UNIVERSITY FOR DEVELOPMENT STUDIES

EFFECTS OF FERTILISER SUBSIDY ON SMALLHOLDER MAIZE FARMERS' ACCESS TO FERTILISER AND TECHNICAL EFFICIENCY IN THE NORTHERN REGION OF GHANA

BY

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DECLARATION

I hereby declare that this thesis is the result of my own original work and that no part of it has been presented for another degree in this university or elsewhere:

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ABSTACT

The study examines technical efficiency in maize production and how fertiliser subsidy programme influences technical efficiency. The study employs the stochastic frontier to estimate technical efficiency and how farmer, farm characteristics and fertiliser subsidy affects technical efficiency. The study also examines factors that determine success at participating in the subsidy programme using the Probit model and farm and farmer characteristics collected from households in the northern region. Cross-sectional data collected from 301 households in three districts was used for the analysis. The study finds that relatively older farmers were more likely to participate in the subsidy programme than younger farmers. Factors such as farm size, price of the subsidised fertiliser, distance to input shop, attempt at participation in the subsidy programme, credit borrowed and off-farm income were the factors that influence the probability of the farmer participating in the subsidy programme. Participation in the fertiliser subsidy programme however did not have any significant effect on the technical efficiency of maize farmers in the sampled study area as participation did not make farmers more technically efficient. The study recommends other factors such as seed and measures to ensure effectiveness in the subsidy system must be implemented before the subsidy can have the desired effect.

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DEDICATION

I dedicate this work to the Almighty Allah for His guidance and protection during the course of my study.

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ACRONYMS

AU	Africa Union
DCE	District Chief Executive
DFID	Department for International Development
FAO	Food and Agriculture Organisation
GDP	Gross Domestic Product
GH₵	Ghana Cedis
GSS	Ghana Statistical Service
MOFA	Ministry for Food and Agriculture Organisation
MP	Member of Parliament
MSU	Michigan State University
NEPAD	New Partnership for African Development
NGO	Non-Governmental Organisation
$NHSO_4$	Sulphate of Ammonia
NPK	Nitrogen, Phosphorus, Potassium
OECD	Organisation of Economic Co-operation and Development
OLS	Ordinary Least Square
SSA	Sub-Sahara Africa
TE	Technical Efficiency

UN	United Nation
USD	United State Dollar

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the study

Agriculture is a basic tool for sustainable development, poverty alleviation and improving food security in developing countries (Obisesan, et al, 2013). It is an important development instrument for realising the Millennium Development Goals (MDGs), one of which is to reduce the number of people suffering from extreme poverty and hunger by half by the year 2015 (World Bank, 2008). In Africa, agriculture remains the most viable option for inducing growth, overpowering poverty, and improving food security. As a result, agricultural productivity improvements are required to stimulate and sustain growth in other sectors of the economy. Nonetheless, agricultural productivity in Africa has continued to deteriorate over the last two decades while poverty levels have increased over the same period (Olwande, et al, 2009). Agricultural productivity growth in Sub-Saharan Africa lags behind that of other regions of the world, and is well below what is needed to attain food security and poverty goals (Akpan, et al., 2012). Many of the farmers in Sub-Sahara Africa are facing decreasing crop yields, which have unfavourable results on the region's economic growth (Hassan, et al.,, 1998). A prominent constraint to higher productivity among farmers in Africa is "soil infertility", related mainly to low nutrient status of the soils and continuous cultivation without planned replenishment of depleted soil nutrients (Wanyama et al., 2009).

According to Eboh, et al., (2006), most policies for economic development in Africa give an increasing consideration to the need for greater increments in agricultural productivity in order to achieve GDP growth, food security, and substantial reduction in poverty. Majority of the research on agriculture in Africa shows that farmers' failure to intensify agricultural production is an essential component of inefficiency and lower productivity (Crawford, Jayne, and Kelly, 2006).

Improving agricultural productivity in Sub Saharan Africa, particularly Ghana, is a pre-requisite for achieving food security and economic development. One way of enhancing agricultural productivity is through the introduction and use of improved agricultural technologies. One basic technology with the potential to improve crop production is appropriate use of fertiliser. This argument is the drive behind widespread fertiliser programmes in many developing countries (Obisesan et al., 2013).

More than 70 percent of Africa's population are directly involved in agriculture (Minde, Pedzisa and Dimes, 2008). Traditionally, smallholder farmers clear their land, grow a few crops, and then move on to clear new parcels of land, leaving the old plot to regain its fertility (Sanchez, 2002). However, the annual rate of population growth of 3% in Africa which is among the world's highest, forces farmers to adopt more sedentary and continuous methods (Africa News Network, 2007). This depletes the soil of nutrients over time when farmers are not able to replenish the soil through fertiliser application and other complementary methods.

Due to rapid population growth, Africa is no longer a land-abundant region where food production can be increased by expansion of land area. Large areas in Africa are increasingly becoming marginal for agriculture and arable land has become scarce, requiring agricultural intensification through the adoption of technologies such as fertiliser to improve productivity (Obisesan et al., 2013; Duflo et al, 2006).

In spite of the growing signs that fertilisers can significantly increase crop yields in Sub-Saharan Africa (SSA) as well as slow down environmental degradation, fertiliser use in this region still falls far behind other developing countries such as the Asian and Latin American countries (Liverpool-Tasie et al, 2010). Access to fertiliser is limited, with prices too high for smallholder farmers in SSA. According to Mosier and Syers (2005), fertiliser in some cases cost up to five times more than the world market price in SSA.

Increasing scarcity of land in Africa made land expansion very hard for agriculture which means that what Africa needs is intensification of land for Agriculture (Holden, 2013). In the last decade, production has risen almost at equal rates as population growth but this is attributable to area expansion rather than land use intensification (World Bank, 2008). Increased cultivation on marginal lands is seen as a cause of yield decline among smallholder farmers.

In the developed world, the use of agricultural inputs is essential in modern agriculture and this was the basis for the green revolution in Asia and Latin America. Between 2002 and 2003, the average fertiliser used by Sub-Saharan African farmers was 9 kg per hectare of arable land as against 100 kg per hectare in South Asia, 135kg per hectare in Southeast Asia and 73kg per hectare in Latin America (Crawford et al, 2006). While agricultural production and productivity increased in Asia and Latin America throughout the last four decades, these have remained stagnated in Africa, increasing the continuous reliance on imported grains and the percentage of undernourished people (Wiggins and Brooks, 2010; Future Agricultures, 2010).

The management of soil fertility in Ghana is sub-optimal and has had a negative effect on crop yield (Martey et al., 2013). The application rate of fertiliser in Ghana is estimated at 7.4 kg per hectare while nutrient depletion rates, which are among the highest in Africa, range from 40 to 60 kg of nitrogen (N), phosphorus (P), and potassium (K) per hectare per year. Nutrient balance estimates in Ghana for all crops are largely negative (FAO, 2005). The increasing rates of nutrient mining in the soils are threat to the sustainability of agricultural growth and reduction of poverty (Martey et al., 2013). There are also inefficiencies and bottlenecks in fertiliser delivery networks which restrict access, and add to the cost of fertiliser in farming communities (Martey et al., 2013). The elementary nature of agro-input marketing and the weak farmer-based organisations in the country make it difficult for them to obtain credit and purchase inputs including fertiliser in bulk to reduce cost (FAO, 2005).

Ghana's agriculture is largely dominated by smallholders (Martey et al., 2013) with about 90 percent of farms being less than two hectares in size, even-though there are few large farms and plantations, specifically for rubber, oil palm and coconut and to smaller degree, rice, maize and pineapples (Chamberlin, 2007). Smallholder farmers are scattered making delivery of assistance (support services) more costly and largely unsuccessful (Martey et al., 2013). Production is generally rain-fed with limited mechanisation and insufficient use of modern technologies such as high and stable yielding crop varieties, good agricultural practices, fertilisers, and other agro-inputs. These, together with many other things, have resulted in the observed low levels of productivity in the agricultural sector (Chamberlin, 2007). By the arguments indicated, the extent to which crop yields can be improved is dependent greatly on soil fertility improvement.

More often, limited smallholder access to fertiliser is attributed to the inability of these farmers to access credit, long distances to fertiliser retailers, weak market infrastructure, and government inability to assist the smallholder farmers. In many countries, the removal of state input distribution systems has resulted in fertiliser use reduction as commercial delivery systems compete with subsidised government programmes (Ariga and Jayne, 2009). The problem faced by smallholder farmers in SSA with regards to access to fertiliser has received a lot of consideration by governments and other policy makers through a variety of interventions to improve smallholder access to inputs.

1.2 Problem Statement

Ghana, unlike other countries that have attained middle-income status, is an underperformer in terms of fertiliser usage with an average of 7.4 kg per hectare, compared to 35.2kg per hectare for Côte d'Ivoire (Benin et al., 2013). Many countries in Africa have reverted to input subsidy programmes which they abandoned years back, especially; fertiliser subsidy programmes as a move to bridging the fertiliser gap in the continent. Under the subsidy programmes, fertilisers are given as free inputs to farmers as was the initial case for Malawi or at prices below the market prices (subsidised prices) as was practiced in Ghana. They can also be given in the form of credit or 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. The assumed goal of the programme was to boost farmers use of fertiliser so that food crop output would not decline significantly below 2007 output levels (Banful, 2009). The programme was also intended to assist farmers to increase the rate of fertiliser application as a means of increasing crop productivity. The target of the subsidy programme was to increase fertiliser use rate to at least 50kg as recommended in the Medium Term Agricultural Sector Investment Programme (METASIP). The Ghana fertiliser subsidy programme was unique and very different from similar programmes in the continent as it was a public-private partnership. The fertiliser sector in Ghana is liberalised and the distribution of the subsidised fertiliser to farmers is in the hands of the private sector to ensure programme effectiveness. The subsidy did not include targeting of farmers based on their income or the type of crop they produce (Banful, 2009). The stated goals and objectives of the Fertiliser Subsidy Programme were to

1. increase farmers average fertiliser application rate to 20 from 8kg per hectare,
2. increase crop yields and production,
3. raise the profitability of farm production, and
4. improve private sector development.

The 2008 and 2009 subsidy was implemented using the voucher system while the waybill system was used between 2010 and 2013. The voucher system was visualised to target only smallholder farmers while under the waybill systems, all types of farms and farmers who have the ability to buy fertiliser included.

An estimated 713,215 metric tonnes of fertiliser costing GH₵ 335,156,000.00 has been distributed under six year lag subsidy programme. The huge budgetary allocation on a private good has raised questions about the programme sustainability, given the associated huge fiscal cost. However, the Ghana fertiliser subsidy was bedeviled with design problems, as the criteria for enlistment of beneficiaries were not specific and was characterized by delays in the delivery of the subsidised fertiliser. While the programme required that a beneficiary obtained a coupon from the Ministry of Food and Agriculture (MoFA), some beneficiaries acquired the subsidised fertiliser without the coupon. The subsidy programme in Ghana did not have specific target beneficiaries even though the subsidy was designed for poor smallholders. Again, processes of selecting beneficiaries of the subsidy were done without the community involvement as was done in other countries such as Malawi and Tanzania. The lack of proper design of the subsidy programme in the country leads to rent-seeking behaviour, corruption and gross abuse of the input aside the fiscal burden. Subsidy programmes in Ghana are good in the sense that they are targeted and the benefits are not regressive. Fertiliser subsidy can raise fertiliser use and increase crop yields in the country if the subsidy is well targeted to the resource poor smallholder farmers who cannot access and use fertiliser in the absence of subsidy. However, the untargeted nature of the Ghana fertiliser subsidy programme may have resulted in the input being accessed by people who did not have use of the input or could afford it in the open market. This meant that elite and wealthy farmers in the country who bought fertiliser in the open market were now using subsidised fertiliser. There was also the phenomenon of black-marketing of the subsidised fertiliser and subsequent abuse of the system. An argument that could also arise is the amount of the subsidised fertiliser that genuinely found its way into the hands of smallholder farmers especially in the Northern region of Ghana.

With the region being one of the poorest in Ghana, the ability of households to buy fertiliser is even more difficult. With no research on the subsidy programme, it is not possible to examine how the subsidy programme has contributed to improve the access of smallholders to this all important input. Similarly, it is not clear how much the fertiliser subsidy has contributed to enhancing the utilisation of fertiliser and farmer productivity in the Northern region. Considering these challenges, it is imperative that an empirical study is conducted to assess how the subsidy programme affects smallholder access to fertiliser and its effect on utilisation and farmer productivity in the northern region.

1.3 Research Questions

The study poses the following research questions:

1. How is Ghana fertiliser subsidy programme performing in Northern region?
2. What are the characteristics of farmers who receive the subsidised fertiliser?
3. What perception do farmers hold about the subsidy programme?
4. What factors influence farmer's access and use of fertiliser?
5. What is the effect of participation in the subsidy programme on technical efficiency of the smallholder farmers?

1.4 Research Objectives

The main objective of the study is to assess the effectiveness of the fertiliser subsidy programme in delivering fertiliser to smallholders in the Northern region, and how the access is affecting fertiliser utilisation and productivity of smallholders in the region.

The specific objectives were to:

1. assess the accessibility of the fertiliser subsidy programme for the smallholder farms in the Northern region.
2. identify the characteristics of households who receive the subsidised fertiliser.
3. examine smallholder households' perceptions of the fertiliser subsidy programme.
4. examine the factors that influence household's access and use of fertiliser.
5. examine the effect of the subsidy programme on technical efficiency.

1.5 Justification

Various benefits have been cited in justifying input subsidies; including economic, environmental and social (World Bank 2008). Input subsidies can bring economic benefits to society but can also be a major cause of negative environmental externalities when they promote excessive use of fertilisers, agrochemicals and irrigation water. Globally, there has been extensive work and policy analysis on fertiliser promotion and use (Crawford et al., 2005). However, in SSA and for that matter Ghana, this has not been the case. Knowledge gaps still remain, especially as it pertains to the effects of the subsidy on fertiliser access and utilisation by smallholder farmers. These have not been studied especially after the introduction of the subsidy programme in Ghana. This study will add to the existing literature bordering on the fertiliser subsidy available in the country. This study will also help policy makers to evaluate the potential benefits of the subsidy programme by providing information on the effects of fertiliser subsidies on farmer access and utilisation of fertiliser. Comparatively, not much attention is drawn to the effect of Ghana's fertiliser subsidy on crop productivity. This implies that the effect of the fertiliser subsidy on the resource poor smallholder farmer remain largely under-researched. This study thus is important as it would provide information relevant for evaluating Ghana's fertiliser subsidy programme in line with its goals and objective.

1.6 Organisation of the study

This work is organised into five chapters. Chapter two reviews theoretical and empirical literature pertinent to the issues articulated in the thesis. Chapter three outlines the research methodology which consists of description of the study area, sampling and sampling procedure, data collection procedures and analytical techniques. Chapter four presents and discusses the results while conclusions and policy implications are presented in the fifth chapter.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter review relevant literature on theoretical, empirical and policy related issues as pertains relevant to the study. The chapter first provides an overview of agricultural input subsidies outlining theoretical positions and empirical findings on fertiliser subsidies in SSA and other developing countries. The review discusses the driving force behind agricultural input subsidy programmes in developing countries, especially how politics drive and influence subsidies on agricultural input, the approaches and methodology employed in related studies. The chapter is concluded by looking at the Ghana fertiliser subsidy, the scope of the programme and the targeting criteria.

