THE DISTRIBUTIONAL IMPACT OF FERTILIZER SUBSIDIES ON RURAL FARMERS IN

GHANA

DAUDA, Hambali

(B.A. ECONOMICS)

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DECLARATION

I, Hambali Dauda, do hereby declare that this submission is my own work towards the Master of Philosophy (Economics) and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in the text.

Hambali Dauda ..... 22/10/2013.....
(PG5542011) Signature Date

Certified by:

..... 22/10/13.....
Mr. J D Quartey
(Supervisor/Erst Internal Examiner) Signature Date

Certified by:

_____
Dr. George Adu
(Second Internal Examiner) Signature Date

QI-\D-2òß

Dr (Sr) Eugenia Amporfo
23/10/13
(Head of Department) Date

Signature

DEDICATION

Dedicated to the farmer from whose efforts and benevolence the world is fed.

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ABSTRACT

The Government of Ghana instituted a country-wide subsidy on 50Kg bags of four types of fertilizer in an effort to mitigate the effect of rising food prices. This study sought to fill the knowledge gaps related to the implementation of the intervention with respect the distributional profile of subsidized fertilizer, the impact of subsidized fertilizer of the the market, the impact of subsidized fertilizer on fertilizer use and the impact of subsidized fertilizer on farm productivity. Using a single cross section of data from the rural divide of the Wenchi administrative enclave, this study makes an assessment of the distributional impact of the 2012 fertilizer subsidy programme on rural farmers. It was found that the bags of subsidized fertilizer purchased were strongly and positively associated with resource-rich farners and more to the disadvantage of smaller land holders. There was also a negative association with the size of farmers' house hold and hence the conclusion that the distribution does not improve the welfare of the families most vulnerable to food security. Evidence of crowding out was also found as purchases of subsidized fertilizer led to a displacement of commercial fertilizer. It was found that farmers who had access to subsidized fertilizer used more fertilizer in the major season although this seemed not to impact on their output for the season. It is the view of this study that fertilizer subsidy needs to be targeted at vulnerable and needy groups to ensure that it does not displace the sale of non-subsidized fertilizer. Increased stake holder paltictÃiõßalso necessary to clamp down on the leakages of subsidized fertilizer both within and outside the country.

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ACRONYMS

CIMMYT International Maize and Wheat Improvement Centre Centro (Internacional de Mejoramiento de Maíz y Trigo)

DFID	Department for International Development
FASDEP	Food and Agriculture Sector Development Policy
FAO	Food and Agriculture Organization
FISP	Fertilizer Input Subsidy Programme
IFDC	International Fertilizer Development Centre
MOFA	Ministry of Food and Agriculture
SSA	Sub-Saharan Africa
SOAS	School of Oriental and African Studies

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CHAPTER ONE

INTRODUCTION

1.1 Background

Fertilizer use played a profound role in the green revolution which eventually guaranteed a high level of food security in the 1960's. The inorganic input is known to have helped to raise agricultural productivity and farm incomes, and hence laid the foundation for broader economic growth. As much as 50% of yield growth in regions which experienced the green revolution has been attributed to increased fertilizer use (Toenniessenn, Adesina and De vries, 2008).

Despite the growing evidence that fertilizers can substantially increase yields in Sub-Saharan Africa (SSA) as well as slow down soil degradation, farmers in SSA still lag far behind other developing countries in fertilizer use (Liverpool et al, 2010). The average intensity of fertilizer use throughout SSA increased from 4 kg/ha in 1970 to 10 kg/ha in 1996 from which period, the intensity had stabilized with the 2002 intensity being 10 kg/ha. This level had been far lower than that of South Africa whose average intensity was 62 kg/ha with a low of 45 kg in 1970 and a peak of 99 kg/ha in 1981. Intensity has generally been highest in Southern (16 kg/ha average) and East (8 kg/ha average) Africa and lowest in the SudanoSahel (4 kg/ha)- and Central Africa (3 kg/ha) regions (Eric et al, 2006).

Ghana's own statistics in terms of fertilizer application rates stands as some of the poorest within Sub-Saharan Africa (SSA). Fertilizer application rate as at 2008 was estimated at 8kg per hectare (MoFA, 2008). The low rate of application has been attributed to high cost of fertilizers. The Government of Ghana instituted a country-wide subsidy on 50Kg bags of four types of fertilizer in an effort to mitigate the effect of rising energy and food prices. By restoring fertilizer prices to previously lower levels, the government hoped it could motivate

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farmers to increase their use of the inorganic substance to increase food production (Banful, 2009).

