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Fertiliser subsidy effects on fertiliser use in the northern region of Ghana

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This study examines the effect of fertiliser subsidy on application rates of fertiliser among maize farmers in Northern Region. The study uses cross-sectional data from 301 households in the northern region of Ghana. The Probit and Tobit models were respectively used to analyse the determinants of participation in the subsidy programme and the effect of participation on fertiliser application rates. The results of the study show that farm size, price of the subsidised fertiliser, distance to input dealers, amount of credit borrowed and off-farm income are key determinants of farmer's participation in the subsidy programme. Participation in the subsidy programme was found to exert a positive effect on the quantity of fertiliser farmers applied on their farms. The study recommends among other things, the inclusion of cash credit schemes in the subsidy programme as smallholders still found the down payment 79% of the cost of fertiliser high. The study also suggested restructuring in the subsidy programme to allow for channelling of fertiliser through farmer-based organisations (FBOs) in order to curb exploitation by politician and elite farmers.

Key words: Fertiliser subsidy, fertiliser use, Ghana.

INTRODUCTION

Low crop yields in Ghana are attributed to various biotic and abiotic constraints including low soil fertility. However, the average fertilizer use in Ghana is only 7.4 kg per hectare of cropland compared to an average application rate of 35.2 kg/ha in Côte d'Ivoire (Benin et al., 2013). This compares with an average of 35.2 kg per hectare applied in Côte d'Ivoire (Benin et al., 2013). Several African countries are implementing fertiliser subsidy programmes under which fertiliser is given as free inputs to farmers as was the initial case for Malawi, or at subsidized prices as in the case of Ghana or even in the form of credit and loans at subsidised interest rates (Minde et al. 2008; SOAS, 2008).

Ghana's Fertiliser Subsidy programme was instituted in 2008 as a direct response to increasing global fertiliser and food prices with the goal of increasing fertiliser use among smallholder farmers and to prevent a decline in crop production below 2007 output levels (Banful, 2009). The goal of the subsidy programme was to increase fertiliser use rate to at least 50 kg/ha as recommended in the Medium Term Agricultural Sector Investment Programme (METASIP).

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Since the fertiliser sector in the Ghana is liberalised, the Ghana fertiliser subsidy programme was a public-private partnership under which the distribution of subsidised fertiliser to farmers was entrusted to private sector service providers. The subsidy did not specify the targeting of farmers based on their income or the type of crop they produce (Banful, 2009). The stated objectives of the Fertiliser Subsidy Programme included:

1. increase the average of fertiliser application rate from 8 kg/ha to 20 kg/ha ;
2. Increase crop yields and production;
3. Raise the profitability of farm production, and
4. Improve private-sector development.

One key concern of government and agricultural sector policy makers was the lack of knowledge of who actually got access to subsidised fertiliser and how participation in the subsidy programme influenced per acre fertiliser consumption at the smallholder level. The subsidy programme also lacked effective monitoring and evaluation of the programme's impact on smallholder farmers' use of fertiliser.

This paper examines Ghana' six year lag fertiliser subsidy programme (the past six years in which the fertiliser subsidy has been implemented) and how the subsidy affected fertiliser use by farmers. The paper specifically examines the identification and selection of beneficiaries of the subsidy programme and how participation in the programme affected fertiliser application rates among farmers in the Northern region of Ghana, where crop production is predominantly undertaken by smallholders with low per capita earnings, and where fertiliser use among farmers is perceived to be relatively lower than what pertains in the Southern regions of Ghana.

Overview of Ghana's Fertiliser Subsidy Programme Different methods of targeting beneficiaries and distribution of fertiliser have been used by managers of Ghana's fertiliser subsidy programme. The voucher system was used in the first two years, between 2008 and 2009 and replaced with the waybill system from 2010. Under voucher system, selected farmers were assigned coupons with which they could acquire subsidised fertiliser at the price indicated on the coupon. The waybill system on the other hand, was an arrangement under which government absorbed port handling, loading and transport costs as well as commission and margins of agents to arrive at prices perceived as affordable to farmers. The voucher system was visualised to target only smallholder farmers while the waybill extended the subsidy to any farmer with the ability to buy fertiliser at the subsidised rate.

An estimated 713,215 metric tonnes of fertiliser costing GH₵ 335,156,000.00 has been distributed under Ghana's six year lag subsidy programme. However, the fertiliser subsidy programme encountered two key challenges shortly after it was launched. Firstly, the huge budgetary allocation on a private good and the associated fiscal challenge raised concerns regarding the sustainability of the programme. Secondly, the fertiliser subsidy programme was bedevilled with design problems, as the complicated and poorly defined criteria for enlistment of beneficiaries brought about delays in the delivery of the fertiliser. More challenging was the lack of clarity regarding the category of farmers who should benefit from the programme even though the desire to target resource poor smallholders was muted at the beginning. The lack of proper design of the subsidy programme in some instances lead to rent-seeking behaviour and gross abuse of the subsidy programme notwithstanding the huge fiscal burden on the economy. The unregulated nature of the Ghana fertiliser subsidy programme also allowed elite and wealthy farmers capable of buying fertiliser at the open market or unsubsidised prices to crowd out resource poor smallholders.