2.1 Overview of Agricultural Input Subsidies

Subsidised inputs are social protection interventions designed to enhance production-based entitlements (Kodamya, 2011). The use of input subsidies as a way of transferring income to poor farmers or those living in disadvantaged areas needs to be set against the effectiveness and economics of doing the same by direct payments, distribution of food aid, or employment programmes paid in cash or kind (Wiggins and Brooks, 2010). Interest in input subsidies, especially fertiliser, has been revived, particularly in Africa in recent times apparently against the orthodox economic recommendation that subsidies on private goods are inefficient and can distort resource allocation, come with high budget cost and not easy to sustain without reducing the expenditure on valuable public goods (Wiggins and Brooks, 2010). An OECD analysis on high income countries has shown that less than half of the value of input subsidy leads to higher net incomes for farm households, as a greater part of the transfer goes to input dealers or incurred as efficiency losses (OECD, 2001). According to Crawford, Jayne and Kelly, (2008) cited in Wiggins and Brooks (2010) arguments in favour of subsidies is attractive base on several grounds: the continued call for subsidies is difficult to refuse to accept; they are attractive politically, implementation seem very easy, and the intended problems they seek to address remain compelling at both the national and international levels.

Subsidies appear as ready answers to otherwise difficult problems of developing input markets and associated financial services to smallholder farmers. While the other ways of solving such problems are complicated with uncertainty of success, a subsidy programme is a relatively a simple measure to implement (Wiggins and Brooks, 2010).

According to Morris et al., (2007) scholars and practitioners have argued for input subsidies as a way of encouraging increased agricultural productivity growth, with some argued that input subsidies can be used as a tool for realising welfare goals. A UN Millennium Project Report proposed “fertiliser safety nets” or “fertiliser-for-work” programmes targeted at the persistently food-insecure (UN Millennium Project, 2005: 119). Morris et al. (2007) made an argument that the economic case for fertiliser aid rests on a number of assumptions and they contended that a well-functioning markets especially for food and fertiliser are one important condition. Recently, a number of arguments are being made about how fertiliser subsidies can be used to achieve not only economic growth targets but also welfare goals (Kodamaya, 2011). Some economists have acknowledged the political demand of fertiliser subsidies, and they are reasonably aware that some African countries implemented fertiliser subsidies for their political gains (Morris et al., 2007: 102).

Recent studies on agricultural performance has shown significant consequences for policies of agricultural inputs subsidy provision, such as seeds and fertiliser and their effects on productivity and farmer incomes (Foster and Rosenzweig, 2010; Conley and Udry, 2010; Duflo, Kremer and Robinsion., 2008). There is a common understanding that increased use of fertiliser and other productivity-enhancing inputs is a precondition for increased farm productivity and by extension poverty reduction (Morris et al, 2007; Gollin, 2009). This noble objective of poverty reduction associated with input subsidies is the drive behind the resurgence of programmes across developing world aiming to provide subsidies (Dorward et al., 2008a). The argument that input subsidies act direct safety nets and presents less costly ways of ensuring food security is also behind the resurgence of input subsidy programmes (Morris et al., 2007). Increasing global food and fertiliser prices in 2007 and 2008 have created a sense of urgency in meeting productivity and social welfare goals, and hence the policy of fertiliser subsidies high on the list of options for government and donor responses to the crisis (Dorward et al., 2008a).

2.1.1 Fertiliser Subsidy Programme Design and Effectiveness

According to Crawford et al, (2005) fertiliser subsidies may differ in terms of the point at which the subsidy is applied whether to the farmer, trader, or even at domestic fertiliser producer. The form or nature of the subsidy, or how it is provided, that is cash payment, voucher/coupon, reduced market price, transport subsidy would also have implication on access by the beneficiaries (Dorward, 2009). Fertiliser subsidy can either be direct or indirect, for example through subsidised credit for fertiliser purchase.

Chinsinga, (2007) and Jayne et al, (2002) made argument on the design and structure of a subsidy programme, suggesting that no system is perfect enough to counter leakages of subsidised input to the unintended beneficiaries. The structure and the design of the subsidy programme matters if the poor are to be the target beneficiaries.

de Moor and Beers (2010) in Minde et al (2008) links, the effectiveness and efficiency of a subsidy programme to the specifics of implementation and designs of subsidy programmes. They argue that subsidy programme design should take into account, a number of factors notably, the political acceptability and leakage of the benefits that may go to the untargeted group. A better targeting of a subsidy programme requires that access to the subsidised input is restricted for some groups. Targeted input programmes as indicated by Dorward (2009), require that a list of entitled beneficiaries is generated with specifications of the subsidised input entitlement, followed by a mechanism that allow listed beneficiaries to access the entitlement. He suggested the mechanism may involve the physical distribution of inputs from a specified distribution points against a list of entitled beneficiaries held at the distribution point with some form of identification. Evidence of entitlement is most commonly a paper voucher. Different systems offer diverse possible benefits but have different political, technical, administrative and social challenges within communities and households (Dorward, 2009).

The purposes of subsidy on fertiliser are often to reduce poverty, and increase production of staple crops such as maize and rice (Kelly, Crawford and Ricker-Gilbert, 2011). Efficiency of a subsidy programme may reduce when the design of subsidy is targeted at more productive households as beneficiaries of the subsidy programme. Results from Malawi and Zambia have shown that households that are better-off are more likely to buy fertiliser at commercial market prices, and richer households displace a larger amount of their commercial fertiliser purchases when they obtain subsidised fertiliser (Xu et al. 2009; Ricker-Gilbert and Jayne., 2011; Mason, 2011).

Supporters of subsidy programme state that the resultant improvement in staple food production has led to better rural livelihoods (DFID, 2007; Dorward, 2007). However, subsidies involve macroeconomic fall out and budgetary implication which overshadow any livelihood improvement accumulating to either the producer or the consumer (Morris et al., 2007). Skeptics further suggested that any improvements in livelihood outcomes are compensated by decline in staple food prices and the weakening and dislodgement of the private input markets and networks (Minde, et al., 2008; Ricker-Gilbert & Jayne, 2008). Empirical evidence exists to support these arguments that subsidy programmes have resulted in livelihood improvements and food security (Chirwa, 2010; Rickert-Gilbert & Jayne, 2008). Evidence also exist to show that the huge budgetary cost of subsidy programmes have often brought about a reduction in other public activities funding (Minde et al., 2008).

2.1.2 Delivery of Subsidy Programme

There is a consensus on the productivity and poverty reducing effects of agricultural input subsidies. The World Development Report (2008), in proposing the "New Approaches to Input Subsidies" stated that, subsidising inputs can assure the risks involved in adopting new technologies early and that it can help distributors of the input to achieve economies of scale, which would result in reduction of prices charged to farmers. The OECD in 2010 cited in AU/NEPAD (2011) report on input subsidies in developing countries came to conclusion that, there may be a role for limited-time input subsidies as an antidote to market failures in situations in which there are: a) widespread and stern market failures with resulting poverty traps, so that an increased production reduces poverty directly and raises the potential of humans; and b) areas in which the food markets are naturally guarded by distance from other markets, so that prices locally will fall by increases in production locally. In cases like these, a time-limited input subsidy may offer an option to markets that are failing, resulting in greater use of the input, with higher production that increases the farmers' incomes, offers more work for labourers in the agricultural sector, and a decline in the cost of food (AU/NEPAD, 2011).

A study by Ricker-Gilbert and Jayne (2011) in Malawi has shown that subsidies on fertiliser crowd out the demand for commercial fertiliser such that 1kg of subsidised fertiliser displaces between 0.18-0.3 kg commercial fertiliser. This means a subsidy on fertiliser can weaken the private fertiliser sector if the programme design is not effective. However, Holden and Lunduka (2012) suggested that fertiliser subsidy programme does not result in crowding out of organic manure use. Their results indicate that an increase in fertiliser use by 1% was associated with a 1.9% increase in manure use outside the subsidy programme and a 0.6-1.7% increase in the use of manure with the subsidy programme.

Using cross-sectional data Chibwana et al. (2012) reported a positive link between participation in an input programme and maize farm size suggesting beneficiaries of fertiliser subsidy used more of their land for maize cultivation. However, Holden (2013) shows that input subsidy programmes are more likely to increase land use intensification than land expansion. He reported further there was reduction in maize farm land even though maize has increased due to expansion of the subsidy programme. This was after the study had controlled for selection associated with unobservable household and farm characteristics using household fixed effects.

The current debate on the role of subsidies to intensify agricultural production and improve food security is a step forward in that (a) it focuses on ways to improve targeting to reach farmers effectively meaning that voucher system will be useful for that purpose and (b) fertiliser promotion programmes are increasingly considered explicitly in relation to a range of alternative and complementary investments and policy tools.

2.2 Political influence on fertiliser subsidies

Evidence from across Africa has shown that political interest and interference have profound disruptive effects on fertiliser subsidies. Dorward (2009) reports that political economy challenges are particularly difficult in poor rural communities to the extent that, the eventual personal and political benefits coming from subsidy rents are very huge relative to other income opportunities, thus motivations for political exploitation are high. Secondly, fiscal resources are limited and expensive to collect, so the unfavourable effects of wasteful policies are great. According to Mkwara and Marsh (2011) there is evidence showing that the allocation of subsidised fertiliser in Malawi is spatially discriminatory and based on political influence and association. Mkwara and Marsh (2011) indicated that in 2008, a Minister of National Defence admitted to the media that government ministers were given 2000 coupons each to distribute in their respective districts.

Ricker-Gilbert and Jayne (2010) examine the effect of subsidies on fertiliser on the demand of commercial fertiliser by farmers using a ‘Double-Hurdle’ model of fertiliser demand in Malawi. Their results suggest that social and political relationship of a household affects the amount of subsidised fertiliser a household receive. Banful (2010b) indicated that the manner in which subsidised fertiliser was distributed in Ghana has political influence attached in the Ghana fertiliser subsidy programme in 2008. Banful indicates that districts in which the ruling party had lost in previous national election received more of the subsidised coupon than the districts they won.

Reports elsewhere in Zimbabwe have shown that beneficiaries of an irrigation scheme were smallholder farmers who have relationship with people in political power (Robinson, 2002). Finally, in the Park regime of 1961 to 1979, South Korea, was dominated by people from Kyongsang, 'imposed regionally biased policies via the employment of elites and the allocation of public resources to obtain political support from Kyongsang' (Park, 2003,). Cox and McCubbins (1986) have reported that policies adopted by politicians to invest little opposition groups while in some case more to swing regions and more still in the regions they enjoy their support most. Even though 'political colour of governments influences the distribution and access to scarce good' (Westert and Groenewegen, 1999), public finance theories assume that political influences result in inefficient allocation of resource (Oates, 1999).

According to Druilhe and Barreiro-Hurlé (2012), subsidies are likely to stay, nonetheless, highly politically good-looking to governments of the nations because the problems they are meant to tackle or deal with remain convincing both at the national and international levels and because they give quick and clear benefits that can win quick political gains. Ricker-Gilbert and Jayne (2010) employed instrumental variable regression and found out that the instrumental variable, if a member of parliament (MP) resides in the community, was significant at 6% level meaning that it was a strong instrument because it was partly correlated with the amount of subsidised fertiliser a household receives. The coefficient estimate indicated that households got 7.34 more kilograms of subsidised fertiliser if a village had an MP coming from there than households in other villages where the MP does not come from. The finding by Ricker-Gilbert and Jayne highlights the likelihood of political relationships affecting subsidised fertiliser distribution. According to Wiggins and Brooks, (2010) politically, subsidies are a highly visible gesture to rural voters, as well as potentially also being an instrument of patronage. The sight of the state taking direct action to overcome the failures of the markets, often regarded with suspicion in the first place, is welcome. Moreover, in some parts of the developing world, orthodox advice to avoid subsidies is treated with suspicion, since it usually comes from people in countries where farmers enjoy a lot of subsidies. The advice is seen as hypocritical. Holmén (2005) argues that, state interventions in agriculture in SSA prior to the structural adjustment period were partly aimed at development and partly at nation-building, i.e. the consolidation of power. Government monopolies, subsidies, and high-default credit programmes were a way for states to ingratiate themselves with their largely agrarian populations. As such, "malpractices, nepotism and diversion of resources from their intended use were often tolerated" (Holmén 2005, 91).

Theories of fiscal federalism (Samuelson, 1954; Musgrave, 1959; Oates, 1972, 1991, 1997, 1999) show that resource distribution based on political motivations are inefficient. In all, politics seriously aggravated the inefficiencies of those fertiliser subsidy programmes.

Case (2001) and Miguel and Zaidi (2003) find that special treatments were given to followers that were central to governments which ensures that more transfers or resources went to locations where the incumbent presidents' vote share was greater in the last election.

2.3 Targeting Agricultural Input Subsidy, the Mechanisms and the effects

Studies of fertiliser targeting programme have highlighted the importance of targeting subsidies such that fertiliser subsidies does not crowd out demand of unsubsidized (commercial) fertilisers (Dorward et al, 2008a; Ricker-Gilbert and Jayne, 2008; 2009). These have indicated that well connected and richer farmers were having more possibility of acquiring coupons for the subsidised fertiliser. This implied that subsidised fertiliser coupons should be targeted towards poor households who at the prevailing market price of fertiliser cannot afford fertiliser and to areas where commercial production is not well developed. Dorward et al. (2008b) argued that a considerable amount of fertiliser that has been subsidised went to wealthy households in the 2006/07 season in Malawi and this brought about crowding out of a significant amount of commercial fertiliser demand. Holden and Lunduka (2010) found proof of crowding-out mechanisms that look more severe in restricting the efficiency of targeting of the subsidy programme in some two districts (Kasungu and Zomba) in Malawi. Holden and Lunduka identify two problems that were limiting the efficiency of targeting; one was due to administrative errors and manipulation that has been captured partially by the DFID-supported monitoring system and secondly there is a considerable illegal market for coupons and subsidised fertilisers.

2.4 Fertiliser use in Ghana

Fertiliser use in Ghana is estimated at 8kg per hectare, which represent one of the lowest rates among countries in Sub-Saharan Africa, which already represent the lowest fertiliser consumer in the world (MOFA, 2007). Maize is the only non-cash crop (food crops) that accounts for about 40 percent fertiliser use on food crops (FAO, 2005). According to Banful (2009), there is little data on past rates of fertiliser use in Ghana but it appears that the level has always been low. In the1970s and early part of 1980s, fertiliser use in Ghana increased swiftly with a variety of agricultural support programmes which included fertiliser subsidies (FAO, 2005). However, in the late 1980s and the 1990s, there was a significant decline in fertiliser use, probably as a result of the withdrawal of subsidies in 1987 triggered by economic hardship, and the depreciation of the cedi. Fertiliser use started again to increase as the economic situation in the country began to improve in the late 1990s but decline again due to depreciation of the cedi. Fertiliser consumption began to get better once again with improvement in the economy and by 2002 fertiliser consumption was again at1980 level. Even so, the current per hectare consumption rates are about half the application rates in Sub-Saharan Africa and at a quarter of the application rates in Africa as a whole (FAO, 2005).