The evidence from experience outside and even within Africa shows that increased use of inorganic fertilizers has been responsible for an important share of world-wide agricultural productivity growth. The need to increase fertilizer use intensity derives from the role inorganic fertilizers are estimated to have played in the green revolution (Hopper 1993 and Tomich et al, 1995).

1.2 Problem Statement

According to Kaburu (2012) various factors and constraints do exist in the environment that the farmers do operate in. These include factors in the macroeconomic environment, sociopsychological factors and socio-economic factors all of which work to affect a farmer's decision on whether to use or not to use a particular farm input. An optimum production innovation is achieved only when a farmer perceives the recommended practices to be, for him "technically feasible, physically possible and socially compatible".

It is widely accepted that the government can play a key role in redistributing income through targeted subsidy policies. Presumably it is preferred that such public payments benefit the poor and hence programmes and policies should consider whether poor people's average participation in them is higher than that of the non-poor. Sanchez et al.(1997) notes, that the —-bèñèfits of scil fertility replenishment activities are likely to be limited to a small number of farmers in the near future until appropriate programs and policies are put in place. Results by Edward et al (2011) shows that fertilizer subsidies tend to favour households with larger parcels of land than those deemed to be resource-poor and vulnerable.

There have been debates about the issue of real beneficiaries of fertilizer subsidy like small versus large farmers and well-developed versus less developed regions (Vijay and Hrima,

2010). The Malawi Fertilizer input subsidy has been widely acclaimed to be successful and has received massive endorsements from the donor community as a way to increase productivity for small holder or resource poor farmers with an emphasis on marketsmartness[1] (World Bank, 2007; Dorward, 2009).

- According to the Ghana Statistical Service (2012) agriculture makes up 22.7% of Ghana's GDP. Agriculture also provides employment to over half of the labor force in Ghana who are primarily small holder farmers and produce up to 80% of agricultural output (MoFA, 2008;IFDC, 2013). It is obvious from the foregoing that agricultural productivity plays a key role in promoting growth and poverty reduction in the Ghanaian economy. Despite the crucial role of increased fertilizer use in raising agricultural productivity and rural incomes, fertilizer use in Ghana. stagnated for a long time at 8kg/hectare (MoFA, 2008). This was attributed to high fêrtilizer prices, which eventually led to supply side constraints with food requirements.

In response to the continuous spiralling increases in food and fertilizer prices the government instituted the fertilizer subsidy programme in 2008. Maize prices had increased by an average of 77% between May 2007 and May 2008. 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, thyprice of nitrogen-phosphorous-potassium (NPK) 15:15:15, the most widely used food crep fertilizer irfGG7iaeased from GHS 26 to GHS 35 per 50-kilogram (kg) bag between June 2007 and March 2008 (MoFA, 2008)

The Fertilizer Subsidy Programme (FSP) has been running for the past five years, it is not clear as to who is benefiting from the programme and how much the subsidy has contributed to the improvement of farmer productivity and food security, especially for rural farmers.

Market-smart input subsidies are part of a broader productivity enhancement program, have clear exit

Secondly, given the nature of distribution process it is also important to know the effects of the subsidy on private sector fertilizer supplier and market development. The lack of knowledge on the effects of the fertilizer subsidy programme with respect to who benefits, fertilizer use, farmer productivity and market development represents gaps in the policy making process which this research seeks to fill.

1.3 Research Objectives

The main objective of this study was to determine the distributional effects of government fertilizer subsidies in Ghana.

Specific objectives are to:

- Review issues that triggered the fertilizer subsidy intervention for the agricultural sector ;
- Assess the distributional equity and welfare implications of the fertilizer subsidy programme;
- Examine the effects of subsidy programme on the fertilizer market in Ghana; and
- Assess the impact of the fertilizer subsidy programme on rural farmers fertilizer use and farm output.

1.4 ReseareWHypothesis

This study therefore tested the following hypothesis:

I. Ho: Distribution of subsidized fertilizer to farmers in the Wenchi Municipal is not equitable.

H Distribution of subsidized fertilizer to farmers in the Wenchi Municipal is equitable.

