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FERTILISER SUBSIDY AND TECHNICAL EFFICIENCY OF SMALLHOLDER FARMERS IN SELECTED DISTRICTS IN THE TRANSITIONAL AND THE GUINEA SAVANNAH ZONES OF GHANA

MUSTAPHA SALISU

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BY

MUSTAPHA SALISU

(UDS/MEC/0016)

THESIS SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS, FACULTY OF AGRIBUSINESS AND COMMUNICATION SCIENCES, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF PHILOSOPHY DEGREE IN AGRICULTURAL ECONOMICS

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Declaration

Student

I Mustapha Salisu hereby declare that this thesis is the result of my o9/wn original work and that no part of it has been presented for another degree in this university or elsewhere:

Candidate's Signature:……………...…………… Date:…………………..………………

Name: MUSTAPHA SALISU

Supervisor's

I hereby declare that the preparation and presentation of the thesis was supervised in accordance with the guidelines on supervision of thesis laid down by the University for Development Studies.

Name: JOSEPH AMIKUZUNO (PhD)

Principal Supervisor's Signature:………………………… Date:……………………….

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Abstract

The study examined the impact of Ghana's fertiliser subsidy programme on maize output and technical efficiency among smallholder farmers in Ghana. Several null hypotheses were tested based on data gathered from a sample of three hundred and fifty-two (352) farmers drawn from two of Ghana's five agro-ecological zones, the Transition zone and the Guinea savannah zone. Both a probit and stochastic frontier models were used to estimate the determinants of access by farmers to fertiliser subsidy and to assess the impact of the fertiliser subsidy programme on maize output and technical efficiency, respectively. Among others, the study found that age, sex, education, access to improved seed, off farm activities, political influence and distance to the nearest fertiliser retail shop influence farmers' access to subsidised fertiliser. The study also revealed that access to subsidised fertiliser was low (42.3%) although it positively increases maize output in both Guinea savannah and Transition zones. The study estimated mean TEs of 68.7% and 68.9% in the Transition and the Guinea savannah zones respectively. Also, access to subsidy was found to decrease TE of smallholder farmers in both zones significantly. It is therefore concluded that access to subsidised fertiliser has a mix effect on maize output and needs further investigation.

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Dedication

This thesis is dedicated to the loving memory of my late dad, Sheikh Mustapha Baba of Bawku may the almighty Allah be pleased with him.

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Acronyms

AAU	All African Union
CD	Cobb-Douglas
DANIDA	Danish International Development Agency
DEA	Data Envelopment Analysis
FAO	Food and Agriculture Organization
FBO	Famer-Based Organisation
FGD	Focus Group Discussion
GDP	Gross Domestic Product
GFSP	Ghana Fertiliser Subsidy Programme
GGDP	Ghana Grain Development Programme
GSS	Ghana Statistical Service
GSSP	Ghana Strategy Support Programme
IFPRI	International Food Policy Research Institute
IMF	International Monetary Fund
ISP	Input Subsidy Programme
JHS	Junior High School
MAISP	Malawi Agriculture Input Subsidy Programme
MiDA	Millennium Development Authority
MLE	Maximum Likelihood Estimation
MOFA	Ministry of Food and Agriculture
NDC	National Democratic Congress
OLS	Ordinary Least Square

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PFAG	Peasant Farmers' Association of Ghana
RTS	Rate of Technical Substitution
SAP	Structural Adjustment Programme
SD	Standard Deviation
SHS	Senior High School
SPF	Stochastic Production Frontier
SRID	Statistical, Research and Information Directorate
SSA	Sub-Sahara Africa
TE	Technical Efficiency
US	United States

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CHAPTER ONE

INTRODUCTION

1.1 Background

Agriculture plays a crucial role in the economy of developing countries including Ghana by providing food, raw material, income and employment. Despite the overall differences in statistics for Africa concerning the contribution of agriculture to individual country's GDP, on average, the agricultural sector makes up about 30% of Africa's GDP (World Bank, 1996) and 30% of her exports. Agriculture supports 75% of Africa's population by providing livelihood, trade and subsistence (UNIFEM, 2010). In Ghana, agriculture employs 50.6% of the country's labour force (GSS, 2010) and contributed 22.0% to GDP in 2013 (GSS, 2014). The mainstay of the economy is agriculture which depends largely on small scale production by smallholder farmers who are usually poor with little or no capacity to access farm inputs such as fertiliser and improved seed.

There is strong evidence that suggest that efficient utilisation of fertiliser can raise productivity substantially and that agricultural inputs are essential for practicing intensive agriculture in the long term without compromising the fertility of soil (Crawford, Jayne, & Valerie, 2006). Low fertiliser input use is often associated with declines in soil fertility, yields and income levels among smallholder farmers while increased use of fertiliser and improved seeds are credited with the large increases in agricultural productivity growth in Asia during the Green Revolution (Marika and Banful, 2010). Fertiliser input use must therefore increase in Ghana and Africa at large if the continent is to see significant growth in productivity and the attainment of food security and sovereignty.

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In response to high fertiliser input prices and in view of its effect on productivity, most African countries subsidised fertiliser inputs through state-owned enterprises during the 1970s and 1980s. Debates on the fiscal cost and ineffective implementation of these subsidies, as well as pressure from Africa's international financial partners warranted liberalisation of the input markets during the early 1980s and 1990s to limit state participation in the input market (Kherallah et al., 2002).

In Ghana, the fertiliser subsidy programme was introduced in 2008 by government with the goal of boosting agricultural output (yields), raising farmers' income and reducing poverty amongst smallholder farmers. The programme was implemented through the voucher system to ensure proper targeting of farmers and to ensure that the government's investment is not abused. Despite the fact that fertiliser is highly subsidised by government and its development partners, poor implementation of the programme limit the number of farmers who have access to such inputs. These inefficiencies result in limited access to fertiliser inputs at the subsidised prices by smallholder farmers (MOFA, 2011).

When properly implemented, the subsidy programme will trigger both short term and long term development of not only the agricultural sector, but other sectors of the economy as well. Subsidies that are effective in raising land and labour productivity and in driving down staple food prices will substantially raise the real incomes of large numbers of poor consumers, drive up local labour demand and wages and improve people's nutrition. Increasing maize crop productivity can at the same time release resources for production of other non-staple foods as well as non-farm goods and services (Hazell and Rosegrant, 2000).

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These constitute the growth multipliers critical in driving growth in Asia and can be replicated in Ghana and Africa at large if the programme is effectively implemented and beneficiaries efficiently use the quantities of subsidised fertiliser received. The potential contributions of subsidies to the three core development processes of 'hanging in, stepping up and stepping out' (Dorward, 2009b) implies that special attention be placed on the impact of subsidy on wages and food prices for poor consumers and producers who are net food buyers (around 50% of African farmers) as well as subsidy implementation over a longer period, to achieve structural change rather than short-term productivity gains.

On one hand inorganic fertiliser may significantly increase yields in Sub-Sahara Africa (SSA), on the other hand subsidising fertiliser purchases also over burdens an already limited government and donor resources. For example, the government of Ghana spent over US$100 million in 2011 on fertiliser subsidy alone. This accounted for about 30% of public agricultural spending for that year (Jayne and Rashid, 2013). Some therefore argue strongly that agricultural subsidies are fiscally unsustainable and encourage misuse of resources, leading to environmentally malevolent developments and may not necessarily resolve distortions of input markets completely, but yet come with high opportunity cost as it reduces funding of important government projects (Mahendra, 2012; Dorward, 2009a). There are also concerns that smallholder farmers may not have the technical knowhow and right attitude to efficiently use cheaper fertiliser more productively raising issues on the technical efficiency levels of beneficiaries of the Ghana Fertiliser Subsidy Programme (GFSP) in achieving the goals of the programme.

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Maize is the largest and most important staple crop in Ghana (accounting for over 50% of cultivated lands in Ghana). Its production is dominated by smallholder farmers who usually rely heavily on rainfed conditions with limited use of fertilisers and other inputs due to high cost of such inputs. The government's intervention in providing fertilisers at subsidised rate is intended to improve production of crops including maize (MOFA, 2012). However, the ability of maize farmers in Ghana to use fertiliser acquired and improve sustainable small-scale production depends on their level of technical efficiency. Efficiency measurement is very important because it is a factor for productivity growth. Efficiency studies can help Ghana to determine the extent to which they can raise productivity by improving the neglected source, i.e., efficiency, with the subsidy programme and the available technology (Al-hassan, 2008). Such studies could also support decisions on whether to improve efficiency first or to improve on the effectiveness of targeting under the Ghana Fertiliser Subsidy Programme (GFSP) in the short run.

1.2 Problem Statement

Maize production is currently dominated by smallholder farmers who rely on rain-fed conditions with limited use of fertiliser, improved seeds, mechanisation, post-harvest facilities and low levels of technical efficiency. Even though fertiliser use in Ghana has improved (from 8kg/ha in to 12 kg/ha), it is still below the target of 50kg/ha needed to increase crop productivity and production to desired levels resulting in average yields well below optimum levels while post-harvest losses are still high (MOFA, 2012).

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The Ghana government in an effort to boost productions of staple crops including maize, to cope with the ever growing demand for maize and reduce poverty associated with smallholder farmers, instituted the Ghana Fertiliser Subsidy Programme (GFSP) in 2008 with the aims of: increasing fertiliser use, output and productivity, and eliminating food security threats.

While a lot of studies have been carried out in several countries that invest so much in that sector, research in Ghana on fertiliser subsidy is limited in scope (Xu et al., 2009b; Ricker-Gilbert, Jayne and Black, 2009; Holden and Lunduka, 2010; Dorward and Chirwa, 2011; Banful, 2010; Mason, Jayne and Mofya-Mukuku, 2013; Mason, Jayne and van de Walle, 2013). With succeeding governments' continuation to invest millions of Ghana Cedis in subsidising fertiliser, there is the need for thorough evaluation of the programme.

Even though the stated goals of fertiliser subsidies are typically to raise fertiliser use and crop productivity, improve food self-sufficiency, and/or raise incomes, the GFSP may also have explicit or implicit political economy objectives as studies in other African countries (Zambia, Malawi) reveal. Empirical evidence on the extent to which voting patterns affect subsidy targeting in Africa has presented mixed results. There is growing evidence that the fertiliser subsidy programme has political under pinning as beneficiaries of the subsidy programme may be selected partly due to previous and/or future election outcomes (Banful, 2010; Mason, Jayne and Mofya-Mukuku, 2013; Mason, Jayne and van de Walle, 2013). On one hand, Banful (2011), suggested that subsidised fertiliser vouchers were targeted more at opposition strongholds than places where the ruling government won in an effort to win more votes or improve vote margins. On the other hand, Mason, Jayne and van de Walle (2013) tested empirically whether election

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outcomes influence the quantity of subsidised fertiliser received and whether quantities of fertiliser subsidy win votes using panel data from Zambia. Their study revealed that the Zambian government allocated considerably more quantities of subsidised fertiliser to households in constituencies that the ruling government won in the last election, and more so the larger its margin of victory. They, however, did not find past quantities of subsidised fertiliser allocated affecting the share of votes garnered by the incumbent.

This worrying revelation undercuts the essence of the GFSP as an effective targeting tool for achieving the stated goals of the programme. According to Jayne and Rashid (2013), effective targeting is believed to make it possible to: (i) promote economic efficiency; (ii) be pro-poor and promote equity; and (iii) promote development of the private sector. Therefore, an ineffective targeting scheme will fall short of these important benchmarks and waste scarce government resources.

It is therefore imperative that in measuring the effectiveness of the fertiliser subsidy in achieving its goal of increasing productivity and reducing poverty that we also examine the determinants of the GFSP. Jayne et al. (2013) observes that when inputs are targeted at poorer households, crowding out of the private sector is considerably lower than when targeted at large scale farmers with high income and ability to purchase fertiliser at commercial rates.

The discussions above however, leave a number of research questions including the following; firstly, what are the characteristics of beneficiaries of the GFSP? Secondly, to what extent does receiving fertiliser subsidy or having access to the GFSP impacts maize output? Last but not the

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least, what are the technical efficiency differences between beneficiaries and non-beneficiaries of the GFSP? Does having access to the GFSP improve technical efficiency?

To the best of my knowledge, this study is the first to examine the impact of the GFSP that answers the important questions above simultaneously.

1.3 Research Objectives

1.3.1 Main Research Objective

The main objective of this study is to examine the impact of Ghana's fertiliser subsidy programme on maize crop output and technical efficiency of smallholder maize farmers in Ghana.

1.3.2 Specific Objectives

The specific objectives are to:

Investigate the factors that determine maize farmers' access to the GFSP,

Examine the effect of access to GFSP on maize output,

Establish the effect of access to the GFSP on the technical efficiency of maize farmers.

1.4 Justification for the Study

The success of the agricultural sector in Ghana and the maize sector for that matter is very critical for raising the standard of living and food self-sufficiency for the smallholder farmers in

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particular and the whole population as a whole. Maize farmers' output depends largely on the efficient combination of productive resources in order to maximise output.

In an effort to boost cereal production in Ghana, to meet the high demand for maize and reduce poverty associated with smallholder farmers, the government instituted the GFSP in 2008 to stabilise staple food prices and avoid hikes that may trigger uncontrollable food related inflation.

It is imperative to measure efficiency of maize farmers because efficiency is an indicator of productivity growth (Al-hassan, 2008). Also, smallholder farmers' ability to use fertiliser acquired in achieving sustainable levels of production depends partly on their level of technical efficiency.

However, studies on Ghana's fertiliser subsidy programme are limited especially in the area of technical efficiency of beneficiaries. This study seeks to contribute to the literature on the GFSP in particular and the Input Subsidy Programmes (ISPs) in Africa as a whole by examining the impact of the subsidy programme on maize output and technical efficiency of smallholder farmers in Ghana.

Given that the majority of farmers targeted are smallholder farmers who are hard hit by high poverty, access inputs at high prices mostly beyond their reach, a close examination of the Ghana Fertiliser Subsidy Programme (GFSP) is necessary, especially in the wake of increasing government expenditure, high exchange rates and the need to ensure food security and productivity by increasing efficiency of farmers.

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A close examination of the GFSP is necessary to ensure that government's continuous support is put into good use and that it results in improved maize output. As the most common staple crop in Ghana, maize also represents the most produced cereal crop in Ghana and accounts for large proportions of land under cultivation. It is therefore prudent in examining government policy intervention in Ghana's agricultural sector such as the GFSP to assess how it improves maize production.

This study will also make policy recommendations on the way forward for the GFSP in terms of ensuring effectiveness of targeting beneficiaries of the programme. This will ensure that the programme is tailored towards promoting the welfare of especially the poor and vulnerable smallholder farmers.

1.5 Organisation of the Study

The study is organised into five chapters. Chapter one provides the introduction, problem statement, objectives of the study and justification of the study.

Chapter two gives an overview of literature relevant to the study. It examines literature on fertiliser subsidies in SSA, the GFSP, targeting of fertiliser subsidy, fertiliser use and productivity, theoretical framework, smallholder farming in Ghana, government's dilemma and the future of the GFSP and sampling.

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Chapter three outlines the methodology employed to achieve the objectives of the study. In particular, it describes the study area, discusses the conceptual framework of the probit and the stochastic frontier models, the sampling techniques used for the data collection and the data analysis.

In chapter four, the descriptive and inferential results of the study are presented followed by discussions of the results obtained.

Finally in chapter five, summary of the study, conclusions from the study and recommendations are drawn.

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CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter examined available literature on fertiliser subsidy in Africa and Ghana, targeting of subsidy coupons, fertiliser use and productivity, theoretical framework, determinants of technical efficiency, maize production and productivity in Ghana, smallholder farming in Ghana and finally, the government's dilemma and the future of the fertiliser subsidy programme.

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2.2 Fertiliser Subsidies in Sub-Saharan Africa

Many African smallholder farmers are said to use fertiliser below the economically optimal level. The reasons for such low use of fertiliser include but not limited to: inadequate information on how to use fertiliser effectively and profitably, risk averse nature of farmers especially in the face of unreliable rainfall, or inadequate cash to pay for the fertiliser input due to low income and poorly functioning credit markets (Minot and Benson, 2009). In countries where demand for fertilisers is erratic, private retailers do not make economic sense of stocking fertiliser, resulting in a collapse of the local fertiliser supply chain (Minot and Benson, 2009).

Subsidies may be justified on cost-benefit or equity grounds. On cost-benefit grounds, subsidies may be justified if they help farmers offset their constraints and reach optimal level of fertiliser application such that the marginal income received by farmers exceeds the cost of the subsidy programme. On equity grounds however, fertiliser subsidies are justified as a cost-effective way of assisting the rural poor farmers who otherwise could not have access to fertiliser at the prevailing market rates (Minot and Benson, 2009).

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Based on the arguments above, as well as the imperfection of the fertiliser markets, the fertiliser markets were tightly controlled by most African governments in the 1970s and 80s with limited state-owned enterprise monopoly in the importation and distribution of fertiliser products. In line with this, fertiliser prices were subsidised at below-market levels and fixed at one rate throughout the country. The fertiliser was often distributed as part of government-run agricultural credit schemes, and a large percentage of the fertiliser was provided by donor agencies as in-kind aid.

These policies, however, resulted in high financial costs and inefficient distribution. Fertiliser was often delivered to farmers late and in limited quantities. Although fertiliser subsidies were politically popular, economists and policymakers began to believe that the fiscal cost was not worth the benefits to farmers (Minot and Benson, 2009).

In addition, growing evidence showed that larger and richer farmers were the major beneficiaries of these subsidies, thus undercutting the equity argument for providing subsidies. As part of wider market reforms in economies of SSA countries, most African countries phased out fertiliser subsidies and thus removed government interference in the fertiliser market sector under the Structural Adjustment Programmes (SAP) of the International Monetary Fund (IMF) and the World Bank. This led to the creation of a free market system in the 1990s there by promoting competitiveness in the private sector.

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Available literature on the relationship between fertiliser policy and fertiliser use in Africa has mixed results. The Food and Agriculture Organization of the United Nations (FAO) reported an annual growth rate of 9% in fertiliser use in Sub-Saharan Africa over the 1960s and 1970s. But fertiliser use has stagnated at around 1.9–2.2 million metric tonnes since 1981, with some possible signs of growth since 2000 (Minot and Benson, 2009). This stagnation cannot however be associated with the gradual liberalisation of the fertiliser market system in few countries in 1981. This is because Ghana and some countries (Cameroon, Nigeria, Senegal, and Tanzania) experienced sharp reduction in fertiliser use after subsidy removal and devaluation, other countries (Benin, Madagascar, Mali, and Togo) experienced upsurge in fertiliser use. Minot and Benson (2009) therefore conclude that fertiliser policy is only but one of the many factors affecting fertiliser prices and likewise fertiliser prices are one of several factors that determine fertiliser use.

Fertiliser input subsidy in particular and agricultural input subsidies in general currently enjoys considerable budgetary allocation and has received massive public endorsement across SSA. The stated objectives of the programme include making fertiliser more accessible to smallholder farmers, raising agricultural productivity and income, and improving household and national food security among others.

In Africa, inputs are heavily subsidised and have required unaffordable continuous financial support and budget allocations. Increasingly, consensus has emerged for the need to foster private sector–led development of agricultural input markets (Freeman and Kaguongo, 2003). Many fertiliser input dealers are concentrated in urban or semi-urban areas with very few of

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them located in the rural interior areas near smallholder farmers. These farmers often travel at least 20 to 30 kilometres to purchase fertiliser inputs, which raises the cost of using fertiliser to farmers, thereby undermining the essence of the huge government investments in subsidising the fertiliser (Morris et al., 2007; Marika and Banful, 2010). To induce private sector participation and ensure farmers access fertiliser inputs at the subsidised rates, countries must initiate policy reforms and institutional changes as well as investments that can make its distribution more profitable and attractive.

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Some are of the view that new ways of designing subsidy programmes may help avoid past mistakes. Smart subsidies have often been suggested as mechanisms to provide subsidised goods and services designed both to promote market development and to enhance the welfare of the poor. In Ghana, the smart subsidy approach started in the form of vouchers. Under the voucher system, farmers acquire vouchers at the Ministry of Food and Agriculture (MOFA) regional and district offices and then redeem the fertiliser at the private agro chemical fertiliser stores. Below-market-cost provision of fertilisers, by private-sector dealers, from which the poor famers in particular are likely to benefit, can be considered “smart subsidies” (Minot and Benson, 2009).

Previous studies exist in African countries including Ghana which implemented the subsidy programme. A study by Xu et al. (2009a) and that by Ricker-Gilbert and Jayne (2009) focuses on the crowding out effects of the fertiliser subsidies on sales in the private fertiliser market sector. Several other studies have examined the effect of fertiliser subsidies on increasing maize yields (Xu et al., 2009b; Ricker-Gilbert, Jayne and Black, 2009; Holden and Lunduka, 2010). A study by Duflo, Kremer and Robinson in 2009 reveals that timely offer of fertiliser quantities during

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the harvest season increases fertiliser use the next season significantly. The authors argue that this small but timely discount is more likely to improve welfare of farmers than large-scale fertiliser subsidies.

Other policy papers have raised doubts as to whether or not subsidising fertiliser can effect long term growth (Harrigan, 2008; GRAIN, 2010). Ricker-Gilbert and Jayne (2010) used household-level data to look at impacts of fertiliser subsidies beyond just the plot level by also considering their effect on household well-being. Their study determined how fertiliser subsidies affect the well-being of rural households in Malawi, both contemporaneously and also over time.

Dorward and Chirwa (2011), through descriptive analyses find that the Malawi fertiliser subsidy programme improved smallholder maize productivity. Dorward and Chirwa (2013), in another study, revealed the positive impacts of the fertiliser subsidy programme on wages and maize prices. Ricker-Gilbert, Jayne and Chirwa (2011) also suggested that fertiliser use can be further increased if the rural poor are targeted by the Malawian fertiliser subsidy programme. Similarly, Liverpool-Tasie and Salau (2013) found that farm households in Nigeria who benefited from the fertiliser subsidy programme enhanced the use of corresponding agricultural technologies.

However, studies in Ghana are limited in scope and have not examined the efficiency of beneficiaries of the programme. There is also the need to update previous research in Ghana on the Fertiliser Subsidy Programme.

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The most recent study on the GFSP is the one by Wiredu, Zeller and Diagne (2013). Using cross sectional data from 820 rice-producing household, their study estimated local average treatment effect impact of the GFSP on land and labour productivity. The study concluded that on its own the GFSP is not a strong enough instrument for improving the productivity of farm households.

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2.3 The Ghana Fertiliser Subsidy Programme (GFSP)

During the 1960s and 1970s, Ghana, like many other countries in Africa, implemented fertiliser subsidies for farmers through state owned agencies. Economic reforms brought about by the SAP in 1987 encouraged liberalisation and privatisation of many sectors of the economy including the fertiliser sub-sector. These programmes also led to the phasing out of most fertiliser subsidy programmes. The GFSP introduced in 2008 is the largest government intervention in the fertiliser sector since the SAP liberalisation reforms in that sector in 1991.