2.5. Ghana Fertiliser Subsidy Programme

In a reaction to increasing oil and food prices that hit the world in 2007/2008, many governments around the world implemented strategies to mitigate high oil and food prices. The Ghana government introduced fertiliser subsidy programme in 2008 as a short term measure to boost fertiliser. The stated objective of the fertiliser subsidy programme was to ease the effects of the food crisis by increasing food production through fertiliser use (Wanzala-Mlobela, Fuentes and Mkumbwa, 2013).

The Ghana fertiliser subsidy was very different from similar programmes implemented in other African countries like Malawi and Zambia. Ghana's programme was not intended to be all-inclusive programme, targeted at achieving a sustainable increase in adoption of agricultural inputs by smallholder farmers (Baltzer and Hansen, 2011). The programme was designed with a high speed as an emergency response to reduce the adverse effects of high prices of fertiliser. The decision to execute a nation-wide fertiliser subsidy programme in 2008 as a brief response to the unusual coming together of events in that year which led to concurrent spikes in global food, energy, and fertiliser prices (Banful, 2010a). As fertiliser price increased rapidly through 2007 and 2008, the government feared fertiliser use would decrease even further by an estimated

70%, reducing agricultural productivity and food production (by potentially 20%), and increasing the importation of food (Baltzer and Hansen, 2011). In March 2008, the government started deliberating with the lead importers of fertilisers for the possible subsidisation of fertiliser to respond to the rising prices, and in May 2008, the government announced its plan to subsidise fertiliser. However, it was not until early July that details of the programme were published. The subsidy programme kick started. July, 2008, at which it was too late for the major season in the southern sector to benefit and the plantings in the northern regions, which means that it was hardly in time for the second application of fertiliser in the north and the minor season in the south (Baltzer and Hansen, 2011).

2.5.1 The Scope of the Ghana fertiliser subsidy programme

As against input subsidy programmes that has been put into practice in other African countries such as Malawi and Zambia, the Ghana fertiliser subsidy was one of a very small scale. The cost in total of the subsidy programme was estimated to be around USD 14 million in 2008 and that of 2009 to be USD 26 million extension of the programme (Yawson et al 2010), corresponding to approximately 0.05% and 0.1% of GDP respectively (Baltzer and Hansen, 2011).

The size of the subsidy was set to ensure that the prices faced by farmers were roughly the same as in 2007. The government planned to supply 600,000 vouchers in 2008, but ended up printing more than 1.1 million vouchers even though less than 50 percent of the vouchers were eventually redeemed (Baltzer and Hansen, 2011). The lack of a clear criterion for voucher allocation and the general inconsistency about the amount of vouchers that were available to each district resulted in an initial shortage of vouchers during the critical periods when fertilisers are most effectively applied. This incited the government to supply more vouchers which resulted in shortage of the subsidised fertilisers. There were also reports of hoarding, in some cases even by farmers who had no intention or capacity to utilise the vouchers.

2.5.2 The targeting criteria of the Ghana fertiliser subsidy

Initially, Ghana's fertiliser subsidy programme targeted food crops, making use of vouchers, not considering who grow the crops, as long as the crops were grown in Ghana.

The strategies change in the 2008/09 farming season when the subsidy programme faced a number of difficulties due to its implementation modalities, relating to input voucher redemption. Furthermore, the overhead and administrative costs of the voucher system were seen to be too high. The Ministry of food and Agriculture Staff spent much time monitoring and administering the voucher system which took time away from their other duties – that is, in addition to the time spent by farmers travelling back and forth from their homesteads to the Region and District Agricultural office to gather endorsement signatures, a situation that discouraged many farmers from participating. Due to the problems associated with the fertiliser voucher system, the voucher system was replaced with the waybill receipt system in 2009/10. Important features in the design of the 2010 programme were the removal of vouchers and the introduction of a farmer inclusive system as long as the farmers were involved in cultivation of crops that use the fertiliser types that are part of the subsidy programme.

The vouchers for the subsidised fertiliser were being allocated to District Agricultural Directors, who forwarded the vouchers to extension officers for final distribution to the farmers. The sharing of vouchers between districts was formally based on vague notions of "farmers' need" (Baltzer and Hansen, 2011). However, Banful (2010b) argues that the actual sharing of vouchers to the regions was more related to political factors than efficiency or equity factors. Banful has shown that more vouchers were allocated to districts in which the party of the day lost in the previous election than the districts it has won.

2.7 Analytical Approaches in Adoption and productivity Response Studies

2.7.1 The Probit and Tobit Models

Adoption behaviour models range from a simple relationship to a complex multivariate regression analyses. These simple and complex multivariate regression models have been used extensively to analyze factors influencing a certain outcome, as in Omamo et al. (2002) and MSU (1999). However, analyses that seek to identify factors influencing the use or adoption of a technology typically use logit, probit and by extension the tobit models (such as Makokha et al. 2001). The Logit and probit models and their modified forms have been used extensively to study adoption behaviour of farmers however these are limited to functional forms with limited dependent variables that are continuous between zero and one.

Thuo et al., (2011) used both the Probit and the Tobit models to estimate the adoption of chemical fertiliser in the peanut basin in Senegal for three crops (peanut, millet and peanut-millet). For the probit model they found that farm size was a significant factor influencing chemical fertiliser among peanut farmers in the basin. They also found off-farm income negatively influence chemical fertiliser adoption among peanut, millet and millet-peanut farmers.

Thuo et al., (2011), reported that off-farm income and farm size significantly influence fertiliser use intensity among peanut, millet and millet-peanut in the peanut basin in Senegal. While off-farm income has negative effect on fertiliser use intensity among peanut and millet-peanut farmers, farm size positively influences fertiliser use intensity among peanut farmers only. Waithaka et al., (2007) used the tobit model to analyses factors influencing the use of fertilizers and manure by smallholders and found that both distance to nearest in input market and farm size determine fertiliser use in Kanya. Chirwa et al., (2011) used the probit and the tobit models to determine factors that influence agricultural input subsidies in Malawi. They found age of household head, and household size to significantly influence access to fertiliser coupon and land area and access to fertiliser coupon to significantly influence the quantity of subsidised fertiliser acquire by a household.

2.7.2 Measure of Productive Efficiency

Productivity can be measured or defined as the ratio of a firm's output to inputs (Lovell, 1993). However productivity can be distinguished in terms of technology used in production, the process and environmental conditions under which the production occurs (Porcelli, 2009).

The publication by Farrell in 1957 on "The Measurement of Productive Efficiency" arouses the interest in the estimation of production frontier function. Farrell's (1957) after deriving the production function, identifies two sources of efficiency: technical efficiency and allocative efficiency and indicated a multiplication of the two efficiencies gives an economic efficiency. Technical efficiency is the farmer's ability to achieve maximum output with a given input under a given technology while allocative efficiency can be defined as the firm's capacity to combine inputs and outputs in optimal proportions given relative prices.

Two approaches are commonly used for the estimation of the technical efficiency in production; the stochastic production frontier (SPF), developed independently by Aigner, Lovell and Schmidt (1977) and Meeusen and Broeck (1977), and data envelopment analysis (DEA), developed by Charnes, Cooper and Rhodes (1978). A third approach which is the statistical deterministic production frontier, developed by Afriat (1972), has not gained much popularity. The stochastic and statistical approaches utilise a parametric function to represent the production frontier, while DEA, which is based on a linear programming technique, is a non-parametric method.

2.7.3 The Stochastic Frontier Model

Considering the production function

$$q_i = f(x_i; \beta) \quad (2.1)$$

Where x_i is a [1 x k] vector of inputs, q_i is output, and β is a $[K \times 1]$ vector of parameters to be estimated.

We can think of efficiency being measured as ζ_i multiplied by the theoretical norm where $\zeta_i \in [0, 1]$ such that

$$q_i = f(x_i; \beta)\zeta_i \quad (2.2)$$

If $\zeta_i = 1$ then the firm is fully efficient and produces the highest possible output and

If $\zeta_i < 1$ then the firm is not fully efficient.

Let $q_i = f(x_i; \beta)$ be the level of output that should happen. Let q_0 be observed output where

$q_0 < q_f$ because of inefficiency and other factors.

As $q_0 < q_f = f(x_i;\beta)$, Aigner and Chu (1968) suggested adding a non-negative random variable to $f(x_i\ \beta)$ which would capture the technical inefficiency of the firm i

$$q_i = f(x_i;\beta) - u_i \tag{2.3}$$

For the estimation of this model, fixed effects model could be use where $u_i$is treated as the firm fixed effects.

Assume that

$$f(x_i;\beta) = \beta_0 X_1^{\beta_1} X_2^{\beta_2} \ldots\ldots\ldots\ldots\ldots\ldots.. X_k^{\beta_k}$$

$$\ln f(x_i;\beta) = \ln \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \cdots \ldots\ldots\ldots\ldots\ldots\ldots. \beta_k \ln X_k$$

$$\ln q_i = \beta_1 \ln X_1 + \beta_2 \ln X_2 + \cdots \ldots\ldots\ldots\ldots\ldots\ldots. \beta_k \ln X_k \tag{2.4}$$

Aigner and Chu (1968) suggested a measure of technical efficiency of

$$\frac{observedoutput}{frontieroutput} = \frac{q_i}{\exp(x_i\beta)} = \frac{\exp(x_i\beta - u_i)}{\exp(x_i\beta)} \tag{2.5}$$

Where $0 < exp(-u) \leq 1$

While this is a decent shot at the problem it leave much to be desired. Mainly u_i is supposed to measure inefficiency but it might also be capturing other random shocks that are beyond the control of the firm's management.

Aigner, Lovell and Schmidt (1977) suggested adding a two-sided error term to the one-sided error term of Aigner and Chu (1968).

Now,

$$q_i = f(x_i\beta)\zeta \exp(v_i) \tag{2.6}$$

which gives

=1

$$\ln q_i = \ln[f(x_i\beta)] + \ln(\zeta_i) + v_i \qquad (2.7)$$

defining $u_i = -\ln(\zeta)$ yields

$$\ln q_i = \ln[f(x_i\beta)] + v_i - u_i \qquad (2.8)$$

In a Cobb Douglas type of production,

$$\ln q_i = \beta_0 + \sum_{j=1}^{k} \beta_j \ln(x_{ji}) + v_i - u_i \qquad (2.9)$$

The basic assumption is that $v_i \sim iidN(0,1), u_i \geq 0$ and $cov(v_i, u_i) = 0$ where v is measurement error such as weather and other random factors, and u is technical inefficiency (one-sided).

Therefore u_i requires to make assumption about the distribution of the u.

The composite error term $v_1 - u_1$ does not cause any problem using OLS as long as v_1 u_1 are independent production inputs, x. ˆis unbiased, consistent and efficient amongst linear estimators except that the intercept is not consistent. But it is possible to extricate $\delta_u^2 and\ \delta_v^2$

It is important to note that MLE procedure yields more efficient $\hat{\beta}_1$ and a consistent intercept var$(v_i - u_i)$.

Kumbhakar and Lovell (2000) show that using the dual production it is possible to derive frontier cost function.

$$\ln(c) = \beta_0 + \beta_q \ln(q) + \sum_{j=1}^{k} \beta_j \ln(P_{ji}) + v_i + u_i \qquad (2.10)$$

Where P_{ji} is the price of the input i for firm j.

Note that u_i is added to the cost frontier as inefficiency is expected to increase cost.

Aigner, Lovell and Schmidt (1977) assume that $v \sim iidN(0, \delta_u^2)$, $u \sim iidN^+(0, \delta_u^2)$ [half normal] and define the variance parameter as

$$\delta^2 = \delta_v^2 + \delta_u^2, \ \lambda = {}^{\delta_u}/_{\delta_v} \geq 0 \qquad (2.11)$$

[there is no δ_u and hence no technical inefficiency]

Battese and Cora (1977) took a different approach and set their variance parameter as

$$\delta^2 = \delta_v^2 + \delta_u^2 \qquad (2.12)$$

$$\gamma = {}^{\delta_u^2}/_{\delta_v^2} \qquad (2.13)$$

If $\gamma = 0$ then all deviations from the frontier are noise and if $\gamma = 1$ then all deviations from the frontier are inefficiencies.

Assume that v is normally distributed and let u take some form of a one-sided error term.

$$\ln L = -\frac{N}{2}\ln\left(\frac{\pi}{2}\right) - \frac{N}{2}\ln(\delta^2) + \sum \ln[1 - \Phi(z_i)] - {}^1/_2\, \delta^2 \sum (\ln y_i - x_i\beta)^2 \qquad (2.14)$$

Where

$$z_i = \left[\frac{(\ln y_i - x_i\beta)}{\delta}\right]\left(\frac{\gamma}{1-\gamma}\right)^{1/2} \qquad (2.15)$$

Where x_i are in log form and $\delta^2 = (\delta_u^2 + \delta_v^2)$ and Φ is the standard normal distribution. This $(\ln L)$ can be maximise over β, δ^2, γ for $K \times 2$ parameters wher k includes the intercept term.

Assuming that u is half normal, then

$$E[(exp(-u_i))] = 2[1 - \Phi(\delta\sqrt{\gamma})]exp\left(-\gamma\delta^2/_2\right) \qquad (2.16)$$

This gives average technical efficiency across the entire sample of a firm, but for an individual firm, Jondrow, Materov, Lovell and Schmidt (1982) give one measure.

$$TE_i = \left[1 - \frac{\Phi(\delta_A + \gamma \epsilon_i/\delta_A)}{1-\Phi(\gamma\epsilon_i/\delta_A)}\right] \times \exp(\gamma \in_i + \delta_A^2/2 \qquad (2.17)$$

Where $\in_i = \ln y_i - x_i\hat{\beta}$, x_i are in logs form and $\delta_A = (\gamma(1-\gamma)\delta^2)^{\frac{1}{2}}$

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter presents the various methods and analytical and sampling approaches used in the data collection and analysis. The chapter describes the study area, highlighting the climate and vegetation of the study area. Sampling procedure, sample size determination, sources of data and the instruments used for the data collection are also described in this chapter. The chapter also provides a description of the variable and parameters measured as well as hypothesis and apriori expectations.

3.1 Research design

Research design is the research process that involves the overall assumptions of the research to the method of data collection and analysis (Creswell, 2009). The choice of research design depends on the objectives of the research in order to be able to answer the research questions (Crotty, 1998). One most important and equally difficult decision to make is choosing between qualitative or quantitative research methods or a mixed approach. The difference between the qualitative and quantitative approaches is grounded on the conclusion of different authors because both designs may include different methods (Hanson and Grimmer, 2007). Some researchers prefer to use mixed design approach which take advantage of the differences between quantitative and qualitative designs, and combine these two designs for use in a single research project depending on the kind of study and its methodological foundation (Brysman and Burgess, 1999). In this study, the mixed design approach also known as quasi-experimental design was used for the collection and analysis of the data since the data involved included both qualitative and quantitative data type. The study used cross-sectional data collected from smallholder maize farmers in the northern region. Cross-sectional data was used because it permitted the study of either the entire population or a subset of the population. This type of data helps to study large group of people within a short period of time. In cross-sectional data, different categories of people can be study at the same time which enriches the data.