Il.Ho: Fertilizer subsidies in the Wenchi Municipal do not crowd out the private sector.

HI: Fertilizer subsidies in the Wenchi Municipal crowds out the private sector.

Ill. Ho: Receiving subsidized fertilizer does not raise fertilizer use intensity.

HI : Receiving subsidized fertilizer raises fertilizer use intensity.

IV. Ho: Subsidized fertilizer has no impact on rural farm yields.

HI: Subsidized Fertilizer has an impact on rural farm yields.

1.5 Method of the Study

The study was based on the analysis of household and field surveys in relation to the research objectives. The approach was to collect, organise and analyse data at micro levels. The study therefore employed analytical tools like statistical tables, ordinary least square regressions, Tobit models and quantile regression analysis to evaluate the various outcomes emerging from the interventions under consideration. In between the study employed quantile regressions to estimate the impact of the programme at various levels of wealth and household asset distributions.

1.6 Justification/Policy Relevance

The results of this study will serve as an important reference for the policy making process, and strengthenpro-poor proposals and reforms in particular. The central idea is to gain a better insight into who captures government payments and the effects there off. Studies elsewhere hayœshown that similar programmes work to the advantage of well-endowed farmers and to the disadvantage of the vulnerable including women and poor people. This study will make proposals regarding the avoidance or arrest of such an occurrence in Ghana.

1.7 Study Area

The Wenchi Municipal area is located in the Western part of Brong Ahafo Region of Ghana. It is bounded to the South by Sunyani Municipality and to the North by Kintampo South

District. It also shares a common boundary with Tain District to the West and Techiman Municipality to the West. It lies within latitudes 70 30' and 80 05' North and longitudes 20 15' West and 10 55' East. In terms of land size, the Municipality covers Three Thousand Four Hundred and Ninety-Four square kilometers.

Figure 1.1: Map of Study Area (Wenchi Municipal)

