subsidized fertilizers as they are the intended beneficiaries who used to receive insufficient or no fertilizer for their production. Institutional factors such as Extension services and Fertilizer dissemination points should be effective to access more farmers who are in need of the much desired fertilizer. Improvement in infrastructure such as road and lessening the distance and associated transport costs is crucial for successful adoption of subsidized fertilizers to farmers

REFERENCES

[1]. Akudugu, M. A., Guo, E., & Dadzie, S. K. (2012). Adoption of modern agricultural production technologies by farm households in Ghana: What factors influence their decisions. *Journal of biology, agriculture and healthcare*, *2*(3).

[2]. Asante, B. O, Afari-Sefa V., &Sarpong, D. B (2011). Determinants of Small-Scale Farmers' Decision to JoinFarmer Based Organizations in Ghana. *Afr. J. Agric. Res*., *6*(10), 2273-2279.

[3]. Cavane, E. (2016). Farmers' attitude and adoption of improved maize varieties and chemical fertilizers in Mozambique. *Indian Research Journal of Extension Education*, *11*(21), 1-6.

[4]. Cochran, W. G. (2007). *Sampling techniques*. John Wiley & Sons.

[5]. Cragg, J. (1971). Some statistical models for limited dependent variables with application to the demand for durable goods.*Econometrica*, *39*(5), 829-844.

[6]. Dorward, A., Chirwa, E., & Jayne, T. S. (2011). Malawi's Agricultural Input Subsidy Program Experience over 2005–09. *Yes Africa Can: Success Stories from a Dynamic Continent*, 289-317.

[7]. Druilhe, Z., & Barreiro-Hurlé, J. (2012). *Fertilizer subsidies in sub-Saharan Africa* (No. 12-04). ESA Working paper.

[8]. FAO. (2018) *Kenya at a glance | FAO in Kenya | Food and Agriculture Organization of the United Nations*. (2018). *Fao.org*. Retrieved 9 April 2018, from http://www.fao.org/kenya/fao-in-kenya/kenya-at-a-glance/en/

[9]. Kothari, C.R. (2004). *Research Methodology. Methods and techniques*, 2nd Ed. New Delhi: New Age International (P) Ltd.

[10]. MAKAU, J. M. (2016). *AN ASSESSMENT OF THE EFFECT OF SUBSIDIZED FERTILIZER ON FARMER PARTICIPATION IN COMMERCIAL FERTILIZER MARKETS IN NORTH RIFT REGION OF KENYA* (Doctoral dissertation, University of Nairobi).

[11]. Mal, P., Anik, A.R., Bauer, S., and Schmitz, P.M., (2012), "Bt Cotton Adoption: A Double-hurdle Approach for North Indian Farmers", *AgBioForum*, 15(3): 294-302

[12]. Martey, E., Wiredu, A. N., Etwire, P. M., Fosu, M., Buah, S. S. J., Bidzakin, J., & Kusi, F. (2013). Fertilizer adoption and use intensity among smallholder farmers in Northern Ghana: A case study of the AGRA soil health project. *Sustainable Agriculture Research*, *3*(1), 24.

[13]. Mathenge, M., Place, F., Olwande, J., & Mithoefer, D. (2010). Participation in agricultural markets among the Poor and marginalized: analysis of factors Influencing participation and impacts on income and Poverty in Kenya. *Unpublished Study Report Prepared for the FORD Foundation*.

[14]. Ng'ang'a, Stanley Karanja, An Notenbaert, Chris Miyinzi Mwungu, Caroline Mwongera, and Evan Girvetz. "Cost and benefit analysis for climate-smart soil practices in Western Kenya." (2017).

[15]. Noltze, M., Schwarze, S., & Qaim, M. (2011, September). Understanding the adoption of systemic innovations in smallholder agriculture: the System of Rice Intensification (SRI) in Timor Leste. In *presentation at the EAAE 2011 Congress, August* (Vol. 30).

[16]. Ochola, R. O., & Fengying, N. I. E. (2015). Evaluating the effects of fertilizer subsidy programmes on vulnerable farmers in Kenya. *Journal of Agricultural Extension and Rural Development*, *7*(6), 192-201.

[17]. Odame H, Muange E (2012). Can Agro-dealers deliver the green revolution in Kenya? Future Agricultures Consortium DFID UK. Future Agricultures Policy Brief No. 45.

[18]. Vanlauwe, B., Kanampiu, F., Odhiambo, G. D., De Groote, H., Wadhams, L. J., & Khan, Z. R. (2008). Integrated management of Striga hermonthica, stem borers, and declining soil fertility in western Kenya. *Field Crops Research*, *107*(2), 102-115.