In an effort to increase productivity of Ghanaian farmers and modernise agriculture, the government of Ghana following the 2008 food price crises instituted a country-wide subsidy on four types of fertiliser, namely; nitrogen-phosphorous-potassium (NPK) 15:15:15, NPK 23:10:05, Urea, and Sulphate of ammonia. The subsidy was also in response to dramatic hikes in food, energy and fertiliser prices (Banful, 2010). Between May 2007 and May 2008 for example, the price of maize in Accra and Tamale rose by an average of 77% and the prices of other staples such as rice and wheat also spiked as a result of shocks in the global food market and skyrocketing energy costs.

Similarly, the price of NPK 15:15:15, the most widely used food crop fertiliser in Ghana increased from GH¢ 26 to GH¢ 35 per 50 kilogram (kg) bag between June 2007 and March 2008 (MOFA, 2008). Although the subsidy programme was initially launched as temporary in response to the 2008 global food crises, it has since been expanded.

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The fertiliser market in Ghana was one of the most liberalised in SSA prior to 2008 with virtually no government intervention. The termination of universal subsidy programmes through the 80s and 90s "coincided" with a decline in fertiliser intensity from 22 kg/ha in 1978 to 8 kg/ha in 2006 (Yawson et al., 2010). As fertiliser prices grew rapidly through 2007 and 2008, the government feared that fertiliser use would decline even further by an estimated 70%, reducing agricultural productivity and food production by potentially 20%, necessitating imports of food crops, the prices of which also reached an all-time high during this period (Mahendra, 2012).

In 2008 and 2009 the subsidy was implemented via the voucher system and then via the way-bill system starting in 2010. In essence, the voucher system targeted small-scale farmers as conceived; while the subsidy under the way-bill system is available for all types of farms and farmers that can afford the subsidised price (MOFA, 2011).

From 2008 to 2011, the fertiliser subsidy programme was estimated to cost the government 164 million cedi (approximately $82 million) over the four years (MOFA, 2012). In June 2012, the government announced that the subsidy would be expanded to cover seeds in addition to fertiliser; the provision was to subsidise 176,000 tonnes of inorganic fertiliser (120.3 million cedi, or $60 million) and 151,000 tonnes of certified seed (4.8 million cedi, or $2.4 million) but

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the total cost of the fertiliser subsidy at the end of the 2012 crop season was GH¢124.1 million or $66.4 million (MOFA, 2012).

The fundamental issue the fertiliser subsidy programme seeks to address is the high cost of fertiliser in the open market leading to low fertiliser demand and utilisation, which in turn leads to low yield and low income to farmers. This is based on the assumption that farmers will be induced by the lower prices to use more of fertiliser and other subsidised inputs which will eventually lead to increased yields and income to farmers (MOFA, 2010). Under the way-bill system, the government absorbs, among other things, the port handling charges, loading and transport costs as well as agents' commission and margins to the fertiliser companies. This is to arrive at prices that are affordable to the small-scale farmers.

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Increasing prices of fertiliser, seed, fuel and machinery are the main concerns for farmers as it has the potential of not only dwindling their net income but also affecting their productivity and motivation to produce more (Reuters, 2012).

Government expenditure on the GFSP has more than tripled since its inception in 2008. From an initial US$10 million in 2008 to US$35 million in 2011 (Benin et al., 2011), subsidy cost in 2013 stood at $64 million (MOFA, 2012). This trend is likely to continue, as the fertiliser subsidy programme has become the preferred policy of the government in trying to stimulate increased food crop production, and reduce food price hikes and rural poverty rates.

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2.4 Targeting of fertiliser subsidies

Targeting is one of the critical elements of the effectiveness of subsidy policy and in achieving efficiency in resource use. In developing economies with poor marketing systems such as Ghana, it is imperative to ensure that the subsidised fertilisers reach the intended beneficiaries and does not displace commercial sales of fertilisers. In other words, the subsidised fertilisers should be targeted at smallholder farmers who cannot acquire fertilisers at the prevailing market prices but are able to efficiently use fertiliser if they have access.

Thus, fertiliser subsidy is likely to be more economically efficient and effective if the subsidised fertiliser are directed or targeted at farmers who otherwise would not use fertiliser for example, due to affordability or risk aversion constraints but who will make productive use of any subsidised fertiliser they can obtain. Dorward (2009a) asserts that effective targeting poorer farmers are targeted increases the economic efficiency of the subsidy programme as compared with a universal or wholesale subsidy and leads to a transfer from wealthy producers and tax payers to poorer producers and consumers.

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The political, economic, welfare, and equity issues associated with targeting implies that targeting criteria and methods are constrained by political concerns and practicalities at community, regional, and even at the national levels, by programme objectives for example, output, income levels, or social protection objectives, and also by the practicality and costs of targeting. There may be arguments for universal or area targeting that delivers smaller quantities of fertilisers to all farmers in a country or area to allow for greater accountability, avoid political

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and financial costs of skewed targeting, and possibly even reduce targeting errors if targeting mechanisms are very ineffective.

It has been argued that targeting poor producers can improve subsidies' effectiveness in addressing market failures, reducing displacement, and increasing welfare and distributional benefits (Jayne, 2012). These arguments, however, are undermined if poor farmers make less efficient use of inputs than wealthy farmers. There is substantial empirical evidence supported by continually growing literature that poorer farmers, smaller farmers makes more efficient use of land when it comes to the cultivation of non-commercial staple crops in poor rural economies, while wealthier, larger farmers tend to be more efficient users of land in the cultivation of capital-intensive cash crops (Poulton, Dorward and Kydd, 2010).

Poor targeting limits total subsidy volumes and costs by limiting access to subsidised fertiliser to a limited number of beneficiaries through leakages. Rationing also limits total subsidy volumes, by limiting quantities of subsidised input per beneficiary. Like targeting, rationing can be an effective way of reducing the total costs of a subsidy programme while at the same time allowing a higher per unit subsidy. Dorward (2009a) uses marginal analysis and supply and demand analysis to show that rationing can also raise the efficiency of input use, with or without targeting, as there are commonly diminishing marginal benefits to increased input use.

According to Chirwa, Matita and Dorward (2011), targeting fertiliser subsidies is influenced by the fact that informal markets for fertiliser coupons as well as for subsidised fertilisers have surfaced, that have poverty, productivity, and equity results that have not been studied in

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previous impact appraisal of the programme. Earlier studies in Malawi concerning fertiliser targeting programme have highlighted the need for subsidies to be targeted such that they do not crowd out demand of unsubsidised (commercial) fertilisers (Ricker-Gilbert and Jayne, 2008; 2009; Dorward et al., 2008). They indicated that well connected and richer farmers were having more probability of acquiring coupons for subsidised fertiliser and therefore suggested that coupons for subsidised fertiliser should be targeted towards poor households who cannot buy fertiliser at the commercial price and also to areas where commercial production is not well developed.

According to Dorward et al. (2008), a considerable amount of fertiliser that have been subsidised by government went to wealthy households in the 2006/07 season in Malawi suggesting possibility of crowding out commercial fertiliser demands. 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. Earlier studies in Malawi that have examined access to subsidised fertilisers have found that male-headed households were more likely to be given coupons than female-headed households (Chirwa, Matita and Dorward, 2011) and in the case where households headed by female obtain subsidy coupons, they receive relatively less compared to a household headed by their male counterparts (SOAS et al., 2008; Dorward, Chirwa and Jayne, 2010). Coady, Grosh and Hoddinott (2002) indicate that leakage occurs when wealthy or unintended households are part of the programme which they term as errors of inclusion and that under coverage takes place when the intended or poor households are excluded in the programme which they also called errors of exclusion.

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Chianu and Tsujii (2004) in their study revealed that the factors that increase the probability of adoption of fertiliser as being: from the Guinea savannah zone, a younger farmer, a better educated farmer and farmer who practices multiple cropping. Using household data, DANIDA (2011) suggested that subsidy coupons were unequally distributed to favour households with relatively more land, more assets and to male-headed households.

Morris et al. (2007) reveal that subsidised fertiliser to farmers often ended up being captured by richer farmers who do not need support, rather than getting to the smallholder farmers who are expected to benefit. According to Banful (2010) fertiliser subsidies of the 21st century in general are no longer universal, and almost all proclaim goals of being targeted to poor farmers.

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2.5 Fertiliser Use and Productivity

Agricultural productivity is a major determinant of a country's development and performs a significant role in the country's developmental process. Krueger, Valdes and Schiff (1991) and Stern (1989) have demonstrated that countries with high levels of productivity growth with little discrimination against their agricultural sectors have been the most successful industrialisers while countries with low levels of productivity growth and a strong bias against agriculture were unlikely to be successful in their industrialization process.

Agricultural productivity may vary from one country to another; and based on gender. These productivity differences are accounted for by so many factors with difference in inputs playing major role. Outputs of developed countries are comparatively higher than developing countries;

with men farmers' outputs higher than their women counterparts especially in developing countries (Agnes, 1995).

Agricultural productivity is defined in several ways throughout literature, including as general output per unit of input, farm yield by crop or total output per hectare, and output per worker. Regardless of how productivity is measured, empirical studies have suggested that improvements in agricultural productivity are significant for poverty alleviation (Mellor, 1999).

The appropriate methodology for measuring agricultural productivity is a subject of debate. The stochastic frontier model proposed by Aigner, Lovell and Schmidt (1977), and then extended by Huang and Liu (1994) and Battese and Coelli (1995) is recognised as an ideal approach to identify the significance of improving the productivity of smallholder farmers (Sesabo and Tol, 2007).

Increasing agricultural productivity in Ghana is critical if the country is to mitigate the increasing demand for food resulting from the high rates of population growth, but productivity growth is continuously challenged by pressures on agricultural resources and low level of technical efficiency (Morgan, 1996; World Bank, 2006; Nin-Pratt et al., 2011). The quality of agricultural lands, low and erratic rainfall patterns, and high soil erosion rates have been particularly singled out as important constraints to increasing agricultural productivity (Pearce, Barbier and Markandya, 1988). Diao and Sarpong (2007) estimated that soil loss through erosion would reduce agricultural income in Ghana by a total of $4.2 billion and cause a 5.4% point increase in the poverty rate over the period 2006–2015. Indigenous farming practices such as slash and burn

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a piece of land, shifting cultivation and land rotation are gradually disappearing and in many areas giving way to continuous cropping due to increasing population pressure on the limited fertile land resources. This has increased pressure on the quality of soil and limits the ability of the soil to recover important nutrients as experienced with the indigenous farming practices (Nye and Greenland, 1960; Szott and Palm 1986).

Several productivity-enhancing varieties of maize have been developed for farmers in Ghana. The Ghana Grains Development Project (GGDP) engaged in developing and distribution of several maize varieties, as well as providing guidelines for maize farmers, evaluating various farming practices, and making a heavy investment in providing the extension services and dissemination of improved technologies. Fertiliser subsidies have been implemented in Ghana for several decades and the GFSP has been another central strategy in increasing productivity and promoting agricultural intensification in the country.

Ghana, like most countries in South Saharan Africa (SSA), is confronted with the challenge of finding the best strategy to address stubbornly low agricultural productivity. The country's recent increase in agricultural output has been associated with area expansion rather than increased crop productivity (Breisinger et al., 2008). However, the World Bank (2007) contend that raising agricultural productivity provide the needed stimulus for agricultural transformation that can lead to sustainable poverty alleviation and improved standards of living for the poor and vulnerable (World Bank, 2007). The GFSP is at the centre of Ghana's strategy to raise agricultural productivity and boost income levels of smallholder farmers.

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In comparing Ghana's maize productivity to that of countries with similar rainfall systems such as Thailand and Mexico, Chapoto and Ragasa (2013) observed that Ghana lags behind in terms of maize yield. Average maize yield (tonnes/ha) in Ghana is 1.21 tonnes, while that of Thailand is 3.75 tonnes/ha and Mexico 2.2 tonnes/ha in rainfed maize production systems (Ekasingh et al., 2004; Luanmanee and Paisancharoen 2011; Bellon and Helin 2011; and Hibon et al., 1992). They further argued that although all three countries have four decades of history of fertiliser subsidy programmes, Ghana has continued to lag behind the other two countries in fertiliser adoption and productivity. For example, almost all maize farmers in Thailand and Mexico, apply fertiliser, while in Ghana, apart from the northern part where there is high adoption of fertiliser (87%), less than half of maize farmers apply fertiliser (Chapoto and Ragasa, 2013).

However, in terms of intensity of use, the fertiliser application rate in Ghana is quite similar to that in Thailand. And in the northern part of Ghana, the application is much higher than that in Thailand. Chapoto and Ragasa (2013) therefore concluded that the major difference in input use and practices that could explain the significant difference in the use or adoption of fertiliser in Ghana as against Thailand and Mexico is the adoption of hybrid/improved seed varieties. While these conclusions may be right, it may appear to be hastened if examination of technical efficiency of recipients of the GFSP is ignored.

2.6 Maize Production and Productivity in Ghana

Maize is Ghana's largest produced staple crop and its domestic demand is growing significantly. Between 2010 and 2015, maize demand was projected to grow at a compound annual rate of 2.6%. Despite the increase in maize production over the years in Sub-Sahara Africa, Ghana is not

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self-sufficient in maize production, as she has experienced an average of 12% shortfalls in domestic maize supplies in recent years and makes up for this shortage through imports (Codjoe, 2007). This shortfall can easily be arrested through local production given the enormous potential for maize cultivation in Ghana (Codjoe, 2007).

As the largest staple crop in Ghana, maize contributes significantly to consumer diets as well as serves as a substitute for other cereals short in supply. It accounts for 50-60% of total cereal production and thus, the largest cereal crop produced in Ghana in terms of area planted (MOFA, 2012; MiDA, 2010). Maize also represents the largest commodity crop in the country, second to cocoa. Maize therefore constitutes one of the most important crops for the country's agricultural sector.

Maize is produced in almost all the agro-ecological zones in Ghana either as a mono crop or an intercrop. It is grown on 846,300 hectares and has an annual production of 1,470,000 metric tonnes (MOFA, 2009; Addai, 2011). Domestic production has however been fluctuating over the past two decades, which threatens food security and incomes of smallholder farmers (MOFA, 2009). The success of the agricultural sector in Ghana is very critical for raising the standard of living, food self-sufficiency and sustainable livelihood for the population. Production outputs of smallholder maize farmers depend largely on the efficient combination of productive resources in order to maximize output.

The figure below illustrates the variations in Maize production in Ghana between 2009 and 2012. From an initial increase of 10.2%, maize production grew by 15.6% in 2010 and then fell drastically by 10.0% in 2011 before growing marginally again in 2012 by 5.2%. The figure

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shows the inconsistency in maize production which needs urgent attention to meet the growing demand.

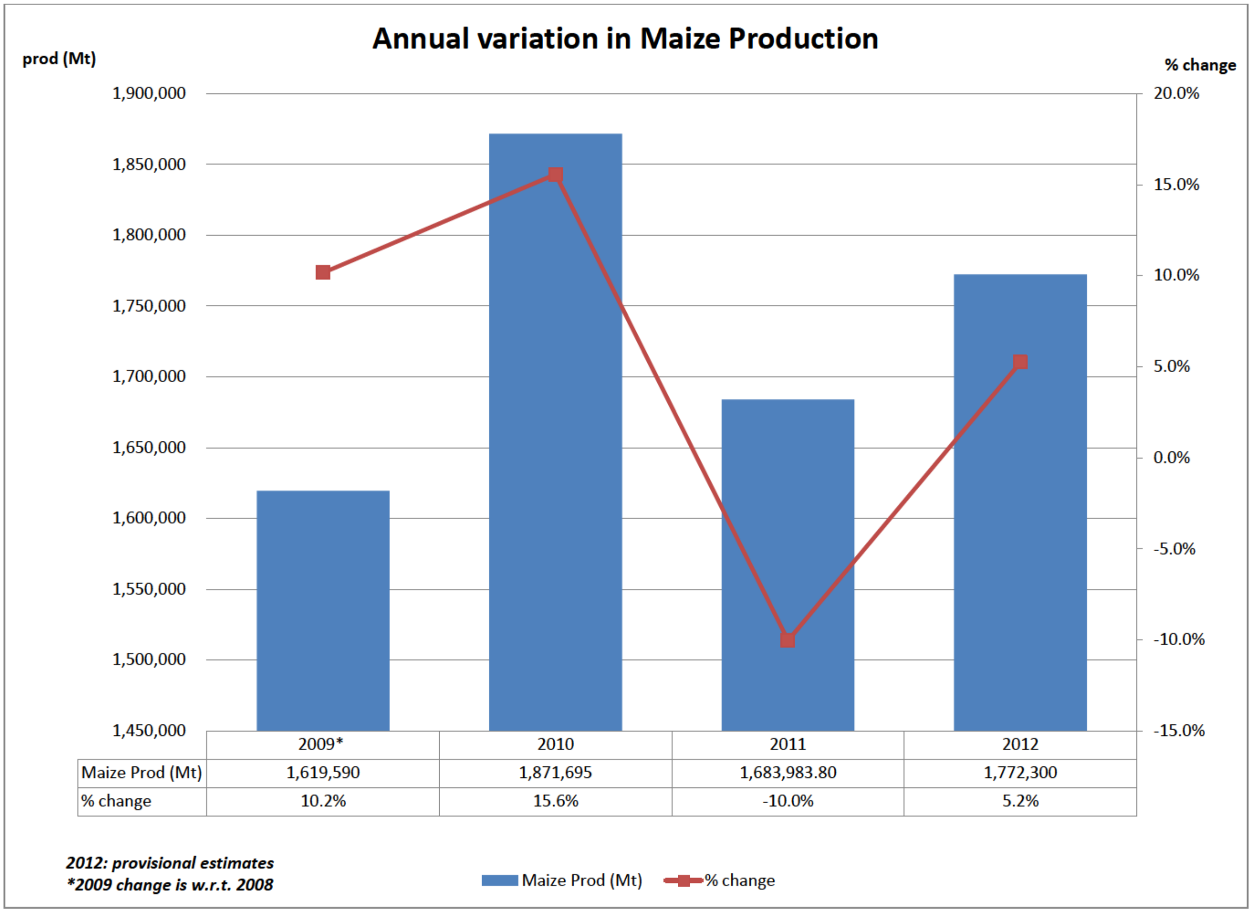

Figure 2.1 Annual variations in maize production

Maize has been cultivated in Ghana for several years. Since its introduction in the 16th century, maize has been time-honoured as an important food crop in the country (Morris, Tripp and Dankyi, 1999). In no time, maize also attracted the attention of commercial farmers, even though it never achieved economic prominence as compared to traditional plantation crops, such as cocoa. However, the eroding profitability of many plantation crops over the past few years due to falling productivity and falling world commodity prices have strengthened interest in commercial food crops, including maize (Morris, Tripp and Dankyi, 1999). According to Al-Hassan and Jatoe (2002) maize is currently Ghana's most important cereal crop and grown by

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the vast majority of rural households in almost all parts of the country except for the Sudan Savannah zone of the North.

Using five waves of nationwide household survey data from Kenya covering 13 years, Sheahan and Jayne (2013) estimate the relative and absolute profitability of nitrogen application rates on maize fields and compare these profitability conditions to observed nitrogen use patterns over time. The study finds that farmers are consistently and steadily increasing towards risk-adjusted economically optimal rates of fertiliser application over time and that, in the most agriculturally productive areas, farmers' application rates on maize sometimes exceed rates that maximize profitability.

The study asserts that fertiliser use rates may nevertheless be profitably raised in these areas, but doing so will require the adoption of complementary inputs and management practices that raise maize response rates to fertiliser application.

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2.7 Smallholder Farming in Ghana

Ghana's agricultural sector is tremendously dominated by smallholders. More than 70% of Ghanaian farms are 3 hectares (ha) or smaller in size (Chamberlin, 2007). The smallest average holdings are in the south (for example, 2.3ha at the coast versus 4.0 ha in the northern savannah). Smaller farms tend to produce fewer commodities; for example, farms of 2 ha or smaller produce an average of 3.1 crops; whereas those of 4 ha or larger produce 4.7 crops, on average.

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Maize and cassava are particularly important crops for the smallest farms, reflecting the importance of these crops to food security objectives of farmers under poor or variable market conditions. (For the 12% of households that grew only these two crops, the median holding size was 0.8 ha.) Smallholder market participation rates vary by holding size. Smaller farms produce fewer marketed crops and are less likely to sell the crops they do produce.

The holding sizes increase from south to north, but this increase is accompanied by lower land productivity in the north. At the same time, land endowments are more important to farm livelihood strategies in the north, where larger holding sizes correspond to higher household incomes. This finding appears to indicate that efforts to increase farmer incomes should particularly emphasise land productivity in the north, where fewer off-farm opportunities exist. In contrast, small farmers in the south— especially at the coast—tend to have more diversified income sources. Their smaller holdings are more likely to be compensated by greater off-farm employment opportunities.

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In recent years, agricultural growth in Ghana has been generally positive. However, much of this growth has resulted from area expansion rather than increased yield (MOFA, 2009).

To increase agricultural performance, it is essential to target the small farmers who constitute the largest segment of producers. Improving the productivity of smallholders could enhance their market participation opportunities. This will require the continued development and dissemination of technologies for enhancing productivity (IFPRI, 2007).

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The use of inorganic fertiliser is an agricultural technology that has enormous potential for raising the productivity of poor smallholder farmers, raising their farm income, and enhancing their relieving them of their poor economic standards. Input Subsidy Programmes should therefore aim at poorer farmers who cannot afford to buy fertiliser at the commercial rates to avoid crowding out of effects on private input suppliers, reduce burden on the government, increase income and productivity among smallholder farmers. Proper targeting of fertiliser subsidies are important in ensuring that the stated goals of the GFSP are achieved and that government is not unnecessarily overburdened and that resources which could have been used to target wrong and inefficient beneficiaries are released for other developmental projects.

In their review of numerous studies in Malawi, Lunduka, Ricker-Gilbert and Fisher (2013) conclude that the most vulnerable households are not sufficiently included in the subsidy programme, and that the targeting system is not particularly effective (see also Chibwana et al., 2010; Holden and Lunduka, 2012; Ricker-Gilbert et al., 2011). Dorward et al. (2008) also find that farms with greater landholdings and asset wealth were significantly more likely to receive fertiliser vouchers. Although targeting poor households is a stated programme objective in Malawi, wealthier households acquired significantly more subsidised fertiliser (Chibwana et al., 2010; Dorward et al., 2008; Ricker-Gilbert et al., 2011). Holden and Lunduka (2012) found that vouchers tend to be sold by smaller farms and purchased by larger farms. Jayne and Rashid (2013) in their review of micro-level evidence on ISPs undertaken since the mid-2000s reveal that targeted beneficiaries in all three countries (Malawi, Zambia and Kenya) tended to be wealthier than non-beneficiaries. In Zambia, for instance, although 73%of smallholder households cultivate less than two hectares of land, and these households constitute 78% of the smallholder farms below the US$1.25/capita/day poverty line, 55% of ISP fertiliser has been allocated to the 23% of households cultivating larger areas.

2.8 Government Dilemma and the Future of the Ghana Fertiliser Subsidy Programme

The government of Ghana is in a dilemma as to the future of the GFSP as it battles with increasing cost associated with the programme, dwindling foreign grants, depreciation of the Ghana Cedi and the coming to an end of the World Bank funds supporting the programme. With no exit strategy in place to gradually wean poor smallholder farmers off, the future of the GFSP is under threat. The sustainability of the Ghana Fertiliser Subsidy Programme (GFSP) which was initiated in 2008 to assist farmers increase fertiliser usage and farm productivity is under threat following uncertainties about financing if the current World Bank support for the programme dries up.