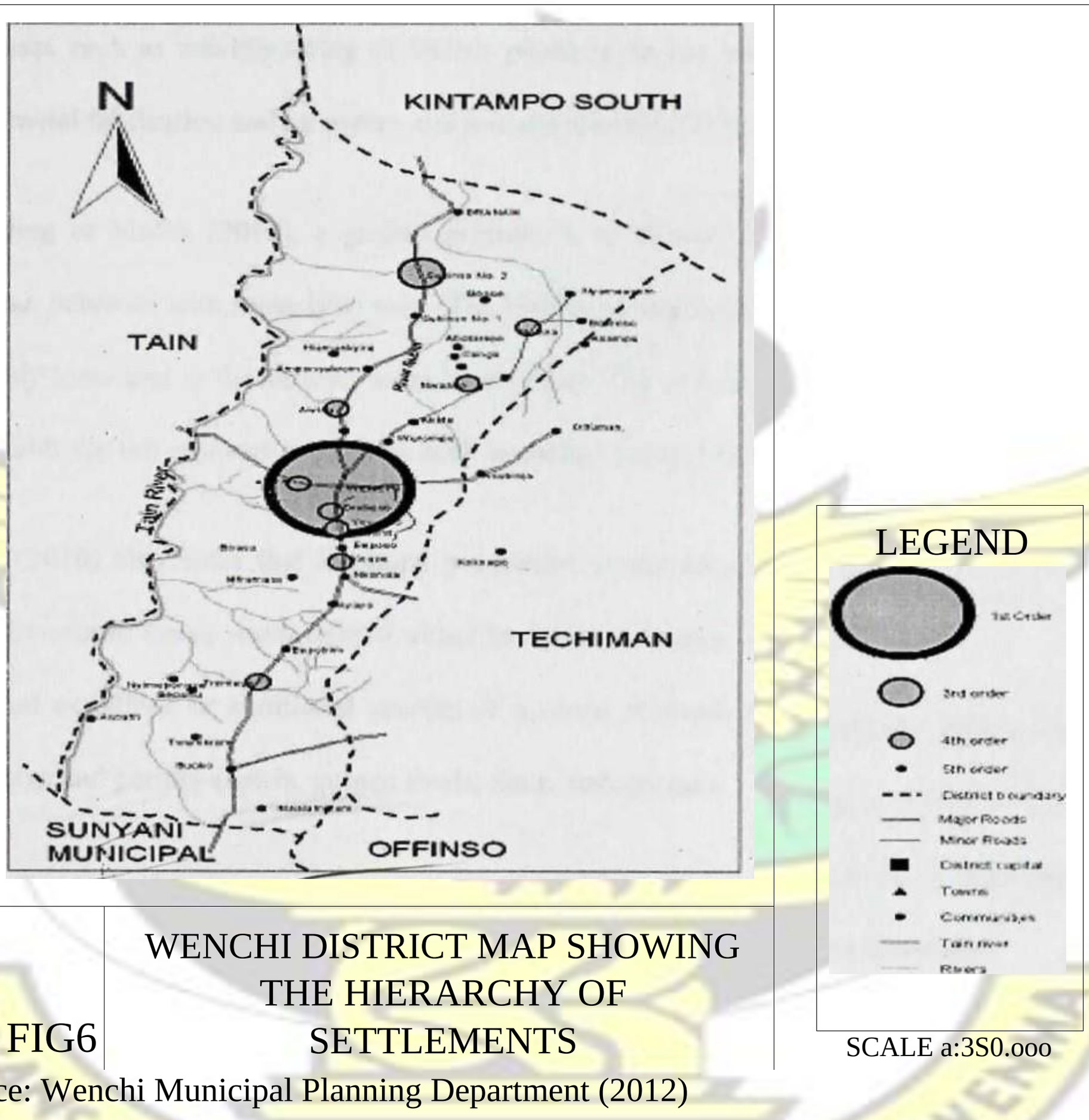

FIG6 WENCHI DISTRICT MAP SHOWING THE HIERARCHY OF SETTLEMENTS

SCALE a:3S0.ooo

Source: Wenchi Municipal Planning Department (2012)

Wenchi town, the district capital is 56km to Sunyani and 29km from Techiman. Its closeness to Techiman, a major national market, poses several benefits for agricultural production and agro-processing and farmers especially must be sensitized and supported to take advantage of this opportunity. According to the 2010 population and housing census the population under

the administration is estimated at 89739 people with 51% being males and 49 % being females. The population of the Municipality is largely rural as 58.6% (52587) live in rural settlements while 41.4% (37152) is urban.

Agriculture and related works are the predominant activities around with 57.6% of the active population engaged in agriculture and its related activities. The manufacturing sector also employs a significant proportion of the work force (10 percent) in several small-scale businesses such as manufacturing of leather products, bricks and tiles, clay products, sachet water, metal fabrication and carpentry and joinery(MoFEP,2012).

According to MoFA (2010), a greater proportion of Wenchi Municipality falls under the savannah ochrosol with some litho sols. The land is generally low lying and most of the soils are sandy loam and in the valleys, loamy soils exist. The soils are fairly rich in nutrients and are suitable for the cultivation of crops such as maize, yams, cocoyam, and cassava.

MoFA (2010) also notes that livestock production in the area is also significant as almost every household keeps some animal either to serve as source of protein diet or for use on important occasions or additional sources of income. Animals reared include cattle, sheep, goats, pigs and poultry (fowls, guinea fowls, duck, turkeys etc).

MoFA (2010þgain notes thaõ4GÑthese animals are reared on small-scale basis and by the free-range method. Only few farmers keep poultry and other livestock on commercial purposes. The poultry industry in the district in particular provides a large and reliable market for the large quantities of maize produced in the District. There are processing plants set up to process cassava into various products. The district produces fish for the general market through aquaculture which has contributed to improve the nutritional needs of the communities (MoFA, 2010).

The supply of starchy staples and cereals in the market is satisfactory. Truckloads of plantain, cassava, maize and citrus are transported from the District on weekly basis to the Northern, Greater Accra and Western Regions. Agricultural technology adoption is high although availability is an often mentioned constraint. The cultivated plots are on average much larger and the use of tractor service is more common. Furthermore, use of herbicides is much more common (used by around 70 % of the farmers). The availability of labor often determines the total cultivated area and the crop mix of the individual farms (MoFA, 2010).

1.9 Organization of the study

Chapter I provides the general background and introduction to the study. Chapter 2 reviews both theoretical and empirical works on the key concepts of the study. Chapter 3 deals with the methodology which covers the estimation and techniques used in the study. Chapter 4 analyses and discusses the findings of the study. Finally chapter 5 provides a summary of the findings and also makes recommendations for policy.

