Subsidized Fertilizer Utilization and Determinants among Small-scale Maize Farmers in Kakamega County, Kenya

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Phoebe Bwari Mose
Maseno University

Subsidized Fertilizer Utilization and Determinants among Small-scale Maize Farmers in Kakamega County, Kenya

Dennis Kimoso Mulupi, Mose P. B Ph.D, Kenneth Waluse Sibiko Ph.D
Department of Agricultural Economics and Rural Development, Maseno University, Kenya

***Abstract*: Decline in soil fertility due to continuous use of land has been outlined as one of the major challenges facing crop productivity in Africa. However, a number of government-led interventions and strategies have been introduced to raise fertilizer usage including the fertilizer subsidy program for small-scale farmers. This study investigated the determinants and whether, and extent of successful of the government subsidy program among small-scale maize farmers in Kakamega County, Western Kenya. The study employed cross-sectional survey research design using semi-structured questionnaires to obtain data from 300 farmers, who were selected using a multi-stage sampling technique. Data was analyzed by econometrically employing descriptive analysis and a one-limit Tobit regression – controlling for programme selection bias. Results reveal that the average proportion of subsidized fertilizer utilized was59.48% among subsidy program participants. The intensity of subsidized fertilizer utilization by farmers was significantly influenced by the farm size under maize, household size, seed rate, age and education level of the household head, distance to the market and amount of credit borrowed. By the findings showing higher average fertilizer application rate of 85.6 kg per haamong the program participants compared to 74 kg per ha for non-participants, the study recommends expansion of the program to incorporate more farmers by increasing quantities of subsidized fertilizer supplied and consider socio-economic factors of small scale farmers when formulating policies on allocation as they are the main target of the program.**

***Keywords:* fertilizer subsidy program, maize, productivity, Tobit model, small-scale farmers**

I. INTRODUCTION

Agriculture contributes about 26 percent to Kenya's GDP directly and 25 percent indirectly (UNEP, 2015). Regardless of its status in the country on food security and development of the economy (Ochola & Fengying, 2015), maize productivity has generally stagnated in recent years (DTMA, 2015; Jena *et al*., 2021). Production and productivity rates are way lower than global and regional averages (Naseem *et al*., 2018). This has led to persistent maize shortages with annual maize output often falling below the country's consumption (Kirimi *et al*., 2011; Barmao & Tarus, 2019).

Poor soils and scarce use of modern technologies are part of the main factors contributing to low maize yields (Hijbeek *et al*., 2021; Ejigu *et al*., 2021). Furthermore, much of the soil productiveness depletion have been attributed to increasing human activities and climate change (Diiro & Ker, 2009; Brevik, 2013; Mutea *et al*., 2020). In addition, poor agronomic practices, limited crop research and inadequate institutional support (Kogo *et al*., 2020), inadequate use of inorganic fertilizer and market-failure in the agricultural input system (Druilhe & Barreiro-hurlé, 2012),which are exacerbated by new challenges such as variability in weather and patterns of pest and disease (Akuku *et al*., 2019), are the other reasons for reduction of soil fertility and low crop output in Kenya.

According to the Kenya Soil Health Consortium, in collaboration with other partners, in the period 1925-2015, soil fertility and soil health deteriorated in Western Kenya resulting in low crop yields. Macharia *et al*. (2009) also reported low grains yields for farmers in North Western province being caused by declining soil fertility and susceptibility to pests and disease. Similarly, Mbakaya*et al*. (2011) and Mulinya *et al*. (2015) mentioned that soil fertility diminution on farms was a major natural cause of reduced food productivity in Kakamega North District.

To sustainably increase crop productivity, it is necessary to apply moderately higher quantities of fertilizer (Anago*et al*., 2020;Debnath & Babu, 2020). However, commercial farm inputs are expensive for most farmers to access (Selejio, 2017; Barasa, 2019). With an average poverty index of 51% in Kakamega County, it implies that affordability of fertilizer is a major concern for many farming households (AfDB, 2016). This has potentially lowered the fertilizer application rates exposing farming households to land degradation and food insecurity hitches (Paul *et al*., 2015). In order to address the issue of input access, the government of Kenya through NAAIAP program has been implementing farm input subsidies since 2007. The first phase of NAAIAP subsidy program was known as *Kilimo* plus which lasted for two years, providing mainly less economically empowered farmers with fully subsidized farm inputs.