With the support of the World Bank, the government has steadily increased subsidies on fertilisers from a little over 43,000 metric tonnes at GH¢20 million in 2008 to 173,000 metric tonnes at GH¢117 million in 2012 and 180,000 metric tonnes at GH₵64 million in 2013. A total of 180,000 tonnes is expected to be subsidised this year for farmers.

Evidence of the unsustainable nature of the programme on government came to bear in 2014 when the programme was suspended due to government's inability to pay private fertiliser importers. On the other hand, despite the seeming rise in volumes of fertiliser by the year, they are still insufficient, as more people go into farming with existing farmers using more fertiliser.

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MOFA which is responsible for the implementation however, does not have its entire budget request to ensure that the fertiliser subsidies are carried out fully.

According to the Peasant Farmers Association of Ghana (PFAG) only 39% of the MOFA's budget was approved in the 2013 budget, thus making it difficult to undertake certain programmes, thus, the budget deficit the government runs has led to perennial shortage of subsidised fertiliser and this is gravely affecting food crop farmers, particularly those in the Upper East and Upper West regions of Ghana.

To compound issues, a World Bank facility under which the GFSP is being funded would soon end and calls are being made for alternative funding. The Bank has announced a shift in focus of its funding for the government. Each programme funding would be results-based and the World Bank would therefore conduct a sector review before committing funds.

With limited study on the GFSP, should the government continue to endure the increasingly uncontrollable cost or quit? Are the beneficiaries well targeted? Does access to subsidised fertiliser impact positively on output and productivity as the government assumes? Are beneficiaries efficient in using the fertiliser obtained from government to produce desired and maximum output levels? The above literature raises these important issues and there are ways to investigate such in quantitative terms to inform government actions on the programme.

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2.9 Empirical Review

2.9.1 Factors Determining Adoption of Fertiliser and Access to Fertiliser Subsidy

Several studies have analysed the factors affecting the adoption of chemical fertiliser. Admassie and Ayele (2004) and Beshir et al. (2012) in their studies revealed that age of household head, farm size, education, livestock, gender, non-farm income and access to information are major factors affecting adoption and use of fertiliser. Other studies have also revealed that limited knowledge and education are major constraints to technology adoption while access to extension services positively affect fertiliser adoption (Beshir et al., 2012; Wubeneh and Sanders, 2006; Carlsson et al., 2005; Asfaw and Admassie 2004). Abebaw and Haile (2013) showed that membership of co-operative has positive impact on fertiliser adoption. Although all farmers are eligible to benefit from the GFSP, it is only those who actually buy the subsidised fertiliser who benefit from it. Benin et al. (2011) as well as Marika and Banful (2010) suggested that proximity of farmers to fertiliser distribution points impacts significantly on farmers ability to participate in the programme or determines access to the subsidy programme.

Using data from the 2007/08 and 2008/09 evaluation of the Malawi Agriculture Input Subsidy Programme (MAISP) collected from rural households drawn from all livelihood zones in Malawi covering 14 districts, Chirwa, Matita and Dorward (2011), determined the factors influencing access to fertiliser input subsidy in Malawi. The study employed both the probit and tobit models in examining determinants to fertiliser subsidy. Their study revealed that coupons for subsidised fertiliser contrary to claims since 2006/7 that targeting criteria in that country gives priority to more vulnerable households, that the poor and vulnerable groups are generally marginalised. Their study also revealed that the number of coupons received per household increases with farm size, wealth (represented by value of assets and livestock) and welfare as well as food security while the proportion of female-headed households decreases with the number of coupons received per household (Chirwa, Matita and Dorward, 2011). Chibwana et al. (2010) also found that the most vulnerable and female-headed households were not likely to get vouchers, whereas residents who stayed longer in the villages were more likely to be selected.

In determining the relationship between fertiliser subsidies and voting patterns, Mason, Jayne and van de Walle (2013) used the tobit model with quantity of government fertiliser received as the dependent variable. For the explanatory variables, the hypothesised that farmer/household characteristics related to cooperative membership, landholding size, and income/wealth, as well as other household, community, and regional characteristics affect targeting of subsidised fertiliser.

This study, based on the literature above models access to the GFSP as a dependent dummy (choice) variable with the explanatory variables being the farmer/household characteristics as well as previous election outcomes of farmers' polling station.

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2.9.2 The Production Frontier

The standard definition of a production function is that it gives the maximum possible output for a given set of inputs. The production function therefore defines a boundary or a frontier. All the production units on the frontier will be fully efficient. Efficiency can be of two kinds: technical and allocative.

An implicit assumption of the production function is that all firms are producing in a technically efficient manner, and a representative (average) firm therefore defines the frontier. Any deviation from the frontier is thus assumed to be random, and is likely to result from mis or under-measured production factors. Estimation of the production frontier assumes that the boundary of the production function is defined by "best practice" firms. It therefore indicates the maximum output for a given number of inputs along a ray from the point of origin. It allows for some "white noise" to be accommodated, since the estimation procedures are stochastic, but also includes an additional one-sided error which represents any other reason for which firms may deviate away from (within) the frontier. Observations within the frontier are deemed "inefficient". So from an estimated production frontier it is possible to measure the relative efficiency of certain groups or a set of practices from the relationship between observed production and some ideal or potential production (Greene, 1993).

Technical efficiency is defined either as producing the maximum level of output given a set of inputs or as using the minimum level of inputs to produce a given output. Measurement of efficiency is justified in several fronts, firstly, in that its measure provides a credible basis for comparing across economic units.

Secondly, and perhaps more significantly, when a discrepancy in efficiency is found, there is an underlying basis for some further research to be undertaken to understand which factors led to it. Finally, differences in efficiency show that there is scope for implementing policies addressed to reduce them and to improve efficiency and maximise output using the scarce resources available.

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Technical efficiency can be modelled using either the deterministic or the stochastic production frontier.

In the case of the deterministic frontier model the entire shortfall of observed output from maximum feasible output is attributed to technical inefficiency, whereas the stochastic frontier model includes the effect of random shocks to the production frontier. There are two alternative approaches to estimate frontier models: one is a non-parametric approach which uses linear programming techniques, the other is a parametric approach and utilises econometric estimation. The characterising feature and main advantage of the non-parametric approach, (also called "Data Envelopment Analysis", or DEA), is that no explicit functional form needs to be imposed on the data. However, one problem with this approach is that it is extremely sensitive to outlying observations (Aigner and Chu 1968). Therefore, measures of production frontiers can produce misleading information.

Moreover, standard DEA produces efficiency "measures" which are point estimates: there is no scope for statistical inference and therefore it is not possible to construct standard errors and confidence intervals. The parametric or statistical approach imposes a specification on the production function which of course can be overly restrictive. This approach does, however, have the advantage of allowing for statistical inference. Hence, we can test the specification as well as different hypotheses on the efficiency term and on all the other estimated parameters of the production frontier.

The choice of technique employed to obtain estimates of the parameters describing the structure of the production frontier and technical efficiency depends, in part, on data availability. The

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main difference between cross-sectional and panel-data estimation techniques is that with cross-sectional data it is only possible to estimate the performance of each producer at a specific period in time, whereas with panel data, we are able to estimate the time pattern of performance for each producer. One problem with cross-sectional data in efficiency measurement is that technical inefficiency cannot be separated from firm specific effects that are not related to inefficiency (Battese and Coelli, 1995). Panel data avoids this problem. Panel data contains more information than a single cross section; it therefore enables to relax some strong assumptions used in cross-sectional data and to obtain estimates of technical efficiency with more desirable statistical properties.

Assuming the production frontier is deterministic. That means that the entire shortfall of observed output from maximum feasible output is attributed to technical inefficiency. Such a specification ignores the producer-specific random shocks that are not under the control of the producer.

To incorporate the fact that output can be affected by random shocks into the analysis, the stochastic production frontier is specified such that the stochastic frontier will consist of a deterministic part common to all producers and a producer-specific part which captures the effect of the random shocks to each producer. Since the stochastic frontier model includes the effect of random shocks on the production process, this model is preferred to the deterministic frontier.

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2.9.3 Determinants of Technical Efficiency

Technical efficiency, derived from production function, is one of the components of productive efficiency. Productive efficiency consists of technical efficiency and allocative efficiency. "Productive efficiency represents the efficient resource input mix for any given output that minimises the cost of producing that level of output or, equivalently, the combination of inputs that for a given monetary outlay maximises the level of production" (Forsund, Lovell, and Schmidt, 1980). Technical efficiency reflects the ability of a firm to maximise output for a given set of inputs, while allocative efficiency reflects the ability of the firm to use the inputs in optimal proportions given their respective prices and the production technology.

Developments in cost and production frontiers are attempts to measure productive efficiency as proposed by Farrell (1957). The frontier defines the limit to a range of possible observed production (cost) levels and identifies the extent to which the firm lies below the frontier.

The ability of maize farmers in Ghana to adopt new technology and achieve sustainable small-scale production depends on their level of technical efficiency. Efficiency measurement is very important because it is a factor for productivity growth. Efficiency studies can help Ghana to determine the extent to which they can raise productivity by improving the neglected source, i.e., efficiency, with the subsidy programme and the available technology. Such studies could also support decisions on whether to improve efficiency first or to improve on the effectiveness of targeting under the GFSP in the short run. More importantly, enhanced technical efficiency will not only enable farmers to increase the use of productive resources, it will also give direction for the adjustments required in the long run to achieve food sustainability (Al-hassan, 2008).

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To do this there is the need to assess the current levels of technical efficiency of maize farmers and to identify the factors that affect their levels of efficiency. More importantly, there is also the need to determine whether access to subsidised fertiliser improves efficiency, whether there are differences between beneficiaries and non-beneficiaries in their production efficiencies, and why. In fact, it is unlikely that the Ghanaian government's objectives of increasing food supply and income of smallholder farmers can be fully achieved unless positive steps are taken to adequately improve farmers' technical efficiency.

The factors that explain technical efficiency in agriculture are many, especially in developing countries like Ghana where there is a prevalence of subsistence farming. Inefficiency may result from socio-demographic, environmental, or economic factors. Farm-specific efficiency or efficiency can be related to farmer characteristics. These variables may measure level of information and managerial skills, such as access to education, extension services, as well as institutional or system factors exogenous to the farm, such as credit, input markets or tenancy (Ali and Byerlee, 1991). Thus, individual farmer variability and not random variability is the major cause for yield variability (Kalirajan, 1981).

There are various socio-demographic, economic, institutional, environmental and non-physical factors that affect efficiency (Kumbhakar and Bhattachury, 1992; Addai, 2011). These factors include sex, age, level of educational, household size, hybrid seed, mono cropping, access to credit, off-farm activity, membership of a farmer based organisation (fbo), land tenancy and so on (Nchare, 2007; Rahman and Hassan, 2006; Tesfay et al., 2005; Abdulai and Eberlin, 2001).

Abdulai and Eberlin (2001) pointed out that, the level of education, farming experience and access to formal credit contribute positively to production efficiency, while farmer's participation in off- farm work tends to reduce production efficiency. Sherlund, Barret and Adesina (2002) further emphasised that variables such as farm size, cropping experience, gender, age and rainfall also affect the technical efficiency of farmers (Addai, 2011).

Most studies dealing with agricultural production argue that schooling or the level of education of a farmer helps the farmer in the use of production information leading to increased yield and hence increases technical efficiency. Kumbhakar et al. (1991) investigated the determinants of technical efficiency in US dairy farms. Their study established that levels of education of the farmer are important factors determining technical efficiency. This investigation concluded that both technical and allocative efficiencies, increase with a decrease in the level of education of the farmer and that large farms were more efficient (technically) than small and medium-sized farms.

Ajibefun and Daramola (2003) in their study also concluded that education is an important policy variable and could be used by policy makers to improve both technical and allocative efficiency. Weir (1999) investigated the effects of education on farmer productivity of cereal crops in Ethiopia using average and stochastic production functions. The study revealed a significant positive effect of education on farmer productivity in terms of efficiency gains. They, however, found a threshold effect that implies that at least four years of schooling are required to lead to significant effects on farm level technical efficiency. Moreover, the study found evidence that average schooling in the villages (external benefits of schooling) improves technical efficiency.

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However, Kalirajan and Shand (1985) argued that although education is a productive factor, farmers' education is not necessarily related significantly to their productivity. Thus, illiterate farmers can equally understand a modern method of production just as their educated counterparts, only if the technology is properly communicated.

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The impact of agricultural extension on farm production has received extensive attention in the existing efficiency studies. Agricultural extension represents a means by which information on new technologies, modern or improved farming practices and enhanced farm management strategies can be transmitted to farmers. Kalirajan (1981) explained that access to limited extension contacts and farmers' misunderstandings of the new technologies, explains the difference between the actual and maximum yields among the farmers. The researcher therefore stressed the need for policy makers to focus on extension work in order to increase production and increase efficiency.

Owens, Hoddinott and Kinsey (2001) investigated the impact of farmer contact with agricultural extension services on farm productivity using data during the period1993–1997 in Zimbabwe. The results showed that access to agricultural extension services raises substantially the value of crop production.

The findings of a frontier analysis by Ogundele and Okoruwa (2004) showed that farm size significantly determines levels of technical efficiency in Nigeria. Other determinants included fbo membership, herbicides, hybrid seeds, education and farming experience amongst others.

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Binam et al. (2004) examined factors influencing technical efficiency of groundnut and maize farmers in Cameroon and concluded that access to social capital, credit and extension services are important factors influencing the variations in technical efficiencies.

Seyoum, Battese and Fleming (1998) considered the technical efficiency and productivity of maize producers in Ethiopia and compared the performance of farmers within and outside the programme of technology demonstration. Their empirical results showed that farmers who participated in the programme were more technically efficient compared with those outside the project.

Lindara, Johnsen and Gunatilake (2004) in investigating technical efficiency in the spice based agroforestry sector in Matale, Sri Lanka found that, higher number of farm visits of extension officer, more farmers training, more experience, and higher species diversity of agroforestry system increased the efficiency level of farmers in the study area. However, higher education level and more off-farm income sources decreased the level of efficiency of farmers.

Addai (2011) examined the differences in the production efficiency of maize producers and identified inefficiency effects across three agro ecological zones in Ghana with and without the inclusion of environmental variables. On determinants of technical efficiency, their study found that household size, land tenure and off farm activities significantly decreased technical efficiency while age, mono cropping, use of hybrid seed, extension contacts and access to credit are positively related to technical efficiency.

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Asante, Villano and Battese (2014) used cross-sectional data collected from 375 smallholder yam farmers in Ghana to examine the effect of the adoption of yam minisett technology on the technical efficiency of production of the yam farmers. Their analysis revealed that the effect of adoption of the technology on the technical efficiency of smallholder farmers was positive and significant in the Ashanti region while negative in the Brong Ahafo region.

To estimate the impact of the adoption of the yam minisett technology on TE, Asante et al. (2014) followed Oduol et al. (2011) and modelled adoption as a choice variable and estimate the determinants of adoption. The predicted probabilities of adoption is then estimated and regressed together with other farmer, farm-level and institutional characteristics in the stochastic frontier inefficiency model. This approach corrects for endogeneity in adoption before incorporating it into the TE estimation.

The GFSP is neither randomly assigned nor targeted at specific farmers. Instead, all farmers are offered the opportunity to participate in the programme. This implies that the GFSP is a non-random and endogenous programme. To estimate the impact of access to the programme on maize output and TE therefore, this study modelled access to the programme as a choice variable to estimate the determinants of access to the programme. The predicted probabilities of the access was then estimated and regressed together with other farmer/household characteristics in the stochastic frontier model to correct for the endogeneity associated with access to the GFSP.

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CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter discusses the methodologies used in obtaining data and analysing the data. The chapter discusses the study areas, data, sample technique, sample size, research instruments used, data analysis and presentation.

3.2 Study Areas

This study was conducted in two (2) of Ghana's agro-ecological zones: the Transition zone and the Guinea savannah zone. A total of four (4) districts were randomly selected, two (2) districts from each of the ecological zones. In Ghana, there are five main agro-ecological zones: Rain Forest, Deciduous Forest, Transition zone, Coastal Savannah and Northern savannah (Guinea and Sudan savannah) zones.

The Transition zone covers an area of 39,557 square kilometres and accounts for about 16.6% of the total area of Ghana. It shares boundaries with the Guinea savannah zone to the north and the Deciduous Forest zone to the south. The Transition zone has a tropical climate, with high temperatures averaging 23.9 ^{0}C (75 ^{0}F) and average rainfall of 1,000 millimetres in the northern parts and 1,400 millimetres in the southern parts. It has two main types of vegetations, the moist semi-deciduous forest, mostly in the southern parts and the guinea savannah woodland, which is predominant in the northern parts. As a result of the clear distinction in vegetation types, there is difference in the level of development and economic activities engaged by the people in these areas. For example, the moist semi-deciduous forest zone is conducive for the production of Ghana's leading cash crop, cocoa.

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The Guinea savannah zone occupies an area of about 70,383 square kilometres, representing the largest (29.5%) zone of Ghana and covers the northern parts of Ghana. It shares boundaries with the Sudan Savannah zone to the north and the Transition zone to its south. Generally, the zone has a low lying land that is more suitable for food crop production. The vegetation is known as grassland interspersed with the guinea savannah woodland, and also characterised by drought-resistant trees such as the shea nut, baobab, dawadawa, mango and neem. The climate of the region is relatively dry, with a single rainy season that begins in May and ends in October. The amount of rainfall recorded annually varies between 750 mm and 1050 mm. The dry season starts in November and ends in April with maximum temperatures occurring towards the end of the dry season and minimum temperatures in December and January. The harmattan winds, which occur during the months of December to early February, have considerable effects on the temperatures in the region, which mostly vary between 14°C at night and 40°C during the day.

3.3 Data

Both qualitative and quantitative data were collected from 352 farmers. Two districts were selected from each of the two ecological zones. In the Transition Zone, the Dormaa West District and the Nkoranza West District were selected while in the Guinea savannah Zone, the Savelugu-Nantong Municipality and the Tolon District were selected.

3.4 Sampling Technique

The study used multistage sampling technique in the selection of the farmers. The two ecological zones were selected (Guinea savannah and Transition zones) based on the fact that they produce

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high quantities of maize, have the largest agricultural lands and considered the food basket of the country. Stratified and simple random sampling methods were used to select the districts from each ecological zone. From each of the districts selected, simple random technique was used in selecting communities from each district as well as maize farmers from each community.

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3.5 Sample Size

A total of 352 maize farmers were selected for this study. 222 of the farmers from the Guinea savannah and the remaining 130 from the Transition zone.

3.6 Research Instruments Used

Specific research instruments used in this study are: Focus group discussions (FGDs), questionnaire, and document analysis.

FGDs were held with key farmers and some FBOs as a follow up to the questionnaire administered. These were undertaken to authenticate some of the findings and to ask for clarifications especially with regards to the targeting of the fertiliser subsidy.

This study applied the personal interview type of survey questionnaire. This was conducted with the help of an interpreter, especially in the Transition zone where Twi is the main language. In the Guinea savannah zone, the interview was conducted in Dagbani. In this study, a pre-test of the questionnaires was conducted and feedback was used to further improve the questionnaires to ensure validity and reliability of the data.

As in the case of qualitative research, document analysis is useful in quantitative research to verify, analyse and make projections based on data submitted by agencies. In this study, the researcher was able to generate significant information from various documents obtained from MOFA on the operational guidelines of the GFSP and other published literature on fertiliser subsidy and technical efficiency. All these materials turned out to be significant sources of information. In view of the six pieces of criteria outlined at the beginning of this section, document analysis was found to be the most convenient, time saving and cheapest method to use.

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3.7 Data Analysis and Presentation

Data analysis was done based on responses to questions and the objectives outlined in chapter one of the study. The data were analysed using both qualitative and quantitative approaches. In the former approach, descriptive statistics such as percentages were used while a probit model and stochastic frontier were estimated quantitatively. The Stata 13 and Frontier 4.0 software were employed in the analysis.

3.7.1 Theoretical Review

This section presents a theoretical review of the probit model and the stochastic production frontier model. The specifications of the models as well as their assumptions of and the variables used are outlined.

3.7.1.1 Model 1: Probit Model

In practices, adoption behaviour models may take simple expressions or complex multivariate analyses. In decision theory analysis, the logit, probit and tobit models are commonly used

(Makokha et al., 2001; Imai, 2003). Probit or logit models are appropriate when the dependent variable is dichotomous (0, 1), while the Tobit model is useful for continuous values that are censored, usually at or below zero (Anley, Bogale, and Haile-Gabrie, 2007).

The underlying economic theory of factors that influence the decision to participate in a programme or use chemical fertiliser is based on the assumption that farmers are motivated by utility maximization (Shakya and Flinn, 1985; Adesina and Zinnah, 1993). Farmers form expectations of the costs and benefits of a technology on the basis of their own experimentation or through analysis of information from early adopters and key informants in their communities. Following Marenya and Barrett (2007) and Nkamleu and Adesina (2000), it is assumed that farmers behave consistently with utility maximisation and that farmers used the subsidised fertiliser when the expected utility from the access exceeds that of non-access. Although the utility from subsidised fertiliser cannot be directly observed, theory allows that the utility (AS_{ij}) for a given farmer (i) to have access to subsidise fertiliser (j) can be defined as a function of a vector of explanatory variables (X), and an error term with zero mean (e_{ij}). Following Thuo et al. (2012), the utility function can be given as:

$$AS_{ij} = \alpha_0 + a_j \sum_{k=1}^{3} X_i + e_{ij} \text{ where} U_{ij} = 1,0 \qquad i = 1,2,....n \quad \text{and } X = X_1 + X_2 + X_3 \qquad (1)$$

From the function, the ith farmer have access to subsidised fertiliser $(j = 1)$ if and only if $AS_{i1} > AS_{i0}$. X_1 represents farmer-specific characteristics such as age, position in household, sex, education years, household size, and off farm activities. X_2 represents farm-specific characteristics such as maize farm size, organic manure use, use of improved/hybrid maize seed, quantity of fertiliser acquired at the commercial rate and commercial farming. X_3 represents

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institutional factors such as access to credit, access to extension services, distance to the nearest fertiliser retailer and political factors.

For empirical purposes, the expected utility of access AS_{ij} can be construed from a farmer's observed binary choice of access to or non-access to subsidised fertiliser, which implies a probit model (Anley et al., 2007; Thuo et al., 2012). In the context of the choice of whether or not a farmer had access to subsidised fertiliser, the probit model is specified (Fufa and Hassan, 2006; Thuo et al., 2012) as:

$$Y = F(\omega + \alpha X_i) = F(z_i), \qquad (2)$$

where Y is the discrete choice variable of adoption, F is a cumulative probability distribution function, α is a vector of unknown parameters, X is a vector of explanatory variables as in (1) and z is the Z-score of the αX area under the normal curve. The expected value of the discrete dependent variable in equation 2 is conditional on the explanatory variables, and also given as:

$$E[Y / X] = 0[1 - F(\alpha' X)] + [F(\alpha' X)] = F9\alpha' X) \qquad (3)$$

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

$$\frac{\partial E[Y / X]}{\partial X} = \phi(a' \mathrm{X})a \qquad (4)$$

where $\phi(.)$ is the standard normal density function (Fufa and Hassan, 2006; Thuo et al., 2012).