CHAPTER TWO

LITERATURE REVIEW

This chapter presents literature on studies related to this study. It covers areas such as the theory of subsidies, fertilizer subsidies and Issues, the concept of distributional impact analysis, an empirical review of related works, soil and fertilizer usage in Africa, and then ends with a briefing on the fertilizer subsidy programme ain Ghana and fertilizer supply chains.

2.1Theoretical Review

2.1.1 The Concept of Subsidy

Investopedia (2012) defines a subsidy as "a benefit given by the government to groups or individuals usually in the form of cash payment or tax reduction". This is usually done to remove some kind of burden as the Concise Oxford Dictionary puts it as "money granted by state, public body, etc., to keep down the prices of commodities, etc." often considered being in the public interest. Mostly subsidies are put up by the government for producers or given as subventions to protect a particular industry against decline or increases in the prices of inputs. Types of subsidies include welfare payments, low interest loans, transfers to public enterprises, agricultural subsidies, fuel subsidies, etc.

2.1.2 Economic Theory o ubsidies

Neoclassical economic theory posits that, a Pareto-efficient allocation of resources emerges under assumptions of perfect competition. It is assumed that a properly working competitive system leads to some allocation on the utility possibilities curve. The conditions of the competitive market system have been termed as "first best" approach to resource distribution and allocation. These conditions outlined however hardly ever exist and hence the need to resort to "second best" approaches. The theory of the second-best suggests that if there are irremovable distortions in some sectors of the economy, then economic performance or social welfare may be higher if free-market pricing principles are deliberately violated in other sectors of the economy.

Subsidies form part of "second-best" approaches to remove market imperfections. According to Atsu (2006) "a subsidy, by reducing the price of the commodity, may increase the consumption of the commodity towards the equilibrium (perfectly) competitive quantity, given that output was initially too low." "This benefit must be balanced against the cost of the subsidy, which also includes the cost of financing the subsidy through distortionary taxation."

The theory of the second-best suggests that if there are irremovable distortions in some sectors of the economy, then economic performance or social welfare may be higher if freemarket pricing principles are deliberately violated in other sectorŠ of the economy. Subsidies are mostly offered to producers of merit goods and services to reduce their cost of production and hence enable them to produce more and reduce prices. A subsidy would cause the supply curve of a producer to move to the right and thus reduce the cost of production.

Despite the popularity of subsidies, economic theory posits that they are inefficient because they come with an element of deadweight loss and also have distortionary effects on the market. RogeÐAnd Ram (2011) state that "income transfers are superior to subsidies and reduce ineffiðiencies, as e former do not create the deadweight loss associated with subsidies and maximize welfare".

The validity of this view however stands challenged as it has been noted that "well targeted subsidies tend to be superior to-cash transfers in improving welfare." Ross (1991) makes a simple analogy that "when a government directs resources to a deserving family in which all consumption decisions are made by the head of the household, an agency problem arises. The head, as the government's agent, may not allocate resources in the way the government, or the family, would wish. By constraining the transfer using subsidies or in-kind gifts, the government may be able to influence the intra-family allocations in a desired way".

2.2 Fertilizer Subsidies

Fertilizer subsidy programs have tried to remedy low fertilizer use by small-scale farmers in Africa. Various benefits are cited in justifying them mostly economic (real productivity increases), environmental (reductions in land degradation), and social (poverty alleviation or emergency relief). Despite having some obvious drawbacks[2] fertilizer subsidies continue to

have strong support from farmers and from politicians who view farmers as an important constituency.

Morris et al., (2007) argue that subsidies raise fertilizer use to optimal levels for farmers who may be affected conditions of a failed market.[3] They argue that if subsidies can raise fertilizer use to optimal levels at lower cost than the benefits then there is a basis for their implementation. The efficiency argument contends that subsidies could bring about farm level innovation and aid a rapid industry level development. Zoe and Jesus (2012) also note that [fertilizer] subsidies enhance technology promotion and farmer learning by encouraging farmers to test inputs, and also increasing the affordability of fertilizer by reducing input prices, until a m ket reaches a size sufficient to capture economies of scale.