The aim of *Kilimo* plus was to uplift these farmers so that after two years they would be able to make part payments of the inputs offered through the program (NAAIAP, 2014; Belt *et al*., 2015). Program participants were supposed to pay Ksh. 1800 lower than market price of Ksh.3100 per 50 kg bag from other sources such private agro-dealers. This translates to 41% subsidy on the price, which is lower than the a-two-third of market cost as was done in Malawi. This initiative was a reaction to the Abuja Declaration on fertilizer for African resolutions in which the African heads of states resolved to increase fertilizer usage to at least 50 kilogram per hectare by the year 2015 from eight kg/ha at the time (NEPAD, 2006).

Despite the initiatives, a substantial improvement in yields is yet to be realized even after widening the targeted area under the fertilizer subsidy to the whole country (Druilhe & Barreiro-Hurlé, 2012; Jena *et al*., 2021). In Kakamega County, Kenya, this fertilizer subsidy program was aimed at achieving increased application rate of fertilizer from the usage of 37kg/ha at the time to the recommended 100kg/ha (NAAIAP, 2014). However, this was not achieved such as subsidies did not reach targeted farmers. The study therefore, investigated the extent of subsidized fertilizer usage and the factors that influence the use in the overall inorganic fertilizer. In addition, the study investigated determinants of government subsidy inputs program participation among small scale farmers in Kakamega County.

II. METHODOLOGY

Study area.

Kakamega County, one of the densely populated Counties in the country, was purposively sampled for the study due to its declining soil fertility and the subsidy program being operational amidst stagnating maize productivity (Munialo *et al*., 2020). Beans, sugarcane, and maize farming is practiced in the whole County. However, tea farming is practiced only in a few parts. It has cool and wet climatic conditions with an average temperatures of 22°C. The first quarter of the year is normally the hottest, however, the third quarter experiences increased rainfall making it the coolest period (KCIDP, 2018). Moreover, during the months of March to July, the County receives moderately heavy rainfall. However, relatively lower rainfall is experienced in December and February (Chepkoech *et al*., 2020). In addition to the cash crops mentioned, finger milletand sorghum are also grown for subsistence reasons. Cash crops occupies comparatively a higher acreage as compared to the food crops. Poverty index is 51%, 22.2% of the households' rear sheep, 11.2% goats, 1.7% pigs, 92% poultry and 0.7% keeps donkeys (KCIDP, 2018). The mean land ownership is 1.4 ha. Agriculture is dominantly rain-fed.

Study design

A descriptive survey research design was adopted in conducting the study. A list of beneficiary farmers was acquired from the County Ministry of Agriculture. Semi-structured personal administered questionnaires were used to collect primary data focusing on the household head and key informant interview on extension offices and ministry of agriculture officers. A multistage sampling method was employed. Purposive, clustered and simple random sampling design were used to select participants on condition that the farmer had less than 2.5 hectare of land to meet the merit of being a small holder farmer. A formula adopted by Anderson *et al*. (2008) was used to determine the required sample size. Thereafter, proportional allocation was used to determine responses from each sub-County.

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

Denoted by n is the least required sample, z is 1.96 at 5% significant level, d represents the acceptable error limit taken as 0.05, q signifies the weight variance calculated as 1-p. Records shows that 80% of all farmers in the County engage in maize production thus p will be 0.8

$$n=\frac{1.96^2(0.8)(1-0.8)}{0.05^2}=245.8624 \quad (3)$$

According to the above calculation, 245 farmers was the basic sample size essential for the study, but; this number was increased to 300 to give room for incomplete, unreturned questionnaires and increase reliability of the data.

Data analysis

1. Estimation of subsidized fertilizer proportion usage

The study adopted descriptive analysis focusing on frequencies, means and percentages. Comparisons of means were done by Chi-square and t-test and the findings presented in a table.

2. Factors hypothesized to influence subsidy program adoption and proportions of subsidized fertilizer utilized

To determine factors influencing program adoption and the proportions of subsidized fertilizer usage among farmers, the study employed Cragg's two stages model (Cragg, 1971) using probit model in the first stage as many other studies analyzing uptake of technology in agricultural economics or a decision involving two outcomes and Tobit model in the next phase (Mal *et al*., 2012).