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3.7.1.2 Empirical Model 2: Stochastic Production Frontier (SPF)

In estimating the impact of the adoption of a technology or intervention on technical efficiency (TE), several approaches can be used as demonstrated by Asante et al. (2014). The first approach involves a two-stage estimation procedure in which the probability of adoption is estimated using the probit or logit models and then used to obtain matched samples for each of the groups (beneficiaries and non-beneficiaries). The matched samples obtained are used in the second stage to estimate separate stochastic frontier models for each of the groups and the impact of the intervention assessed by comparing differences in mean TE between the beneficiaries and non-beneficiaries. The two-stage approach is, however criticised for its inability to take into account selection bias associated with observed and unobserved variables (Asante et al., 2014).

A second approach similar to the first one involves estimating the probability of adoption after the probit or logit; then the matched samples are used to estimate a single stochastic frontier model and the resulting TE scores. The mean difference in the TEs of adopters and non-adopters or beneficiaries and non-beneficiaries is used to assess the impact (Mouelhi, 2009; Oduol et al., 2011, Asante et al., 2014).

A third and recent approach, proposed by Greene (2010), involves a simultaneous estimation of both the matched samples and a single stochastic frontier model. This approach takes into account both observed and unobserved biases by jointly estimating the probit, the propensity scores as well as the TE scores (Solís, Bravo-Ureta and Quiroga, 2009; Bravo-Ureta et al., 2011). This study used the second approach in analysing the effect of access to the GFSP on maize output and TE of smallholder farmers in Ghana.

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Access to fertiliser subsidy is modelled as a choice variable as in the Empirical Probit Model 1 above and the predicted probabilities of access to subsidised fertiliser is estimated and regressed together with other farm-level, household and institutional characteristics on the inefficiency scores in the stochastic frontier inefficiency model. This approach corrects for endogeneity in adoption before incorporating it into the TE estimation (Asante et al., 2014)

The stochastic frontier production function was independently proposed by Aigner et al. (1977) and Meeusen and van den Broeck (1977). The original specification involved a production function specified for cross-sectional data which had an error term with two components which accounts for the random effects and the technical inefficiency. This is given as:

$$Y_i = X_i\beta + V_i - U_i \quad (5)$$

where X_i is a vector of variables believed to influence efficiency, β are parameters to be estimated. The two error terms, V_i and U_i are together known as the composed error term and this differentiated the stochastic frontier from the average response functions such as ordinary least square. The stochastic frontier has been used in a number of empirical applications over the past decades.

Several functional forms have been used to measure the physical relationship between inputs and outputs, and the most common forms being the Cobb-Douglas (CD) and the Transcendental logarithmic (translog) functional forms. The translog production function reduces to the CD if all

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the coefficients associated with the second-order and the interaction terms of inputs are zero. In this study, the generalised likelihood ratio test is used in selecting the functional form and specification of the estimated models

The critical values of the test statistic come from a χ^2 distribution (at the 5% level of significance) and a mixed χ^2 distribution, which is drawn from Kodde and Palm (1986).

The transcendental logarithmic (translog) function developed by Christensen, Jorgenson and Lau (1973) is a flexible function which has both linear and quadratic terms with the ability of using more than two factor inputs. A Cobb-Douglas functional form was also considered for representing the production model. However, the results of the generalised likelihood ration test of hypothesis suggested that the Cobb-Douglas is not an adequate representation of the data, given the assumptions of the translog stochastic frontier model.

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Following Battese and Coelli (1995), the translog stochastic frontier model is defined by:

$$\ln Y_i = \beta_0 + \beta_{ik} D_k + \sum_{k=1}^{3} \beta_k \ln X_{ik} + 0.5 \sum_{k=1}^{3} \sum_{j=1}^{3} \beta_{kj} \ln X_{ik} \ln X_{ij} + V_i - U_i \qquad (6)$$

Where i indicates the i^{th} farmer in the sample (i=1, 2….., 352)

Y represents the maize output of the i^{th} farmer (kilograms)

D is a dummy variable of Organic Manure use where D=1 if a farmer uses Organic Material and 0 if otherwise

X_1 represents maize farm size (in hectares);

X_2 represents quantity of labour used (labour mandays); and

X_3 represents the quantity of fertiliser (kilograms)

The V_is are random variables which are assumed to be independently and identically distributed (iid) as $N(0,\sigma_v^2)$, and independent of the U_i which are non-negative random variables which are assumed to account for technical inefficiency in production and are often assumed to be iid as $|N(0,\sigma_u^2)|$.

The frontier production is a two-sided stochastic component embedded in the disturbance term (V_i– U_i). The first component, V_i, is supposed to capture statistical noise (i.e. measurement error) and random exogenous shocks such as bad weather and machine breakdowns, etc. that disrupt production. The second component U_i is also a random variable, but unlike V_i, it is only a one-sided variable taking non-negative values. This term captures technical inefficiency of producing maize output. One of the disadvantages of the SPF method is that its estimation requires explicit specification of the distribution of the inefficiency term. There is no consensus among econometricians as to what specific distribution u should have. In previous empirical studies a variety of distributions, ranging from the single-parameter half-normal, exponential and truncated normal distributions to the two-parameter gamma distribution have been used (Jaforullah and Devlin, 1996; Bravo-Ureta and Rieger, 1991; Battese, 1992; Sharma, Leung and Zaleski, 1999). However, there is no *a priori* argument that suggests that one form of distribution is superior to another, although different assumptions yield different efficiency levels.

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The inefficiency component represents a variety of features that reflect inefficiency, such as firm-specific knowledge; the will, skills and effort of management and employees; and work stoppages, material bottlenecks and other disruptions to production (Aigner et al., 1977; Lee and Tyler, 1978; Meeusen and van den Broeck, 1977). Other proposed specifications of the distribution of *u* include a truncated normal distribution – $N(\mu, \sigma u^2)$ (Stevenson, 1980) and the gamma density (Greene, 1980). In this paper, a half-normal distribution for *u* has been assumed in estimating the stochastic production frontier. Therefore, $U \sim N(0, \delta_u^2)$. Different simulation exercises carried out by Greene (1990) indicated that the half-normal is preferable to other assumptions (exponential, truncated and gamma) from an econometric point of view.

Following Battese and Coelli (1995), the inefficiency distribution parameter can also be specified as

$$u_i = \delta_0 + \sum_{j=1}^{7} \delta_{0j} D_{0j} + \sum_{j=1}^{5} \delta_j z_{ij} \qquad (7)$$

where u_i is normally distributed as $N(0, \sigma_u^2)$;

D_{01} is the Dummy variable for Access to Fertiliser Subsidy;

D_{02} is a Dummy variable for Male (Sex of respondent);

D_{03} is a Dummy variable for Extension visit;

D_{04} is a Dummy variable for cultivation of cropping;

D_{05} is a Dummy variable for Credit access;

D_{06} is a Dummy variable for Farmer Based Organisation (FBO); and

D_{07} is a Dummy variable for Off farm.

δ is a parameter to be estimated

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Z_i represents a vector of household specific technical inefficiency where

Z_1 represents age;

Z_2 represents experience of the farmer;

Z_3 represents household size;

Z_4 represents years of education; and

Z_5 represents farm size

Following Battese and Corra (1977) and Battese and Coelli (1995), the variance are parameterised by replacing σ^2_{vu} and σ^2_{μ} with

$$\delta^2 = \sigma_u^2 + \sigma_{vu}^2 \quad \text{and} \quad \lambda = \frac{\sigma_u^2}{(\sigma_{vu}^2 + \sigma_u^2)} \qquad (8)$$

Where $0 \le \lambda \le 1$, with the value equal to 1 indicating that all the deviations from the frontier are due entirely to technical inefficiency (Coelli, Rao, and Battese, 1998).

The technical efficiency of the household can be defined as:

$$TE = \frac{E(Y_i / u_i, \mathrm{X_i})}{E(Y / u_i = 0, \mathrm{X_i})} = e^{-u_i} \qquad (9)$$

Where; E is the expectation of a maize farmer. Thus the measure of technical efficiency is based on a conditional expectation given by Equation (8), given the value of V_i-U_i evaluated at the maximum likelihood estimates of the parameter in the model, where the expected maximum value of Y is conditional on u_i=0 (Battese and Coelli, 1988). The measure TE_i takes the value between zero and 1 and the overall mean technical efficiency of households is estimated as:

$$TE = \left\{ \frac{1-\phi\left[\sigma_u - (u/\sigma_u)\right]}{1-\phi\ (u/\sigma_u} \right\} e^{-u+(o.5)\sigma_u{}^2} \qquad (10)$$

Where; φ represents the density function of the standard normal variable.

3.8.2.1 Hypotheses

The technical inefficiencies in equation (9) can only be estimated if the technical inefficiency, *u*, are stochastic and have particular distribution properties (Coelli and Battese, 1995). Therefore, the following null hypotheses of interest were tested: no technical inefficiency $H_0 = \delta_{01} = \delta_{02} = \ldots = \delta_{07} = \delta_1 = \ldots = \delta_5 = \gamma = 0$; and the household specific factors do not influence the technical inefficiencies $H_0 = \delta_{01} = \delta_{02} = \ldots = \delta_{07} = \delta_1 = \ldots = \delta_5 = 0$.

The third null hypothesis tested is H_0: $\beta_{ij} = 0$ for all $i \leq j = 1, 2, \ldots, 4$, which tests the functional form that best represents the data, either the Cobb-Douglas or the Translog. If the null hypothesis is not rejected, the Cobb-Douglas production function will be used.

Finally, the fourth null hypothesis, H_0: $\beta_4 = 0$, states that the probability of access to the GFSP has no effect on the productivity and efficiency of maize farmers and should not be considered in the production function.

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Tests of the various null hypotheses above for parameters in the frontier production functions as well as in the inefficiency model are performed using generalised likelihood-ratio test statistic defined by;

$$\lambda = -2[\ln\{L(H_0)\} - \ln\{L(H_1)\}]$$

Where $L(H_0)$ and $L(H_1)$ represents the value of the likelihood function under the null and the alternative hypotheses, respectively. If the null hypothesis is true, the rest statistic has approximately a chi-square or a mixed chi-square distribution with the degree of freedom equal to the difference between parameters involved in the null and alternative hypotheses.

3.7.3 Variables Used in this study

Some of the variables used in this Study and their measurement are explained below

Access is the dependent variable in the probit model (empirical model 1) and the inefficiency terms in the stochastic frontier function. The variable measures whether the farmer had access to fertiliser subsidy. Access is a dummy variable; it is 1 if a farmer has received fertiliser at the government subsidised rate and 0 if otherwise.

Age is measured in years and is expected that the age of the farmer would have a positive effect on access to fertiliser subsidy and negative effect on technical inefficiency. This is the case because in terms of access to fertiliser subsidy coupons or passbooks, elderly farmers are more connected to the government agencies and are more likely to access the programme. In terms of

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technical inefficiency, as a farmer gets older her/his technical inefficiencies is expected to decrease due to the enormous experience in farming associated with age.

Access to Credit is a binary variable used to capture the effect of credit on access to subsidy and the efficiency of farmers. This variable is measured as a dummy, 1 if farmer had access to credit, 0 otherwise during the season. A farmer having access to credit in cash will enable her/him to purchase fertiliser inputs in a timely manner and hence is supposed to increase efficiency. The coefficient estimate is expected to be negative as indicated by Owuor and Shem (2009) and Chukwuji et al (2007).

Household Size measures the number of people who were living with the farmer during the season. It is expected that large households may not have excess income to enable them purchase fertiliser at the commercial rates, hence larger households rely on the GFSP for their fertiliser needs. On TE, the expected sign for household size is mixed. A negative sign indicates that the larger the household size, the greater is the technical efficiency. A reason for this negative sign is allocation of financial resources to family members for their education and health (Coelli et al, 2002). On the other hand, larger household size might benefit from being able to use labour resources at the right time (Dhungana et al, 2004).

Sex variable measures the effect of gender on access to fertiliser subsidy and technical inefficiency. It is a dummy indicating 1 if the farmer is male and 0 otherwise. Male farmers are heads of households and in control of resources. Given general perception of discrimination against women, male farmers are expected to have more access to the GFSP. The *a priori* sign of

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the coefficient of sex in the technical inefficiency model is however indeterminate because of the argument that men and women farmers are both efficient in resource use (Adesina and Djato, 1997).

Improved Seed is a variable capturing special crop species with shorter maturation period, drought resistance and high-yielding. It is a dummy variable indicating 1 if the farmer cultivates hybrid seed and 0 otherwise. Use of improved seed shows the willingness and knowledge of a farmer to adopt new farming practices and therefore expected to use fertiliser.

Maize output is the dependent variable in the production frontier and measured as the logged value of the kilograms of maize output produced by a farmer.

Farm size is the area of land in hectares of maize cultivated. The variable was used to investigate the influence of farm size on output. It is measured in hectares and consists of the total land size used by every farmer.

Labour is measured as the man-days spent on the farm from land preparation to harvesting on a hectare of plot. This is made up of both family and hired labour.

Fertiliser refers to the quantity of chemical fertiliser applied on maize plot in kg during the farming season. Fertiliser is expected to have a positive effect on maize output.

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Education variable was measured as the number of years of schooling of a farmer. It represents the managerial ability of the farmer. Education as is a relevant factor in technology adoption. Well educated farmers easily adopt improved farming technology and therefore should have higher technical efficiency than farmers with low level of education and therefore expected to be positively related to technical efficiency (Seyoum et al, 1998).

Mono Cropping is a binary variable used to capture the effect of practicing mono cropping on access to the GFSP and the efficiency of farmers. Mono cropping is a dummy indicating 1 if the farmer practiced mono cropping and 0 otherwise. A positive relationship with access and efficiency is expected as mono cropping not only enables farmers to work tirelessly, but also saves the maize crop from competition that might occur among various crops in the case of mixed cropping for the use of input available at the farm level (Nchare, 2007). Farmers who depend solely on one crop will invest more resources (such as fertiliser and other inputs) and energy to ensure maximum yield is obtained.

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Extension variable indicates whether the farmer had access to extension services during the farming season. This variable is measured as a dummy, 1 if farmer had access to extension service and 0 otherwise. Extension officers are charged with the responsibility of educating farmers on new and improved methods of farming. If farmers receive visits by extension agents, they learn more about the farm operations and the farm business. Extension is expected to be positively related to access to subsidy while negatively related to technical inefficiency.

Extension access is measured in two ways: as a binary (dummy) variable to simply capture if farmers had extension contacts or as the number of times farmers are visited by extension service officers. Extension access in the probit is measured as number of visits to capture the effectiveness of the visits on access to the GFSP.

Off-farm work variable measures whether farmer engaged in any other business aside the farming during the farming season. It is a dummy indicating 1 if the farmer engages in off-farm work and 0 otherwise. The expected impact of off-farm activity on technical efficiency is mixed. Some argue that off-farm labour reduces farming efficiency (Abdulai and Huffman, 2000). Others also contend that the additional income generated by other household members who engage in off-farm activity, can provide compensation that surpasses the lost labour hours (Abudulai and Eberlin, 2001).

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CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the results and a discussion of the study. It includes descriptive statistics of socio-demographic characteristics of farmers, factors influencing farmers' access to fertiliser subsidy and technical efficiency of maize production.

4.2 Socio-Demographic Characteristics of Farmers

4.2.1 Agro-Ecological Zones

As stated earlier, this study was conducted in two of the five agro-ecological zones in Ghana, namely, The Transition zone and the Guinea Savannah ecological zones. In total, 352 farmers answered to all questionnaires, 130 from the Transition zone and the remaining 222 farmers from the Guinea savannah zone as in figure 4.1 below.

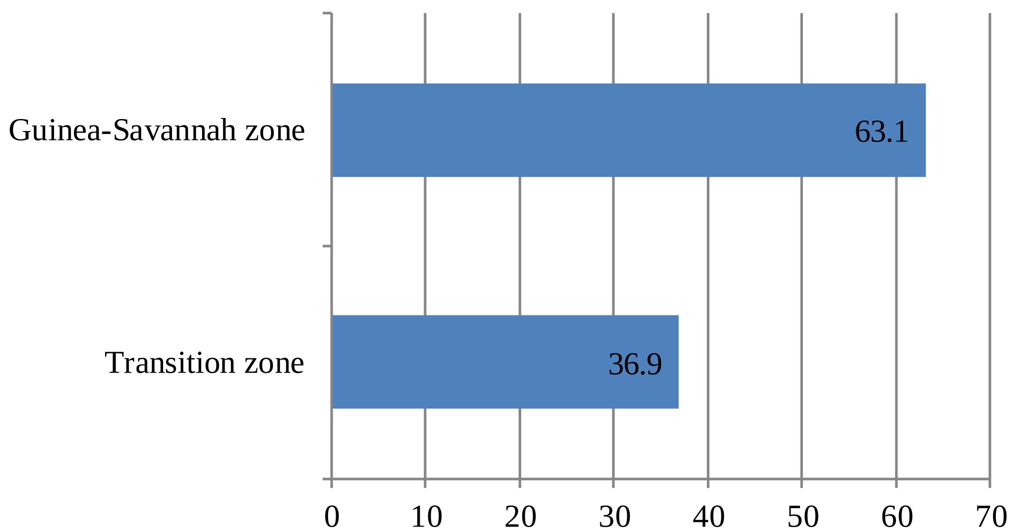

Figure 4.1 Percentage distribution of farmers

Source: Field Survey

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4.2.2 Age of Farmers

The Table 4.1 below shows the ages of farmers.

The results of data collected indicate that the average age of farmers is 40.5 years. Farmers in the Transition zone have an average of 40.6 years while that of the Guinea savannah zone is 40.4 years as shown in the Mean-Table below. As indicated in table 4.1 below, the minimum age of farmers is 19 years while the maximum age is 80 years for the whole sample of 352 farmers. For the Transition zone, the minimum age is 19 years while the maximum age is 79 years as indicated in table 4.1 below. For the Guinea savannah zone, however, the minimum age is 19 years while the maximum age is 80 years as indicated in table 4.1 below. The results suggest a high participation of the more experienced farmers in the study areas.

With regards to ecological distribution of ages, majority of farmers in both the Transition zone (36.8%) and the Guinea savannah zone (38.7%) are in the age bracket 31- 40 years while 11-20 years contributes the least to farmers in both the Transition zone (2.3%) and Guinea savannah zones (2.3%).

The age distributions show that, agricultural labour force in the study areas are largely between 31-40 years class and therefore expected to benefit more from any policy that intends to target more farmers in these areas. The famers per their age should have the experience to use fertiliser more efficiently to bring about desired output levels.

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Table 4.1 Ages of farmers in the study areas

Item	Transition		Guinea savannah		Pooled	
Mean	40.6 (years)		40.4 (years)		40.5 years	
Min	19		19		19	
Maximum	79		80		80	
Farmers	**130**		**222**		**352**	
Age Distribution of farmers						
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**
11 – 20	3	2.3	5	2.3	8	2.3
21-30	29	22.3	35	15.8	64	18.2
31-40	44	33.8	86	38.7	130	36.9
41-50	28	21.5	59	26.6	87	24.7
51-60	9	6.9	14	6.3	23	6.5
61+	17	13.1	23	10.4	40	11.4
Total	**130**	**100**	**222**	**100**	**353**	**100**

Source: Field Survey

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4.2.3 Sex

The total numbers of female farmers for this study are 167 (which represent 47.4% of total farmers) while total male farmers are 185 (52.5% of total farmers) as indicated in Figure 4.2 below.

In the Guinea savannah zone for instance, of the 222 farmers, 50% are female (111 farmers) and the remaining 50% male (111 farmers). In the Transition zone, the results show slight difference with females constituting 43.1% (56 farmers) while males constitute the remaining 56.9% (74) of the farmers in that zone. It is important to note that there was no deliberate effort by the researcher in selecting males or females for the study, but selected at random. Therefore, it can be noted that there are more male farmers involved in maize production than female farmers in the study. Considering maize as a major food crop in the study area, male farmers would go into maize production for family subsistence. Considering the less variation in proportion of males to females, the study, therefore can make an assessment of how the fertiliser subsidy programme benefits are enjoyed by both males and females.

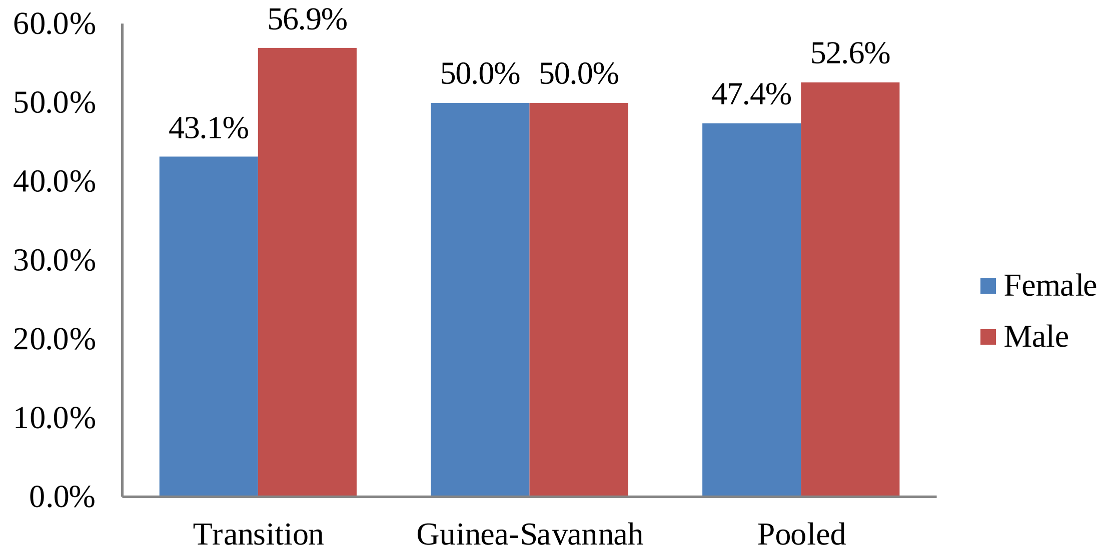

Figure 4.2 Sex distribution of farmers in the study areas

Source: Field Survey

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4.2.4 Household Headship of Farmers

This variable measures the level of authority and who controls resources within a particular household. Household heads are more likely to receive fertiliser subsidy and are more efficient than non-household head since they are seen as having control over other members in terms of household resources and making decisions.

The results of farmers' position in households are shown in the figure below. As indicated in the figure below, 58.5% of farmers in the Transition zone (76 farmers) are household heads while the remaining 41.5% (54 of the farmers) are non-household heads. For the Guinea savannah zone, majority of the farmers (114 farmers representing 51.4% of the farmers) are not household heads while the remaining 108 farmers (48.7% of farmers in that zone) are household heads.