THEORETICAL FRAMEWORK FOR ASSESSING PARTICIPATION IN THE SUBSIDY PROGRAMME

The framework for examining the factors that influence access to the subsidised fertiliser and its utilisation has its grounding from the threshold theory of decision making, in which a reaction occurs only after the strength of the stimuli increases beyond the household’s reaction threshold (Hill and Kau, 1981). This implies that every individual has a reaction threshold determined by several factors. The household decision to participate in the subsidy programme is one of dichotomous between two mutually exclusive alternatives. The household either participate in the programme or not participate in the programme. This means that there exists a ‘breaking point’ or the threshold in the dimension of the explanatory variables below which a stimulus elicits no observable response. Only when the strength of the stimulus reaches the threshold level that a reaction occurs. Additional increases in the strength of the stimulus results in no effect on the observed response. Models for such behaviours have been propounded in literature (Maddala, 2001; Gujarati, 1995). These models on adoption range from simple relationships to complex multivariate analyses.

The frequently used models to identify factors influencing decision to participate in a new technology are Probit, Logit and Tobit models (Makokha et al., 2001; Imai, 2003). When the dependent variable is dichotomous (0, 1), the Probit and the logit models are preferable but for continuous dependent variables that are censored at or below zero; Tobit model is preferable (Anley et al., 2007).

The Probit model

Probit model is ideal for models in which the dependent variable for is dichotomous, and equals 1 if the *ith* household has adopted the technology at a particular time, and 0 otherwise. OLS estimation is inappropriate because the basic assumptions of normality and homoscedasticity of the error term are violated. Moreover, the computed probabilities may lie outside the 0 to 1 range (Greene, 2003). Probit and Logit models are the commonly used statistical methods developed to analyse dichotomous response dependent variables.

Probit is preferred for this analysis due to its power to limit the utility value of the dependent variable (access to the subsidised fertiliser) to lie within zero and one, and the ability to resolve the problem of heteroscedasticity (Asante et al., 2011). For this reason, the dependent variable, participation in the subsidy programme (Y) will take only two values: one if the farmer participate in the subsidy programme and zero if a farmer does not participate in the subsidy programme.

A farmer's decision to participate in the subsidy programme which is influence by several factors is based on the economic theory of utility maximization (Shakya and Flinn, 1985; Adesina and Zinnah, 1993). The expectations farmers developed about the costs and benefits of a technology are based on their own testing or by analysing information from early adopters and key informants in their communities (Thou et al., 2011)

Following the work done by Marenya and Barrett (2007) and Nkamleu and Adesina (2000), this study presumes that farmers' behaviour is consistent with utility maximization and that would participate in the subsidy program when the expected utility from participation surpasses that of non-participation. The utility (*Uij*) for a given farmer (*i*) though not observed directly, to enlist in the subsidy programme and use fertiliser (*j*) can be explained as a farm-specific function of a vector of explanatory variables *(X*), and an error term with zero mean (*eij*) (Thou et al., 2011). This function is given as:

$$U_{ij} = \beta_j X_i + e_{ij} \quad (1)$$

j = 1, 0; *i* = 1, ...,*n*

Where *j=1* shows participation in the subsidy programme and *j=0* shows non-participation in the subsidy programme. Hence, the i^{th} farmer access the subsidised fertiliser *(j = 1)* if *Ui1 >Ui0*. The expected utility of access to subsidised fertiliser *Uij*can be speculated for empirical purposes from a farmer's observed binary choice of adoption or non-adoption (for this study accessed or not accessed the subsidised fertiliser), which means that a probit or Logit model is required (Anley et al., 2007). Following Asante et al. (2011), this study used the Probit model. In the framework of the choice of whether or not to participate in the subsidy programme, the Probit model is specified as

$$Y = F\omega + \alpha X = Fz \quad (1)$$

Where, Y is the discrete choice variable (access to subsidised fertiliser), *F* represents a cumulative probability distribution function, α is a vector of unknown parameters, *X* is a vector of explanatory variables and *z* is the *Z*-score of the αX area under the normal curve. The value expected of the discrete dependent variable (participation in the subsidy programme) is conditioned on the independent variables, which is given as:

$$E[Y/X] = 0[1 - F(\alpha' X)] + [F(\alpha' X)] = F(\alpha' X) \quad (3)$$

And the marginal effect of each explanatory variable on the probability of adoption is given by:

$$\frac{\partial E[Y/X]}{\partial X} = \Phi(\alpha' X)\alpha \quad (4)$$

Where Φ(.) is the standard normal density function according to Fufu and Hassan (2006).

Tobit model

As stated earlier, the Probit model is appropriate for analysing choice decisions that have discrete values. However, if the adoption choice has a continuous value range with zero values, then its applicability is no longer possible. The appropriate model for these conditions is the Tobit model (Thou et al., 2011). Since the study is interested in not only the factors influencing participation in the subsidy programme (a binary choice) but also the factors that determine fertiliser use intensity (continuous) by the smallholder farmers, it is important that the Tobit model is also estimated. In this case, the Tobit model (McDonald and Moffit, 1980; Yilma et al., 2008) can also be stated as:

$$Y_i^* = \beta X_i + e_i \quad (5)$$
$$Y_i = Y_i^* \text{ if } Y_i^* > 0 \quad i = 1, 2, \ldots N$$
$$Y_i = 0 \text{ if } Y_i^* \leq 0$$

Where Y_i^* is a latent (unobserved) variable indicating participation in the subsidy programme, *Yi* is the observed dependent variable, *ei* is the error term independently distributed with constant variance (σ^2) and zero mean and *N* is the number of observations. The dependent variable has a restrictive value being observe for non-negative outcomes which allows it to meet the criteria as a latent variable. The expected value of *Y* in the Tobit model according to McDonald and Moffit (1980) is specified as:

$$E|Y| = \beta X F(z) + \sigma f(z) \quad (6)$$

and the expected value of *Y* for observations above the limit (Y^*>0) is:

$$E|Y^*| = \beta X + \sigma f(z)F(z) \quad (7)$$

where z represents $\beta X/\sigma$, $f(z)$ is unit normal density, $F(z)$ is cumulative normal distribution function, and X is a vector of explanatory variables.