The first analysis step determined factors affect the chances of a farmer taking part in the program. Individual adoption of the program is a double outcome or dummy situation comprising of two choices which are participating or failing to participate. Everyone involved in the selection process has a range of responses that are influenced by various factors.

Probit regression was used to estimate and compute factors affecting the likelihood of subsidy program participation. This model was preferred due to its potential to minimize heteroscedasticity limitations and its ability of compelling the probability of adoption (P_i= (q=1|X) to increase or decrease only in an interval of 0 to 1(Asante *et al*., 2011).

A number of models could have been used as an alternative for approximating the nominal response of this dummy variable such as linear probability model and Logit model. However, shortcomings such as the probabilities exceeding 1 or being less than 0 for linear probability model makes probit the best. Participating or not participating in the program cannot be defined on a definite scale. They are qualitative in nature, since they do not have any natural scale of measurements, they are therefore, defined on a nominal scale. The decision of a household either to adopt subsidy program or not is as a results of the utility value q*****, which is the outcome of other variables. Household's adoption rate of the subsidy program is higher when the utility value q***** is also high. The latent utility index is expressed as:

$q*=X'\beta+\mu$ (1)

$q=1 \; if \; q^*>0$; $q= 0 \; if \; q^*\leq 0$, (2)

A utility-maximizing (Y^*) farm household will decide to adapt, if the satisfaction derived from adapting (U_{Ai}) exceeds the benefits of not adapting at all (U_{Ni}) for the *i*th farmer ($Y^*= U_{Ai} - U_{Ni}>0$) (Onzima, 2017). Therefore, $U_{Ai}=X_i'\beta_1+\mu i_1$ and $U_{Ni}=X_i'\beta_0+\mu i_0$ represents the utility for accessing subsidized fertilizer and not accessing respectively. Since the farmers only decides to assume fertilizer subsidy program when the utility gained is greater ($U_{Ai}-U_{Ni}>0$). The probability of i^{th} farmer accessing subsidized fertilizer is calculated as follows:

$Prob\,(Y_i=1|X) = P\,(U_{i1}>Ui_0)$ (3)

$=Prob\,(X_i'\beta_1+\mu i_1>Xi'\beta_0+\mu i_0)$ (4)

$=Prob\,(\mu_{i0}-\mu i_1<Xi'\beta_1-Xi'\beta_0)$ (5)

$=Prob\,(\mu_{i0}-\mu i_1<Xi'\,(\beta_1-\beta_0)$ (6)

$=Prob\,(\mu_i<X_i'\beta)$ (7)

$=\phi\,(X_i'\beta)$ (8)

Thus the model that is used to estimate the probability of accessing subsidized fertilizer is $\phi\,(X_i'\beta) = P\,(Y_i=1|X)$. Where ϕ (.) Is the standard normal distribution cumulative distribution function, X' represents vector of independent variables, β is a vector of parameters P is the probability that the i^{th} farmer access subsidized fertilizer.

The functional form of Probit regression model equation that empirically explain factors affecting decision to access or participate in the subsidy program was expressed as:

$Y^*\,(0, 1) =\beta_0 + \sum_{i=1}^{13} \beta_i X_i + \varepsilon_i$ (9)

$Y^*(0, 1)$ = Variable describing decision on utilization of subsidized fertilizer (1) access subsidized fertilizer (0) not access to subsidized fertilizer; β_0 is an unknown intercept, $\beta_i \ldots \beta_k$ (*i= 2, 3…, k)* are slope coefficients and μ is the standard error term.

The next phase of the model used a left censored linearized Tobit regression model in estimating the coefficients for determining factors influencing the proportions of subsidized fertilizer utilized in the overall fertilizer by a farmer. This model was preferred since the proportions of subsidized fertilizer were continuous variables; Inverse mills ratio (IMR) computed in stage 1 were used as an independent variable to account for self-selection biasness in the Tobit model

$(K/T)\; Q=\beta_0 + \sum_{i=1}^{13} \beta_i X_i + \varphi\omega + \mu_I$ (10)

Q= proportions of subsidized fertilizer utilization (K/T-where K-subsidized fertilizer quantities and T is total inorganic fertilizer); While β_0 is a constant (unknown intercept), $\beta_i \ldots \beta_k$ (*i= 1, 2.., k*) are slope coefficients and ε is the standard error term.