Crawford et al. (2006) arguing on equity grounds contend that fertilizer subsidies are an effective way for achieving desirable social objectives. They serve as an income transfer to poor smallhclder households, when well-targeted. A key issue however is that poor subsistence farmers may lack complementary resources, such as skills, scales of operation, productive assets, or the financial resources to pay even the subsidized prices, to make effective use of the subsidized inputs. In other words, use of agricultural inputs by poor smallholders may simply be unprofitable even if unconstrained by market failures and therefore resurrect the recurring issue of balancing equity with efficiency.

[2] High costs, pressures on government budgets, targeting difficulties, and crowding out of commercial sales.

[3] Lack of knowledge, perceived high risk against benefits and high prices.

2.2.1 Issues o; Fertilizer Subsidies

Large scale agricultural input subsidies were a common and major feature of agricultural development policies in poor rural economies from the 1960s to the 1980s. They were generally implemented as 'across the board' price subsidies accessible to all producers, or to

all producers of a particular category. If they were sold through a state monopsony then there were commonly attempts at price discrimination, with, for example, only smallholder farmers allowed to purchase subsidised fertiliser and forbidden from selling it on to other farmers. Fertiliser subsidies were particularly expensive and made heavy and growing demands on government budgets as they stimulated increased fertiliser consumption (and hence increased volumes of fertiliser subsidy), while political pressures also led to pressures for the subsidy rate to increase, or at least not contract, in the face of growing fertiliser prices.

Conventionally, it has been argued that agricultural subsidies have focussed on the promotion of increased agricultural productivity through the adoption of new technologies (Ellis, 1992). Reduced costs of subsidised inputs increase their profitability and reduce risks perceived by farmers in adopting them in-EíFCThßGnces where farmers' limited knowledge first of input benefits and second of their correct usage inappropriately constrain their expenditure on input use. Together with credit and extension services, input subsidies were supposed to help farmers implement, benefit from and then, with the withdrawal of the subsidy, themselves fully fund economically and technically efficient input purchases and use: rapid learning with subsidies about input use and its benefits should mean that subsidies would be needed for only a short time and could be rapidly phased out. However subsidies were often subsequently implemented more widely with pan territorial pricing to support agricultural development in more remote areas, and to counteract taxes on agriculture through export tariffs, managed exchange rates and controls on domestic prices. Transfers to producers can be analysed in terms of inefficiencies associated with economic rents.

First, if a general input subsidy is intended to deliver an economic gain by stimulating increased input use to increase production, part of the cost of the subsidy goes to reducing the cost of production for produce that would be produced anyway. Unless there is some social

or economic benefit from transferring income to producers already using fertiliser, then the subsidy is an inefficient way of stimulating increased production and increased productivity, since the producer surplus accruing to existing fertiliser use is not delivering any economic gain (Dorward, 2009).

Also where sUbsidised inputs are rationed (as is common), then such rationing leads to opportunities for those controlling subsidised inputs (politicians, government officials, fertiliser suppliers, farmer organisation office bearers, etc), to divert subsidised inputs from their intended beneficiaries for a side payment or to demand payments from beneficiaries in return for provision of subsidised inputs.

Another major concern with input subsides is the extent of leakages and diversion of subsidised inputs away from their intended use. Dorward (2009) outlines three ways of such a

manifestation;

- Firstly farmers are likely to apply inputs to the use from which they expect to get the greatest return. Fertilisers, for example, may be applied to a variety of crops. If returns to fertilisers are higher-on other crops (for example cash crops) then farmers may apply subsidised fertilisers to cash crops which have much more price elastic demand and which are not consumed by the poor. Even if fanners do initially apply subsidised input to staple foods, with inelastic demand, a large'scale subsidy will tend to reduce prices farmers receive for this crop, and this may in turn lead to fertiliser profitability and use switching to more demand elastic tradable there resulting in increases in deadweight losses and reduced benefits for consumers.

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- Secondly, input subsidies in developing countries have commonly been targeted towards small holder rather than commercial farmers, with mechanisms directing subsidised inputs away from large scale commercial farms and regulations prohibiting sale of subsidised inputs by recipients. Where a general subsidy is applied it is difficult to channel subsidised inputs to smallholders unless there are a limited number of tightly controlled supply chains, clear ways of identifring intended beneficiaries, and a high degree of discipline and control of private fertiliser transactions. If subsidised inputs are used by larger scale commercial farms this is likely to lead to increased diversion away from staple food crop production to cash crops and a greater share of transfers to less poor producers. Similar issues arise in subsidy access between richer and poorer smallholders.