According to Adesina et al. (1995) the Tobit model permits the study of technology adoption and the conditional level of use of the technology if the initial decision to adopt is made. The Tobit model also permits us to find out the effect of a change in the i^{th} variable on changes in the probability of adopting the technology and in its expected intensity of use (Thou et al., 2011).

The independent variable effects can be decomposed into the decision to access subsidised fertiliser and the fertiliser use intensity following the decomposition of the Tobit model by McDonald and Moffit (1980) and Nkonya et al. (1997). This means that the explanatory variables have two effects: The effects on the conditional mean of Y_i^* in the non-negative part of the distribution, and the effects on the probability that the observation will fall in that part of the distribution. Hence, the marginal effect of an explanatory variable (Xi) on the expected value of the dependent variable (McDonald and Moffit, 1980; Greene, 2003) is given as:

$$\frac{\partial E(Y)}{\partial X_i} = F(z)(\delta EY^*/\delta X_i) + EY^*(\delta F(z)/\delta X_i \quad (8)$$

The overall change in Y can be disaggregated into two (McDonald and Moffitt, 1980): The change in the participation probability as the independent variable X_i changes which equals to:

$$\frac{\partial F(z)}{\partial X_i} = \frac{f(z)\beta_i}{\sigma} \quad (9)$$

The participation intensity of participants in the subsidy programme as a result of the independent variable changing (McDonald and Moffitt, 1980; Norris and Batie, 1987; Fufu and Hassan, 2006) also equals to:

$$\frac{\partial E(Y^*)}{\partial X_i} = \beta_i + (\sigma/F(z))\,\delta f(z)/\delta X_i - (\sigma f(z)/F(z)^2)\delta F(z)/\delta X_i$$

$$= \beta_i[1 - zf(z)/F(z) - f(z)^2/F(z)^2] \quad (10)$$

METHODOLOGY

Data and sampling

The Northern Region of Ghana occupies about 70,383km2 with 2,479,461 people (GSS, 2012). Smallholder agriculture is the most dominant economic activity, employing over 73% of the population. A multi-stage sampling procedure was employed in the selection of districts, communities and households. Three districts, namely Tolon, West Mumprusi and Saboba districts were selected. In the second state, four communities in each district were selected using a cluster sampling procedure. The districts were divided into north, south, east and west, after which one community was selected from each group. Finally, the study stratified the communities based on ethnicity before random sampling of households. A sample size of 301 household was selected from the twelve communities.

Empirical models

The empirical model employed to assess the factors influencing access to subsidised fertiliser is specified as:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13} + \beta_{14} X_{14} + \beta_{15} X_{15} + \beta_{16} X_{16} + u_i \quad (11)$$

Where; Y_i = access or participation in the subsidy programme (dummy; 1 if participated in the programme and 0 if otherwise); X_1 = age of household head (number of years); X_2 = sex of household head (dummy; 1 if male headed household and 0 = otherwise); X_3 = marital status of household (dummy; 1 if household head is married and 0 if otherwise); X_4 = ancestry (dummy; 1= indigene and 0 = otherwise); X_5 = household size (number of people in a household); X_6 = farm size (number of acres); X_7 = wealth rank of household (the wealth status of the household head relative to neighbouring households in the community); X_8 = community influence (dummy; 1 = leader and 0 = otherwise); X_9 = extension visit (number of visits by an extension agent); X_{10} = extension training (dummy; 1 if a household received extension training and 0 if otherwise); X_{11} = cost of fertiliser (NPK) in Ghana Cedis per 50 kg bag; X_{12} = distance from farm to input shop (distance from the farm to an input shop in kilometres); X_{13} = participation effort (dummy; 1 if a household attempted to participate in the subsidy programme and 0 if otherwise); X_{14} = political affiliation (the political linkage of the household head. Dummy; 1 if affiliated to the ruling party and 0 if otherwise); X_{15} = credit borrowed (amount of credit borrowed in Ghana Cedis); X_{16} = off-farm income (amount of money gotten from off-farm activities in Ghana Cedis); β_0= constant term; β_1, β_2,β_3, … … . . , $\beta_{10,}$ are the parameters of the respective explanatory variables in the model, and u_i is the error term.

The second stage of the analyses involves analysis of factors that influence fertilizer use intensity in the study area. As stated earlier the tobit model was used. The intensity of fertilizer use (Y_i) is specified as:

$$Y_i = \frac{quantity\ of\ fertiliser\ use\ (kg)}{total\ land\ area\ (acres)} \quad (12)$$

Therefore, the model to determine the fertilizer use intensity is specified as:

$$Y_i = Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13} + \beta_{14} X_{14} + \beta_{15} X_{15} + \beta_{16} X_{16} + u_i \quad (13)$$

where,Y_i = quantity of fertiliser use (kg); X_1 = age of household head (number of years); X_2 = sex of household head (dummy; if household head is male = 1 and 0 otherwise); X_3 = marital status of household head (dummy; 1 if married and 0 = otherwise); X_4 = education of head (number of years schooled); X_5 = community influence (dummy; 1 if leader and 0 = otherwise); X_6 = organic manure use (dummy; 1 = organic manure use and 0 = otherwise); X_7 = extension visit (number of visits by extension agent); X_8 = household labour (number of people from the household who work on the farm); X_9 = hire labour (number of people hired to work on the farm); X_{10} = cost of fertiliser (NPK) (price of NPK fertiliser in Ghana Cedis per 50 kg bag); X_{11} = farm size (number of acres); X_{12} = wealth rank of the household (the wealth rank of the household

Table 1. Demographic characteristics of sample household heads.