X_1 Farm size under production,

X_2 Manure application,

X_3 Household size,

X_4 Seed quantities per hectare,

X_5 Value of Agricultural assets,

X_6 Age of the farmer,

X_7 Farmers' Education levels,

X_8 Gender,

X_9 Occupation,

X_{10} Distance to market,

X_{11} Amount of credit,

X_{12} Group membership,

X_{13} Location, φω Inverse Mills Ratio.

III. RESULTS

Subsidized fertilizer proportions use

The results from Table 1 below shows that 13300 kg of subsidized fertilizer were utilized out of the 22 358 kg of overall inorganic fertilizer usage for planting and top-dressing among the sampled subsidy program participants. In addition, they further utilized 9,058kg of commercial fertilizers. This translates to 59.48% government subsidy fertilizer and 40.51% of fertilizer from private agro-dealers. The average fertilizer application rate among program beneficiaries was 91.39 kg per hectare for planting and 82.45 kg per hectare for topdressing averaging to 85.64 kg per hectare while non-subsidy program beneficiaries was 19,858 kg with an average application of 81.51kg/ha for planting and 71.63 kg/ha for topdressing having an average of 74.92 kg per hectare as shown in Table 2 below. A significant t-test implied that program involvement improved inorganic fertilizer use, therefore, those who engage in the program had a higher application rates. In addition, the average fertilizer application rate for the County was found to be 80.7 kilogram per hectare which is lower compared to the recommended country application rates and the average fertilizer utilization in the neighbouring Counties of Nandi and Trans Nzoia which is over 100kg per hectare.

Table 1: Subsidized Fertilizer Proportions Utilization in the overall Inorganic Fertilizer

	Aggregate		Beneficiary		Non-beneficiary		t-test
	Sum	Prop	Sum	Prop	Sum	Prop	
Government supplied subsidized fertilizer applied (kg)	13 300	31.50%	13 300	59.48%	000	0	22.42*
Private agro-dealers supplied commercial fertilizer applied (kg)	28 916	58.50%	9 058	40.51%	19,858	100%	6.451**
Total inorganic fertilizer used (kg)	42 216	100%	22,358	100%	19 858	100%	2.278**

Source: Authors' own computation from survey data. Notes: kg represents kilogram, * statistically significant at the 10% level; ** statistically significant at the 5% level; *** statistically significant at 1% level

Table 2: Fertilizer application rates

	Average rate (Kg per ha)
Program beneficiaries	85.64
Program non-beneficiaries	74.92
Average application	80.68

Leakage of subsidized fertilizer was further noticed. A 6.84% deviation from what was received and what was utilized on maize crop was evident. The potential causes of this deviation was suspected to be side selling of the subsidized fertilizer by beneficiaries and diverting to other crops or unintended purpose.

Table 3:Leakage from the subsidy program

	Sum (Kg)	Percentage(%)
Received	14, 275	100
Usage	13,300	93.17
Leakage	975	6.83

Determinants of subsidized fertilizer adoption and proportions use in the overall inorganic fertilizer

One limit left censored Tobit regression model was used to estimate the factors that influence the intensity of the proportions of subsidized fertilizer utilized by the small scale farmers. The estimates coefficients of the factors are presented in Table 4 below. The model having a Pseudo R^2 of 81.7 %, shows a good fit indicating that the model fitted the data well. The independent variables that were fitted in the model were able to explain the variation in the proportions of subsidized fertilizer utilization by 81.74%. In addition, since the Chi-square was 68.8% and statistically significant at 5% level, this shows that the model was correctly estimated. Adoption of fertilizer subsidy program was influenced by household size, age, education level, distance from market, amount of credit borrowed and farmers' group participation. However, the intensity the proportions of subsidized fertilizer usage in the overall fertilizer was significantly influenced by farm size, household size, seed quantities, age, education, distance to market and amount of credit accessed.

The results in Table 4 shows that an increase in farm size under maize production by one hectare reduced the proportions of subsidized fertilizer usage by 1.172% per ha at 1% significant level. In addition, an increase by one in the household size increased the probability of a farmer participating in the subsidy program by 0.07% and a corresponding increase of 0.112% per ha was experienced in the proportions of subsidized fertilizer use in the overall inorganic fertilizer. Furthermore, results indicates that an increase in the quantities of seed planted by 1kg/ha increased the proportion of subsidized fertilizer usage in the overall inorganic fertilizer by 0.085% per ha at 99% confidence interval.