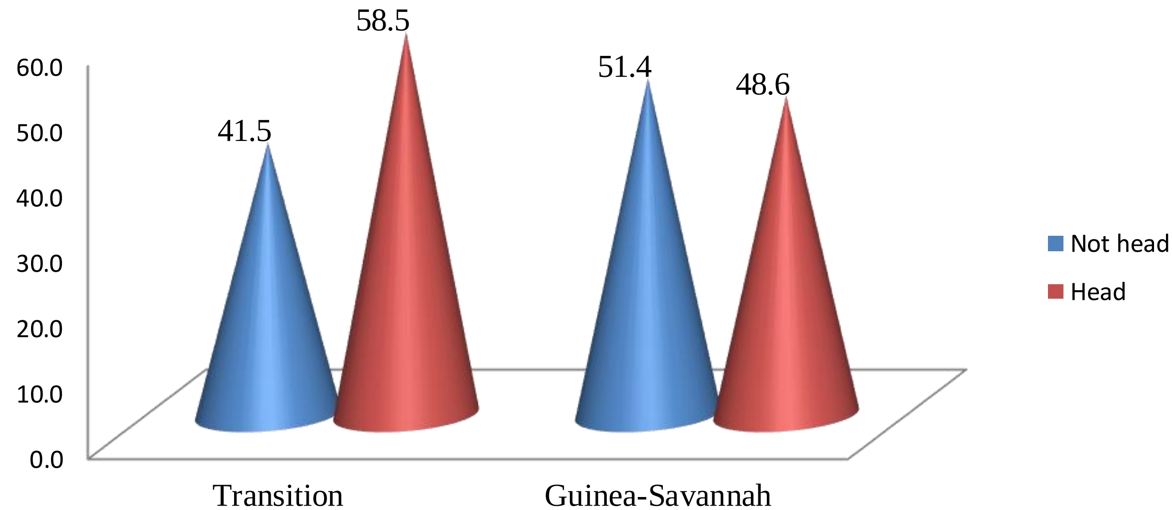

Figure 4.3 Household headship of farmers in the study areas

Source: Field Survey

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4.2.5 Marital Status

The results show that 91.5% (322) of the total farmers are married while 8.5% (30 farmers) are not as indicated in Table 4.2 below. Married people are respected in most African societies and may therefore be given more consideration in fertiliser allocations.

For the Transition Zone, 91.5% of the farmers are married while 8.5% are not as indicated in Table 4.2 below. In the Guinea savannah Zone, 91.4% are married while 8.6% are not married.

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Table 4.2 Marital Status of farmers in the study areas

Marital Status	Transition zone		Guinea savannah zone		Pooled	
	Freq.	%	Freq.	%	Freq.	%
Not Married	11	8.5	19	8.6	30	8.5
Married	119	91.5	203	91.4	322	91.5
Total	**130**	**100**	**222**	**100**	**352**	**100**

Source: Field Survey

4.2.6 Education

Farmers were first asked if they had any formal education. The results (Table 4.3) show that 85.5% of the total farmers do not have formal education while only 14.5% of total farmers have a formal education as indicated in Table 4.3 below. The results therefore indicate a high illiteracy rate among maize farmers in both ecological zones.

The results also show a high illiteracy rate among farmers, 85.2% in the Guinea savannah zone and 86.2% in the Transition zone. The low level of education among the farmers may affect their ability to access and process information on new technologies and modern farming practices. Generally, however, farming, especially small scale cropping is dominated by the less educated in the Ghanaian society as those with higher formal education seek white collar jobs.

Among those with formal education, the highest percentage (35.3%) had 7-9 years of formal education, indicating that they had formal education up to JHS. This was followed by those with over 14 years of formal education as they represent 31.4% of the total number of farmers with

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formal education. Only 5.9% of the farmers had primary education. However, it can be observed from the table that majority of the farmers in the Transitional zone had a higher formal education, at least from SHS (10 years) and below than in the Guinea Savannah zone.

Table 4.3 Education status of farmers in the study areas

Years of Education	**Transition zone**		**Guinea savannah zone**		**Pooled**	
Level of education	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**
No formal	112	86.2	189	85.2	301	85.5
Formal	18	13.8	33	14.9	51	14.5
Total	**130**	**100.0**	**222**	**100.0**	**352**	**100.0**
Years of formal education						
1-6	1	5.6	2	6.1	3	5.9
7-9	5	27.8	13	39.4	18	35.3
10-13	5	27.8	9	27.3	14	27.5
14+	7	38.9	9	27.3	16	31.4
Total	**18**	**100.0**	**33**	**100.0**	**51**	**100.0**

Source: Field Survey

4.2.7 Land Tenure

The land tenure system may affect land investment and to the large extent productivity of farms. The majority of the farms (51.4%) in both ecological zones used family land, followed by those who used own land (40.3%), and others (7.7%) who used communal or hired lands. as indicated in Table 4.4 below.

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Table 4.4 Land Tenure Systems of farmers in the study area

Farm Ownership	**Transition**		**Guinea savannah**		**Pooled**	
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**
Family	56	43.1	125	56.3	181	51.4
Rented	17	13.1	0	0	17	4.8
Self	51	39.2	91	41.0	142	40.3
Other	6	4.6	6	2.7	12	3.4
Total	**130**	**100%**	**222**	**100%**	**352**	**100%**

Source: Field Survey

In the Transition zone, 43.1% of farmers used family lands, 39.2% of farmers own their land, 13.1% rented their land and 6.1% got their land through other means. On the other hand, results from the Guinea savannah zone show that 51.4% of farmers use family land, 40.3% of farmers use their own land and 2.7% obtained their land through other means.

Analyses of the results show that there are more family owned lands in the Guinea savannah zone (51.4%) than in the Transition zone (43.1%). From the result, it can be noted that majority of the farmers used family or own land. This is important for the sustainability of maize production in the study area, considering the role of land in most conflicts in the country.

Moreover, rented lands are uncommon in the Guinea savannah compared to the Transition zone revealing the ease with which land can be accessed in the Guinea savannah zone.

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4.2.8 Experience of farmers in the study areas

The results show that the average experience of farmers interviewed is 29.2 years as indicated in Table 4.5 below.

The distribution of the experiences of farmers show that in the Transition zone, the highest percentage of the farmers in that zone (29.2%) have experience of 11-20 years while in the Guinea savannah zone, the highest percentage of the farmers (37.4) have experience of 21-30 years as indicated in the table below. This implies that farmers have a great deal of experience with their occupation and are therefore expected to bring it to bare in improving farm level productivity.

Table 4.5 Experience of farmers in the study areas

Experience (Years)	**Transition zone**		**Guinea savannah zone**		**Pooled**	
Average Experience	25.4		31.4		29.2	
Total Farmers	**130**		**222**		**352**	
Distribution of Experience						
Interval	**Transition**		**Guinea savannah**		**Pooled**	
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**
1-10	21	16.2	2	0.9	23	6.5
11-20	38	29.2	36	16.2	74	21.0
21-30	36	27.7	83	37.4	119	33.8
31-40	9	6.9	57	25.7	66	18.8
41-50	15	11.5	16	7.2	31	8.8
50+	11	8.5	28	12.6	39	11.1
Total	**130**	**100.0**	**222**	**100.0**	**352**	**100.0**

Source: Field Survey

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4.2.9 Distribution of Maize Farm Sizes

The table below shows the summary and distribution of farm size of farmers in hectares.

This is measured as the part of land dedicated to maize production in hectares. Farm sizes given in acres and other units were converted to hectares. The size of the farm is significant in increasing output (increasing output of maize has been associated with increasing land size over the years) and may as well affect the efficiency of farmers depending on their abilities.

Maize farms of farmers in the Transition zone range from 0.8ha to 6.9ha with an average of 2.1ha while for the Guinea savannah zone, farmers' maize farms ranged from 0.4ha to 6.9ha. The results as indicated in the table below shows that 56.3% of total farmers own land less than 2.01ha, while 4.8% use land greater than 4.0 ha.

In the Transition zone, 66 farmers (50.8% of farmers) own land less than 2.01 compared to 59.5% of farmers in the Guinea savannah zone. Also, 31.5% of farmers in the Transition zone own maize farm sizes between 2.01 and 3.00 ha while 31.8% of farmers in the Guinea savannah zone own land within the same farm interval. Moreover, farmers with maize farm size greater than 3.0ha constitute 17.7% and 8.6% in the Transition and the Guinea savannah zones respectively. The results therefore suggest the dominance of smallholder farmers in the agricultural sector.

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Table 4.6 Maize farm sizes *in the study area (ha)*

Farm Size (ha)	Transition zone		Guinea savannah zone		Pooled	
Mean	2.1		1.8		1.9	
Minimum	0.8		0.4		0.4	
Maximum	6.9		5.3		6.9	
Total	**130**		**222**		**352**	
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**
0-2	66	50.8	132	59.5	198	56.3
2.01-3.00	41	31.5	71	32.0	112	31.8
3.01-4.00	14	10.8	11	5.0	25	7.1
4.01+	9	6.9	8	3.6	17	4.8
Total	**130**	**100**	**222**	**100**	**352**	**100**

Source: Field Survey

4.2.10 Access to Extension Services

The farmers were asked to indicate whether or not they had had contact with extension officers during the farming season and if they had, the number of times of contact they had. The findings are shown in Table 4.7.

Majority of the total farmers (55.4%) answered positive, thus had extension visit at least once during the crop season. The farmers are therefore expected to be abreast with knowledge on the fertiliser subsidy programme as well as other modern farming practices. As indicated in the table below, majority of farmers in the Guinea savannah zone (57.7%) and the Transition zone, (51.5%) had extension visits.

From the result, majority of the farmers (55.4%) had contact, at least once with extension officers during the crop season. In the Guinea savannah zone, 57.7% had extension service; 31.5% of them were visited once and the remaining 26.2% had at least two visits from extension officers. In the Transition zone, 51.5% had extension services; 26.2% of them were visited once and the remaining 25.3% had at least two visits. Extension services are very vital in agriculture, especially, in providing education and training of farmers. In recent times also, extension officers are able to introduce farmers to new technologies and also train them on the use of these new technologies. The fertiliser subsidy programme is managed by MoFA, specifically, the extension officers. Therefore, the fact that majority of the farmers had contact with extension officers means that the farmers were at least aware of the programme and are expected to have access to the fertiliser subsidy and to make use of modern agricultural practices to enhance maize output.

Table 4.7 Access to Extension Services by farmers in the study areas

Extension Visits	**Transition zone**		**Guinea savannah zone**		**Pooled**	
No Extension Visit	63	48.5	94	42.3	157	44.6
Extension visit	67	51.5	128	57.7	195	55.4
Total	**130**	**100%**	**222**	**100%**	**352**	**100%**
			Extension Visits			
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**
0	63	48.5	94	42.3	157	44.6
1	34	26.2	70	31.5	104	29.5
2	31	23.8	51	23.0	82	23.3
3	2	1.5	7	3.2	9	2.6
Totals	**130**	**100**	**222**	**100**	**352**	**100**

Source: Field Survey

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4.2.11 Livestock Ownership and Value

Livestock value is an important measure of a farmer's wealth. It also serves as a cheap source of organic manure for farmers who use them. Farmers were first asked if they owned any livestock and then further questions were asked about the value of the livestock.

Table 4.8 Livestock Ownership

Livestock	**Transition zone**		**Guinea savannah zone**		**Pooled**	
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**
No Livestock	44	33.9	94	42.3	138	39.2
Livestock	86	66.2	128	57.7	214	60.8
Totals	**130**	**100**	**222**	**100**	**352**	**100**
Livestock Value						
Mean Livestock Value	9314.40		4841.70		6639.10	
Minimum	120.00		370.00		120.00	
Maximum	74600.00		86500.00		86500.00	
Total Farmers	**86**		**128**		**214**	

Source: Field Survey

On whether farmers rear livestock, 60.8% of the total farmers rear livestock in addition to maize crop farming while 39.2% do not as in the table below. In the Transition zone, the results show that 66.2% of farmers in that zone rear livestock as against 57.7% of farmers in the Guinea savannah zone.

With respect to the value of livestock, on average every rearer of a livestock owns livestock worth GH₵6639.10; farmers with livestock in the Transition zone own an average of GH₵9314.40 while those in the Guinea savannah zone own an average of GH₵4841.70

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4.2.12 Access to Agricultural Credit, FBO Membership, Improved Seed Use, Organic manure use, off farm activities of farmers, mono cropping and commercial farming.

The table below represents the below dummy variables in the study areas.

Access to agricultural credit by farmers

Credit is an important component of every economic activity. In the case of farmers, they receive cash or kind credits. From Table 4.9 below, there was a low level of credit access across the ecological zones (14.5%) as against 85.5% who had no access to agricultural credit. Specifically, credit access in the Guinea savannah zone is 8.1% compared to the Transition zone (25.4%). The low access to credit may be as a result of the high default rate and the lack of collateral to support access to credit. One of the key inputs farmers use their cash credits to acquire is fertiliser. Therefore, the fact that some farmers had access to subsidised fertiliser would mean that the demand for cash credit by these maize farmers would be low.

Farmer Based Organisation (FBO)

The results show that in the Transition zone, 52.3% belong to FBO while the remaining 47.7% do not. In the Guinea savannah zone, majority of the farmers (60.8%) do not belong to any FBO. Group membership is very essential in accessing agricultural credit schemes and subsidised fertiliser. It is also essential in determining technical efficiency of farmers.

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Improved/Hybrid Seed Use

Farmers who adopt improved seed are more likely to use fertiliser to improve productivity. The results show low adoption of improved/hybrid maize seed, which is equally important in improving productivity. Adoption of improved/hybrid seed in the Transition zone is 40.8% with the remaining 59.2% using the conventional seeds. In the Guinea savannah zone, 29.3% use improved seed. If the desired productivity levels are to be achieved, fertiliser and improved seeds must be used together. This low adoption of improved seed may therefore affect efforts at increasing productivity and efficiency of smallholder farmers in Ghana.

Organic Manure Use

This is an alternative soil improvement material. As indicated in the table below, in the Transition zone, 27.7% of the farmers use organic material as against 41.4% in the Guinea savannah zone. There is, therefore, high use of organic manure in the Guinea savannah zone than in the Transition zone.

Off Farm Activities

Farmers were asked if they are involved in any off farm activities. The results show that in the Transition zone, 46.9% involve in other farm activities while in the Guinea savannah zone, 49.5% involve in non-farm activities. Farmer's engagement in off farm activities affect time allocation for main farm activities and may therefore affect efficiency. However, if resources obtained from such activities are invested in the purchase of fertiliser and other inputs, productivity and technical efficiency will be improved.

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Mono cropping

On the cropping system used by farmers in the study area, 66.9% of farmers in the Transition zone practice mono cropping while the remaining 33.1% grow other crops in addition to maize. In the Guinea savannah zone, 78.4% of the farmers practice mono cropping while 22.6% do not as indicated in Table 4.9 below.

Commercial Farming

Farmers who are more likely to sell their produce are more likely to invest in their farms so as to get enough for their family sustenance and the rest for sale. The table below represents the results on farmers who sold part of their produce. Famers were asked if they sold part of their produce. Commercial farming is coded 1 if a farmer sold some maize output and 0 otherwise.

The results, as in the table below show that majority of the farmers (77.3%) reported selling some of their output to supplement their domestic needs and provide basic needs while large scale farmers sell their excess output to provide other needs. In the Transition zone, 78.5% of the farmers reported selling some of their output while 76.6% of farmers in the Guinea savannah zone sold some of their output.

Table 4.9 Agricultural Credit, FBO, Improved seed, organic manure, off farm and commercial farming

Variables	Categories	Transition zone		Guinea savannah zone		Pooled	
		Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**
Credit Access	0=No Credit	97	74.6	204	91.9	301	85.5
	1=Credit	33	25.4	18	8.1	51	14.5
FBO Membership	0=No FBO	62	47.7	135	60.8	197	56.0
	1=FBO	68	52.3	87	39.2	155	44.0
Hybrid seed use	0=No Hybrid	77	59.2	157	70.7	234	66.5
	1=Hybrid	53	40.8	65	29.3	118	33.5
Organic manure use	0=No	94	72.3	130	58.6	224	63.6
	1=Yes	36	27.7	92	41.4	128	36.4
Off farm activity	0=No	69	53.1	112	50.5	181	51.4
	1=Yes	61	46.9	110	49.5	171	48.6
Mono Cropping	0=Other	43	33.1	48	21.6	91	26.9
	1=Mono	87	66.9	174	78.4	261	74.1
Commercial Farming	0=No	28	21.5	52	23.4	80	22.7
	1=Yes	102	78.5	170	76.6	272	77.3
	Total	**130**	**100%**	**222**	**100%**	**352**	**100%**

Source: Field Survey

4.3 Access to the GFSP

4.3.1 Access to the GFSP

Access to the GFSP is low as indicated in the figure below

The results show that in both Transition and Guinea savannah zones, those who accessed fertiliser at the subsidised rate among farmers constitute 42.3% while the remaining 57.7% did not get subsidised fertiliser. The results show low access among farmers partly due to the difficulty in accessing subsidy coupons and also due to the growing demand for fertiliser. Despite the government's continuous increase of quantity fertiliser under the GFSP, demand continues to outweigh supply, hence the need for the programme to effectively target poor farmers who could otherwise could not have purchased fertiliser at the commercial rates.

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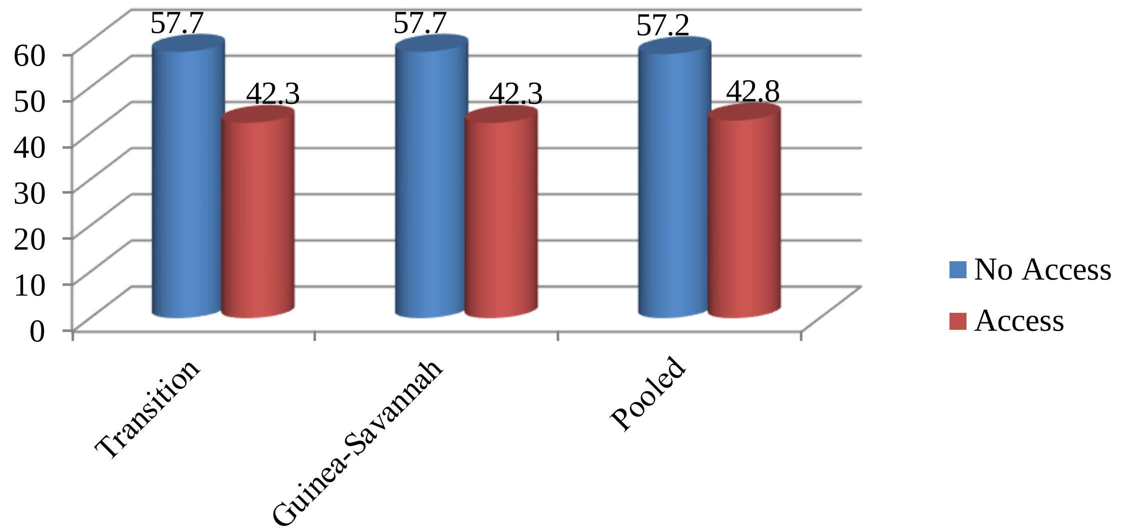

Figure 4.4 Access to the GFSP

Source: Field Survey

4.3.3 Quantity of Subsidised Fertiliser

Average quantity received by beneficiaries is 379.2kg as indicated in the table below. The average quantity received by beneficiaries in the Transition zone is 410.9kg while in the Guinea savannah zone, the average quantity is 330.1kg as indicated below. The distribution chart below indicates that majority of the farmers (83.3%) received quantities between 50-250kg. Also in the Transition zone, majority of the farmers who benefited from the programme (81.8% of the farmers) received 50-250kg as it is the case in the Guinea savannah zone (84.2%). Moreover, 300-500kg of subsidised fertiliser went to 14.7% of beneficiaries in the Tradition while in the Guinea savannah zone 13.7% of the beneficiaries received 300-500kg of fertiliser as indicated in the table below. Since 83.3% of farmers (beneficiaries) received maximum of 5 bags of the 50kg (250 kg), it implies that quantities received by each farmer may not be enough to trigger the necessary improvement in technical efficiency of farmers.

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Table 4.10 Quantity of subsidised fertiliser received

Quantity Received (kg)	Transition zone		Guinea savannah zone		Pooled	
Average Quantity	195.5		179.5		379.2	
Minimum	50		50		50	
Maximum	700		1000		1000	
Total Farmers	**55**		**95**		**149**	
Distribution of Quantity of Fertiliser Subsidy Received						
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**
50-250	45	81.8	80	84.2	125	83.3
300-500	9	16.4	13	13.7	22	14.7
550-750	1	1.8	0	0.0	1	0.7
800-1000	0	0.0	2	2.1	2	1.3
Total	**55**	**100.0**	**95**	**100.0**	**150**	**100.0**

Source: Field Survey

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4.3.2 Commercial Fertiliser

Apart from the GFSP, farmers also acquire fertiliser at commercial rates from fertiliser retailers and wholesalers either to complement the quantity they receive from government at the subsidised rate or as their main source of fertiliser supply.

The results in the table below show that 66.2% of farmers acquired fertiliser at the commercial market rates. In the Transition zone, 68.5% of the farmers acquired fertiliser at the commercial rates while in the Guinea savannah zone 64% of the farmers acquired fertiliser at the commercial markets.

In terms of quantities, the results show that on average, farmers acquired 356.4kg of fertiliser at the commercial rate. Farmers in the Transition zone have acquired an average of 394kg of fertiliser from the commercial market as against farmers in the Guinea savannah zone who acquired an average of 332kg of commercial fertiliser. This indicates the relatively poor financial standing of farmers in the Guinea savannah zone and is in line with the relative poverty rates in Ghana. Agricultural credit schemes must therefore be intensified to provide inputs including fertiliser to farmers and complement the GFSP.

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Table 4.11 Purchase of Commercial Fertiliser by farmers in the study

Commercial Fertiliser	**Transition zone**		**Guinea savannah zone**		**Pooled**	
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**
No	39	31.5	80	36.0	119	33.8
Yes	91	68.5	142	64.0	233	66.2
Total	**130**	**100**	**222**	**100**	**352**	**100**

Quantity of Fertiliser at Commercial Rate			
Average Quantity	394.5	332	356.3
Minimum	50	50	50
Maximum	1600	900	1600
Total Farmers	**91**	**142**	**233**

Source: Field Survey

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4.3.3 Distance to Fertiliser Wholesaler/Retailer

Nearness of farmers to sources of fertiliser inputs enhances access to the GFSP. Fertiliser coupons received by farmers at the MOFA offices are redeemed at the various private fertiliser retail points across the country. The table below summarises the average time taken by farmers to get to the nearest wholesaler or retailer.

The results show that average time taken by farmers in the Transition zone to the nearest fertiliser retailer is 95 minutes (I hour 35 minutes) while in the Guinea savannah zone, farmers take an average of 93.2 minutes (1 hour, 33 minutes).

Table 4.12 Distance of farmers to source of fertiliser

Time to Wholesaler (mins)	**Transition zone**	**Guinea savannah zone**	**Pooled**
Average time	95.4	100	93.2
Time to Retailer (mins)			
Average time	56	56	56
Total Farmers	**130**	**222**	**352**

Source: Field Survey

4.3.4 Political Influence

To account for the effect of political influence on fertiliser subsidy, a question was asked to each farmer, which political party won in the last poll at the station where she/he voted and the results tabulated below. Since the National Democratic Congress (NDC) won in 2012 and will rule till

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2016, the dummy variable (Political Influence) is included in the adoption model. Political influence=1 if NDC won at the farmer's polling station in 2012 and 0 otherwise.