Variable	Mean	Standard deviation
Age (in years)	37.78	10.26
Sex (1 = male, 0 = female)	0.92	0.27
Marital status (1 = marriage, 0 = single)	0.92	0.26
Education (years spent in school)	2.09	3.83
Household size (number of people in the household)	9.56	5.33
Household labour (number of people in the household who work in the farm)	4.22	2.56
Hire labour (number of people hired to work on the farm)	2.28	4.46
Community influence (1 = leader, 0 = member)	0.14	0.35
Farmer experience (number of years in farming)	14.61	9.15
Wealth position (1 = wealthy, 0 = not wealthy)	0.72	0.45
Farm size (in acres)	7.10	4.24
Land ownership (1 = owned land, 0 = not owned land)	0.86	0.35
Years of extension delivery	2.24	2.98
Number of extension visits	1.48	1.99
Extension training (1 = trained, 0 = not trained)	0.33	0.48
Farmer group (1 = grouped member, 0 = not a member)	0.43	0.50
Years in farmer group	1.42	2.06
Credit borrowed (in Ghana cedis)	41.22	105.43
Off-farm income (in Ghana cedis)	272.62	361.99

Source: Author's computation, 2014.

head relative neighbouring households in the community. Dummy; 1 if wealthy and 0 if otherwise); X_{13} = distance from farm to input shop (distance in kilometres from the farm to input shop); X_{14} = access or participating in the subsidy programme (dummy; 1 if X_{15} = land ownership (dummy; 1 if owned land and 0 otherwise); X_{16} = off-farm activity (amount in Ghana Cedis earned from off-farm activities); β_0= constant term

β_1, β_2, β_3, … … . . , $\beta_{10,}$ are the parameters of the respective explanatory variables in the model, and u_i is the error term.

RESULTS AND DISCUSSION

Household socio-demography characteristics

Table 1 presents summary statistics of variables used in the models. The mean age of the sampled household heads was 38 years. About 92% of the sampled households were male headed. The average number of years spent in school by sampled household head was 2 years which means the average sampled farmer was most likely to have truncated their education at the primary level. The low level of education may affect the rate of technology adoption (Abdallah et al., 2014). The average household size was 9 members with an average of 4 within the economically active age range.

The wealth rank of the households measured household perception of their wealth status relative to other households in the study area. Households compared themselves to other households and reported as whether they were among the average, top wealthy or bottom ranked households in the community. About 72% of the sampled respondents reported that they were among the average households in the community. The result further showed that, households owned an average 2.8 ha. This is high considering the fact that farm land holdings by majority in Ghana were less than 2 ha (MOFA, 2013). At least every household in the sample has received extension services for the past two years on the average. About 43% of the sampled household heads were members of a farmer based organisation in the study area. Average household non-farm income was estimated at GH₵ 272.6[1] while average amounts borrowed by households was GH₵ 41.2[2] in 2013/14 farming season.

Participation in the subsidy programme by farm households in the study area

The study examined the accessibility of Ghana's fertiliser subsidy programme in the 2013/2014 farming year. The parameters studied included the percentage of farm households whose members got access to participate in the subsidy programme and the ease with which they enlisted in the programme. The study investigated the enlistment procedure designed by the programme and compared it with the actual process of selection of

[1] Approximately 98 united states dollars
[2] Approximately 15.2 united states dollars

Table 2. Percentage of households whose members participated in the subsidy programme.

District	Community	Percentage access or participation by household heads in the community (%)			
		Yes		No	
		Percentage	Frequency	Percentage	Frequency
Tolon	Dimabi	67.9	19	32.1	9
	Galinkpegu	80	16	20	4
	Golinga	95.2	20	4.8	1
	Tingoli	68.8	22	31.2	10
West Mamprusi	Loagri	52.2	12	47.8	11
	Kukua	60.9	14	39.1	9
	Nayorku	52.0	13	48	12
	Gurunsi-fong	37.9	11	62.1	18
Saboba	Kimoteer	70	28	30	12
	Nalongni	65	13	35	7
	Boagbon	60	12	40	8
	Baakoli	70	14	30	6
	All Communities	64.5	194	35.5	107

Source: author's computation, 2014.

beneficiaries on the ground. Table 2 presents participation data of the subsidy programme for each community. About 95% of households in Golinga in the Tolon district had at least one member that participated in the subsidy programme. Out of the sampled 21 farm households, only one household was not enlisted to participate in the subsidy programme in the Golinga community. This means the programme was more accessible to farmers in this community compared to other communities such as Galinkpegu, Kukua, Gurunsi-fong among others. Across all communities and districts, about 64.5% benefited from the subsidy programme.

Procedure for enlisting participants

The process of fertiliser distribution under the subsidy programme in the 2013/2014 farming season involved the used a coupon system under which eligible farmers were issued coupons which they redeemed at selected input distributors across the districts. Eligibility was ascertained by the farmer either possessing a voter's identification card or National Health Insurance Scheme card to prove citizenship. The farmer was to be known to the extension agent from MOFA who was perceived to be familiar with the area. Farm size information was also required to determine the quantity of the fertiliser an enlisted farmer could purchase at the subsidised price. Farmers who satisfied all these conditions were issued with the coupon stating the quantity of subsidised fertiliser to redeem at the fertiliser retail shop at any time subsidised fertiliser was available. The maximum quantity of fertiliser allowed for a farmer under the programme was 15 bags (10 bags of NPK and 5 bags of NHSO4).