Moreover, it indicates as age increases by one year, the likelihood of a farmer participating in fertilizer subsidy program increased by 0.1% and the portions of subsidized fertilizer usage in the overall inorganic fertilizer increases by 0.38% per ha. In addition, as years of schooling increased by one, the probability of a farmer participating in the subsidy program increased by 0.124%, similarly the proportions of subsidized fertilizer utilization increased by 0.178% per ha. The results show that as distance increase by one km from the market increased the likelihood of participating in the fertilizer subsidy program by 0.329% while quantities of subsidized fertilizer utilized in the total inorganic fertilizer increased by 0.227% per ha. Furthermore, an increase in the probability of borrowing by 1000 units access increased the likelihood of a farmer participating in the subsidy program by 2.47% and increased the proportion of subsidized fertilizer usage in the total inorganic fertilizer by 1.098% per ha. Lastly, farmers' group participation significantly reduced the probability of a farmer participating in fertilizer subsidy program by 0.023% per ha at 5% level.

Table 4: Probit and Tobit Regression Estimates of Factors Influencing Subsidized Fertilizer Adoption and use Intensity.

Variables	Probit model				Tobit model			
	Coefficient	Std. Error	Z	P>|t|	Coefficient	Std Error	T	P>|t|
Farm size (Hectares under maize crop)	-3.409	0.085	-1.15	0.320	-1.172	0.195	-6.01	0.000***
Manure quantities (Carts Ha^{-1})	-0.124	0.049	-1.02	0.306	-0.024	0.046	-0.58	0.565
Household size (Labor for production)	0.070	0.027	2.62	0.009***	0.112	0.018	6.15	0.001***
Seed rate (Kg Ha^{-1})	0.793	0.415	1.73	0.230	0.085	0.017	5.01	0.000***
Agricultural asset value (Ksh. 1000)	0.047	0.266	1.21	0.264	0.047	0.266	0.57	0.566
Age (Years)	0.090	0.009	9.65	0.000**	0.378	0.772	4.35	0.000***
Schooling (Years)	0.124	0.015	7.84	0.000***	0.178	0.119	6.49	0.000***
Gender of household head (1=M, 2=F)	0.230	0.039	0.59	0.555	0.032	0.029	1.22	0.223
Occupation (1=Farming, 2= Business related, 3=Salaried)	0.009	0.015	0.63	0.529	0.749	0.133	1.17	0.241
Distance to market (Km)	0.329	0.540	9.98	0.000***	0.228	0.116	13.98	0.000**
Amount of credit (Ksh. 1000)	2.471	0.430	5.78	0.000***	1.098	0.427	5.78	0.000**
Group membership (1=Yes, 0=otherwise)	- 0.023	0.036	-0.64	0.003***	0.051	0.040	1.17	0.243
Location (1=Malava, 2= Otherwise)	0.002	0.035	0.04	0.965	-0.002	0.024	-0.90	0.368
Inverse Mills Ratio	-0.083	0.220	-0.38	0.706	-0.083	0.095	-0.72	0.471
Constant	-4.575	0.281	-16.2	0.000	-4.848	0.598	-8.10	0.000
Number of observations	300				No. of observations 150			
Rho	-0.543				Log likelihood -45.18			
Sigma	0.162				Pseudo R^2 81.74			
LRchi^2(14)	62.33				LRchi^2(13)68.88			
Prob>chi^2	0.000				Prob>chi^2 0.000			

Source: Authors' own computation from survey data. Notes:*, **, *** statistically significant at the 10% level, statistically significant at the 5% level and statistically significant at 1% level.

IV. DISCUSSION

Proportions of subsidized fertilizer utilization in overall inorganic fertilizer

As from Table 1, the proportion of subsidized fertilizer used among the program participants is commendable at 59.5%. This implies that the government has been focused to reach most of the resource-poor farmers through the subsidy program. In addition, from Table 2, fertilizer application rates for the program participants is significantly higher at 85.6 kg per hectare compared to 74.7 kg per hectare for non-participants. Moreover, the average fertilizer application rate has improved to 80.6 kg per hectare. This higher quantities of subsidized fertilizer usage could be linked to affordability and accessibility. In addition, elimination of fertilizer brokers from inputs subsidy market distribution network chain, therefore, fertilizer market efficiency, could be another reason. The fact that subsidized fertilizer is supplied on time according to most farmers; makes it available at the time of planting raising utilization level. However, not all small scale farmers in productivity trap have access to this program as its goal was initially set to raise productivity and attain food reliance. The reasons for this partial program adoption could be poor information dissemination, inefficiency in subsidy input distribution network or complicated procedures in acquiring inputs or less inputs supplied.