3.2 Study location

The study was conducted in the Northern Region, the largest region in Ghana in terms of land mass and the most populated of the three northern regions. The region occupies an area of about 70,383 square kilometres. The region lies on latitudes 9^o 15"S and 9$_o$ 15"N and longitudes 0^o 45"E and 0^o 93"W. It shares boundaries with Upper East and the Upper West Regions to the north, Brong-Ahafo and Volta Regions to the south, and two neighbouring countries, the Republic of Togo to the east, and La Cote d' Ivoire to the west.

The land is mostly low lying except in the north-eastern corner with the Gambaga escarpment and along the western corridor. The region is drained by the Black and white Volta rivers and their tributaries such as River Nasia and River Daka. The 2010 population and housing census puts the region's population at 2,479,461 with a population density of 35/km^2 (GSS, 2012). The most dominant economic activity in the region is agriculture.

3.2. 1 Climate and vegetation

The region has a relatively dry climate, with a unimodal rainfall season that starts in May and ends in October. The annual rainfall varies between 750 mm and 1050 mm.

The dry season starts in November and ends in March or April with maximum temperatures occurring towards the end of the dry season and the lowest temperatures occurring in December and January. The Harmattan season which begins in December and ends in February is characterised by dry and hot winds from the Sahara. The temperatures of the region vary between 14°C at night and 40°C during the day.

The vegetation is Guinea savannah that grade into Sudan savannah in the semi-arid region of the Upper East Region. The region is predominantly of grassland, especially savannah with clusters of drought-resistant trees. The dominant trees are 'dawadawa' tree (*Parkia biglobosa*), Shea (*Vitellaria paradoxa*) and Kapok (*Ceiba pentandra*) with a ground cover of perennial grasses such as *Andropogon gayanus*. Further north is the baobab (*Adansonia digitata*) and whitethorn (*Faidherbia albida*). Below is a map of Northern region with arrows showing the selected districts for the study.

Maize has been grown under conventional agricultural practices in Northern Ghana for years.

It is produced predominantly by smallholder resource poor households under rain-fed conditions. The crop is well adapted and grows in most of the ecological zones of Ghana including the northern savannah. It has nearly replaced traditional staple crops like sorghum and pearl millet in northern Ghana. An average maize grain yield on household's maize field is about 1.7 t/ha as against an estimated achievable yield of about 6.0 t/ha (MoFA, 2011). The northern region grows 9 percent of maize produced in the country (MoFA, 2011).

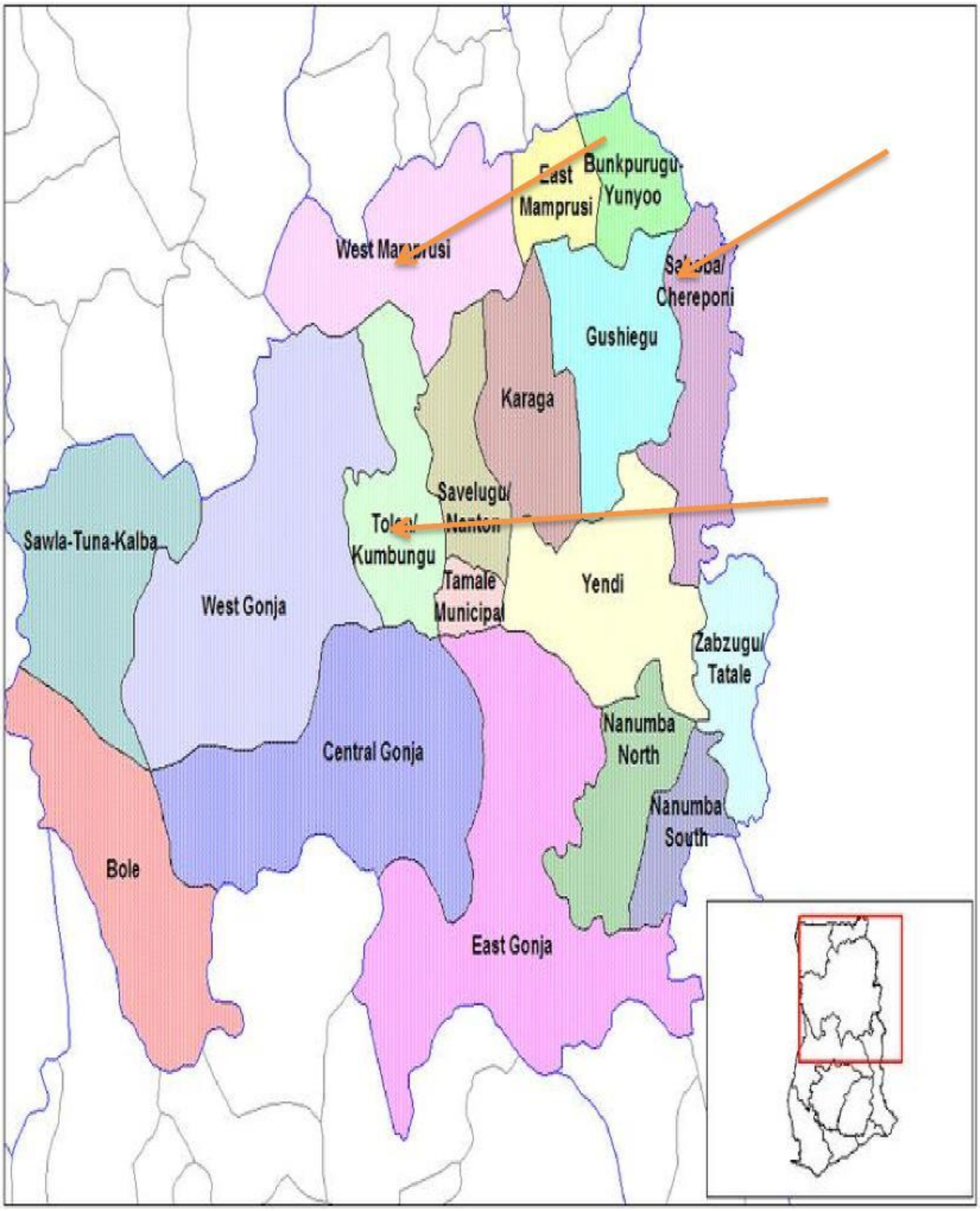

Figure 1 Map illustrating the study area
Source: Ghanadistricts.com

3.4 Sampling Procedure and sample size

This study focused on investigating the effects of fertiliser input subsidy on maize production in the Northern Region of Ghana. A multi-stage sampling procedure was employed in the selection of districts, communities and household heads. The first stage involved the selection of three districts from the Northern region contrasting based on geographical location, ethnicity and farming intensity. The three districts selected were Tolon, West Mumprusi and Saboba districts. Tolon is to the west and largely Dagomba area. Maize production is intensive as the district is largely rural and has rural farm households of 6655 being engaged in crop farming. West Mamprusi was selected because it is located farther north and closest to the Upper East region and largely a Mamprusi settlement. The district is an intensive farming location. The district has an estimated 8260 farm households who are into crop farming and living in the rural areas. The third district selected (Saboba) is located in the Eastern corridor. It is predominantly rural and a Konkonba area. It is also noted for farming and has about 7659 rural farm households doing crop farming. In the second stage, four communities were selected from each district using 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 100 household heads was selected from each district making a total of 300 household heads from the three districts. The sample size was based on rule of thumb predictions as suggested in the literature. Literature has shown that a sample size that is appropriate for any research is determined by a number of variables in the models. As the number of variables increase, the sample size should be statistically large to avoid biased results (Ayele, 2011). Schmidt (1971) suggested a minimum subject-to-predictor ratio ranging in value from 15:1 to 25:1. According to Cohen (1988) a research that uses 15 regressors should have at least a sample size of 138 observations and if 20 regressors, then the least sample size should be 156 observations. An appropriate sample size for a research, however, depends on the type of problem studied, precision required and the resources available (Rao and Richard, 2006). Sample size has an effect on how the sample findings accurately represent the population (Burns and Bush, 2010). The larger the sample is, the more likely that the generalizations are an accurate reflection of the population (Saunders, Lewis and Thornhills, 2009). Sample sizes depend on factors such as the time and money available to collect the data (Hair, 2006). Sample size also depends on the statistical analysis used in the study (Saunders, Lewis and Thornhills, 2009). According to Hair (2006), small or very large sample size have a negative impact on the statistical test because either the sample is either not big enough to make generalisations or too big to make conclusions. Tabachnick and Fidell (2007) established that a sample size of 300 is adequate for factor analysis and for regression analysis, a sample size N >= 50 + 8*M is adequate, where M is the number of independent variables. There are 16 independent variables in this study; a sample size of 50 + 8*16 = 178 is adequate for regression analysis.

3.4 Data Collection and Field Instruments

Basic information for the study was obtained from survey of sampled household heads and other secondary sources. The primary data was collected from smallholder maize household heads using semi-structured questionnaires, focus group discussions and guided face-to-face interactions with key informants. The data collected included the socio-demographic data of the household head, household heads' perception on the fertiliser subsidy program and production data. The secondary data was collected from two fertiliser importing companies, namely; Louis Dreyfus Commodities Ghana Ltd and Olam Ghana Ltd. The fieldwork was carried out in June and July 2014. Two senior research assistance from the University for Development (UDS) and an Mphil student also from UDS assisted in carrying out the fieldwork with me the candidate serving as the supervisor. After the development of the questionnaire, pre-testing was done in the Tamale Metropolis which is located outside of the sampled three districts. This was done to identify potential unanticipated difficulties during the field work with the data collection instruments. The feedback from the pre-testing was used to further improve the questionnaires as well as for the focus group discussions.

3.5 Method of Data Analysis

The analysis of the data involved both qualitative and quantitative techniques. Specifically, four analytical tools were used in the analysis of the data. First, descriptive statistics such as means and percentages were used to examine the categories of farmers who participated and accessed the subsidised fertiliser and the general perception of the farmers about the subsidy programme. One of the objectives of the study was to examine the factors that influence farmers' participation in the subsidy programme and fertilizer use intensity. This involved a two-stage econometrics estimation. The study used the probit and tobit models while controlling for selection bias. Finally, the study employed the stochastic frontier model to examine the effect of participation in the subsidy programme on the smallholders' productivity in the northern region (objective five). The details of these analytical tools and methods are presented in the subsequent sections.

3.5.1 Analysis of Farmer Access and Participation in Subsidy Programme

Descriptive statistics and measures of central tendencies such as cross tabulation, frequencies, means, percentages and standard deviation were used to analyse the programme accessibility, category of farmers that received the subsidised fertiliser and the perceptions of the smallholder household heads about the subsidy programme. Under this section the study analysed the socio-economic characteristics of household heads participating in the subsidy programme and their impression of the subsidy programme. The results are presented in frequencies and percentages; especially in the case of the proportion of sampled household heads participating and their impression of the fertiliser subsidy programme. The socio-economic characteristics of beneficiaries of the subsidy programme was analysed using cross-tabulation and percentages.

3.5.2 Analytical framework for factors influencing access to subsidised fertiliser and fertiliser use intensity

The framework of examining the factors that influence household heads' access to subsidised fertiliser and 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 head's reaction threshold (Hill and Kau, 1981). This implies that every individual has a reaction threshold determined by several factors when they are faced with choices. The household head decision to access or participate in the subsidy programme is one of dichotomous between two mutually exclusive alternatives. The household head either accesses or participates in the programme or does 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 (Madala, 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).

3.5.2.1 The Probit Model

The dependent variable for an adoption model is dichotomous, and equals 1 if the *ith* household head 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 0-1 range (Greene, 2003). Probit and logit models are the commonly used statistical methods developed to analyse dichotomous response dependent variables.

The 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, access or participation in the subsidy programme (Y) will take only two values: one if the household head access or participate in the subsidy programme and zero if a household head does not access the subsidy programme.

A household head's decision to access or 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 household heads 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 household heads' behaviour is consistent with utility maximization and that a technology is adopted when the expected utility from adoption surpasses that of non-adoption. The utility (*Uij*) for a given household head (*i*) though not observed directly, to access and use a particular practice (*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:

$$U_{ij} = \beta_j X_i + e_{ij} \qquad (3.18)$$

$j = 1, 0;$ $\qquad i = 1, \ldots, n$

Where *j=1* shows technology adoption and *j=0* shows non-adoption of the technology (in this case, access to subsidised fertiliser). Hence, the i^{th} household head 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 household head'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 access the subsidised fertiliser, the probit model is specified as

$$Y = F\omega + \alpha X = Fz \quad (3.19)$$

where

V 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 (access to subsidised fertiliser) is conditioned on the independent variables, which is given as;

$$E[Y/X] = 0[1 - F(\alpha' X)] + [F(\alpha' X)] = F(\alpha' X) \quad (3.20)$$

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

$$\frac{\partial E[Y/X]}{\partial x} = \Phi(\alpha' X)\alpha \quad (3.21)$$

where ϕ (.) is the standard normal density function according to Fufu and Hassan, (2006).

3.5.2.2 The Tobit Model

As stated earlier, the probit model is appropriate for analysing adoption 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 access or participation in the subsidy programme (a binary choice) but also the factors that determine fertiliser use intensity (continuous) by the smallholder household heads, 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

$$Y_i^* = \beta X_i + e_i \quad (3.22)$$

$$Y_i = Y_i^* \text{ if } Y_i^* > 0 \qquad i = 1, 2, \ldots\ldots\ldots N$$

$$Y_i = 0 \text{ if } Y_i^* \leq 0$$

Where Y_i^* is a latent (unobserved) variable indicating adoption, *Vi* is the observed dependent variable, *ei* is the error term independently distributed with constant variance (α^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 *V* in the Tobit model according to McDonald and Moffit, (1980) is specified as

$$E|Y| = \beta XF(z) + \sigma f(z) \quad (3.23)$$

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

$$E|Y^*| = \beta X + \sigma f(z)F(z) \quad (3.24)$$

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 decompose 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 has 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

$$\frac{\partial E(Y)}{\partial x_i} = F(z)(\delta EY^*/\delta X_i) + EY^*(\delta F(z)/\delta X_i \quad (3.25)$$

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

$$\frac{\partial F(z)}{\partial x_i} = \frac{f(z)\beta_i}{\sigma} \tag{3.26}$$

The adoption intensity of users of the technology as a result of the independent variable changing (McDonald and Moffitt, 1980; Norris and Batie, 1987; Fufu and Hassan, 2006) also equals to

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

$$=\beta_i[1 - zf(z)/F(z) - f(z)^2/F(z)^2] \tag{3.27}$$

3.6 Empirical models

From the previous section, the study provided theoretical models on adoption and intensity; access to subsidised fertiliser and fertiliser use intensity respectively. This allows for the following empirical models for the study.