Redeeming the fertiliser

With regards to how the communities actually got to participate in the subsidy programme, political connections, accidental discovery, daily distribution, group membership and the use of coupons were the most common modes of participating in the subsidy programme. The majority (38%) of the sampled households used the coupon to access the subsidy programme (Table 3). The coupons were distributed by MOFA, through its extension agents. The study further found that about 22% only learned of and enlisted in the subsidy programme when arrived at the fertiliser retail store to buy fertiliser implying that some farmers were not verified by extension agents and that there were many loopholes for hoarders and smugglers to exploit. In some instances, retail agents filled the daily record sheets in the absence of the farmers and inflated the quantity of fertilisers redeemed by the farmers under the programme. Political connection was another channel through which households participated in the subsidy programme. Households were asked whether they have any connections with their Members of Parliament (MP), District Chief Executive (DCE), Assemblyman or any political party official through which they acquired the subsidised fertiliser. About 16% of enlisted farm households were able to access the subsidised fertiliser through connections with the DCE, Assemblyman, MP and political party officials. The study further identified group membership as another means through which farmers gained access to subsidised fertiliser. Though not explicitly spelt in the processes of acquiring the subsidy, it became a common practice since the group members were able to help one another to acquire the

Table 3. Methods of distributing subsidised fertiliser.

Method of participation	Frequency	Percentage
Political connections	31	16.0
Accidental discovery	43	22.2
Daily registration	33	17.0
Group membership	13	6.7
Use of coupon	74	38.1
Total	194	100

Source: Author's computation, 2014.

subsidised fertiliser. Farmers who were in groups and under out-grower systems were required to apply through their nucleus farmer association to MOFA. About 10% of successful participants in the subsidy programme enlisted through their farmer groups.

Knowledge and perception of the fertiliser subsidy programme in the study area

Farmers' knowledge of the fertiliser subsidy programme

The study attempts to investigate farmers' knowledge of the subsidy programme in the Northern region. In line with the study objective, sampled respondents were asked if they knew about the subsidy programme in the northern region. About two thirds (65.1%) of the respondents indicated that they were aware of the government fertiliser subsidy programme in the 2013/14 cropping season. About 34.9% of the households indicated that they were not aware that the government had subsidised fertiliser for smallholder farmers (Table 4). They however indicated that they were aware of the programme in the previous years but were not aware that the programme has been continued as they were no longer beneficiaries of the subsidy programme.

Effect of the subsidy programme on fertiliser usage

One of the goals of the Ghana fertiliser subsidy programme was to encourage farmers to increase fertiliser use to about 50 kg per hectare by 2015 as recommended in the Medium Term Agricultural Sector Investment Programme (METASIP) and also per the Abuja declaration of the AU member states at the AU summit in Abuja, Nigeria in 2006. The average fertiliser use per hectare in the study sample was 36 kg. Even though a significant improvement over pre-subsidy application rates, the data showed per hectare fertiliser use rates in Ghana were still below the Abuja declaration and the METASIP targets. About 57% of the households indicated that the fertiliser subsidy programme did not have any effect on the quantity of fertiliser they used while 42% indicated that the subsidy had a positive effect on their fertiliser use intensify as they were able to increase the quantity of fertiliser they used during the period of the subsidy. Table 5 presents the perceived effect of the subsidy programme on household fertiliser use. Among those who indicated an increase in fertiliser use, about 57.3% of them reported that the increase in fertiliser usage was high while 43% indicated that the increment was marginal.

Factors that influence farmers' participation in the subsidy programme and fertiliser use intensity

The main focus of this paper was to analyse the factors that influence farmer's participation in the subsidy programme and how participation in the fertiliser subsidy programme affected application fertiliser use rates. The Probit model was used to analyse farmer, farm and household characteristics that influenced the probability of an individual's participation in the subsidy programme while the Tobit model was used to analyse the effects of participation in the programme on quantities of fertiliser applied by households. Table 6 presents the results of the probit model. Age of the respondent was statistically significant at the 5% level and exerted a positive effect on the probability of participating in the subsidy programme. This means that older farmers were more likely to participate or get access to the subsidy programme than younger farmers. The estimated marginal effect for age was 0.03 meaning the probability of getting to participate in the subsidy programme increased by 0.03 if the age of the household head increased by one year. This finding is in tandem with Chibwana et al. (2010) and Chirwa et al. (2011) and contrary to findings of Martey et al. (2013). Also, sex of the respondent was statistical significant and negatively associated with participation in the subsidy programme. This finding suggests that female household heads were more likely to participate in the subsidy programme. This finding is in line with apriori expectations as female farmers were given priority in attempt to encourage women farmers to participate in the subsidy programme. This result is contrary to Chibwana

Table 4. Farmers awareness of the subsidy programme.

Awareness	Frequency	Percentage
No	105	34.9
Yes	196	65.1
Total	301	100

Source: Author's computation, 2014.

Table 5. Effect of the subsidy programme on fertiliser usage.

Effect	Frequency	Percentage
No increase	167	57.4
Increase	124	42.6
Total	291	100
Level of increment		
Marginal	53	42.7
High	71	57.3
Total	124	100

Source: Author's computation, 2014.