This subsidy usage rate is similar to the findings of Allotey (2019) who reported subsidy program participants constituting 64.8% subsidized fertilizer and 35.2% commercial fertilizer of the total fertilizer utilization in Ghana.

These results are in agreement with Dorward (2009) and Minot *et al*. (2009) who reported subsidy program being a cost effective way of assisting poor rural farming households acquire more fertilizer and achieve optimal application rates and can be justified on the ground of equality as it enables farmers to off-set financial constraints. Similarly, in the report by Druilhe & Hurle (2012) and Anago *et al*. (2020) reveal availability of proof suggesting subsidy program being effective in intensifying usage of inputs in agriculture. The results are supported by the work of Jongare & Michael (2015) and Zinnbauer *et al*. (2018)who reported that subsidy program improved the fertilizer use intensity in Ghana and Zambia respectively. According to Chirwa (2010) and

Aiyabei (2018)farmers who received subsidy inputs were able to use more quantities of fertilizer. The findings tally with Ricker-Gilbert (2011), who reported an extra kilogram of subsidy fertilizer use reducing the purchase of commercial fertilizer by 0.22 kg. Hemming *et al*. (2018), found that a decrease in purchasing salable fertilizer by 0.05% resulting from 1% increased utilization of subsidized fertilizer. In support of the findings, Xu *et al*. (2009), reported a decrease of commercial fertilizer purchase by almost the same amount increase in government funded fertilizer in Zambia after the program implementation.

According to Banful *et al.* (2010), fertilizer utilization was higher in the states with generous fertilizer subsidies based on the state subsidy rates of 2008 in Nigeria. In agreement with Takeshima *et al*. (2012), farmers using both commercial and subsidized fertilizer applied more fertilizer by over 60 kg/ha. They reported that the supply of fertilizer from public sources reduced approximately 19 to 35% of fertilizer supplied from commercial sources with a higher potential of reduction effects on farmers who obtain fertilizer from both sources. In addition, Ariga & Jayne (2008) reported that subsidy program increased the amount of fertilizer application in western highlands to up to 163 kg/ha. According to Birch (2018), inputs subsidy program tend to reduce commercial fertilizer application. Additional 100 kg of subsidized fertilizer is estimated to have a crowding out effect of up to 50 kg commercial fertilizer compared with 13 kg reported in Zambia (Kahsay *et al*., 2015). In the report by Makau *et al*. (2016), a kg increase in the quantities of subsidized fertilizer utilized among the farmers crowded out the commercial fertilizer used by 0.20 kg in the North Rift Valley region in Kenya.

However, in contrary, Hanjra & Culas (2011) reported low fertilizer availability due to subsidy program in Malawi and Liverpool-Tasie (2014), testified against subsidized fertilizer by revealing its potential to only expand the participation in and intensity of fertilizer procured from commercial dealers. The author attributed this to the multifaceted delivery channels in acquiring subsidies in Nigeria. Similarly, subsidy program lowered inputs utilization, potentially reducing yields in the years the program was operational and few years that followed thereafter in Haiti (Gignoux *et al*., 2021).

Determinants of subsidized fertilizer program adoption and the proportions use in the overall inorganic fertilizer

Farm size significantly influenced proportions of subsidized fertilizer utilized. However, the influence was inverse as the farm size under maize production increased by one hectare, the proportions of subsidized fertilizer in the overall fertilizer applied reduced by 1.172% at 1% significant level. This could be closely related to the initial objective of the program of targeting resource-poor farmers. The results are in agreement with the earlier hypothesis that farmers owning large farm sizes might afford agro-dealers commercial fertilizer. In addition, the government policy of the program focusing on small scale farmers might be restricting resourceful farmers from access to larger quantities of subsidized fertilizer.