The empirical model that was employed to determine the factors influencing access to subsidised fertiliser is given as:

$$Y_i = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + \beta_{12}X_{12} + \beta_{13}X_{13} + \beta_{14}X_{14} + \beta_{15}X_{15} + \beta_{16}X_{16} + u_i \tag{3.28}$$

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 head (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 50kg 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

$\beta_1, \beta_2, \beta_3, \ldots \ldots \ldots, \beta_{10,}$ 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 (*i*) is specified as:

$$Y_i = \frac{quantity\ of\ fertiliser\ use\ (kg)}{total\ land\ area\ (acres)} \qquad (3.29)$$

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

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13} + \beta_{14} X_{14} + \beta_{15} X_{15} + \beta_{16} X_{16} + u_i \qquad (3.30)$$

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 50kg bag)

X_{11} = farm size (number of acres)

X_{12} = wealth rank of the household (the wealth rank of the household 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 participated and 0 if otherwise)

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

$\beta_1, \beta_2, \beta_3, \ldots \ldots \ldots, \beta_{10,}$ are the parameters of the respective explanatory variables in the model, and u_i is the error term.

3.7 Analytical framework for analysing the effect of participation in the subsidy programme on maize productivity

Literature has shown two main approaches for estimating technical efficiency: the data non-parametric mainly Data Envelopment Analysis (DEA) and the parametric mainly stochastic frontier analysis (SFA). The DEA has its origin dated back to Farrell (1957), but then its widespread use is mainly as a result of the empirical work of Charnes et al. (1978). But this approach suffers heavy criticism because it does not take account of the possible effect of measurement error and noise in the data (Coelli, 1995). The second approach which is the SFA uses econometrics model to estimate a stochastic frontier function, and also to estimate the inefficiency element of the error term. However, the SFA was used in this study because it allows for the estimation of the determinants of output, inefficiency and the efficiency scores of each producing unit.

A number of extensions of Farrell's model have been made, the most recent being the stochastic frontier models by Aigner, Lovel, and Schmidt (1977) and Meeusen and van den Broeck (1977), which have an extensive usage (Coelli, 1995). The SFA builds upon the classical econometric regression approaches (Aigner and Chu, 1968) to estimating production function, which depends on the ex-ante specification of the functional form. The stochastic frontier model presumes an error term with two additive components – an asymmetric component, which accounts for pure random factors (*vi*), and a one-sided component, which captures the effects of inefficiency relative to the stochastic frontier

(ui). The random factor (v) is independently and identically distributed with $N(0, \sigma_v^2)$ while the technical inefficiency effect, (u), is often assumed to have a half normal distribution

$N(0, \sigma_v^2)$ The model is expressed as

$$Y_i = x_i \beta + (v_i - u_i) \tag{3.31}$$

The u_i component of the function can be obtained by dividing equation 14 by the observed frontier (without the u). This gives a measure of TE as

$$TE_i = z_i \delta$$

Where xi is the vector of input quantities of the i^{th} firm, zi is the vector of firm-specific factors determining the inefficiency. The $\boldsymbol{\beta}$ and δ are unknown parameters to be estimated together with the variance parameters expressed as $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and $\gamma = \sigma_u^2/(\sigma_v^2 + \sigma_u^2)$. The parameter, , has a value between zero and one such that the value of zero is associated with the traditional response function, for which the non-negative random variable, ui, is absent from the model.

Technical efficiency is defined as $TEi = exp(-ui)$, . It is predicted using the conditional expectation of $TEi = exp(-ui)$, , given the composed error term in equation (3.31). In this specification, the parameters β, σ, σ_u, and γ, can be estimated by the maximum likelihood method.

3.7.1 Empirical model for the Cobb-Douglas production function and the inefficiency model

The empirical model of the Cobb-Douglas production function is specified as below;

$$\ln Yi = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + v_i - u_i \quad (3.32)$$

Y = out of maize in kg

X_1 = organic manure – a dummy variable; 1 if use organic manure and 0 if otherwise

X_2 = household labour (number of man-days)

X_3 = hire labour (number of man-days)

X_4 = farm size (number of acres)

X_5 = quantity of fertiliser used (kg)

V_i = two-sided random error term assumed to be independent of U, identical and normally distributed with zero mean and constant variance N (0, σv^2).

U_i = one sided random variable that accounts for technical inefficiency effects which are assumed to be independent of Vi and non-negative truncation at zero or half normal distribution with N (0, σu^2).

β_0, β_1, β_2, β_3, β_4 and β_5 are the production elasticities.

The inefficiency model is also specified empirically as

$$Ui = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7 + \delta_8 Z_8 + \delta_9 Z_9 + \delta_{10} Z_{10} + \delta_{11} Z_{11} + \delta_{12} Z_{12} + \delta_{13} Z_{13} + \delta_{14} Z_{14} + e_i \quad (3.33)$$

Where

Z_1 = age of respondent (number of years)

Z_2 = sex of respondent (dummy; 1 if male headed household and 0 if otherwise)

Z_3 = marital status of respondent (dummy; 1 if married and 0 if otherwise)

Z_4 = education of household head (number of years school by the household head)

Z_5 = household size (number of people in the household)

Z_6 = community influence (dummy; 1 if a leader and 0 if otherwise)

Z_7 = ancestry (dummy; 1 if and indigene and 0 if otherwise)

Z_8 = wealth rank of household (the wealth status of the household head relative neighbouring households in the community. Dummy; 1 if wealthy and 0 if otherwise)

Z_9 = land ownership (dummy; 1 if owned a land and 0 if otherwise)

Z_{10} = tenure system practice (dummy; 1, if family land, 2 community land, 3 rented land and 4 lease land)

Z_{11} = extension contact (number of visits by extension agent)

Z_{12} = farmer group (dummy; 1 if belong to farmer group and 0 if otherwise)

Z_{13} = off-farm income (amount in Ghana Cedis earned from off-farm activities)

Z_{14} = participation in the subsidy programme (dummy; 1 if participated and 0 if otherwise)

$\delta_1, \delta_2, \delta_3$ .... and δ_{14} are coefficients to be estimated

e_i is the error term.

3.8 Hypotheses formulation and testing

Two main hypotheses were formulated and tested for their significance.

First hypothesis: the fertiliser subsidy programme has no influence on fertiliser use intensity.

$H_0: \beta_{14} = 0$

$H_1: \beta_{14} \neq 0$

Secondly, the probability of access or participation in the subsidy programme has no impact on the productivity of the smallholder maize farmer.

$H_0: \beta_{14} = 0$

$H_1: \beta_{14} \neq 0$

Table 1 Definitions of Variables and Expected Outcomes

Variable	**Definition and Measurement**	**A prior expectation**
Age of household	Number of years the household head lived	+
Sex	Dummy; whether the household head is male headed or female headed 1= if the household is male head 0 = if otherwise	+
Marital status	Dummy; whether the household is married or single 1 = if married 0 = if otherwise	+
Household size	Number of people living in the household	+
Experience	Number of years the household head has been farming maize	+/-
Hired labour	The number of people the household head hired to work on the farm	_
Frequency of extension contact	Number of times a household received extension services.	+
Extension training	Dummy variable; whether the household received an extension training or not 1 = if receive extension package 0 = if otherwise	+
Educational level	Educational level of household head (number of years in school).	+

Distance to input shop	Distance in kilometre travelled by the farmer to access the subsidised fertiliser to buy or get it free.	–
Total land area	The total land area available to the household for farming in acres.	+/-
Participation in the subsidy programme	Dummy variable; whether the household participated in the subsidy programme or not 1 = if the household participated 0 = if otherwise	+
Cost of fertiliser	The cost of NPK fertiliser	-
Group membership	Dummy variable; whether the household belong to a farmer group or not 1 = if belong to farmer group 0 = if otherwise	+
Credit borrowing	Dummy variable; whether the household has access to credit or not 1 = if household have access to credit 0 = if otherwise	+
Off-farm activity	Dummy variable; whether the household has off-farm activity or not 1 = if household has off-farm activity 0 = if otherwise	+
Wealth position	Dummy variable; the household perception of their income status relative to other households. 1 = if rich 0 = if otherwise	+
Land ownership	Dummy variable; whether the household owns land or not 1= if household owns land 0 = if otherwise	+
Nativity	Dummy variable; whether the farm household is a native of the community or farm household came and settled in the community 1 = if native 0 = if otherwise	+
Organic material	Dummy variable; whether or not the household uses organic manure on his or her farm 1 = if used organic manure 0 = if otherwise	+
Extension service	Dummy variable; whether household receive extension visits or not 1 = if household receive extension visits	+

	0 = if otherwise	
Tenure system	Dummy variable; the type of tenure system practice by the household 0 = if family land (reference group) 1= if community land 2 = if rented land 3 = if lease land	+/-
Attempted to participate in the programme	Dummy variable; whether the household is able to receive the subsidised fertiliser or not 1 = if household attempts participated in the subsidy programme 0 = if otherwise	+
Leadership position in the community	Dummy variable; whether the household head holds position in the community or not 1= if member of community leadership 0 = if otherwise	+
Amount of credit receive	Amount of money in Ghana Cedis a household received as credit	+
Amount earn in off-farm activities	Amount of money earn from off-farm activities	-
Farm size	The log of farm size in acres cultivate for maize	+
Fertiliser	The log quantity of fertiliser (kg) applied to maize farm	+
household labour	The log of man-days of household labour	+

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Introduction

This chapter presents and discusses the results of the study. The chapter is divided into six major sections. The first section presents socio-demography characteristics of sampled households. The second section discusses participation in the subsidy programme by farm households, looking at the procedure for enlisting participants in the subsidy programme and the type and quantity of fertiliser supplied under the subsidy programme. The characteristics of participants in the subsidy programme and perception of the subsidy programme are presented in sections three and four respectively. The fifth section presents the factors that influence farmers' participation in the subsidy programme and fertiliser use intensity, by looking at factors that influence participation in the programme and the effect of participation in the fertiliser subsidy on fertiliser application rates. Finally, the sixth section presents the effect of participation in the subsidy programme on maize productivity.

4.1 Socio-Demography characteristics of sampled households in the study area

The study measured household and farm characteristics of the household heads. Table 2 presents the demographic characteristics of the sample households in the Northern region. The result shows that the mean age of the sampled household heads was 37.8 years. This means that maize farmers in the region are largely youth. About 92 percent of the sampled households were male headed households, an indication that farming in the area is a male dominated occupation. Similarly, 92 percent of the household heads interviewed were married. Maize is an important staple especially among the married farmers in the region. It is therefore not surprising that the married household heads were more into its production. The mean number of years spent in school by sampled

Table 2 Demography characteristics of sample households

Variable	Mean	Standard deviation
Age	37.78	10.26
Sex	0.92	0.27
Marital status	0.92	0.26
Education	2.09	3.83
Household size	9.56	5.33
Household labour	4.22	2.56
Hire labour	2.28	4.46
Community influence	0.14	0.35
Farmer experience	14.61	9.15
Nativity	0.93	0.24
Wealth rank	0.72	0.45
Farm size	7.10	4.24
Land ownership	0.86	0.35
Years of extension delivery	2.24	2.98
Number of extension visits	1.48	1.99
Extension training	0.33	0.48
Farmer group	0.43	0.50
Years in farmer group	1.42	2.06
Credit borrowed	41.22	105.43
Off-farm income	272.62	361.99

Source: Author's computation 2014

Household head was 2 years which means the average household head in the study area attained primary school education. The low level of education in the region would mean that the tendency for technology adoption would be low in the area. The average size of households in the sampled area is 9 members. These large household members could serve as a source of cheap and readily available source of labour to ease the labour challenges in farming. But in terms of the number of household members in their economically active age, the mean estimate was 4 people on a farm. This means that household heads have more dependents than people that could assist in the farm operations. Household heads also supplemented their labour by hiring. Each household hired an average of two people. About 14 percent of the household heads in the sample hold leadership positions in the area. The mean number of years respondents have been farming was estimated at 14 years. This is considerably high and household heads might have gained a lot of experience in farming and also demonstrate this on their farms. About 93 percent of the sample household heads are indigenes and lived all their lives in the communities. The wealth ranking of household heads measured the perception of the household heads regarding their income status relative to other households in the study area. Household heads compared themselves to other households and reported as whether they are among the average, top (wealthiest) or bottom ranked (among the poorest) households in the community. About 72 percent of the sampled respondents reported that they were among the average household heads in the community. The result further showed that, household heads owned an average 2.8 hectares. This is high considering the fact that farm land holdings by the majority in Ghana are less than 2 hectares (MOFA, 2013). About 86 percent of the households indicated that they owned the land in which they are farming. At least every household head in the sample had contact with extension agents in the past two years. Farmers received an average of one extension visit per year. About 43 percent of the sampled household heads are members of farmer-based organisation in the study area, with a farmer remaining a member of a group for periods not less than one year. Household heads in the area have an average farm income of GH₵ 272.62 and received an average credit of GH₵ 41.22 in 2013/14 farming season. This means that the mean income of the farmers is below the regional average per capita expenditure of GH₵ 362.00 (GSS, 2008).

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

The study examined the accessibility of the 2013/2014 fertiliser subsidy programme and the ease with which household heads got enlisted in the subsidy programme. The variables under consideration were the percentage of household heads who accessed the subsidised fertiliser in each community and how they were selected to participate in the subsidy programme. The actual process of selection on the ground is then compared with the originally designed procedure of the subsidy programme. Table 3 below presents the participation data of the subsidy programme in each community. About 95 percent of farmers in Golinga in the Tolon district accessed or participated in the subsidy programme. Out of the sampled 21 household heads, only one household head did not get access to fertiliser under the subsidy programme in the community. This means the programme was more accessible to farmers in this community. In Galinkpegu, about 80 percent of the household heads in the community had access to the subsidy programme. In the West Mamprusi district, Kukua had the highest percentage rate of participation in the subsidy programme as 60 percent of the sampled household heads in the community participated in the subsidy programme. Gurunsi-fong which is a suburb of Walewale town has the lowest percent (37.9%) of the household heads having accessed and participated in the subsidy programme. This means that as the community becomes more urbanised, the likelihood of getting subsidised fertiliser reduced. This may be attributable to diversification of livelihood activities from agriculture as opportunities in non-farm employment emerge due unbanisation. In Nayorku and Loagri, 52 percent of sampled household heads participated in the subsidy programme. All the four sampled communities in the Saboba district recorded more than 50 percent participation in the programme. Kimoteer and Baakoli had 70 percent level of participation. About 65 percent and 60 percent of the sampled households in Nalongni and Boagbon respectively were able to participate and access the subsidy programme.

In terms of participation at the district level, Tolon district had the highest percentage of the participants in the subsidy programme with about 40 percent of the household heads in the district having access to the subsidy programme. Meanwhile, West Mamprusi and Saboba districts have a household head participation rate of about 25 percent and 34 percent respectively in the programme. In general about 64.5 percent of household heads sampled in the three districts participated in the subsidy programme.