Table 6. Factors that influence household participation in the subsidy programme.

Variable	Marginal effect	Standard errors	p>| z|
Age	0.0261**	0.0105	0.013
Sex	-0.9296***	0.3036	0.002
Marital status	0.2160	0.3516	0.539
Nativity	-0.0590	0.3116	0.860
Household size	0.0175	0.0191	0.359
Farm size	0.0514*	0.0264	0.051
Wealth rank	0.1231	0.2422	0.611
Community leadership	-0.0622	0.3216	0.847
Extension visits	0.0922*	0.0524	0.078
Extension training	-0.6802***	0.2504	0.007
Cost of fertiliser (NPK)	-0.0099***	0.0023	0.000
Distance to retail store	0.1116***	0.0244	0.000
Attempted participation	1.2545***	0.2197	0.000
Political affiliation	0.2265	0.3203	0.480
Credit receive	0.0009*	0.0011	0.085
Off-farm income	-0.0010***	0.0003	0.002
Number of observation	253		
Wald chi^2	93.31		
Prob>chi^2	0.0000		
Pseudo R^2	0.4072		

Dependent Variable is participation in subsidy programme; Source: Author's computation, 2014; *** = 1%, ** = 5% and * = 10%.

et al. (2010) and Chirwa et al. (2011) as they found that female headed households were less likely to access a coupon package.

The coefficient of farm size was positive and statistically significant at 10% level. The sign of the coefficient is consistent with a priori expectation that access to the subsidy programme would increase with increasing farm size. The fact that large farm holders were more likely to participate and benefit from subsidy as opposed to smallholders could mean that the programme was dominated by big and rich farmers thus defeating the core objective of targeting resource poor smallholders.

Number of extension visit received by the household head in the study area was found to also have a positive statistical significant relationship with access to the fertiliser subsidy programme. This means that as the number of visit by the extension agent to the household increased, the probability of accessing the subsidy also increased. The coupons were usually distributed by the extension agents. This means that farmers that received more extension visit within the past 12 months were more likely to have access to the subsidy.

Attempt at participating in the subsidy programme was statistically significant at the 1% level with a positive coefficient sign. This implies that households that have attempted to participate in the subsidy programme were more likely to gain access to the subsidised fertiliser than households that did not make efforts to participate in the programme.

As expected, the price at which subsidised fertiliser was sold exerted a significant and negative effect on participation. The finding is consistent with economic theory, by highlighting the inverse relationship between price and demand. As the cost of subsidised fertiliser increased participation in the subsidy programme decreased.

Distance to the nearest agro-input shop where the subsidised fertiliser could be obtained was positively related with access or participation in the subsidy programme and statistically significant at the 1% level of probability. Distance did not reduce the probability of participating in the subsidy programme which was contrary to apriori expectations.

Similarly, access to credit was positively related with access to the subsidised fertiliser and was significant at the 10% level of significance. The Ghana fertiliser subsidy programme required beneficiary farmers to pay over 70% of the total cost of the fertiliser. It was therefore expected that farmers who received cash credit would be better placed to make the 79% down payment and participate in the subsidy programme. The likelihood of a farmer receiving the subsidised fertiliser increased by 0.0009 for every unit increase in the probability of borrowing.

The effect of fertiliser subsidy on application rates

One of the aims of the fertiliser subsidy programme was to increase the per hectare consumption of fertiliser to 50 kg. The study used the Tobit model to analyse the effect of participation in the subsidy programme on farmer per hectare fertiliser use rate. Table 7 presents the factors that influence fertiliser use intensity in the study area. Marital status, level of influence in community, hours of household labour, hours of hired labour, cost of fertiliser, farm size, wealth status, distance from farm to input shop, participation in subsidy programme and land ownership were the factors found to significantly influence the quantity of fertiliser use in the area. Variables such as age, sex, education, organic manure use, extension visit and off-farm employment did not exert significant statistical effects on fertiliser use intensity in the study area.

Influence in community was proxied by leadership role play in the community. Community influence was an important determinant of fertiliser use intensity in the study area. The quantity of fertiliser used increase by 7.9 kg per acre if the household head was a leader in the community. The implication is that, leaders in the communities were more likely to use more fertiliser than non-community leaders. Many social interventions including subsidy on agricultural inputs are mostly channelled through village leaders in the community. Also, demonstrations of agricultural innovations are often done on group leaders' farms if the organisation doing the demonstration does not own farms at the demonstration sites. The networks influential people in communities have often enable them benefit more for social interventions than those who do not exert similar levels of influence.

Farm size was highly statistical significant at the 1% level of probability and had a negative influence on fertiliser use. This result agrees with many other studies that fertiliser use intensity is negatively influenced by farm size (Martey et al., 2013; Akpan et al., 2012; Chirwa et al., 2011; Thuo et al., 2011; Zhou et al., 2010) but contrary to the finding of Obisesan et al. (2013). Distance from the farm to the input shop though not consistent with a prior expectation influenced fertiliser use intensity in the study area. Distance from farm to the input shop showed positive relationship with fertiliser use and was significant at 10% level of probability. This result is contrary to Zhou et al. (2010) who found distance to negatively related to intensity of fertiliser use. The reason for this observation may be due to the fact that the subsidy beneficiaries did not bear the cost of transporting the subsidised fertiliser and also because of the many distribution outlets across the districts.

Similarly, the wealth rank of a farmer in a community influenced his or her fertiliser use intensity. The wealth rank variable was significant at 10% level of probability and influenced fertiliser use intensity positively. The implication is that relatively richer household heads used more fertiliser than poor household heads.