The results of which indicate that in the Transition Zone, 44.6% of the farmers reported that NDC won at their voting centres while in the Guinea savannah zone, 43.5% of the farmers reported NDC won.

Table 4.13 Election outcomes at farmers' Polling Stations

NDC won	**Transition zone**		**Guinea savannah zone**		**Pooled**	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
No	72	55.4	127	57.2	199	56.5
Yes	58	44.6	95	42.8	153	43.5
Total	**130**	**100**	**222**	**100**	**352**	**100**

Source: Field Survey

4.3.5 Determinants of Access to the GFSP (Probit Results)

The marginal effects of these factors on the probability of receiving a fertiliser subsidy are reported in Table 4.14 below. The results show that access to the GFSP is not significantly different between farmers in the Transition and the Guinea savannah zones.

The models explain about 42% and 52% of the determinants of access to the GFSP as indicated by the Pseudo R^2. The Wald X^2 statistics show that we reject the null hypotheses that the marginal effects are equal to zero at the 1% significance level.

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Results of the probit regression in the Transition zone indicates that age, sex, household headship, use of improved seed, off farm activities and political influence all have significantly positive effects and therefore increases the probability of individuals to participate or have access to subsidised fertiliser. On the other hand education, household size, quantity of commercial fertiliser and time to the nearest fertiliser retailer have significantly negative effect and therefore reduces the probability of farmers to participate or have access to subsidised fertiliser in the Transition zone.

The results indicate that in the Guinea savannah zone household headship, sex, number of extension visits, use of improved seed, commercial farming and political influence all have significantly positive effects and therefore increases the probability of individuals to participate or have access to subsidised fertiliser. On the other hand, education, household size, quantity of commercial fertiliser used and time to the nearest fertiliser retailer have a significantly negative effect and therefore reduces the probability of farmers to participate or have access to subsidised fertiliser in the Guinea savannah zone.

Household headship (farmers position in the household) has the *a priori* sign in both zones but significant only in the Guinea savannah zone. The results show that household heads receive 27% of subsidised fertiliser than non-household heads in the Guinea savannah zone. The positive sign is expected as household heads are better positioned, well connected and seen as more representative of their households in social programmes.

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The results also show that the male-headed households are more likely to access the fertiliser subsidy and the probability increases by as much as 38% in the Transition zone and 59% in the Guinea savannah zone than the female headed households. This shows that there is gender discrimination in the distribution of fertiliser subsidy, and thus, undermines efforts aimed at empowering women and improving productivity of women who constitute the majority of Ghana's population.

Also, educated farmers are less likely to access subsidised fertiliser and the probability of receiving subsidy in each zone decreases by 5% as a person increases her/his years of formal education. This may be so because, educated farmers are endowed and can therefore acquire fertiliser at the commercial rates. It could also be because educated people are less interested in farming and invest less in terms of fertiliser application.

Moreover, small households are more likely to receive subsidised fertiliser. The results show that the probability of a household receiving subsidised fertiliser reduces by 2% in each zone as household sizes increases by a unit.

Generally, awareness of the subsidy programme increases probability of access to the subsidy. Extension officers usually disseminate information on modalities for accessing the GFSP. Therefore, it is not surprising that farmers who had more contact with extension officers had a higher probability of accessing subsidised fertiliser. The results show that number of extension visits has the *a priori* positive sign in both zones but significant only in the Guinea savannah

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zone. Thus, the result shows that an additional extension visit increases farmer's probability of accessing the GFSP by 15% in the Guinea savannah zone.

The type of fertiliser supplied by the GFSP is the same as those sold in the commercial market. This means that the only difference is as a result of the subsidy in the GFSP. It is therefore not surprising that buying fertiliser at the commercial rate reduces the probability of a farmer's access to fertiliser subsidy by 4% in the Transition Zone and 3% in the Guinea savannah zone. This implies that the subsidy is targeted at farmers who cannot buy fertiliser at the commercial rate. This result may also imply that the implementation of the GFSP does not crowd out private fertiliser suppliers. The finding is consistent with that of Chirwa, Matita and Dorward (2011) who found that households that bought fertiliser at the commercial rate in the past season had a less probability of access to subsidy coupons marginally by 0.02%.

Similarly, farmers that engaged in commercial agriculture (those that sold some of their crop output) are more likely to access fertiliser and increase the probability of receiving fertiliser subsidy by 21% in the Transition zone and 28% in the Guinea savannah zone. This implies that subsidised fertilisers are likely to be received by smallholder farmers who engage in maize production for both cash and subsistence. This finding is consistent with the literature on the subsidy of fertiliser (Chirwa, Matita and Dorward, 2011).

The distance to the source of input is hypothesised to have an inverse relationship with the ability to acquire such inputs. Time taken to the nearest fertiliser subsidy retailer as expected has a negative sign but significant only in the Guinea savannah zone. The result implies that as the

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distance to the nearest fertiliser retailer increases, the probability of accessing subsidised fertiliser decreases by 0.6% in the Guinea Savannah zone. This confirms the work of Marika and Banful (2010).

Table 4.14 Results of the Probit Model on Determinants of Access to the GFSP

	Transition zone		**Guinea savannah zone**		**Pooled**	
Access to Fertiliser Subsidy	**dy/dx**	**SE**	**dy/dx**	**SE**	**dy/dx**	**SE**
Age	0.01*	0.006	0.002	0.004	0.005	0.003
Household Headship (Dummy)	0.146	0.146	0.27***	0.095	0.203***	0.077
Sex (Male=1)	0.380***	0.129	0.592***	0.099	0.483***	0.078
Education (years)	-0.053***	0.017	-0.049***	0.018	-0.053***	0.012
Household size	-0.025**	0.013	-0.021*	0.011	-0.019***	0.007
Extension Visits	0.042	0.09	0.152**	0.068	0.117**	0.051
Credit Access	-0.056	0.151	0.221	0.197	-0.042	0.104
Organic manure	0.074	0.147	-0.162	0.106	-0.04	0.081
Improved seed	0.302**	0.136	0.3**	0.131	0.232***	0.086
Commercial farming	0.212	0.148	0.275***	0.1	0.202**	0.083
Commercial Fertiliser (kg)	-0.04**	0.018	-0.034*	0.019	-0.001***	0.002
Off farm	0.323**	0.157	0.258**	0.117	0.294***	0.092
Livestock value	-0.007	0.018	-0.018	0.014	-0.009	0.011
Farm size (ha)	0.25	0.295	0.207	0.196	0.151*	0.084
Time to retailer (mins)	-0.009**	0.005	-0.008**	0.003	-0.009***	0.003
Political influence	0.657***	0.091	0.6***	0.071	0.605***	0.054
Ecological Zone (Guinea savannah=1)					0.111	0.074
Pseudo R-Square	**0.5167**		**0.424**		**0.441**	
LR χ^2	**91.51*** **		**128.62*** **		**211.79*** **	
Log Likelihood Ratio	**-42.8**		**-87.26**		**-134.24**	

Where *, **, and * implies significance at 10%, 5% and 1% respectively**

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The effect of politics on the targeting of subsidy programmes in Africa and Ghana cannot be underestimated. The results show that political influence increases farmer's probability of access to subsidised fertiliser by as much as 66% in the Transition zone and 60% in the Guinea savannah zone. This finding is consistent with the findings of Mason, Jayne and van de Walle (2013) that the fertiliser subsidy coupons in Zambia were received more in places where the government won in the last election.

Organic manure is common in the Guinea savannah zone and used as a soil improvement material and mostly as an alternative to inorganic fertiliser use. It is therefore hypothesised to be inversely related to inorganic fertiliser use. It has the *a priori* (negative) sign in the Guinea savannah zone, but in the Transition zone, the sign is positive but insignificant in both zones.

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4.4 Effect of Fertiliser Subsidy on Maize output

4.4.1 Hypotheses Tests

Tests of hypotheses for the coefficients of the technical inefficiency effects are presented in Table 4.15 below

The first hypothesis tested is that $H_0 = \delta_{01} = \delta_{02} = \ldots = \delta_{07} = \delta_1 = \ldots = \delta_5 = \gamma = 0$, which indicates that all the coefficients of the explanatory variables of the inefficiency model are simultaneously equal to 0. Thus, the explanatory variables in the inefficiency model do not influence the technical inefficiencies in maize production. This null hypothesis is rejected in favour of the alternative hypothesis that the explanatory variables in the inefficiency model explain the technical inefficiencies in maize production.

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Secondly, the hypothesis that the household specific factors do not influence the technical inefficiencies $H_0 = \delta_{01} = \delta_{02} = \ldots = \delta_{07} = \delta_1 = \ldots = \delta_5 = 0$ is also tested. Again this null hypothesis is also rejected at 5% significance level.

The third null hypothesis in Table 4.36, $H_0 : \beta ij = 0$ for all $i \leq j = 1, 2, \ldots, 4$, states that the second-order coefficients in the translog production function have zero values and, if this hypothesis is true, then the translog production becomes a Cobb-Douglas production function. For both ecological zones, this null hypothesis is rejected at 1% level of significance in favour of the alternative hypothesis that the correct functional form for this study is the translog production function.

The fourth hypothesis tested was for the predicted values of the access to be included in the production function. Again, the null hypothesis is rejected in both regions in favour of the alternative that the predicted values of the access to the GFSP be included in the production function.

Table 4.15 Test of hypotheses

Null Hypotheses	**Transition zone**		**Guinea savannah zone**	
	Λ	**Critical Value**		**Critical Value**
$H_0 = \beta_{ij} = 0$ for all $i \leq j = 1,2,\ldots,= 4$	30.5**	11.91	23.68**	11.91
$H_0 = \delta_{01} = \delta_{02} = \ldots = \delta_{07} = \delta_1 = \delta_2 = \ldots = \delta_5 = \gamma = 0$	45.52**	20.41	107.62**	20.41
$H_0 = \delta_{01} = \delta_{02} = \ldots = \delta_{07} = \delta_1 = \delta_2 = \ldots = \delta_5 = 0$	57.1**	19.05	75.12**	19.05
$H_0 = \beta_4 = 0$	14.34***	2.71	3.2***	2.71

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4.4.2 Empirical Results 2: Stochastic Frontier Production Function

The maximum-likelihood estimates of the parameters of the translog stochastic frontier production functions of the two zones are presented in Table 4.16 below. Initial test of hypothesis indicates that separate production functions should be used in analysing technical efficiency of maize farmers in both ecological zones.

The estimated gamma (γ) parameter is 0.9999999 in the Transition zone and 0.99999997 in the Guinea savannah zone are significant at 1% which means that the technical inefficiency effects are significant in determining the level and variability of maize output. The estimated gamma values imply that 99.9% of the total variation in maize output is due to technical inefficiency.

The values of the explanatory variables in the translog stochastic frontier model were mean-corrected by subtracting the means of the variables so that their averages were zero. This approach enables the first-order coefficients of the input variables to be interpreted as estimates of output elasticities for the individual inputs at the mean input values (Asante et al., 20140.

All estimated first-order coefficients in the production function fall between zero and one, except those for farm size and labour in the Transition zone. The results indicate that Organic manure use and farm size have significant effects on maize output in both zones. However, fertiliser quantity and access have significantly positive effects on maize output only in the Guinea savannah zone while in the Transition zone, labour has negative but insignificant effect on maize output.

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Table 4.16 Maximum Likelihood Estimates for parameters of the Translog Stochastic Production Function

		Transition zone		**Guinea savannah zone**		**Pooled**	
Variables	**Parameter**	**Coefficient**	**SE**	**Coefficient**	**SE**	**Coefficient**	**SE**
Constant	B_0	8.71***	0.02	7.76***	0.06	9.04***	0.14
Organic Manure	B_1	0.10***	0.02	0.23***	0.05	0.05**	0.06
Farm size	B_2	1.14***	0.04	0.81***	0.06	0.41***	0.08
Labour	B_3	-0.03	0.03	0.01	0.05	0.03	0.05
Fertiliser	B_4	0.00	0.01	0.12***	0.02	0.27***	0.06
Access	B_5	0.01**	0.01	0.03***	0.01	0.18***	0.05
Farm Square	B_6	0.44***	0.10	0.28***	0.08	-0.07	0.08
Labour square	B_7	-0.25***	0.06	-0.03	0.04	-0.01	0.07
Fertiliser Square	B_8	-0.02***	0.00	0.01***	0.00	-0.01	0.07
Access square	B_9	0.00	0.00	0.01**	0.00	0.02***	0.01
Farm × Labour	B_{10}	0.18***	0.07	0.00	0.09	-0.04	0.13
Farm × Fertiliser	B_{11}	-0.14***	0.01	-0.09***	0.02	0.01	0.14
Farm × Access	B_{12}	0.07***	0.01	0.06**	0.03	-0.01	0.13
Labour × Fertiliser	B_{13}	0.20***	0.01	0.01	0.02	0.15*	0.08
Labour × Access	B_{14}	-0.04***	0.02	0.00	0.02	0.01	0.02
Fertiliser × Access	B_{15}	0.02***	0.00	0.02***	0.01	0.05*	0.03
Ecozone	B_{16}					-0.12	0.02
Log Likelihood		**9.748**		**4.06**		**-99.25**	
LR Test		**102.34**		**182.74**		**269.65**	
Sigma Square		**0.207*** **		**0.325*** **		**0.12*** **	
Gamma	**1.00*** **			**1.00*** **		**1.00*** **	

Where *, ** and *** indicates significance at 10%, 5% and 1% respectively.
Source: Field Survey

It is further revealed that including the predicted values of 'access' has a significantly positive effect of 0.01 and 0.03 units on maize production in the Transition zone and the Guinea savannah zones respectively.

In the Guinea savannah zone, all four inputs have a positive and significant effect on productivity of maize. Maize farm size, labour and fertiliser have partial output elasticities of about 0.81, 0.01 and 0.12 respectively. This implies that a 10% increase in each of the inputs will increase maize output by 8.1%, 0.1% and 1.2% respectively in the Guinea savannah zone. Farm size remains the most important input in maize crop production in the study areas since it has the largest elasticity value. This observation is easily explained by the relative ease with which land can be accessed. In the Transition zone farm size and access have partial elasticities of 1.14 and 0.01 which implies that a 10% increase in the farm size and probability of access will increase maize output by 11.4% and 0.1% respectively. On the other hand, labour has a negative partial elasticity of 0.03 which means increasing labour quantity by 10% will decrease maize output by 0.3%.

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4.5 Fertiliser Subsidy and Technical Efficiency of Smallholder Farmers in Ghana

4.5.1 Determinants of Technical Inefficiency

The estimated coefficients of the inefficiency effects model for these two zones are presented in Table 4.17 below.

The results show that the access to subsidised fertiliser is significant and has a positive effect on technical inefficiency in both agro-ecological zones. The positive effect shows that increased access to subsidised fertiliser decreases the level of technical efficiency of maize production. In other words, farmers who had access to subsidised fertiliser were less technically efficient than

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those who did not. Accessing subsidised fertiliser has been reported challenging, especially, in getting the subsidy coupon. Farmers therefore spend more time in queue before getting the fertiliser. Also, farmers who had access to the subsidised fertiliser might have purchased higher quantities and then tend to be reluctant during the cropping season; thinking that the use of larger quantities of fertiliser in itself is enough for higher gains. The reasons for the estimated low technical efficiency of farmers who accessed subsidised fertiliser can therefore be attributed to the administrative bottlenecks that characterises the distribution and access to the fertiliser subsidy.

The results of both zones further show lower technical efficiency for male farmers, but high technical efficiency for farmers who had more contact with extension officers and farmers who practice mono cropping.

The results therefore indicate that being a male farmer decreases technical efficiency in both zones. This is similar to the findings of Onyenweaku and Effiong (2005) and Dolisca and Jolly (2008) that being a male farmer decreases technical efficiency.

Extension services are very essential in agricultural productivity improvement since they provide technical advice to the farmers and also introduce by demonstration, new technologies to the farmers. Hence, farmers are able to perform their farm activities with greater efficiency, reflecting in their overall technical efficiencies. This result is similar to the conclusion reached by Kalirajan (1981), Owens, Hoddinott and Kinsey (2001) and Lindara, Johnsen and Gunatilake (2004).

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Mono cropping also has significant impact on technical inefficiency of farmers in both zones. The results show a negative correlation between technical inefficiency and the practice of mono cropping. The mono cropping dummy is significant in both zones implying that those who grow only maize are more technically efficient than those who grow multiple crops. This result meets the *a priori* expectation and may be explained by the fact that practising mono cropping not only enable farmers to work tirelessly, but also ensures maize farmers invest more in terms of fertiliser and other inputs. This result agrees with the findings of Nchare (2007) and Addai (2011).

In the Transition zone, farm size had a positive effect on technical inefficiency. This means that farmers who have larger farms were less efficient. This could be as a result of managerial deficiency in managing the larger farms.

Age and off farm have significantly negative effect on technical inefficiency in the Guinea savannah zone. The negative effect of age indicates that older farmers are more technically efficient than younger farmers. This is so because as a farmer ages in the farming business, the farmer garners more experience and therefore becomes more efficient.

The negative off farm coefficient means that efficiency was higher for farmers with off farm activity. This may be possible due to farmers' investment of income earned from non-farm activities to purchase fertiliser and other inputs to improve farm level productivity. This finding

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is contrary to the findings of Nchare (2007), Abdulai and Huffman (2000), and Addai (2011) who argued that non- farm labour supply curtails farming efficiency.

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Table 4.17 Determinants of Technical Inefficiency

	Transition zone		Guinea savannah zone		Pooled	
	Coefficient	**SE**	**Coefficient**	**SE**	**Coefficient**	**SE**
Constant	-0.36	0.84	1.92**	0.98	-0.06	1.43
Access (Dummy)	0.22*	0.16	0.30**	0.15	3.03**	0.19
Male	0.64***	0.19	0.30***	0.24	-5.95***	-0.20
Extension	-0.55***	0.17	-0.76***	0.19	2.95***	0.08
Mono Cropping	-0.24**	0.14	-0.18*	0.20	-0.03***	-0.12
Credit Access	-0.16	0.20	0.46	0.28	-3.18	-0.11
FBO	0.03	0.13	0.19	0.18	-0.79**	-0.22
Off farm	-0.06	0.17	-0.69***	0.20	1.05**	0.00
Age	0.03	0.05	-0.14*	0.11	3.72	0.02
Experience	-0.04	0.05	0.13	0.11	2.94	0.13
Household size	0.00	0.01	-0.01	0.02	3.03*	0.19
Education	0.00	0.01	0.02	0.03	-5.95*	-0.20
Farm size	0.66***	0.24	0.16	0.32	2.95**	0.08

Where *, ** and *** indicates significance at 10%, 5% and 1% respectively.

Source: Field Survey

4.5.2 Distribution of Technical Efficiency

The technical efficiency scores of the individual farmers are shown in appendix B and C. The distribution of technical efficiency scores is given in Table 4.18 below.

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The estimated technical efficiency for maize producers in the Transition zone ranges from 0.16 to 1.0 with a mean of 0.687 while that of the Guinea savannah zone ranges from 0.19 to 1.0 with a mean TE of 0.689 as indicated in the table below.

The average predicted technical efficiencies are not significantly different between the two agro-ecological zones (between 0.687 and 0.689), but the distributions are quite different as indicated in the table below. There are relatively more very efficient maize farmers with technical efficiencies of more than 0.80 in the Guinea savannah zone (47.7%) than in the Transition zone (41.6%). Considering average TEs however, farmers in the Transition zone produce maize at about 68.7% of the potential (stochastic) frontier production levels, given the resources and the technology currently at their disposal. For the Guinea savannah zone, farmers produce at about 68.9% of the potential (frontier) production levels. Even though the value of the mean indicates that producers are technically efficient, it also suggests that there exist some potential to increase maize yield with the current technology. The results imply that, there is capacity for increasing maize production by 31.3% and 31.1% by adopting best practices for producing maize in the Transition zone and the Guinea savannah zone respectively.

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Table 4.18 Distribution of Technical Efficiency

Interval	**Transition zone**	**Guinea savannah zone**	**Pooled**
<0.51	28.5 (37)	26.2 (34)	29.0 (102)
0.51-0.60	12.3 (16)	6.2 (8)	9.1 (32)
0.61-0.70	10.0 (13)	8.5 (11)	9.9 (35)
0.71-0.80	7.7 (10)	11.5 (15)	9.7 (34)
0.81-0.90	18.5 (24)	16.9 (22)	19.3 (68)
0.91-1.00	23.1 (30)	30.8 (40)	23.0 (81)
Total Farmers	**130**	**222**	**352**

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Minimum TE	**0.16**	**0.19**	**0.16**
Maximum TE	**1.00**	**1.00**	**1.00**
Mean TE	**0.687**	**0.689**	**0.688**
SD	**0.2349**	**0.2365**	**0.2356**

Figures in brackets are the frequencies

Source: Field Survey

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CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter presents a summary of the main findings, conclusion drawn and recommendations emanating from the study. The limitations of the study are discussed and finally suggestions are made for future research.

5.1 Summary

This study sought to examine the impact of Ghana's fertiliser subsidy programme on maize output and technical efficiency of smallholder farmers in Ghana. Several null hypotheses were tested using a sample of three hundred and fifty-two (352) farmers drawn from two of Ghana's five agro-ecological zones. One hundred and thirty (130) of the total farmers are from the Transition zone while the remaining two hundred and twenty-two (222) are from the Guinea savannah zone. The study estimated a, probit model to examine the determinants of access to fertiliser subsidy and a Stochastic Production Frontier (SPF) to assess the impact of the fertiliser subsidy programme on maize output and technical efficiency.

From the results sex, commercial farming, use of improved seed, off farm activities and political power increases significantly the probability of access to the GFSP in both the Transition zone and the Guinea savannah zone. On the other hand, years of education, household size, distance to the nearest fertiliser retailer, quantity of commercial fertiliser and value of livestock reduces the probability of access to the GFSP in both ecological zones.

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The study also reveals that technical efficiency was higher for the farmers who had no access to subsidised fertiliser, female farmers, farmers who had contact with extension officers and farmers who practice mono cropping in both regions. In addition, efficiency was higher for smaller farm holders in the Transition zone while in the Guinea Savannah zone technical efficiency is higher for older farmers and farmers with off farm activity.

The study reveals mean TE of 68.7% in the Transition zone and 68.9% in the Guinea savannah zone. The study also reveals that access to the GFSP decreases farmers' technical efficiency by 13.7% and 5.8% in the Transition zone and the Guinea savannah zone respectively.

5.2 Conclusion

The following conclusions can be drawn from the results discussed below.

The GFSP is targeted more at farmers who reside in polling stations where the ruling government won, suggesting the use of the subsidy programme as a tool to reward voters. Also, male farmers are more likely to be allocated the subsidy passbooks than female farmers. On the other hand, long distances to the fertiliser retail point reduce farmers' access to the GFSP. And since there is less concentration of private fertiliser retailers in the rural areas where most farming activities take place, access to the programme is difficult for rural farmers.

Access to the GFSP increases maize output significantly. Thus, increasing farmers' access to the GFSP will increase crop output and stabilise food crop prices in the long run.