Table 3 Percentage of community who got to participate in the subsidy programme

District	Community	Percentage access or participation by community (%)			
		Yes		No	
		Percentage (%)	Frequency	Percentage (%)	Frequency
Tolon	Dimabi (28)	67.9	19	32.1	9
	Galinkpegu (20)	80	16	20	4
	Golinga (21)	95.2	20	4.8	1
	Tingoli (32)	68.8	22	31.2	10
West	Loagri (23)	52.2	12	47.8	11
Mamprusi	Kukua (23)	60.9	14	39.1	9
	Nayorku (25)	52.0	13	48	12
	Gurunsi-fong (29)	37.9	11	62.1	18
Saboba	Kimoteer (40)	70	28	30	12
	Nalongni (20)	65	13	35	7
	Boagbon(20)	60	12	40	8
	Baakoli (20)	70	14	30	6

Source: author's computation, 2014

4.2.1 Procedure for Enlisting Participants

Before a farmer could acquire the 2013/14 subsidised fertiliser coupon to redeem fertiliser at any of the retail shops, such a farmer must first be a Ghanaian. Nationality is proven by possession of a voter's identification card or national health insurance card. The farmer must come with a passport size picture, his or her house number and the telephone number. In addition, the farmer must be known to the extension agent of MOFA. The farmer's number of acreages under cultivation must be known to be captured into the coupon to determine the quantity of the fertiliser he or she could receive under the programme. A farmer who satisfies all this criteria is then issued with the coupon stating the quantity of subsidised fertiliser to redeem at the fertiliser retail shop where subsidised fertiliser was distributed. Fertiliser could be redeemed at any agro-input shop where the subsidised fertilisers are sold. A farmer could only obtain 15 bags (10 bags of NPK and 5 bags of $NHSO_4$) of fertiliser under the subsidy programme. Farmers can also go to the fertiliser retail shop

Table 4: Channels for Distributing Subsidised Fertiliser

Method of participation	Frequency	Percentage (%)
Political connections	31	15.8
Accidental discovery	45	23.0
Daily registration	33	16.8
Group membership	13	6.6
Use of coupon	74	37.8
Total	196	100

Source: Author’s computation, 2014

with the above documents without the coupon under the daily record system and redeem the fertiliser. With regards to how the communities actually got to participate in the subsidy programme, political connections, accidental discovery, daily registration at distribution points, group membership and the use of coupons were channels for participation in the programme. The use of coupon was the main channel of participation in the subsidy programme for the 2013 cropping season. Even though the 2013 fertiliser subsidy programme did not involve using only the coupon system in accessing the programme, majority (37.8%) of the sampled household heads used the coupon to access the subsidy programme. The coupons were distributed by MOFA, the ministry in-charge through its extension agents. Household heads who wanted to access the subsidy programme through the coupon system were advised to contact the MOFA extension agents for the coupons before going to the retail store for the subsidised fertiliser. However, household heads who could not exhaust their coupon in the 2012 programme could also use it to access the 2013 subsidy programme. The study further found that about 23 percent as shown in table 4 got the subsidised fertiliser through accidental discovery. This means that household heads went to the fertiliser retail store to buy fertiliser not at a subsidised price but accidentally realised that the subsidised fertiliser was available and they managed to acquire it. Though this is not outside the criteria for accessing the subsidy, it requires that the household heads went there with his or her voter's identification card or national health insurance scheme card to indicate that he or she is a Ghanaian, a passport size picture, house number and telephone number taken. The household heads' details would then be taken after presenting all these documents before redeeming the fertiliser. However, household heads who participated in the subsidy programme through accidental discovery reported that they did not present any document to the retail agent and did not even know whether their details were taken at the retail outlet. This implies that the retail agents could fill the daily record sheet in the absence of the household heads and could inflate the quantity of fertilisers taken by the household heads. The daily record system[1] was another means of accessing the subsidy programme. [1]Less than 20 percent of the household heads used this method to redeem fertiliser under the programme. The main disadvantage of this is the stress associated with queuing for long hours. The study found that some household heads participated in the subsidised fertiliser scheme without using any of the formal channels and procedures. Political connection was another channel through which

[1]This involves forming queues and registering to receive fertiliser. This option was available daily.

households participated in the subsidy programme. Household heads were asked whether they have any connections with their MP, DCE, Assemblyman or any political party official through which they acquire the subsidised fertiliser. About 16 percent of the sampled household heads 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 by which household heads gained access to the subsidy programme. Though not explicitly spelt out in the processes of acquiring the subsidy, it has become a common practice since the group members are able to help one another to acquire the subsidised fertiliser. Household heads who are in a group and under the out-grower systems were required to apply through their sponsors to MOFA to enable them qualify for accessing the subsidy programme. However, less than 10 percent of the sampled household heads participated in the subsidy programme through their membership of farmer group.

4.2.2 Types and quantity of fertiliser supplied under the subsidy programme

Table 5 presents the type of fertiliser received and used by farmers under the subsidy programme. The result shows that each beneficiaries of the subsidy programme received 150kg of NPK and 125kg $NHSO_4$. The implication of the quantities of fertiliser received under the programme may be that household heads are not able to apply the required quantity of fertiliser, thus raising questions about the prospects of achieving the intended benefits of the programme. Farm household heads used all the fertiliser obtained under subsidy on their maize farms, as household heads believed other crops could produce breakeven yields without fertiliser but not so with maize.

Table 5 Types and quantity of fertiliser supplied under the subsidy programme

Variable	Mean	Std. deviation
Quantity of NPK received	3.17	2.94
Quantity of SOA received	2.46	1.32
Quantity of NPK used	3.15	2.93
Quantity of NHSO4 used	2.46	1.32

Source: Author's computation

4.3 Characteristics of Participants in the Subsidy Programme

Objective two of the study was to assess the characteristics of participants in the subsidy programme. The factors examine included social status, networking, and wealth rank among others. Table 6 presents the analysis of the characteristics of participants in the subsidy programme. The table shows that majority of participants were among the wealthy rank in their various communities. About 75 percent of participants of the subsidy programme ranked themselves as wealthy in relation to other household heads in the community. It was mostly those household heads that could pay the 79 percent up front that gets the fertiliser. Those not able to afford the 79 percent gave their coupons to other household heads in exchange for an amount less than the 20 percent subsidy. The Ghana fertiliser subsidy operated on the principle of first come first serve basis as the quantity of the subsidised fertiliser was limited. Since the beneficiary is required to pay a upfront money of more than 70 percent of the cost, households that received credit during the time that the subsidised fertiliser was available are likely to use the credit to buy the fertiliser. The study found that, the average credit received by beneficiaries of the subsidy programme was about GHC 38.94. The next largest groups of recipients were those with social networks such as

Table 6 Characteristics of participants in the subsidy programme

Characteristic	**Mean**
Age	38
Sex	0.93
Marital status	0.93
Education	1.82
Household labour	4.45
Perceived wealth rank	0.75
land size	7.35
Community influence	10.8
Farmer experience	15.23
Indigenes	0.96
Extension visit	2.50
Extension training	0.34
Farmer association	0.42
Distance to input shop	8.37
Political connections	0.14
Farm income	676.53
Credit borrowed	38.94
Off-farm income	259.54

Source: Author's computation, 2014

connections with Assemblymen, Members of Parliament (MP), District Chief Executive and political party officials. About 14 percent of recipients of the subsidy programme reported that they had connections to Assemblymen, MPs and political party officials. The average land size of recipients of the subsidised fertiliser was 3 hectares. Given that land holding is an indicator of wealth, it further underscores the role wealth played in facilitating access to the subsidised fertiliser. Education appeared not to have influenced participation in the programme as the average years spent in school 1.82 years for beneficiaries.

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

The study investigated households' knowledge of the subsidy programme in the Northern region. In line with 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 percent of the household heads indicated that they were not aware that the government had subsidised fertiliser for smallholder farmers. They, however, indicated that they were aware of the programme in the previous years but were not aware that the programme had been continued as they were no longer beneficiaries of the subsidy programme.

Table 7 Farmers awareness of the subsidy programme

Awareness	Frequency	Percentage (%)
No	105	34.9
Yes	196	65.1
Total	**301**	**100**

Author's computation, 2014

4.4.2 Perceived Accessibility of the fertiliser subsidy programme

How easy the household heads can gain access to the fertiliser subsidy programme will influence its effectiveness. A three point scale of very accessible, accessible and difficult to access was used to assess the household heads' perception on the accessibility of the subsidy programme in the northern region. The majority of the household heads thought that access to the fertiliser subsidy programme was complicated and difficult. About 59 percent of the household heads reported that participation in the subsidy programme was difficult. Only three percent thought the subsidy programme was very accessible to smallholders. Without the coupon, household heads had to wake-up early in the morning to queue for several hours in order to be able to write their names with the retail agent under the daily record system before they could get access to the subsidised fertiliser. In some cases household heads waited all day in queue only to be told at the end of the day that stocks were depleted and they would have to try another day. Household heads attributed the difficulty to access the subsidy programme to the limited quantities of subsidised fertiliser and the first come first serve criterion for accessing the programme. This coupled with information asymmetry about the availability of the subsidised fertiliser made the 2013/14 fertiliser subsidy difficult to access. The inability to identify which fertiliser is subsidised and which one is not subsidised made it possible for some retail agents to hoard the fertiliser and sell to their regular customers as a form of loyalty reward.

Table 8 Perceived Accessibility of the fertiliser subsidy programme

Variable	Frequency	Percentage (%)
Very accessible	6	3.2
Accessible	75	38.2
Difficult	115	58.6
Total	196	100

Author's computation, 2014

4.4.3 Perceived effect of the subsidy programme on fertiliser usage

One of the goals of the fertiliser subsidy programme was to encourage farmers to increase fertiliser use to about 50kg 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. With this in mind, the study sought the views of the smallholder farmer on their usage of fertiliser as a result of the subsidy programme. The average fertiliser used in the sampled study area was 36.1 kg per hectare. This means that Ghana is still in the process of meeting the Abuja declaration and the METASIP recommendation. About 57 percent of the household heads indicated that the fertiliser subsidy programme did not have any effect on the quantity of fertiliser they used. About 42 percent (83) of the household heads reported that the subsidy had an effect on their fertiliser usage as they were able to increase the quantity of fertiliser they used during the period of the subsidy. Even though, they reported increment in their fertiliser use, they could not tell in numerical terms the exact increment of their fertiliser use attributable to the subsidy programme as they do not have their past fertiliser use records. However, they gave qualitative descriptions of the extent of increment. Table 9 presents the perceived effect of the subsidy programme on fertiliser use. Among those who indicated an increase in fertiliser use, about 57.3 percent of them noted that the increase in fertiliser usage was high and 43 percent have it that their increment was marginal.

Table 9 Perceived effect of the subsidy programme on fertiliser usage

Effect	Frequency	Percentage
No increase	113	57.4
Increase	83	42.6
Total	196	100
Level of increment		
Marginal	35	42.7
High	58	57.3
Total	83	100

Author's computation, 2014

4.4.4 Timeliness of the subsidised fertiliser for farmers to access

Fertiliser use is more profitable when farmers have access to it at the time it is required. There have been complains about delays in the delivery of the subsidised fertiliser to farmers. The majority (62%) of the household heads reported that the subsidised fertiliser was delivered on time, while 38 percent of the respondents reported that the subsidy was characterised by delays. According to them, the fertiliser should have been applied between May and June but the subsidised fertiliser was delivered to them in July and August. The delay in delivery of the subsidised fertiliser prevented some farmers from reaping the full benefit of the programme.

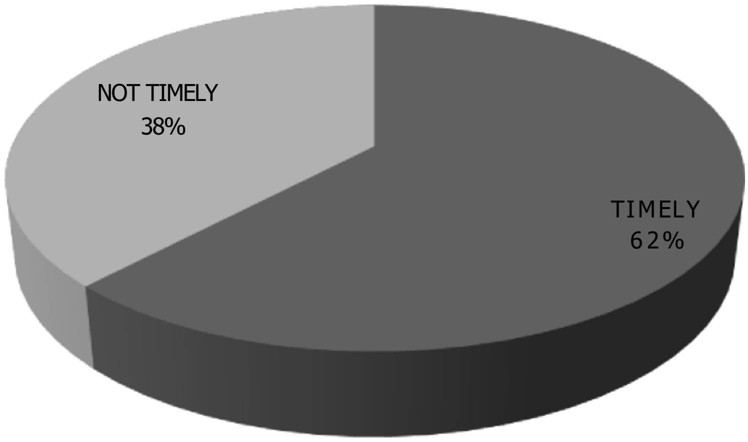

Figure 2 Timely nature of the subsidy programme
Source: Author's computation, 2014

4.4.5 Perception of farmers about the price of the subsidized fertiliser and rating of the subsidy programme

The study asked household heads to give their impression of the price of the subsidised fertiliser. A four-point scale of low, moderate, high and very high was used. Table 10 presents the perception of the household heads on the price of the subsidised fertiliser. About 34 percent of the household heads reported that the price at which the subsidised fertiliser was being sold was high. Similarly, 24 percent of the household heads indicated that the price was very high and that the amount of the subsidy needed to be increased in order to bring the price down. Majority (38%) of household heads reported that the price at which the subsidised fertiliser was sold was moderate while only 4 percent of the household heads have shown that the subsidised fertiliser prices were low. This means that in the view of the household heads, the subsidised fertiliser price is still high and needed to be reduced further if the smallholder resource poor household head is to benefit from the programme.

Table 10 Perception about the price of the subsidized fertiliser

Perception	Frequency	Percentage (%)
Very high	46	23.6
High	67	34.1
Moderate	75	38
Low	8	4.3
Total	196	100

Source: Author's computation, 2014

4.4.6 Rating of the subsidy programme

Household heads were also asked of their perception of the fertiliser subsidy programme in the country. A five-point scale of very good, good, average, poor and very poor was used to assess household heads' perception of the subsidy programme. The results are presented in table 11 below. Majority (40%) of the household heads indicated that the subsidy programme was good as it was intended to improve smallholders' access to fertiliser. About 16 percent of the household heads think that the subsidy programme is very good while 10 percent described the subsidy programme as being average. About 23 percent of the household heads reported that the subsidy programme was very poor in its implementation as it was being used as a political tool for gaining political power while about 11 percent of the household heads perceived the fertiliser subsidy programme to be poor.

Table 11: Household heads rating of the subsidy programme

Perception	frequency	percentage (%)
Very good	32	16.2
Good	79	40.4
Average	19	9.6
Poor	22	11.2
Very poor	44	22.6
Total	196	100

Author's computation, 2014

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

Objective four of the study sought to examine the factors that influenced household head's participation in the subsidy programme as well as fertiliser use intensity. In the case of the former, a probit model was estimated to examine the farm and household characteristics that influenced the probability of an individual's participation in the subsidy programme. Table 12 below presents the results of the probit model.

Age of the respondent was statistically significant at the 5 percent level and exerted a positive effect on the probability of participating in the subsidy programme. This means that older household heads were more likely to participate or access the subsidy programme than younger household heads. The marginal effect of age was 0.03. Thus, the probability of participating in the subsidy programme increased by 0.03 if the age of

Table 12: 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
Efforts at 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 = 293 vif = 0.61

Wald chi^2 = 93.31

Prob>chi^2 = 0.0000

Pseudo R^2 = 0.4072

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

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 household head was statistically significant at 1 percent 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 household heads were given priority in attempt to encourage women farmers to participate in the subsidy programme. The marginal effect of sex of the household head was -0.93 and the probability of having access and participating in the subsidy programme reduces by 0.93 if the household is male headed. However, this result is contrary to Chibwana 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 is positive and statistically significant at 10 percent level with a standard error of 0.026. The sign of the coefficient is consistent with a priori expectations that access to the subsidy programme would increase with increasing farm size. Household heads with large farms need more fertiliser on their farms and if households with large farms were poor they would require subsidies and hence more likely to apply to the subsidy programme. Owning large farms is a sign of influence in the community which may also help such farmers gain access to the subsidy programme. The marginal effect of the farm size is 0.0514 implying that the probability of having access to the subsidised fertiliser increased with farm size. This result agrees with Chirwa et al.(2011) who also found a positive relationship between access to subsidised fertiliser coupon and farm size. This result may suggest that large farm owners used their farm size to bid for the subsidy programme participation as their fertiliser requirement is high.