The variable participation in the government fertiliser subsidy had a positive effect on fertiliser use intensity. The variable is statistically significant at 5% level and consistent with the expectations of the research. This means that farmers that had access to the subsidised fertiliser used more fertiliser on their farms than farmers that did not. The coefficient of participation was 5.9431 implying that fertiliser use increased by 5.9 kg per acre if

Table 7. Effect of fertiliser subsidy on application rates.

Variable	Coefficient	Std error	P>|z|
Constant	32.5190	9.0357	0.000
Age	0.0376	0.1306	0.774
Sex	-4.6353	4.6245	0.317
Marital status	10.1759**	4.5440	0.026
Education	-0.0152	0.3381	0.964
Community leadership	7.8531**	3.3695	0.031
Organic manure	-2.9556	2.3304	0.206
Extension visit	0.3485	0.6249	0.578
Household labour	1.2321**	0.5208	0.019
Hire labour	0.5258*	0.2753	0.071
Cost of fertilizer	0.0508***	0.0173	0.004
Farm size	-2.3369***	0.3129	0.000
Wealth status	4.9317*	2.7257	0.071
Distance	0.7956*	0.4176	0.058
Access or participation in subsidy programme	5.9431**	2.8547	0.038
Land ownership	-7.4663**	3.5548	0.037
Off-farm activity	-0.1977	2.4586	0.936
Number of observations	299	Prob>chi^2	0.0000
LR chi^2 (15)	81.78	Pseudo R^2	0.0305

Source: Author's computation, 2014; *** = 1%, ** = 5% and * = 10%.

a farmer was able to participate in the subsidy programme.

Conclusion

The study examined farm yield response to fertiliser subsidies in Ghana focusing on maize in the Northern Region of Ghana. The study examined the accessibility of the fertiliser subsidy programme, the factors influence participation in the programme and how participation in the subsidy programme affected fertiliser use intensity. The study used the Probit and Tobit models to examine the factors that influenced participation in the subsidy programme and fertiliser use intensity respectively. Results of the analysis indicated communities closer to major towns where there were inputs shops had better access to the subsidy programme than communities not closer to major towns where input shops are available. Many of the beneficiaries of the subsidy programme were male farmers constituting about 93% of the sampled respondents and relatively older than the non-beneficiaries of the programme. The Probit model showed that age, sex, farm size, number of extension visits, extension packages, cost of fertiliser, distance to input shop, attempts at participating in the subsidy programme, credit amount borrowed and off-farm income were significant determinants of farmers decision to participate in the subsidy programme. On the other hand, fertiliser use intensity which was analysed using the Tobit model showed that household and farm characteristics that significantly influenced fertiliser use included marital status, community influence, household labour, hire labour, cost of fertiliser, farm size, wealth status, distance to input shop and participation in the subsidy programme were the influential factors in the model.

Policy implications

The fact that farm size determined the quantity of subsidised fertiliser a farmer was entitled made it possible for large scale farmers to dominate the beneficiaries to the detriment of smallholders. There is the need for criteria that targets resource poor smallholders. There is also the need for greater community involvement in the selection process. The reliance on extension agents for voucher distribution to some degree reinforced elite farmer biases as extension agents have the tendency to focus on the so-called progressive farmers. Options for direct targeting of beneficiaries would go a long way to improve smallholder participation. Borrowing significantly increased both participation and fertiliser use intensity at the household level. It is important to note that the 21% subsidy on fertiliser was still low as some households were unable to make the 79% down payment from their own resources. The need to combine subsidy programmes with credit programmes would go a long way to allow smallholders actually benefit from the scheme. Without credit, the subsidy programme largely benefitted large scale farmers who had the capacity to purchase fertiliser even at market prices. Interference in the implementation of the subsidy programme for partisan political gain was reported in almost all communities. The involvement of civil society groups and traditional leaders is necessary to help curb political exploitation of the subsidy programme. Full disclosure and information sharing would enable communities monitor fertiliser distribution under the subsidy programme. Farmer-based organisations (Farmer-based organisations (FBOs) remain an effective channel for identification of beneficiaries. The results show a significant number of subsidy beneficiaries got access through their FBO. The subsidy programme could restructure to include Farmer-based organisations (FBOs) as a main channel for distribution of subsidised fertiliser.

Conflict of Interests

The authors have not declared any conflict of interest.

REFERENCES

Abdallah A, Ayamga M, Donkoh SA (2014) Smallholder adoption of soil and water conservation techniques in Ghana. Afr. J. Agric. Res. 9(5):539-546.

Adesina AA, Baidu-Forson J (1995). Farmers' perceptions and adoption of new agricultural technology: Evidence from analysis in Burkina Faso and Guinea, West Africa. Agric. Econ. 13(1):1-9.

Adesina AA, Zinnah MM (1993). Technology characteristics, farmers' perceptions and adoption decisions: A Tobit model application in Sierra Leone. Agric. Econ. 9(4):297-311.

Akpan SB, Udoh EJ, Nkanta VS (2012). Factors Influencing Fertiliser Use Intensity among Smallholder Crop Farmers in Abak Agricultural Zone in AkwaIbom State, Nigeria. J. Biol. Agric. Healthcare 2(1), ISSN: 2224-3208

Anley Y, Bogale A, Haile-Gabriel A (2007). Adoption decision and use intensity of soil and water conservation measures by smallholder subsistence farmers in Dedo district, Western Ethiopia. Land Degrad. Dev. 18(3):289-302.