The household size positively influenced the probability of a farmer participating in the subsidy program and also the intensity of the proportions of subsidized fertilizer in relation to the overall inorganic fertilizer utilization. An increase by a member in the household increased the probability of participating in the subsidy program by 0.07% and a corresponding increase of 0.112% per hectare was experienced in the proportions of subsidized fertilizer use in the overall inorganic fertilizer. This could be attributed to the fact that, as a family size increases, the need for more food arises and this in-turn calls for more vibrant technologies in production which minimize the cost and increase the output. According to Wiredu *et al*. (2015), larger households who have a higher labor-land ratio are likely to participate in fertilizer technologies that increases application rates. Similarly, Anago *et al*. (2020), who evaluated inorganic fertilizer technology adoption in Benin, revealed that adoption of fertilizer technology highly depends on household size, age and education of the household head. The author reported larger households adopting more inorganic fertilizer technology. In addition, Mignouna *et al*. (2011) and Mwaura *et al*. (2021) associated larger household size with more labor availability, which has a higher probability to relax the labor constraints and increase the likelihood of trying new technologies.

The seed rate planted positively influenced the proportion of subsidized fertilizer utilized in the overall inorganic fertilizer. An increase in seed rate planted by one kg per hectare increased the proportion of subsidized fertilizer usage in the overall inorganic fertilizer by 0.085% per ha at 99% confidence interval. This is in agreement with a prior expectation. Since seeds are also given to farmers through the program, beneficiaries could be acquiring the two inputs proportionately at affordable prices. This could imply that farmers who receive more proportions of subsidized fertilizer stands a chance of benefiting from more quantities of seeds at an affordable price.

Age significantly and positively influenced the likelihood of a farmer participating in fertilizer subsidy program and the proportion of subsidized fertilizer utilized in the overall inorganic fertilizer. As age increases by one year, the likelihood of a farmer participating in fertilizer subsidy program increased by 0.1% and the portions of subsidized fertilizer usage in the overall inorganic fertilizer increases by 0.38% per hectare. This is attributed to the fact that farmers establish social linkage with government officials and vetting committee over years, therefore, elderly farmers are given priorities in selection and allocation process. Moreover, trust established with selecting committees could favor elderly farmers during inputs allocation. Similarly, according to Kariyasa & Dewi (2013), reported older farmers to have gained knowledge and experience over time and better in evaluating technology information thus faster adoption.

However, in contrary, Martey *et al*. (2013) reported that the probability of fertilizer technology adoption was negatively influenced by age. According to Enete & Igbokwe (2009) young farmers are more dynamic and innovative in terms of technology adoption.

In addition, years of schooling positively influenced the probability of a farmer participating in the subsidy program and proportions of subsidized fertilizer usage in the overall inorganic fertilizer utilization. An increase by one in schooling years increased the probability of a farmer participating in the subsidy program 0.124% and the proportion of subsidized fertilizer utilization by 0.178% per hectare.

This could be attributed to the fact that, highly educated farmers have improved know-how and make decision on inputs use basing on cost-benefit analysis. Therefore, they could be among early adopters of any technology as they are perceived more informed. According to Ajewole, (2010) and Kusumah & Christianingrum (2018), education was strongly significant in the adoption of organic fertilizer technology. This is in agreement with (Makau *et al*., 2016) who reported that highly educated farmers acquired more quantities of subsidized fertilizer. The researcher attributed this relationship to the fact that formal education of the household head enables understanding of market dynamics raising demand of modern inputs. Furthermore, the highly educated farmers have high bargaining power with the subsidy vetting committee. This is in line with Azumah & Zakaria (2019) who reported that in Ghana, education level increased amounts of fertilizer subsidy acquired by farmers significantly.

On the contrary, Alhassan *et al*. (2020) reported educated farmers being more resource endowed and can afford commercial inputs. In addition, the fact that educated people might not be doing farming as the main economic activity, therefore, investment on farm operations is less in terms of fertilizer application. Etwire *et al*., 2013 further recommends that an increase in schooling time by one year, reduces the likelihood of participating in government initiated agricultural projects by 2%.

More findings indicated that distance from the market positively influenced the likelihood of the farmer to participate in the fertilizer subsidy program and the quantities of subsidized fertilizer usage in the total inorganic fertilizer. As distance increase by one km from the market increased the likelihood of participating in the fertilizer subsidy program by 0.329% while quantities of subsidized fertilizer utilized in the total inorganic fertilizer increased by 0.227% per ha. As distance to market increase, farmers go for government sponsored fertilizer. This is in order to cut on the expenditure incurred in transportation.