However, the GFSP in its current form reduces technical efficiency significantly. Even though having access to the GFSP increases maize output, it does not necessarily improve their technical efficiency. This could be as a result of the political considerations and the bureaucratic and laborious processes that characterise the distribution of the subsidy passbooks. Fertiliser passbooks may have been given to farmers who are not technically efficient.

5.3 Recommendation

In the first place and as part of improving targeting of the GFSP, the political coloration of fertiliser distribution must be minimised. This will ensure efficient targeting and that subsidised fertiliser will only go to efficient smallholder farmers who will put the fertiliser into good use. There must also be deliberate efforts aimed at providing more women with the subsidised fertiliser to ensure their participation in agriculture and improve productivity amongst the women. Also, there is the need for government as part of the GFSP to improve access to fertiliser by encouraging more private retailers to participate in the fertiliser distribution process. This will reduce distance to the source of fertiliser and increase probability of farmers' access to subsidised as well as commercial fertiliser. Thus, effective targeting of subsidised fertilisers (targeting devoid of political and gender biases) will enhance fertiliser access, fertiliser use and to the large extent agricultural productivity.

Secondly, technical efficiency for farmers in both the Transition zone and the Guinea savannah zone is low, suggesting the presence of technical inefficiency. There is the need for policy makers to develop formal and informal education programmes that will improve farmers' abilities to retrieve and process information about modern agricultural technology and improve their farm-level efficiency. Providing them with education will be a useful investment and a good mechanism for improving efficiency in maize farming. Emphasis should be placed more on providing extension officers with the needed resources to educate and improve efficiency of

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farmers in adopting modern agricultural practices and in using farm inputs including fertiliser. Finally, efforts at improving technical efficiency through provision of subsidy must include improved seed use. This will increase efficiency of farmers and hence improve productivity among smallholder farmers in Ghana.

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5.4 Limitations of the Study

No study can be without limitations. This study faced a number of challenges especially concerning access to government documents and other publications from organisations. For example, some important documents from government, MOFA containing important information and data were not readily available. Poor record keeping and lack of database on maize output of individual recipients of subsidy under the GFSP was glaring. An analysis of policy such as this requires panel data and nationally representative data to enable convincing deductions to be made and policy alternatives suggested. In the absence of such data however, cross sectional data were painstakingly collected and appropriate models used to ensure the objectives of the research are achieved without compromising the objectives of the study.

5.5 Suggestions for Future Research

In line with the below, the following areas are recommended for future research:

The estimated mixed effect of access to fertiliser subsidies needs further investigation. Therefore, further studies should consider using a panel data since it gives more information and is more suitable in measuring true impact of policy interventions such as this programme.

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Also, a joint estimation approach that jointly estimates the access and the stochastic production frontier model is suggested for future analyses instead of using the predicted values.

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REFERENCES:

Abdulai, A. & Eberlin, R. (2001). Technical Efficiency during Economic Reform in Nicaragua: Evidence from Farm Household Survey Data. *Economic Systems*, 25:113-125.

Abdulai, A. & Huffman, W. (2000). Structural Adjustment and Economic Efficiency of Rice Farmers in Northern Ghana. *Economic Development and Cultural Change*, 48(3): 503-520.

Abebaw, D. & Haile, M. G. (2013). The impact of cooperatives on agricultural technology adoption: Empirical evidence from Ethiopia. Food Policy. 38: 82-91. http://dx.doi.org/10.1016/j.foodpol.2012.10.003

Addai, K. N. (2011). *Technical Efficiency of Maize Producers in Three Agro Ecological Zones of Ghana*. KNUST, Kumasi, Ghana.

Adesina, A. A & Djato, K.K. (1997). Relative Efficiency of Women as Farm Managers: Profit Function Analysis in Cote d' Ivoire. *Agricultural Economics*, 16, pp 47-53.

Adesina, A. A & Zinnah M. M. (1993). Technology characteristics, farmers' perceptions and adoption decisions: A Tobit model application in Sierra Leone. *Agricultural Economics*, 9(4), 297–311.

Admassie, A. & Ayele, G. (2004). Adoption of improved technology in Ethiopia: Addis Ababa, Ethiopia. *Ethiopia Development Research Institute*. PMid: 16895031

UNIVERSITY FOR DEVELOPMENT STUDIES

Agnes, R. Q. (1995). Gender Differences In Agricultural Productivity: A Survey of Empirical Evidence. *FCND Discussion Paper No. 5. International Food Policy Research Institute*, July 1995.

Aigner, D. J. & Chu, S. F. (1968). On Estimating the Industry Production Function. *American Economic Review*, 58: 826-839.

Aigner, D. J., Lovell, C. A. & Schmidt, P. (1977). Formulation and Estimation of Stochastic Fron-tier Function Models. *Journal of Econometrics*, 6 July 1977: 21-37.

Ajibefun, I. A. & Daramola, A. G. (2003). *Determinants of Technical and Allocative Efficiency of Micro-Enterprises: Firm-level Evidence from Nigeria*. African Development Bank, 353-395 pp.

Al-Hassan, R. & Jatoe, J. B. (2002). Adoption and Impact of Improved Cereal Varieties In Ghana. *Paper presented for the workshop on the Green revolution in Asia and its transferability to Africa*. 8th to 10th December, 2002, in Tokyo, Japan.

Al-hassan, S. (2008). Technical Efficiency of Rice Farmers in Northern Ghana. *Final Report Presented At AERC Biennial Research*. Nariobi, Kenya. April, 2008.

Ali, M., & Byerlee, D. (1991). Economic efficiency of small farmers in a changing world: A survey of recent evidence. *Journal of International Development*, 3(1): 1–27.

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

UNIVERSITY FOR DEVELOPMENT STUDIES

Asante, B. O., Villano, R. A & Battese, G. E (2014). The effect of the adoption of yam minisett technology on the technical efficiency of yam farmers in the forest-savannah transition zone of Ghana. *African Journal of Agricultural and Resource Economics*, Volume 9 Number 2 pages 75-90.

Asfaw, A. & Admassie, A. (2004). The impact of education on allocative and technical efficiency of Ethiopian smallholders. *Ethiopian Journal of Economics*, V(1): 1-26.

Banful, A. (2010). Old problems in the new solutions?: Politically motivated allocation of program benefits and the "new" fertilizer subsidies. *IFPRI Discussion Paper 1002*. Washington, D.C. International Food Policy Research Institute.

Battese, G. E. & Coelli, T. J. (1988). Prediction of Firm-Level Technical Efficiencies With a Generalised Frontier Production Function and Panel Data. *Journal of Econometrics*, 38: 387-399.

Battese, G. E. & Coelli, T. J. (1995). A model for technical inefficiency effect in stochastic frontier production for panel data. *Empirical Economics*, 20: 325–45.

Battese, G. E. (1992). Frontier production functions and technical efficiency: A survey of empirical applications in agricultural economics. *Agricultural Economics*, 7: 185–208.

Battesse, G. E. & Corra, G. S. (1977). Estimation of a Production Frontier Model with Application to the Pastoral Zone of Eastern Australia. *Australian Journal of Agricultural Economics*, 21: 169-179

UNIVERSITY FOR DEVELOPMENT STUDIES

UNIVERSITY FOR DEVELOPMENT STUDIES

Bellon, M. R., & Hellin, J. (2011). Planting Hybrids, Keeping Landraces: Agricultural Modernization and Tradition among Small-Scale Maize Farmers in Chiapas, Mexico. *World Development*, 39 (8): 1434–1443.

Benin, S., Johnson, Jimah, M., Taabazuing, K., Tenga, J., Abokyi, A., Nasser, E., Ahorbo, G., & Owusu, G., V. (2011). Evaluation of Four Special Initiatives of the Ministry of Food and Agriculture, Government of Ghana. Fertilizer Subsidy Agricultural Mechanization Block Farms and Youth in Agriculture National Buffer Stock Company (NAFCO).

Beshir, H., Emana, B. Kassa, B. & Haji, J. (2012). Determinants of chemical fertilizer technology adoption in North eastern highlands of Ethiopia: the double-hurdle approach. *Journal of Resource Economics and International Finance* 1 (2): 39-49.

Binam, J.N., Tonye, J., Wandji, N., Nyambi, G. & Akoa, M. (2004). Factors affecting the technical efficiency among smallholder farmers in the slash and bum agriculture zone of Cameroon. *Food Policy*, 29(5): 531–45.

Bravo-Ureta, B. E & Rieger, L. (1991). Dairy Farm Efficiency Measurement Using Stochastic Frontiers and Neoclassical Duality. *American Agricultural Economics Association*, 5:421-427.

Bravo-Ureta, B., Almeida, A., Solís, D. & Inestroza, A. (2011). The economic impact of Marena's investment on sustainable agricultural systems in Honduras. *Journal of Agricultural Economics*, 62: 429–48.

Breisinger, C., Diao, X., Thurlow, J & Al-Hassan, R. M. (2008). Agriculture for Development in Ghana: New Opportunities and Challenges. *IFPRI Discussion Paper 00784*. Washington, DC: International Food Policy Research Institute.

Carlsson, F. Kohlin, G. Mekonnen, A. & Yesuf, M. (2005). Are agricultural extension packages what Ethiopian farmers want? A stated preference analysis. *Working papers in Economics, Department of Economics*, Goteborg University. P 172.

Chamberlin, J. (2007). Targeting smallholders for Agricultural growth in Ghana. *International Food Policy Research Institute, Ghana Strategy Support Programme*, 16 November, 2007. Accra, Ghana.

Chaovanapoonphol, Y., Battese G. E. & Chang H. S., (2009). The impact of agricultural loans on the technical efficiency of rice farmers in the Upper North of Thailand. In Lee, J. D. & Heshmati, A. (eds), Productivity, efficiency, and economic growth in the Asia-Pacific region. *Berlin, Heidelberg: Springer-Verlag.*

Chapoto, A. & Ragasa, C. (2013). Moving in the Right Direction? Maize Productivity and Fertilizer Use and Use Intensity in Ghana. *IFPRI Discussion Paper 01314*, December 2013

Chianu, J. N. & Tsujii, H. (2004). Determinants of farmers' decision to adopt or not adopt inorganic fertilizer in the savannas of northern Nigeria. *Nutrient Cycling in Agroecosystems* 70(3): 293– 301.

UNIVERSITY FOR DEVELOPMENT STUDIES

www.udsspace.uds.edu.gh

UNIVERSITY FOR DEVELOPMENT STUDIES

Chibwana, C., Fisher, M., Jumbe, C., Masters, W. & Shively, G. (2010) . Measuring the impacts of Malawi's farm input subsidy program. Paper for discussion at BASIS AMA CRSP TC meeting.

Chirwa, E. W., Matita, M. & Dorward, A. (2011). Factors Influencing Access to Agricultural Input Subsidy Coupons in Malawi. *Future Agricultures Working paper 027*, December 2011.

Chukwuji, C. O., Inoni, O. E. & Ike, P. C. (2007). Determinants of Technical Efficiency in Gari in Delta State, Nigeria. *Journal of Central European Agric.*, 8(3): 327-336.

Christensen, L. R., Jorgenson, D. W. & Lau, L. J. (1973). Transcendental logarithmic production frontiers. *Review of Economics and Statistics* 55: 28–45.

Coady, D., Grosh, M. & Hoddinott, J. (2002). Targeting Outcomes Redux. *FCND Discussion Paper 144*, Washington, D.C., USA: International Food Policy Research Institute.

Codjoe, S. N. A. (2007). Supply and Utilisation of Food Crops In Ghana, 1960-2000. *African Journal of Food, Agriculture, Nutrition and Development*, 7(2): 1-15.

Coelli, T., Rao, D. S. P. & Battese, G. E. (1998). An Introduction to Efficiency and Productivity Analysis. Kluwer-Nijhoff, Boston.

Coelli, T.J., Rehman, S. & Tirtle, C. (2002). Technical, Allocative, Cost and Scale Efficiencies in Bangladesh Rice Cultivation: A Non-Parametric Approach". *Journal of Agricultural Economics*, 533607-606.

www.udsspace.uds.edu.gh

Crawford, E. W., Jayne, T. S & Valerie, A. K. (2006). Alternative Approaches for Promoting Fertilizer Use in Africa. *Agriculture and Rural Development Discussion Paper 22*, Washington D.C. The World Bank.

DANIDA. (2011). Agricultural input subsidies in Sub-Saharan Africa. Evaluation Study, 2011/2.

Dhungana, B.R., Nuthall, P.L. & Nertea, G.V. (2004). Measuring the economic inefficiency of Nepalese Rice Farmers using data envelopement analysis. *Australian Journal of Agricultural and Resource Economics*, 48: 347-369.

Diao, X., & Sarpong, D. B. (2007). Cost Implications of Agricultural Land Degradation in Ghana: An Economy Wide Multimarket Model Assessment. *IFPRI Discussion Paper No. 00698*. Washington, DC: International Food Policy Research Institute.

Dorward, A. & Chirwa, E. (2011). The Malawi Agricultural Input Subsidy Programme: 2005/06 to 2008/09. *International Journal of Agricultural Sustainability*. 16: 232-247.

Dorward, A. (2009a). Rethinking Agricultural Input Subsidy Programmes in a Changing World. London, School of Oriental and African Studies.

Dorward, A. R. (2009b). Integrating contested aspirations, processes and policy: development as hanging in, stepping up and stepping out. *Development Policy Review,* 27: 131–46.

Dorward, A., Chirwa, E. & Jayne, T. S. (2010). The Malawi Agricultural Input Subsidy Programme 2005/06 to 2008/09. Working paper, School of Oriental and African Studies, London.

UNIVERSITY FOR DEVELOPMENT STUDIES

www.udsspace.uds.edu.gh

Dorward, A., Chirwa E., Kelly, V., Jayne, T. S., Slater, R. & Boughton, D. (2008). Evaluation of the 2006/07 Agricultural Input Subsidy Programme, Malawi. Final Report. Lilongwe, Malawi.

Duflo, E., Kremer, M., & Robinson, J. (2009). Nudging Farmers to Use Fertilizer: Theory and Experimental Evidence from Kenya. *NBER Working Paper No. 15131*, Cambridge MA.

Ekasingh, B., Gypmantasiri, P., Thong-ngam, K. & Grudloyma, P. (2004). Maize in Thailand: Production Systems, Constraints, and Research Priorities. El Batàn, Mexico: Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT).

Farrell, M.J. (1957). The Measurement of Productive Efficiency. Journal of the Royal Statistical Society, 120(3): 253-290.

Farrell, M.J. (1957). The Measurement of Productive Efficiency. *Journal of the Royal Statistical Society*, 120(3): 253-290.

Forsund, F.R., Lovell, C.A.K. & Schmidt, P. (1980). A Survey of Frontier Production Functions and of their Relationship to Efficiency Measurement. *Journal of Econometrics*, 13, 5-25.

Freeman, H. & Kaguongo, W. (2003). Fertilizer market liberalization and private retail trade in Kenya. *Food Policy*, 28(5-6): 505–518.

UNIVERSITY FOR DEVELOPMENT STUDIES

Fufa, B. & Hassan, R. M. (2006). Determinants of fertilizer use on maize in Eastern Ethiopia: A weighted endogenous sampling analysis of the extent and intensity of adoption. *Agrekon*, 45(1): 38–49.

Ghana Statistical Services (GSS). (2010). Census report 2010. *Accra. Ghana*

Ghana Statistical Service (GSS). (2014). *National Accounts Statistics, Gross Domestic Product* 2014, April 2014.

GRAIN. 2010. Unraveling the "Miracle" of Malawi's Green Revolution. Barcelona, Spain.

Greene, W. H. (1980). Maximum likelihood estimation of econometric frontier functions. *Journal of Econometrics*, 13: 27–56.

Greene, W. H. (1990). A Gamma-Distributed Stochastic Frontier Model. *Journal of Econometrics*, 46 (1/2): 141-64.

Greene, W. H. (1993). The Econometric Approach to Efficiency Analyses. In Fried, H. O., Lovell, C. A. K. & Schmidt, S. S. (Eds), The Measurement of Productive Efficiency, Oxford University Press, New York, 68-119.

Greene, W. H. (2010). A stochastic frontier model with correction for sample selection. *Journal of Productivity Analysis*, 34: 15–24.

Harrigan, J. (2008). Food Insecurity, Poverty and the Malawian Starter Pack: Fresh Start or False Start? *Food Policy*, 3: 237-49.

Hazell, P. & Rosegrant, M. (2000). *Rural Asia: Beyond the Green Revolution*. Hong Kong : OUP/ADB.

UNIVERSITY FOR DEVELOPMENT STUDIES

www.udsspace.uds.edu.gh

Hibon, A., Triomphe, B., López-Pereira, M. A. & Saad, L. (1992). Rainfed Maize Production in Mexico: Trends, Constraints, and Technological and Institutional Challenges for Researchers. CIMMYT. *Economics Working Paper 92-03*. El Batàn, Mexico: Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT).

Holden, S. T. & Lunduka, R. W. (2010). Too Poor to be Efficient? Impacts of the targeted fertilizer subsidy program in Malawi on farm plot level input use, crop choice and land productivity. *Working Paper, Depart. of Econ. and Resource Management. Norwegian University of Life Sciences*. In Ricker-Gilbert, J., Jayne, T. S. and Black, J. R. 2010. What are the Dynamic Effects of Fertilizer Subsidies on Household Well-being? Evidence from Malawi.

Holden, S. T. & Lunduka, R. W. (2012). Who benefit from Malawi's targeted farm input subsidy program? For Development Studies, 39(3): 290-314.

http://www.reuters.com/article/2012/11/28/us-usa-farmland-idUSBRE8AR04120121128

Huang, C. & Liu, J. (1994). Estimation of non-neutral stochastic frontier function. *Journal of Productivity Analysis*, 5: 171–180.

IFPRI. 2007. Smallholder Agriculture in Ghana. Ghana Strategy Support Program-IFPRI *Discussion Brief 3*.

Imai, K. (2003). Is livestock important for risk behaviour activity choice of rural households? Evidence from Kenya. *Journal of African Economies*, 12(2): 271–95.

UNIVERSITY FOR DEVELOPMENT STUDIES

Jaforullah, M. & Devlin, N. J. (1996). Technical efficiency in the New Zealand dairy industry: A frontier production function approach. *New Zealand Economic Papers*, 30: 1-17.

Jayne, T. S. (2012). Managing food price instability in East and Southern Africa. Glob. Food Sec. 1(2), 143-149. [http://www.sciencedirect.com/science/article/pii/S221191241200017X]

Jayne, T. S. and Rashid, S. (2013). Input subsidy programs in sub-Saharan Africa: a synthesis of recent evidence. *Agricultural Economics*, 44 (2013): 1–16.

Jayne, T. S., Mather, D., Mason, N. & Ricker-Gilbert, J. (2013). How do fertilizer subsidy programs affect total fertilizer use in sub-Saharan Africa? Crowding out, diversion, and benefit/cost assessments. *Department of Agricultural, Food and Resource Economics, Michigan State University & Department of Agricultural Economics, Purdue University.*

Kalirajan, K. (1981). An econometric analysis of yield variability in paddy production. *Canadian Journal of Agricultural Economics*, 29: 281–94.

Kalirajan, K.P. & Shand, R.T. (1985). Types of education and agricultural productivity: a quantitative analysis of tamil nadu rice farming. *Journal of Development Studies*, 21(2): 232-43.

Kane, E. (1996). Seeing for Yourself: Research Handbook for Girls' Education in Africa. World Bank.

UNIVERSITY FOR DEVELOPMENT STUDIES

Kherallah, M., Delgado C., Gabre-Madhin E., Minot N., & Johnson M. (2002). Reforming agricultural markets in Africa: Achievements and challenges. *Baltimore, Md.: Johns Hopkins University Press.*

Kodde, DA & Palm FC, 1986. Wald criteria for jointly testing equality and inequality restrictions. *Econometrica*, 54: 1243–6.

Krueger, A., Valdes A. & Schiff M., editors. 1991. "Political Economy of Agricultural Pricing Policy: Latin". *America. Baltimore, United States: Johns Hopkins University Press*.

Kumbhakar, S. C., Ghosh, S. & Mc Guckin, J. T. (1991). A generalized production frontier approach for estimating determinants of inefficiency in US dairy farms. *Journal of Business and Economic Statistics*, 9(3): 279–86.

Kumbhakar, S.C. & Bhattacharya, A. (1992). Price Distortion and Resource Use Efficiency in Indian Agriculture: A Restricted Profit Function Approach. *Review of Economics and Statistics*, 74:231-239.

Lee, L. F. & Tyler, W. G. (1978). The stochastic production function and average efficiency: An empirical analysis. *Journal of Econometrics*, 7: 385–89.

Lindara, M.J.K.L., Johnsen, F.H & Gunatilake, H.M. (2004). Technical efficiency in the spice based agroforestry sector in Matale, Sri Lanka, Noragric Working Paper No. 34 (February, 2004) Noragric.

Luanmanee, S. & Paisancharoen, K. (2011). Nitrogen Balance in Upland Fields of Thailand. Extension Bulletin 642. Taipei, Taiwan, ROC: Food and Fertilizer Technology Center.

UNIVERSITY FOR DEVELOPMENT STUDIES

Lunduka, R., Ricker-Gilbert, J. & Fisher, M. (2013). What are the farm-level impacts of Malawi's farm input support program? In Jayne, T. S. & Rashid, S. (2013). Input subsidy programs in sub-Saharan Africa: a synthesis of recent evidence. *Agricultural Economics,* 44:1-16

Mahendra S. D. (2012). Policies for Raising Agricultural Growth and Productivity in India. *IGIDR Proceedings/Projects Series. PP-069-SMD1*

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

Marenya, P. M. & Barrett, C. B. (2007). Household-level determinants of adoption of improved natural resources management practices among smallholder farmers in Western Kenya. Food Policy 32(4): 515–36.

Marika, K. & Banful, A. B. (2010). Overview of the agricultural input sector in Ghana. *IFPRI Discussion Paper 01024, International Food Policy Research Institute,* September 2010

Mason, N. M, Jayne, T. S. & van de Walle, N. (2013). Fertilizer Subsidies and Voting Patterns: Political Economy Dimensions of Input Subsidy Programs. Selected Paper prepared for presentation at the Agricultural & Applied Economics Association's 2013 AAEA & CAES Joint Annual Meeting, Washington, DC, August, 4-6, 2013.

UNIVERSITY FOR DEVELOPMENT STUDIES

UNIVERSITY FOR DEVELOPMENT STUDIES

Mason, N. M., Jayne, T. S. & Mofya-Mukuku, R. (2013). Zambia's input subsidy programs. *Agric. Econs*. In Jayne, T.S. & Rashid, S. 2013. Input subsidy programs in Sub-Saharan Africa: a synthesis of recent evidence.

Meeusen, W. & van den Broeck, J. (1977). Efficiency Estimation from Cobb-Douglas Production Functions With Composed Error. *International Economic Review*, 18: 435-444.

Mellor, J. (1999). Faster, More Equitable Growth – The Relation Between Growth in Agriculture and Poverty Reduction. *Agricultural Policy Development Project (Research Report No. 4)*. Washington, D.C.: United States Agency for International Development.

MiDA. (2010). Investment Opportunity in Ghana Maize, Soya and Rice, Millennium Development Authority (MiDA) in conjunction with the United States Millennium Challenge Corporation.