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 head increased, the probability of accessing the subsidy also increased. The coupons which are the requirements for participating in the subsidy are usually distributed by the extension agents. This means that household heads that received more extension visit within the past 12 months were more likely to have access to the subsidy. With a marginal effect of 0.0922, it means that a farmer's access to the subsidy programme increases by 0.0922 percent for every additional visit by an extension agent to the farmer.

Effort at participating in the subsidy programme was statistically significant at the 1 percent level with a positive coefficient sign. This implies that household heads that have attempted to participate in the subsidy programme were more likely to gain access to the subsidised fertiliser than household heads that did not attempt to participate in the programme. The marginal effect of attempts at participation in the subsidy programme is 1.2545, meaning that, the probability of a household access to the subsidised fertiliser increased by 1.2545 if the household head has made more attempt to participate in the subsidy programme. The result is consistent with a prior expectation and also consistent with Chirwa et al., (2011).

As expected, the cost (price) of subsidised fertiliser was consistent with economic theory, as it shows an inverse relationship with access to the subsidy programme. The cost (price) of the subsidised fertiliser had a negative and significant effect on participation in the subsidy programme. As the cost of fertiliser in the subsidy programme increase, participation in the subsidy programme decreases. This implies that with increasing prices, the purchasing power of the household heads declined and hence their inability to purchase more of the subsidised fertiliser.

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 percent level of probability. This means that, a unit increase in distance to the fertiliser retail shop increases the possibility of accessing or participating in the subsidy programme. The marginal effect of distance to the fertiliser retail shop was 0.11 and the probability of accessing or participating in the subsidy programme increases by 0.11 if the distance increases by 1 kilometre. Distance did not reduce the probability of participating in the subsidy programme which was contrary to aprior expectations.

Similarly, access to credit was positively related with access to the subsidised fertiliser and was significant at the 10 percent level of significance. The Ghana fertiliser subsidy is such that the household head paid more than 70 percent of the total cost of the 50 kg bag of the fertiliser. It was expected that household heads with cash credit would be able to pay the 79 percent upfront payment and would be better placed to participate in the subsidy programme. The likelihood of a household head receiving the subsidised fertiliser increased by 0.0009 for every unit increase in the probability to received credit.

A common problem that exists in any regression analysis is multicollinearity, therefore a diagnostic test was conducted based on the variance inflation factor (vif) to identify any potential misspecification problems that may exist in the estimated model. The diagnostic test indicated that the largest vif in the probability model is 1. This value is far below the maximum value of 10 which is used as a rule of thumb to indicate the presence of multicollinearity. This means that multicollinearity was never a problem in the estimated model. Also, heterocedasticity which is a common problem typical of a cross-section data was check and corrected using the established procedure for its correction. The model was estimated using the rubost standard errors. Therefore, heterocedasticity was corrected in the model using the rubost standard errors.

4.5 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 50kg. The study used the tobit model to analyse how participation in the subsidy programme affected household per hectare fertiliser consumption rate. Table 13 below presents the factors that influence fertiliser use intensity in the Northern Region. Marital status, level of influence in community, hours of household labour, hours hired labour, cost of fertiliser, farm size, wealth status, distance from farm to input shop, participation in subsidy programme and land ownership are the factors that significantly influence fertiliser use in the area. Variables such as age, sex, education, organic manure use, extension visit and off-farm activity did not exert statistically significant influence on fertiliser use intensity in the study area.

Influence in community is proxied by role play in the community. Community influence was an important determinant of fertiliser use intensity in the study area. The coefficient of community leadership was 7.8531, indicating the probability of fertiliser use increase by 7.8531kg per acre if the household head was a leader in the community. The implication of this is that leaders in the communities were more likely to use more

Table 13 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 fertiliser	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
vif	3.59		

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

fertiliser than non-community leaders. Many social interventions including subsidy on agricultural inputs sometimes passed through village leaders in the community before getting to people in the community. Also, demonstrations of agricultural innovations are often done on group leaders' farms if the organisation doing the demonstration does not have their own demonstration farm and fertilisers are often used on the demonstration farms hence the household head chances of using fertiliser on their farms. Due to the leadership role they play in the community, they do have contacts with agricultural development agents who educate them on good agricultural practices and innovations. They may also know much about soil fertility management and know the type of fertiliser to use and the time of its application as a result of the contact they have with these agricultural development officers.

Furthermore, as expected, household labour also positively determined fertiliser use intensity. The variable was statistically significant at the 5 percent level. This means that household heads with access to labour used more fertiliser on their farms than those with limited access to household or hired labour. Unlike hired labour, household labour is readily available and less expensive; hence farmers are able to carry out fertiliser applications timely. Also, household heads will save money if they get enough farm labour from the households to be used on the farm. Such monies saved could be invested on other aspects like buying of farm inputs including fertiliser on the farm.

Farm size was highly statistically significant at the 1 percent 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 influence 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 percent level of probability. This result is contrary to Zhou et al. (2010) who found distance to be 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 influences his or her fertiliser use intensity status on the farm. The wealth rank variable was significant at 10 percent level of probability and influenced fertiliser use positively. The coefficient was 4.9317 which suggest that the intensity of fertiliser use increases by 4.9317 kg per acre if the households wealth rank improved by GH₵ 1.00. The implication is that rich household heads are more likely to use fertiliser more than poor household heads. Fertiliser cost is belief to be one reason why farmers in the region do not use fertiliser, therefore it is expected that household heads with improve wealth status should use more fertiliser than household heads with no improve wealth status.

The variable participation in the government fertiliser subsidy has a positive effect on fertiliser use intensity. The variable is statistically significant at 5 percent level and consistent with the research a prior expectation. This means that household heads that have access to the subsidised fertiliser or participated in the subsidy programme used more fertiliser on their farms than household heads that did not access or participate in the subsidy programme. Farm Household heads that have access to the subsidised fertiliser bought the fertiliser at a relatively lower price than those that did not have access to the subsidised fertiliser. As a result of this, beneficiaries of the fertiliser subsidy are more likely to buy more fertiliser which will result in increased fertiliser use intensity. Also, the goal of the fertiliser subsidy programme is to raise fertiliser use to about 50 kg per hectare by 2015 as a recommendation in METASIP. Therefore it is expected that farmers who have access to the subsidised fertiliser would use more fertiliser than household heads without the subsidised fertiliser. The coefficient of participation was 5.9431 implies that fertiliser use will increase by 5.9431 kg per acre if a farmer is able to access or participate in the subsidy programme. Chirwa et al., (2011) found similar result.

Finally contrary to expectation, land ownership was significant but had negative influence on fertiliser use intensity. This shows that household heads who did not use their own lands used more fertiliser on their farms than those farmers who farm on their own lands. Land owners in most cases feel reluctant in developing the quality of their lands since they have relatively larger land sizes, hence the negative effect. The coefficient of land ownership was -7.4663 which means fertiliser use intensity decline by 7.4663 kg per acre for household heads that farm on owned land.

A diagnostic test was also conducted for multicollinearity based on the variance inflation factor (vif) to identify any potential misspecification problems in the estimated model. The diagnostic test indicated that the largest vif in the probability model is 6.45. This value is far below the maximum value of 10 which is used as a rule of thumb to indicate the presence of multicollinearity. This means that multicollinearity was never a problem in the estimated model. The model was also estimated using the rubost standard errors. Therefore, heterocedasticity was corrected in the model using the rubost standard errors

4.6 Effect of participation in the subsidy programme on maize productivity

With this objective, the study sought to estimate the effect of participation in the fertiliser subsidy programme had on maize productivity. As explained in chapter three, productivity in the study is measured by technical efficiency. Table 13 below presents the estimated elasticities of the inputs used in the efficiency model. Organic material, farm size and quantity of fertiliser used were significant at one percent level. Number of man-days of hired labour was significant at five percent level while number of man-days of household labour is significant at ten percent. While organic material, hire labour, farm size and inorganic fertiliser shift the technical efficiency frontier outward, family labour contracts the frontier as it has negative relationship with maize output.

Table 14 Factors influencing technical efficiency of maize farmers

Input	Coefficient	Std error	P >|z|
Constant	2.7510	0.0869	0.000
Organic material	0.0748***	0.0282	0.008
Log household labour	-0.0657**	0.0376	0.080
Log hired labour	0.0579**	0.0260	0.026
Log farm size	0.7914***	0.0641	0.000
Log quantity of fertiliser	0.1018***	0.0299	0.001

Number of observations = 255

Wald chi^2 259.77

Prob> chi^2 = 0.0000

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

4.6.1 Efficiency level of smallholder household heads in the study area

The bar chart below depicts the frequency distribution of the efficiency levels of the smallholder maize farmers in the study area. A technical efficiency measurement of 100 percent shows a complete efficiency use of inputs included in the frontier function specification. However, a less than 100 percent means the presence of inefficiency. From the result, technical efficiency levels of the household heads range from 40 percent to 96 percent with an estimated mean technical efficiency of 80 percent. This means that under the current farm technology, there is a potential of 20 percent possible efficiency improvement in the study area. The mean technical efficiency of beneficiaries of the subsidy programme was 80.6 percent while the mean of non-beneficiaries of the programme was 78.5 percent. This implies that there is a productivity difference of 2.1 percent between subsidy beneficiaries and non-beneficiaries which may be attributable to the subsidy programme.

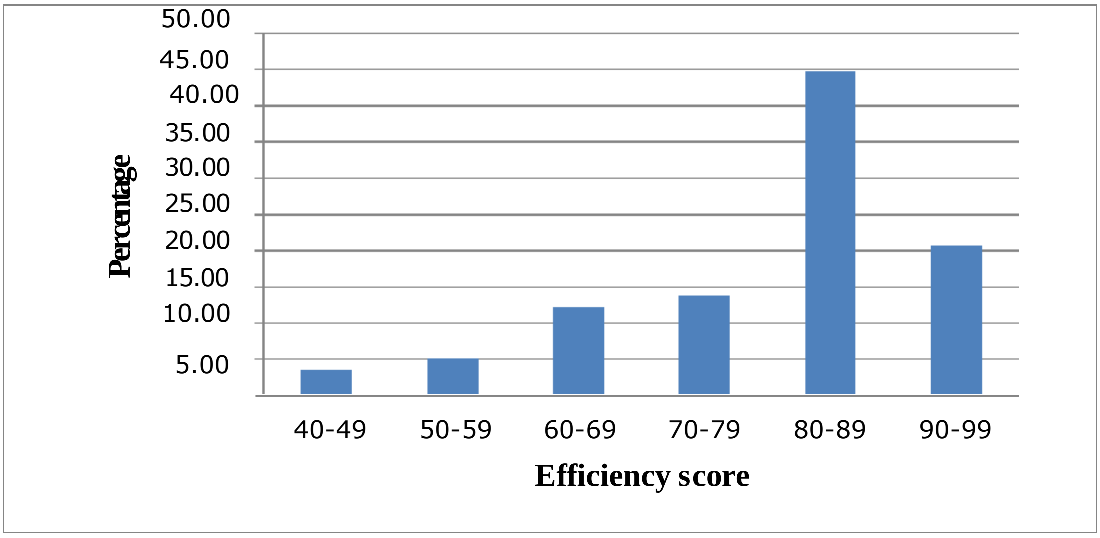

Figure 3 Efficiency score of maize farmers in the northern region

Source: Author's computation, 2014

The results have shown also that 44 percent of the households have an efficiency levels between 80 and 89 percent. Similarly, 19 percent have an efficiency level that is between 90 and 99 percent while 16 percent of the household heads have efficiency levels of 70 and 79 percent. Furthermore, 12 percent of the household heads have an efficiency level of 60 and 69 percent. Besides, 6 percent were producing at an efficiency level of between 50 and 59 percent and only 4 percent have an efficiency level of less than 50 percent.

4.6.2 Factors determining technical inefficiency of smallholder maize farmers

Technical inefficiency was modelled as a function of Participation among other control variables such as age, sex, education of respondent and household wealth variables such as land holdings, farm revenue and off-farm income. Table 15 presents the results of the inefficiency model. The table presents the estimated coefficients of the inefficiency in maize production covariates for the study area. The sign of the coefficients in the inefficiency model has an important policy implication.

To get the real effect of participation in the subsidy programme on technical inefficiency, the predicted values of participation was used in the inefficiency model. Participation in the subsidy programme has a negative relationship with technical inefficiency. The negative sign implies that the efficiency of subsidy participants increases with the use of subsidised fertiliser. However, the coefficient of participation was not significant. The non-statistical significance exhibited by participation implies that participation in the subsidy programme does not lead to increase in technical efficiency.

Control variables that were significant in the inefficiency model included age, sex, community influence, wealth rank of the household, land owner and tenure system. Age

Table 15 Determinants of technical inefficiency in the model

Variable	Coefficient	Std. err.	P >|z|
Constant	1.058891	1.0429	0.334
Age	-0.0360**	0.0161	0.025
Sex	-0.8239*	0.4827	0.088
Marital status	-0.5295	0.4181	0.205
Educational level	0.0075	0.0327	0.818
Household size	0.0304	0.0228	0.182
Community influence	0.5970*	0.3499	0.088
Experience	0.0103	0.0155	0.508
Nativity	0.1925	0.5025	0.702
Wealth position	-0.5914**	0.2774	0.033
Land ownership	-0.7264*	0.4232	0.087
Tenure system			
Family land	-0.6457*	0.3447	0.061
Community land	-0.9295**	0.4071	0.022
Rented land	-0.6993	0.5846	0.232
Lease land	-0.8376	1.7427	0.631
Extension contact	0.0433	0.0579	0.455
Farmer group	-0.1250	0.2491	0.616
Off-farm income	-0.0010***	0.0004	0.010
Access to subsidised fertiliser	-0.0166	0.2364	0.944

Source: Author's computation, 2014 Note, *** = 1%, ** = 5% and * =

was negatively associated with technical inefficiency which implies that an increased in age will improve the technical efficiency of the household head. The implication is that older household heads are more technically efficient than younger household heads in the area. This may be that the older household heads have been into maize production for several years and are able to effectively manage their farms. This may also be as a result of the experience that the household head has accumulated over the past in farming and extension agent should be aware of them as a means of transferring technology to the younger household heads. This finding contradicts the findings of Asante, Villano and Batesse, (2014) who found age to be positively related to technical inefficiency of yam farmers in the Brong-Ahafo and the Ashanti regions of Ghana. Furthermore, ownership of land also influenced technical inefficiency negatively. This means that household heads that owned their lands in the area were less technically inefficient than household heads that do not own land. The efficiency of the household increases by 0.7264 if the land in which the household head farms belong to him or her. Household heads will invest in lands if the lands in which they farm belong to them. This implies that they will ensure proper care of the lands since they know the land is their personal asset that needs to be cared for and that all proceeds from these farms are not going to share with anybody.