- Then there is the case of cross border leakages which arise when subsidised inputs are sold outside the country at a discount. The value of the discount represents a straight loss from the transfer of resources outside the country, with the loss of any chance of consugner benefits or economic gain from increased input use.

According to Ricker-Gilbert et al (2012), "a major factor determining the impact of a fertilizer subsidy program is the average and marginal physical product of fertilizer application on recipient farmers' fields." However measures of crop responses on farms could be confounded by the lack of data on the quality of soil, the quantity and distribution of rainfall, labour input, and management ability of the farmer. Even with access to data on other inputs it is difficult to correctly measure the average product of an input because inputs are complementary with others (Johnson, 1950).

2.3 Distributional Impact Analysis

Distributional impact analysis focuses on the immediate or direct impact of a policy on households and individuals, with possible modifying influence of behavioural responses and market mechanisms, that is, indirect or second round of effects (Eboh et al, 2006). The idea of distributional impact analysis seeks to evaluate the possible welfare and equity implications of an intervention, especially when it is not targeted. Welfare and equity are enhanced if the distribution of the benefits of a subsidy favours otherwise resource-poor and vulnerable households.

Eboh et al (2006) notes that literature on distributional impact of public policy has developed in line with an ever increasing focus on poverty reduction as a central development benchmark following from which there has been an increasing demand for welfare, poverty and distributional analysis. It has become necessary to find out what the possible effects policies are both at the micro and macro levels.

There has been an improvement in knowledge and methods on evaluating the effects of growth, public policy, social spending and targeted interventions on poverty and inequality. This notwithstanding, methods to evaluate the poverty and distributional impact of economic policies are faced with a big challenge in answering relevant questions such as who benefits from government nent fertilizer subsidies, who the target groups are and how much impact subsidies have on poverty (Duclos, 2002).

It is also worth noting that, for most developing countries, decision processes are not bench marked by any "systematic poverty impact evaluations" to show how the various stakeholders within the population would be affected (ex-ante or ex post) by policies and change in policies (Eboh, 2003).

Poverty and distributional impact evaluation processes have been abandoned due to several factors, such as the "lack of relevant data and absence of institutional infrastructure". Key features and trends of methods for evaluating poverty and distributional impact of economic policies are discussed in Bourguignon and Pereira da Silva (2003). Because poverty is essentially a household phenomenon, poverty impact evaluation methods necessarily operate at the micro level. An identification the poor and vulnerable within the populace is necessary to aid a gauging of the poverty impact of a policy requires using household or individual level data. Poverty incidence analysis must therefore necessarily proceed first at the micro level in order to identify who gainers or losers are because of a specific policy or policy change.

According to Eboh et al (2006) using one technique for distributional impact analysis for the most times does not paint the full picture. It is therefore proposed that various techniques be used at the same time to get a less partial picture. They also not that the "link between macro policies and distribution of economic welfare is the systematic reliance on microeconomic data sets, essentially household surveys of various types".

Poverty and distributional impact evaluation of economic policies may be ex ante and/or ex post. Ex ante evaluation involves quantitative techniques that try to predict the various effects of po½cies including those on distribution and poverty. Ex post approaches compare individuals-oñouseholdsþefere-anð•after some policy changes or households involved in some specific program with households not involved in this program (Bourguignon and Pereira da Silva, 2003). Ex post evaluation serves to check whether actual effects were those expected and possibly to reform them. The difference between ex ante and ex post approaches is more significant when possibly complex behavioural responses are taken into account.

A critical methodological issue bearing on the nature of poverty impact (whether direct or indirect impact) is the selective application of accounting vis-à-vis behavioural approaches.

The simple incidence analysis exemplifies the accounting approach — who receives what from the government or public spending? Accounting approaches ignore possible behavioural responses by agents that may critically alter how much is or what is received from the government. This is because accounting approaches focus on first round of effects and disregard second round of effects due to behavioural responses. In contrast, behavioural approaches in poverty impact evaluation of policies take into account behavioural responses. Taking into account behavioural responses is important for poverty incidence analysis, since they may compound, mitigate or reverse first round of effects revealed by accounting approaches. Integrating behavioural responses into the analysis is however constrained by difficulty in identifying them and their determinants.

Literature reveals that every poverty and distributional impact study faces methodological choices at the outset. The mix of techniques would eventually depend on the perspective adopted for poverty evaluation, the data at hand and economic modelling capacity, the nature of the policy and the way and manner of implementation.