Ministry Of Food and Agriculture (MOFA). (2008). Statistics, Research and Information Directorate.

Ministry Of Food and Agriculture (MOFA). (2009). Statistics, Research and Information Directorate.

Ministry of Food and Agriculture (MOFA). (2010). Agriculture in Ghana, Facts and Figures. *Statistics, Research and Information Directorate (SRID).*

Ministry of Food and Agriculture (MOFA). (2011). *Evaluation of Four Special Initiatives of the Ministry of Food and Agriculture, Government of Ghana*. A Draft Report, 8th November 2011.

Minot, N. & Benson, T. (2009). Fertilizer subsidies in Africa: Are vouchers the answer? *IFPRI Issue Brief 60* (July). Washington, D.C.: International Food and Policy Research Institute.

Morgan, W. B. (1996). Economy and Society: Development Issues. In Sustaining the Future: Economic, Social, and Environmental Change in Sub-Saharan Africa, edited by G. W. Benneh, G. W., Morgan, B. & Uitto, J. I. New York: United Nations University Press.

Morris, M. L., Tripp, R. & Dankyi, A. A. (1999). Adoption and Impacts of Improved Maize Production Technology: A Case of Ghana Grains Development Project. *Economics Program. Paper 99-01*. Mexico, D.F.: CIMMYT.

Morris, M., Kelly V., R. Kopicki, & Byerlee D. (2007). Fertilizer use in African agriculture: Lessons learned and good practice guidelines. Washington, D.C.: *World Bank*.

Mouelhi R. B. A. (2009). Impact of the adoption of information and communication technologies on firm efficiency in the Tunisian manufacturing sector. *Economic Modelling*, 26: 961–7.

Nchare, A. (2007). Analysis of Factors Affecting the Technical Efficiency of Arabica Coffee Producers in Cameroon. *Final Report Presented AERC Biennial Research Workshop*, Nairobi, Kenya.

UNIVERSITY FOR DEVELOPMENT STUDIES

Nin-Pratt, A., Johnson, M. Magalhaes, E. You, L. Diao, X. & Chamberlin, J. (2011). *Yield Gaps and Potential Agricultural Growth in West and Central Africa*. Research Report 170. Washington, DC: International Food Policy Research Institute.

Nkamleu, G. B. & Adesina, A. A. (2000). Determinants of chemical input use in peri-urban lowland systems: Bivariate probit analysis in Cameroon. *Agricultural Systems,* 63: 111–21.

Nye, P. H. & Greenland, D. J. (1960). The Soil under Shifting Cultivation. Technical Communications 51. Harpenden, UK: Commonwealth Bureau of Soils.

Oduol, J. B. A., Binam, A. J. N., Olarinde, L., Diagne, A. & Adekunle, A. (2011). Impact of adoption of soil and water conservation technologies on technical efficiency: Insight from smallholder farmers in Sub-Saharan Africa. *Journal of Development and Agricultural Economics* 3: 655–69.

Onyenweaku,C. E. & Effiong, E. O. (2005). Technical Efficiency in Pig Production in Akwalbom State, Nigeria. International Journal of Agriculture and. *Rural Development*, 6:51-57.

Owens, T., Hoddinott, J. & Kinsey, B. (2001). The Impact of Agricultural Extension on Farm Production in Resettlement Areas of Zimbabwe. *Working Paper CSAEWPS/2001-6*. Centre for the Study of African Economies, University of Oxford, UK.

Owuor, G. & Shem, O. A. (2009). What Are the Key Constraints in Technical Efficiency of Smallholder Farmers in Africa? Empirical Evidence from Kenya. A Paper Presented at

UNIVERSITY FOR DEVELOPMENT STUDIES

www.udsspace.uds.edu.gh

111 EAAE-IAAE Seminar 'Small Farms: decline or persistence' University of Kent, 26-27th June.

Patton, M. Q. (2002) Qualitative research & evaluation method (3 ed.). *Thousand Oaks*, CA: Sage

Pearce, D. W., Barbier, E. B. & Markandya, A. (1988). Environmental Economics and Decision-making in SubSaharan Africa. *London: International Institute for Environment and Development* / University College London, London Environmental Economics Center.

Poulton, C. D., Dorward, A. R. & Kydd, J. G. (2010). The future of small farms: New directions for services, institutions and intermediation. *World Development*, *38*: 1413–28.

Pudasaini, S. P. (1983). The effects of education in agriculture: Evidence from Nepal. *American Journal of Agricultural Economics*, 65: 508–15.

Rahman, S. & Hasan, M. K. (2006). Efficiency Effects of Environmental and Managerial Factors: The Case of Wheat Producers in Bangladesh. The Rural Citizen: Governance, Culture and Wellbeing in the 21st Century, University Of Plymouth, UK.

Ricker-Gilbert, J. & Jayne T. S. (2010). What are the Dynamic Effects of Fertilizer Subsidies on Household Well-being? Evidence from Malawi. *Contributed Paper presented at the Joint 3rd African Association of Agricultural Economists (AAAE) and 48th Agricultural Economists Association of South Africa (AEASA) Conference*, Cape Town, South Africa, September, 19-23, 2010.

UNIVERSITY FOR DEVELOPMENT STUDIES

UNIVERSITY FOR DEVELOPMENT STUDIES

Ricker-Gilbert, J., & Jayne T.S. (2009). Do Fertilizer Subsidies Affect Market Participation and Demand for Commercial Fertilizer? An Example from Malawi. *Paper presented at IAAE tri-annual meeting,* Beijing China, 16-22 August.

Ricker-Gilbert, J., Jayne T. S. & Black, J. R. (2009). Does Subsidizing Fertilizer Improve Yields? Evidence from Malawi. *Paper presented at AAEA annual meeting,* Milwaukee WI, 26-28 July.

Ricker-Gilbert, J., Jayne, T. S. & Chirwa, E. (2011). Subsidies and Crowding Out: A Double-Hurdle Model of Fertilizer Demand in Malawi. *American Journal of Agricultural Economics*, 93(1): 26-42.

Robson, C. (1993) Real World Research. Oxford: Blackwells.

Rudestam, K.E., & Newton, R. R. (1992). Surviving Your Dissertation: A Comprehensive Guide to Content and Process. Newbury Park, California: Sage

Sesabo, J. K. & Tol, R. S. J. (2007). Technical efficiency of small-scale fishing households in Tanzanian coastal villages: an empirical analysis. *African Journal of Aquatic Science*, 32(1): 51-61

Seyoum, E. T., Battese G. E. & Fleming, E. M. (1998). Technical Efficiency and Productivity of Maize Producers in Eastern Ethiopia: A Study of Farmers Within and Outside the Sasakawa-Global 2000 Project. *Agricultural Economics.*

Shakya, P. B & Flinn, J. C. (1985). Adoption of modern varieties and fertilizer use on rice in the eastern Tarai of Nepal. *Journal of Agricultural Economics*, 36(3): 409–19.

Sharma, K. R., Leung, P. & Zaleski, H. M. (1999). Technical, allocative and economic efficiencies in swine production in Hawaii: A comparison of parametric and non-parametric approaches. *Agricultural Economics*, 20: 23-35.

Sheahan, M. & Jayne, T. S. (2013). Are Kenyan farmers under-utilising fertiliser? Implications from input intensification and research. *Food Policy*, 41(2013): 39-52.

Sherlund, S. M., Barret, C. B. & Adesina, A. A. (2002). Smallholder Technical Efficiency Controlling For Environmental Production Conditions. *Journal Of Development Economics*, 69: 85-101.

Siyanga, L. (2009). Do Fertiliser Subsidies Work for the poor? Evidence and Challenges of Implementing the Fertiliser Support Programme in Zambia- The Case of Kalomo and Senanga Districts. Graduate School of Development Studies, International Institute of Social Studies.

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

Solís, D., Bravo-Ureta, B. E. & Quiroga, R. (2009). Technical efficiency among peasant farmers participating in natural resource management programmes in Central America. *Journal of Agricultural Economics*, 60: 202–19.

Stern, N. (1989). The Economics of Development: A Survey. *Economic Journal 99(397): 597-685*.

UNIVERSITY FOR DEVELOPMENT STUDIES

Stevenson, R. E. (1980). Likelihood Functions for Generalised Stochastic Frontier Estimation. *Journal of Econometrics*, 13: 57- 66.

Szott, L. T. & Palm, C. A. (1986). Soil and Vegetation Dynamics in Shifting Cultivation Fallows. In First Symposium on the Humid Tropics 1: 360–379. Belem, Brazil: Embrapa.

Tesfay G., Ruben, R., Pender, J & Kuyvenhoven, A. (2005). Resource Use Efficiency On Own And Sharecropping Plots In Northern Ethiopia: Determinants And Implications For Sustainability.

Thuo, T., Boris, E. Bravo-Ureta, Ibrahima H., Patrick, Obeng-Asiedu. (2012). Adoption of chemical fertilizer by smallholder farmers in the peanut basin of Senegal. *AfJARE,* Vol 6 No 1

UNIFEM. (2010). Women's Land and Property Rights. (available at *http://www.unifem.org/gender_issues/women_poverty_economics/land_property_rights.php)*

Weir, S. (1999). The effects of education on farmer productivity in rural Ethiopia. *Working Paper CSAE WPS99-7. Centre for the Study of African Economies,* University of Oxford, UK.

Wiredu, A. N., Zeller, M. & Diagne, A. (2013). Impact of fertilizer subsidy on land and labor productivity of rice-producing households in Northern Ghana. *Sustainable Agriculture Research*, 3 (1): 2014

UNIVERSITY FOR DEVELOPMENT STUDIES

World Bank. (1996). *Rural Development from Vision to Action*

World Bank. (2006). Zambia Public Expenditure Tracking and Quality of Service Delivery Survey in the Health Sector, Findings and Implications, The Ministry of Health, Lusaka, University of Zambia, Lusaka, and The World Bank, Washington DC.

World Bank. (2007). World development report 2008: Agriculture for development. World Bank, Washington, DC.

Wubeneh, N. G. & Sanders, J. H. (2006). Farm-level adoption of sorghum technologies in Tigray, Ethiopia. *Agri*. *Systems*. 91: 122-134. http://dx.doi.org/10.1016/j.agsy.2006.02.002

Xu, Z., Burke, W. J., Jayne, T. S. & Govereh, J. (2009a). Do Input Subsidy Programs "Crowd In" or "Crowd Out" Commercial Market Development? Modeling Fertilizer Use Decisions in a Two-Channel Marketing System. *Agricultural Economics* 40(1): 79-94.

Xu, Z., Guan, Z., Jayne, T. S. & Black, R. (2009b). Factors Influencing the Profitability of Fertilizer Use on Maize in Zambia. *Agricultural Economics,* 40(4): 437-444.

Yawson, D. O., Frederick, A. A., Ernest, K.A. A. & Samuel, K.N. D. (2010). Ghana's Fertilizer Subsidy Policy: Early Field Lessons from Farmers in the Central Region. *Journal of Sustainable Development in Africa*, 12(3):191-203.

UNIVERSITY FOR DEVELOPMENT STUDIES

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APPENDICES

APPENDIX A: QUESTIONNAIRE

FERTILISER SUBSIDY, MAIZE OUTPUT AND TECHNICAL EFFICIENCY OF SMALLHOLDER FARMERS IN GHANA

Socio-demographic characteristics

Name of Interviewer: …………………………………………………………………..

Name of Respondent: ………………………………………………………………….

Household ID: …………………………………………………………………………

Name of Eco-zone: …………………………………………………………………….

Name of community: ………………………………………………………………….

1. Age of respondent……………………………………………………………………
2. Respondent's position in the household: Head of HH=1 Not HH Head=0
3. Sex of household head: Female=0 Male=1
4. Marital status: Married=1 Divorced=2 Single=3 Widowed=4
5. Residential status of HH Head: Resident=1 Non-resident=0
6. Educational level of respondent No education=1 Primary=2 JHS=3 SHS=4 Tertiary=5 Other (specify)……………………………………….
7. Number of years spent in school……………………………………..
8. Time required to get to the plot (mins) ………………………………………
9. Household size…………………………………………………………..
10. House Quality: 1. Mud+Thatch 2. Mud+Zinc 3. Block/Bricks+Thatch 4. Block/Bricks+Zinc

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11. Farm size (hectare): …………………………………………………………………………

12. Farming experience (years): ………………………………………………………………..

13. What is the ownership status of your farm? 1. Family 2. Intercropped 3. Rented 4. Self 5. Other (Specify) ……………………………………………..

14. Are you a native of this town? Yes=1 No=0

15. Did any government extension pay visit to your farm last season? Yes=1 No=0

16. If yes, how many visits?...

A. <u>Extent to which rural households have access to the Targeted Fertiliser Subsidy Programme</u>

1. Time required to get to the nearest fertiliser wholesaler from your home (in mns)……...............
2. Time required to get to the nearest fertiliser retailer from your home (mins) ....
3. Time required to get to the nearest feeder road from your home (mns): ……………....................
4. Do you have livestock? 1. Yes 0. No
5. If yes,

Name of live Stock	Value (GHCedis)	Total (GHCedis)
Other		

6. Do you have farm equipments? 1. Yes 0. No
7. If yes, complete the table below:

Type of equipment	Quantity	Value (GH₵)	Amount (GH₵)

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Other			

8. Are you aware the government has been subsidizing fertiliser for farmers? Yes=1 No=0

9. If yes did you get the pass book to access the subsidised fertiliser? Yes=1 No=0

10. If no, why couldn't you get the quantity you wanted?...
....
…………………………………………………………………………………………

11. Do you have access to agricultural credit? 1. **Yes** **0. No.**

12. Which type of labour did you use? 1. Family/Communal Labour 0 Hired Labour

13. Labour used (labour mandays)?

	Male	Female
Family Labour	☐	☐
Communal Labour	☐	☐
Hired Labour	☐	☐

14. Do you belong to any farmer based organisation? 1. Yes 0. No

15. If yes what is the name of the organisation?...

16. How long have you been a member of the group? ……………........................……………….

B. <u>Extent to which the subsidy programme enhances farm level Productivity</u>

1. Type of fertiliser received under the subsidy programme

Type of fertiliser	**Quantity needed (Kg)**	**Quantity received (Kg)**
NPK (15:15:15)		
NPK (23:10:05)		
Sulphur of Ammonia		

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Urea		
Other:		

2. Which of these crops did you apply the fertiliser to? (**Fill relevant parts even if farmer has not used fertiliser)**

Primary Crop (Tick)	**Crop**	**Land area**	**Quantity of fertiliser applied**	**Output**
	Maize			
	Rice			

Other Sources of fertiliser

1. Did you buy any fertiliser from the commercial market for farm? 1. Yes 0. No
2. If yes, fill the table below

Type of fertiliser	**Quantity**	**Price per bag**
NPK (15:15:15)		
NPK (23:10:05)		
Sulphur of Ammonia		
Urea		
Other		

3. Do you also use any organic material as soil fertility improvement apart from inorganic fertiliser? 1. Yes 0. No

4. Did you use herbicide last season? 1. Yes 0. No

Inputs and Cost

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Crop	Type of seed used	Quantity of seed used	Price per unit seed used (GHC)
Maize			
Rice			

1. Type of seed used: 1. Improved seed 0. Conventional seed
2. Did you sell any of your harvested crops? 1. Yes 0. No
3. If yes, complete the table below

Crop	Quantity (Bags)	Price per bag (GHC)
Maize		
Rice		

4. Complete the table below for the income earned from farm activities

Activity	Gross Income (GHcedis)	
Sale of crops		
Sale of animals		
Rent of farm equipments		

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Other		

5. Do you do any off-farm activities? 1. Yes 0. No

6. If yes,

Activity	**Gross Income earned (GHCedis)**
Other	

7. Before you had applied inorganic or organic fertiliser, kindly rate the inherent soil fertility of this plot [on a scale from 1 (not fertile) to 5 (very fertile)]: ……………………………………………

Thank You for your Time

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APPENDIX B: TECHNICAL EFFICIENCY SCORES OF MAIZE FARMERS IN THE TRANSITION ZONE

armer	TE	Farmer	TE	Farmer	TE	Farmer	TE	Farmer	TE	Farmer	TE	Farmer	TE
	0.82	**21**	0.74	**41**	0.90	**61**	0.40	**81**	0.28	**101**	0.51	**121**	0.49
	0.43	**22**	0.36	**42**	0.90	**62**	0.97	**82**	0.52	**102**	0.94	**122**	0.46
	0.99	**23**	0.89	**43**	0.94	**63**	0.86	**83**	0.93	**103**	0.31	**123**	0.46
	0.44	**24**	0.84	**44**	0.59	**64**	0.73	**84**	0.50	**104**	0.34	**124**	0.43
	0.52	**25**	0.37	**45**	0.97	**65**	0.49	**85**	0.85	**105**	0.59	**125**	0.44
	0.92	**26**	0.71	**46**	1.00	**66**	0.86	**86**	0.42	**106**	0.62	**126**	0.32
	0.26	**27**	0.65	**47**	0.59	**67**	0.87	**87**	0.59	**107**	0.40	**127**	0.43
	0.34	**28**	0.86	**48**	0.80	**68**	0.56	**88**	0.61	**108**	0.93	**128**	0.27
	0.26	**29**	1.00	**49**	0.59	**69**	0.64	**89**	0.40	**109**	0.99	**129**	0.45
0	0.25	**30**	0.80	**50**	0.91	**70**	0.97	**90**	0.93	**110**	0.92	**130**	0.60
1	0.62	**31**	0.98	**51**	0.63	**71**	0.81	**91**	0.88	**111**	0.94		
2	0.80	**32**	0.46	**52**	0.40	**72**	0.53	**92**	0.92	**112**	0.74		
3	0.62	**33**	0.62	**53**	0.52	**73**	0.63	**93**	0.94	**113**	0.51		
4	0.82	**34**	0.71	**54**	0.88	**74**	0.78	**94**	0.73	**114**	0.92		
5	0.42	**35**	0.97	**55**	0.28	**75**	0.48	**95**	1.00	**115**	0.31		
6	0.86	**36**	0.92	**56**	0.84	**76**	0.60	**96**	0.43	**116**	0.25		
7	0.75	**37**	0.80	**57**	0.66	**77**	0.86	**97**	0.58	**117**	0.43		
8	0.99	**38**	0.98	**58**	0.92	**78**	0.85	**98**	0.61	**118**	0.62		
9	0.97	**39**	0.76	**59**	0.51	**79**	0.29	**99**	0.43	**119**	0.96		
0	0.94	**40**	0.82	**60**	0.67	**80**	0.34	**100**	0.44	**120**	0.95		

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APPENDIX C: TECHNICAL EFFICIENCY OF MAIZE FARMERS IN THE GUINEA SAVANNAH ZONE

Farmer	TE	Farmer	TE	Farmer	TE	Farmer	TE	Farmer	TE	Farmer	TE
1	0.23	**21**	0.38	**41**	0.76	**61**	0.46	**81**	0.50	**101**	0.67
2	0.65	**22**	0.52	**42**	0.94	**62**	0.94	**82**	0.48	**102**	0.60
3	0.31	**23**	0.59	**43**	0.98	**63**	0.79	**83**	0.82	**103**	0.63
4	0.41	**24**	0.40	**44**	0.56	**64**	0.31	**84**	0.99	**104**	0.85
5	0.87	**25**	0.99	**45**	0.63	**65**	0.89	**85**	0.19	**105**	1.00
6	0.95	**26**	0.64	**46**	0.86	**66**	0.42	**86**	1.00	**106**	0.71
7	1.00	**27**	0.86	**47**	0.84	**67**	0.52	**87**	0.86	**107**	0.43
8	0.99	**28**	0.56	**48**	0.95	**68**	0.48	**88**	0.99	**108**	0.96
9	0.95	**29**	0.97	**49**	0.24	**69**	0.22	**89**	0.52	**109**	0.83
10	0.26	**30**	0.17	**50**	0.98	**70**	0.60	**90**	0.44	**110**	0.70
11	0.49	**31**	0.75	**51**	0.26	**71**	0.48	**91**	0.96	**111**	0.56
12	0.60	**32**	0.77	**52**	0.98	**72**	1.00	**92**	0.67	**112**	0.66
13	0.95	**33**	0.85	**53**	0.83	**73**	0.90	**93**	0.75	**113**	0.60
14	0.39	**34**	0.39	**54**	0.48	**74**	0.56	**94**	0.39	**114**	0.72
15	0.87	**35**	0.92	**55**	0.38	**75**	0.94	**95**	0.63	**115**	0.43
16	0.90	**36**	0.94	**56**	0.84	**76**	0.95	**96**	0.98	**116**	0.75
17	0.97	**37**	0.84	**57**	0.94	**77**	0.87	**97**	0.36	**117**	0.65
18	0.53	**38**	0.91	**58**	0.98	**78**	0.61	**98**	0.86	**118**	0.85
19	0.54	**39**	0.84	**59**	0.87	**79**	0.24	**99**	0.70	**119**	0.52
20	0.85	**40**	0.94	**60**	0.30	**80**	0.86	**100**	0.68	**120**	0.97

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Farmer	TE	Farmer	TE	Farmer	TE	Farmer	TE	Farmer	TE	Farmer	TE
121	0.35	**141**	0.39	**161**	0.95	**181**	0.59	**201**	0.99	**221**	0.98
122	0.93	**142**	0.95	**162**	0.96	**182**	0.99	**202**	0.95	**222**	0.86
123	0.36	**143**	0.93	**163**	0.99	**183**	0.61	**203**	0.27		
124	0.41	**144**	0.54	**164**	0.99	**184**	0.92	**204**	0.49		
125	0.65	**145**	0.96	**165**	0.63	**185**	0.85	**205**	0.60		
126	0.94	**146**	0.68	**166**	0.52	**186**	0.63	**206**	0.95		
127	0.56	**147**	0.51	**167**	0.96	**187**	0.60	**207**	0.39		
128	0.96	**148**	0.54	**168**	0.95	**188**	0.96	**208**	0.87		
129	0.82	**149**	0.96	**169**	0.86	**189**	0.96	**209**	0.90		
130	0.62	**150**	0.31	**170**	0.73	**190**	0.34	**210**	0.90		
131	0.99	**151**	0.58	**171**	0.94	**191**	1.00	**211**	0.97		
132	0.56	**152**	0.96	**172**	0.34	**192**	0.96	**212**	0.53		
133	0.38	**153**	0.68	**173**	0.62	**193**	0.95	**213**	0.54		
134	0.99	**154**	0.47	**174**	0.99	**194**	0.56	**214**	0.87		
135	0.57	**155**	0.23	**175**	0.27	**195**	0.60	**215**	0.95		
136	0.51	**156**	0.26	**176**	0.95	**196**	0.87	**216**	0.50		
137	0.97	**157**	0.55	**177**	0.72	**197**	0.86	**217**	0.51		
138	0.71	**158**	0.40	**178**	0.96	**198**	0.30	**218**	0.82		
139	0.63	**159**	0.99	**179**	0.40	**199**	0.95	**219**	0.95		
140	0.96	**160**	0.95	**180**	0.55	**200**	1.00	**220**	0.19		

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APPENDIX D: MAP OF AGRO-ECOLOGICAL ZONES IN GHANA