Asante BO, Afari-Sefa V, Sarpong DB (2011). Determinants of small-scale farmers' decision to join farmer based organizations in Ghana. Afr. J. Agric. Res. Econ. 6(10):2273-2279.

Banful AB (2009) Operational Details of the 2008 Fertilizer Subsidy in Ghana – Preliminary Report. GSSP Background Paper 18, Washington D.C., International Food Policy Research Institute.

Benin S, Jonhson M, Abokyi E, Ahorbo G, Jimah K, Nasser G, Owusu V, Taabazuing J, Tenga A (2013). Revisiting Agricultural Input and Farm Support Subsidies in Africa: The Case of Ghana's Mechanisation, Fertiliser, Block Farms and Marketing Programmes. Discussion Paper 01300, International Food Policy Research Institute.

Chibwana C, Fisher M, Jumbe C, Masters WA, Shively G (2010). Measuring the Impacts of Malawi's farm input subsidy programme. Available at SSRN 1860867

Chirwa E, Matita M, Dorward A (2011) Factors Influencing Access to Agricultural Input Subsidy Coupons in Malawi. FAC Working Paper, Brighton, UK: Future Agricultures Consortium.

Fufu B, Hassan RM (2006).Determinants of Fertiliser Use in Maize in Eastern Ethiopia. A weighted Endogenous Sampling Analysis of the Extent and Intensity of Adoption. Agrekon 45(1):38-49.

Ghana Statistical Service (GSS)(2012). 2010 Population and Housing Census – Ghana Statistical Service, May, 2012

Gujarati D (1995). Basic Econometrics, 3rd ed. New York: McGraw-Hill.

Greene WH (2003). Econometric Analysis. New Jersey-U.S.A: Prentice Hall Griffin pp. 736-740.

Hill L, Kau P (1981).Analysis of Purchasing Decision with Multivariate Probit. Am. J. Agric. Econ. 53(5):882-883.

Imai K (2003). Is livestock important for risk behaviour activity choice of rural households? Evidence from Kenya. J. Afr. Econ. 12(2):271-295.

Maddala GS (2001). 3rd Edition.Introduction to Econometrics. New York: John Wiley and Sons Limited.

Makokha S, Kimani S, Mwangi W, Verkuijl H, Musembi F (2001). Determinants of fertiliser and manure use in maize production in Kiambu district, Kenya. International Maize and Wheat Improvement center (CIMMYT) and Kenya Agricultural Research Institute (KARI), Mexico DF.

Marenya PP, Barrett C (2009).State-Conditional Fertiliser Yield Response on Western Kenyan Farms. Am. J. Agric. Econ. 91(4):991-1006

McDonald JF, Moffitt RA (1980).The uses of Tobit analysis.The Review of Economics and Statistics 62(2):318-321.

Martey E, Wiredu AN, Etwire PM, Fosu M, Buah SSJ, Bidzakin J, Ahiabor BDK, Kusi F (2013). Fertiliser Adoption and Use Intensity Among Smallholder Farmers in Northern Ghana: A Case Study of the AGRA Soil Health Project. Sustain. Agric. Res. 3(1):2014.

Minde I, Pedzisa T, Dimes J (2008). Improving Access and Utilisation of Fertiliser by Smallholder Farmers in the Limpopo Province of South Africa.International Crops Research Institute for the Semi-Arid Tropics. Science with a Human Face, Report No. 3

Ministry of Food and Agriculture (MoFA) (2013).Ministry Of Food and Agriculture. Agriculture in Ghana. Facts And Figures (2012). Statistics, Research and Information Directorate (SRID), August, 2013.

Nkamleu GB, Adesina AA (2000). Determinants of chemical input use in peri-urban lowland systems:Bivariate probit analysis in Cameroon. Agric. Syst. 63:111-121.

Nkonya ET, Schroeder T, Norman D (1997). Factors affecting adoption of improved maize seed and fertiliser in northern Tanzania. J. Agric. Econ. 48(1-3):1-12.

Norris PE, Batie SS (1987). Virginia farmers' soil conservation decisions: An application of Tobit analysis. South. J. Agric. Econ. 19(1):79-90.

Obisesan AA, Akinlade RJ, Fajimi FO (2013). Determinants of fertiliser use among smallholder food crop farmers in Ondo State, Nigeria. Am. J. Res. Commun. 1(7):254-260

Shakya PB, Flinn JC (1985). Adoption of modern varieties and fertiliser use on rice in the eastern Tarai of Nepal. J. Agric. Econ. 36(3):409-419.

SOAS - School of Oriental and African Studies (2008). Wadonda Consult, Michigan State University and Overseas Development Institute 'Evaluation of the 2006/7 Agricultural Input Supply Program, Malawi', report presented to the Malawi Government and DFID (Malawi), Lilongwe, Malawi: Malawi Government and DFID (Malawi).

Thuo M, Bravo-Ureta BE, Hathie I, Obeng-Aseidu P (2011). Adoption of Chemical Fertiliser by Smallholder Farmers in the Peanut Basin of Senegal. Afr. J. Agric. Res. Econ. 06(1).

Yilma T, Berg E, Berger T (2008). The agricultural technology-market linkage under liberalisation in Ghana: Evidence from micro data. J. Afr. Econ. 17(1):62-84.

Zhou Y, Yang H, Mosler H, Abbaspour KC (2010). Factors affecting farmers' decisions on fertiliser use: A case study for the Chaobai watershed in Northern China. J. Sustain. Dev. 4(1):80-102.