This could be attributed to the fact that those close to input markets prefer commercial fertilizer because of less cost of transportation incurred. The results are in agreement with Ariga & Jayne (2011) and Makau *et al*. (2016) who reported a negative relationship between distance to inputs seller and the quantities of commercial fertilizer usage. However, the results are in contrary to Barasa *et al*. (2019) who reported a negative relationship between distance to market inputs and the quantities of subsidized fertilizer utilization. This implies that fertilizer deports should be located closer to farmers so as to lower the cost of transport.

In addition, credit accessed positively influenced the probability of a farmer participating in the subsidy program and the quantities of subsidized fertilizer usage in the total inorganic fertilizer despite the earlier expectation that those who had a higher borrowing rates will use more of the commercial fertilizer. An increase in the probability of borrowing by 1000 units access increased the likelihood of a farmer participating in the subsidy program by 2.47% and increased the proportion of subsidized fertilizer usage in the total inorganic fertilizer by 1.098% per ha. According to Karkie & Bauer (2004), credit access encourages farmers to adopt and participate in agricultural technology and innovations. As reported by Mohamed &Temu (2008), access to credit stimulate the adoption of technology significantly in agriculture. With an option of borrowing, a household can do away with inefficient income diversification strategies which are less risk and profitable and concentrate on more efficient technological investments (Simtowe & Zeller, 2006). In Ghana, small scale farmers participants of agricultural input subsidy program had a higher income accessed through credit facilities compared to non-participate as reported by Allotey *et al*. (2019) in a study on the impact of fertilizer subsidy program on maize income. According to Etwire *et al*. (2013), farmers who receive credit are more likely to participate in agricultural program by 15 percent by taking advantages of their credit facilities.

This results are in agreement with Jongare & Michael (2015) who reported that farmers who received higher credit were in a better position to make down payment required for subsidized fertilizer therefore access more. Similarly, Makau *et al*. (2016) reported that credit accessed is an extra income which strengthens the purchasing power of a farmer. The researcher attributed this to availability of social capital to persuade the vetting committee. The results were in contrary to Martey *et al*. (2013) who reported that farmers with access to credit are less likely to adopt fertilizer subsidy technology as they are financially empowered to afford commercial inputs and engage in other more economic rewarding activities. Moreover, in the report by Liverpool-Tasie (2014), the researcher mentions that credit lowers the quantities of subsidized fertilizer in favor of commercial inputs. This implies that credit is highly needed ingredient in promotion of inputs and agricultural technology adoption.

V. CONCLUSION AND RECOMENDATIONS

From the findings it was established that, 13,300 kg of subsidized fertilizer had been utilized out of the 22,358 kg of inorganic fertilizer usage among the subsidy program participants' farmers. Additionally, the subsidy program participants further applied 9,058kg of commercial fertilizers. This translates to 59.48% government subsidy fertilizer and 40.51% of fertilizer from private agro-dealers.

The factors that meaningfully determined the proportions of subsidized fertilizer used in overall quantities of inorganic fertilizer utilization were the size of the household, seed rate, age of the family head, education years, inputs market distance and amount of credit borrowed. However, the size of the farm was adversely influencing output. The factors that positively influenced farmers' participation in the subsidy program were household size, age, years of schooling, amount of credit borrowed and distance to market while distance to the agricultural office negatively affected the program participation.

In conclusion, despite the research establishing that the average fertilizer application rates are higher among the program beneficiaries at 85 kg/ha compared to non-participants at 74 kg/ha, with an average application rates of 80 kg/ha, fertilizer subsidy program has not been able to achieve the potential application rates of above 120 kg/ha yet. The application rates are lower compared to what is recommended and this could fail to make an impact on crop productivity.

The study recommends the government subsidy inputs as a good strategy to address the issue of low fertilizer usage. In addition, it recommends the government to increase the amount of subsidized fertilizer supplied in order to in cooperate more farmers in the program to raise the application rates and consider socio-economic factors of small scale farmers when formulating policies on allocation as they are the main target of the program. It also recommends extension officers to disseminate knowledge about recommended fertilizer application rates and the program to farmers and encourage farmers to participate in the program by registering and applying for the inputs.

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