As expected off-farm income was negatively associated with technical inefficiency and shows a statistical relationship at the 5 percent level of significance. This means that household heads with an off-farm income are more technically efficient but less technically inefficient. The implication is that, with improve off-farm income farmers will invest in their farms by purchasing farm inputs for cultivation that will lead to efficiency in their farms.

Other control variables such as sex of the household head, wealth rank of the household head, tenure system also showed negative and significant relationship with the technical inefficiency of the household head.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary, conclusions and recommendations of the study. The chapter is presented under three sections. The first section presents a summary of the thesis. The second section draws conclusions from the findings of the study and lastly, the third make recommendations based on the findings of the study.

5.2 Summary

The study examined the effect of fertiliser subsidy on smallholder access to fertiliser and technical efficiency in the Northern region of Ghana. Both descriptive and inferential statistical tools were used in this study. The Probit and Tobit models were used to examine the household decision to participate in the subsidy programme and the intensity of fertiliser use respectively.

The results indicated that Tolon district had the highest percentage of the participants in the subsidy programme with about 40 percent of the household heads in the district having access to the subsidy programme. Meanwhile, West Mamprusi and Saboba districts have a household head participation rate of about 25 percent and 34 percent respectively in the programme. In general about 64.5 percent of household heads sampled in the three districts participated in the subsidy programme. The use of coupon was the main channel of participation in the subsidy programme for the 2013 cropping season.

About 75 percent of participants of the subsidy programme ranked themselves as wealthy in relation to other households in the community. It was mostly those households that could pay the 79 percent upfront that gets the fertiliser. The study found that, the average credit received by participants of the subsidy programme was about GH₵ 38.94. About 14 percent of recipients of the subsidy programme reported that they had connections to Assemblymen, MPs and political party officials.

About two thirds (65.1%) of the household heads indicated that they were aware of the government fertiliser subsidy programme in the 2013/14 cropping season. About 34.9 percent of the households indicated that they were not aware that the government had subsidised fertiliser for smallholder farmers. The majority (59) of the household heads thought that access to the fertiliser subsidy programme was complicated and difficult. Only three percent thought the subsidy programme was very accessible to smallholders. About 42 percent (83) of the household heads reported that the subsidy had an effect on their fertiliser usage as they were able to increase the quantity of fertiliser they used during the period of the subsidy. Also, majority (62%) of the household heads reported that the subsidised fertiliser was delivered on time, while 38 percent of the respondents reported that the subsidy was characterised by delays. About 34 percent of the household heads reported that the price at which the subsidised fertiliser was being sold was high. Similarly, 24 percent of the households indicated that the price was very high and that the amount of the subsidy needed to be increased in order to bring the price down. The majority (38%) of household heads reported that the price at which the subsidised fertiliser was sold was moderate while only 4 percent of the household heads have shown that the subsidised fertiliser prices were low. About (40%) of the household heads indicated that the subsidy programme was good as it was intended to improve smallholders' access to fertiliser.

Effort at participating in the subsidy programme was statistically significant at the 1 percent level with a positive coefficient sign. The variable participation in the government fertiliser subsidy has a positive effect on fertiliser use intensity. The variable is statistically significant at 5 percent level and consistent with the research a prior expectation.

Participation in the subsidy programme has a negative relationship with technical inefficiency. The negative sign implies that the efficiency of subsidy participants increases with the use of subsidised fertiliser. However, the coefficient of participation was not significant. The non-statistical significance exhibited by participation implies that participation in the subsidy programme does not lead to increase in technical efficiency.

5.3 Conclusions

The study examined the effects of fertiliser subsidy on smallholder access to fertiliser and technical efficiency specifically the case of maize in the Northern Region of Ghana. The study examined the accessibility of the fertiliser subsidy programme to smallholders by assessing the category of farmers that got access to the programme. The study assessed perception of the subsidy programme by household heads, and the factors that influenced participation in the programme and fertiliser use intensity. Finally, the study assessed effect of the fertiliser subsidy programme on the productivity at the smallholder level.

The study used three regression models and descriptive statistics to assess participation in the subsidy programme, household heads' perception of the subsidy programme as well as the effect of participation on maize yield. Specifically, the study used the probit and tobit models to examine the factors that influence participation in the subsidy programme and fertiliser use intensity respectively. Lastly, the stochastic frontier model was employed to analyse the effect of the fertiliser subsidy on productivity of the smallholder maize household heads.

Result from analysis of the accessibility of the subsidy programme revealed that communities that were closer to major towns where there were many inputs shops were having more access to the subsidy programme than communities farther away from major towns where input shops are available. Golinga and Galinkpegu in the Tolon district were having the highest rates of 95 percent and 80 percent of access to the subsidy programme respectively. With regards to how households got to participate in the programme, about (38%) of the participants used the coupon to access the subsidised fertiliser. The average quantity of NPK fertiliser received from the subsidy programme was 3.17 bags (158.5kg) and used 3.15 (157.5kg) bags of the quantity received on their farms.

Many of the beneficiaries of the subsidy programme were male household heads constituting about 93 percent of the sampled household heads and relatively older. This is an indication that female household heads might have encountered difficulties in participating despite affirmative action to target women household heads. Relatively wealthy household heads were able to get access to the subsidy programme than the less wealthy household heads. This was attributable to the upfront amount that the household heads had to pay to qualify to receive subsidised fertiliser. Indigenes were more likely to receive the subsidised fertiliser more than non-indigene household heads. Also, household heads who had contact with extension agents received more of the subsidised fertiliser probable due to the relationship they might have developed with the extension agents who distribute coupons.

Despite the popularity gain by the programme among the smallholder household heads in the region, accessing the subsidised fertiliser was difficulty if one did not have the coupon. About 59 percent indicated that accessing the subsidy programme was difficult due to the overcrowding of people and the process involved in accessing the programme. Household heads also lamented the inability to identify the subsidised fertiliser as major problem to the availability of the fertiliser as they believed that retailers of the subsidised fertiliser hoard them to sell to their loyal customers. Many of the sampled household heads suggested that the subsidy did not increase their fertiliser use but added that the programme motivated them to use fertiliser. Majority of the sampled household heads believed that the prices that farmers paid for the subsidised fertiliser was still high and served to exclude the poorer households.

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 household heads decision to participate in the subsidy programme. While age, farm size, number of extension visits, distance to input shop, attempts at participation in the subsidy programme and credit positively influenced the decision to participate, sex of the household head, extension trainings, cost of fertiliser and off-farm income negatively influence participation 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. Among all the factors that influence fertiliser use intensity, only farm size was negatively related to intensity of fertiliser use.

The estimation of the stochastic frontier model have shown that Increasing usage of organic material, hired labour, farm size and inorganic fertiliser use increased maize output (shifts the technical efficiency frontier outward) while increasing family labour contracted the frontier. The average efficiency estimated was 0.80. Farmers' participation in the subsidy programme had no effect on the technical efficiency of maize farming in the northern region as participation does not show any statistical relationship with technical inefficiency.

5.4 Recommendations and Policy Implications

The study have found that communities that were closer to places where there are many retail shops where subsidised fertilisers are sold participated more in the programme. The policy implication of this is that efforts should be made by government and the fertiliser companies to establish more fertiliser retail shops closer to the farming communities where private retail outlets are non-existing if the goal of the subsidy to make fertiliser accessible to the smallholder farmers is to be reached. This will ease overcrowding at the subsidised fertiliser distributing point at the urban centres and reduce the difficulty in accessing the subsidised fertiliser without a coupon.

Government subsidised fertiliser should be packaged with special designed bags for easy identification of the subsidised fertiliser by the smallholder farmers. This would help reduce the hoarding done by the retail agents and prevent them from selling the subsidised fertiliser to only their loyal customers when supplies are not adequate.

This study recommends also to the government of Ghana that subsidy programme implementation should be designed such that it excludes large scale farmers and wealthy household heads to enable the poor smallholder household heads to benefit. This will enable the resource poor smallholder household heads to gain more access to the subsidised fertiliser. There should be a set criteria for selection of beneficiaries and the farming communities should be involved in the selection process as is done in other countries.

The government and other agricultural based NGOs should make efforts to increase the number of agricultural extension agents in the region to enable farmers receive more extension visits. Also, financial institutions and Agricultural based NGOs should offer credit support to the resource poor farmers to enable them pay the 79 percent upfront payment of the subsidised fertiliser. Both variables influenced participation in the subsidy programme. The government through MoFA can also offer the subsidised fertiliser to household heads on credit which would be paid immediately after harvest.

The Ministry of Food and Agriculture should give special treatment to female household heads in the distribution of the subsidised fertiliser coupons in their efforts to access the subsidy. Policies should be deliberately made towards improving access to subsidised coupon so that many smallholder household heads will attempt to participate in the subsidy programme. Other factors such as seed and measures to ensure effectiveness in the subsidy programme must be implemented by the government before the subsidy can have the desired effect.

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APPENDIX

QUESTIONNAIRE

I am a post graduate student of the University for Development Studies. I am conducting a research on ***The Effects of Subsidy on Fertilizer Access and Utilisation*** as required by the university in partial fulfillment of my degree (Mphil agric. economics). I wish to seek your views concerning the above topic and am assuring you that all information provided would be used purely for academic purpose and will be treated with needed confidentiality.

Questionnaire

number ....

Name of interviewer ....

Name of community ....

Name of interviewee..

1. Characteristics of household

Please kindle complete this table

S/No.	Household characteristics	Specify information
1.1	How old are you?	
1.2	Sex of respondent (0 = female, 1 = male)	
1.3	Marital status of respondent	
1.4	Educational status of respondent (*please indicate the years in school also*)	

1.5	Respondent position in the house	
1.6	Household size of respondent	
1.7	Quantity of household labour provided to the farm	
1.8	How many hours or workdays a member of the household provided labour for the farm?	
1.9	Quantity of hire labour	
1.10	How many hours of hire labour do you hire out?	
1.11	Leadership position in the community	
1.12	Farmer experience (*number of years in farming*)	
1.13	Are you a settler or a native? (1= native, 0 = settler)	
1.14	Religion of respondent	
1.15	Wealth status of respondent	

Note

*marital status: (0=single, 1=married, 2=widowed, 3= divorce)

*educational status: (0=never being to school, 1=primary, 2=JHS, 3=SHS, 4=tertiary)

*religion of respondent: (0 = Christianity, 1= islam, 2=traditional)

*wealth status: (0=poor, 1=very poor, 2=somehow rich, 3=rich)

2. Land ownership

2.1. Do you own land? a)Yes b)No

2.2. If yes, how far is your farm from your home?....................kilometres

2.3. What is your total land size? .... acres

2.4. Please complete the following table

S/No.	CROP	LAND SIZE/acres	TENURE SYSTEM
Maize			
Rice			
Sorghum			

*Tenure system: (0 = own land, 1 = family land, 2 = community land, 3 = rented land, 4 = lease)

3. Extension contact and Group membership

3.1. Do you receive any extension services in the last farming season? a)Yes b) No

3.2 If no, when was the last time you receive extension services? .

3.2. If yes, for how long have you been receiving extension services?......................years

3.3. For the past 12 months, how frequently did you get extension services? ....

3.4. Did you engage in any extension package for the past 12 months? a)Yes b)No

3.5. If yes what type of package did you get?..

3.6. Who provided the package? ....

3.7. In what form was the package provided? a) In kind b) In cash

3.8. Do you belong to a farmer group in the community? a)Yes b) No

3.9. For how long have you being in the group?..

3.20. What benefit did you get from the group since joining the group?
....
....
....
....

4. Subsidy programme

First explain to the respondent very well to understand what the subsidy programme is before you proceed.

4.1. Are you aware of the government fertilizer subsidy programme? a)Yes b)No

4.2. How did you understand the subsidy program?..

4.3Did you have access or attempted to participate in the subsidy program? a) Yes b)No

If yes, how were you selected?

If no, what do you think prevented you from participating?

....

....

....

4.3. Were you able to access the fertilizer with your passbook/coupon? a)Yes b)No

4.3a If yes, did you get the quantity you needed? a)Yes b)No

If no to 4.3a, why didn't you get the quantity you needed?
....

....

....

....

4.3b if no to 4.3, why are you not able to access the fertilizer with your coupon?
....

....

4.4.How accessible is the subsidized fertilizer? a) very accessible b) accessible c) difficult

4.5.Which type of fertilizer did you needed? ....and which one did get from the subsidy programme?

4.5. please complete the following table

Type of fertiliser	Quantity received	Quantity used	Quantity left
NPK			
So_3NH_4			

4.6.Has the introduction of the subsidy increased your fertilizer use? a)Yes

b) No if yes, by what quantity? ....a) Marginal increment

b)High increment

4.7. How much did you pay for the subsidized fertilizer? .... Ghana cedis

4.8. What is the distance from your farm to the nearest retail store? ....kilometers

4.9. How satisfied are you with the mode of selection of beneficial recipients of the subsidized fertilizer? a) very satisfied b) satisfied c) not satisfied

4.20. How timely is the subsidized fertilizer available to you? a) timely b) not timely

4.20a. If (b) at what time is the subsidized fertilizer available you? ....

4.21. How would rate the price of the subsidized fertilizer? a) still very high b) high c) moderate d) low

4.22. How would you rate the fertilizer subsidy programme? a) very good. b) good c)average d) poor e) very poor

4.23. What is your relation to your relation with your member of parliament? Not related related

4.24. Any general comment(s) for the improvement of the programme?

....

....

....

....

5. **Use of unsubsidized fertilizer**

5.1. Even though you did not get the subsidy did you still apply fertiliser? a)Yes b)No

5.2. If yes, where did you get the fertiliser? ....

(**5.1 and 5.2 for *non-beneficiaries of the subsidy***)

5.3. Did you buy fertilizer from the buy fertilizer from the market aside the subsidized fertilizer? a) Yes b)No

5.4. If yes, Please complete the following table

Type of fertiliser	Quantity bought	Quantity used	Total cost (GHC)

6. **Crop and type of fertilizer applied**

6.1. Please fill the table below:

Crop	Area cultivated	Type of fertiliser applied	Quantity applied
Maize			
Rice			
Sorghum			

6.2. Do you use any organic material as soil fertility improvement apart from inorganic fertilizer? a) Yes b) No

6.3. If yes, which crop(s) do you used the organic material on?

....

....

6.4. What type of organic material do you used and why did you used it?

....

....

6.5. If no, why?

....

....

....

7. Crop productivity and cost of production

Please complete the following table

Crop	Area cultivated/acres	Quantity harvested(bags)	Unit price/bag	Total revenue	Total cost
Maize					
Rice					
Sorghum					

8. Agricultural credit and off-farm activities

8.1. Do you have access to agricultural credit? a)Yes b)No.

8.2. If yes, type of credit received. a) in kind b) in cash (state the amount)......................Ghana cedis

8.3. If (b) amount needed ....Ghana cedis and amount received .... Ghana cedis

8.4.what were the conditions attached to the credit

....

....

....

8.5. Do you engage in any off-farm activity? a)Yes b)No

8.6. How much do you earn from your off-farm activities?

....Ghana csdis

Thank you for your cooperation