2.4 Empirical Review

Despite the potential benefits of subsidizing fertilizer, the costs of implementing large-scale fertilizer subsidy programs are high, and can increase substantially over time, especially when fertilizer and fuel pricšñÇÃFor example, in 2008 Malawi roughly 70% of the Ministry of Agriculture's budget or just over 16% of the government's total budget subsidizing fertilizer and seed (Dorward and Chirwa, 2011). In Zambia, 57% of total government expenditure on agriculture went to •fertilizer and maize subsidies in 2010, equivalent to 2% of the nation's gross domestic product (Nkonde et al., 2011; IMF, 2010).

There has been number of studies on fertilizer use in Africa. One such study by Minot et al. (2000) used a Heckman model to identify the determinants of fertilizer use. The study finds

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that fertilizer use is closely related to crop mix and access to inputs on credit, but not to household income. The study found that in Malawi and Benin (the two countries which were the focus of the study), farmers growing cash crops are three times as likely to use fertilizer on their maize fields as other farmers.

Croppenstedt et al. (2003) estimate a double hurdle fertilizer adoption model for Ethiopia. They found that credit is a major supply side constraint, suggesting that household cash resources are generally insufficient to cover fertilizer purchases. On the demand side, household size, formal education of the farmer, and the value-to-cost ratio has the largest impact on adoption and intensity of fertilizer use. These results underline the cost implications of fertilizer use and the importance of making credit available, developing labour markets, and reducing the procurement, marketing and distribution costs of fertilizer.

Resurrecting fertilizer subsidies seem to be a way out for solving most of the problems faced by farmers when it comes to stimulating the use of the inorganic input. According Zoe and Jesus (2012), there are currently about fifteen subsidy programmes implemented in SubSaharan Africa (SSA) since 2000. These subsidy programmes come in untargeted (Burkina Faso, Senegal, Mali, Nigeria, and Ghana) and targeted (Kenya, Malawi, Rwanda, Tanzania, and Zambia) forms. The stated goals of fertilizer subsidy programs are often to reduce poverty, and-boost production-of-st* crops such as maize (Kelly, Crawford and RickerGilberÇ 2011).

Key issues from these subsidy programmes mostly borders on effective targeting (as to who gets to access the subsidized inputs), the potential effects of the subsidy on the input market, impacts on farm output and incomes, crop diversification and land allocation.

Using data from Kano District and a Tobit regression model Liverpool (2012) assesses the impact of a targeted voucher programme on famer households. Her results indicate that participants tend to be relatively poorer households, as farmer wealth was negatively related to access to subsidized fertilizer. This contradicts findings by Chibwana et al. (2011) and Ricker-Gilbert et al. (2011) who find evidence in Malawi that female headed households are not specifically targeted in practice, and that wealthier household acquire significantly more subsidized fertilizer on average. This is despite the fact that targeting poor and female-headed households is a stated objective of the Malawi Programme.

Results similar to that of Ricker-Gilbert et al. (2011) case have also been found in Tanzania by Pan and Christiaensen (2011) who found that the distribution favours wealthier households than the poor. The targeting issues in Malawi are consistent with those found in Tanzania by Pan and Christiaensen (2011) who find that decentralized targeting in the Kilimanjaro region leads to distribution favouring the politically connected. Pan and Christiaensen also find that rather than distribute to non-fertilizer using households, the subsidized fertilizer is directed at farmers who are more productive and already into fertilizer

Crowding out is another issue which has been identified by the literature on fertilizer subsidies. Using a panel data fixed effects estimator to control for time invariant unobservable characteristics, Ricker-Gilbert et al. (2011) finds that when farmers' ability tó acquire subsidized fertilizer is treated as exogenous, there are significant negative impacts on commercial fertilizer purchases albeit small. Their analysis indicates that one kilogram of subsidized fettilizer crowdsÚŒWograrns of commercial fertilizer on average between 2003 and 20C7. They also find that, at 0.18 kg displaced, crowding out is smaller for the poorest quintile of the sample, compared to the wealthiest quintile, with 0.31 kg displaced.

Liverpool (2012) using cross sectional data finds evidence of crowding in (thus a positive impact on the private market) in Nigeria. This unlike the case of Malawi represented a development of the private market especially when retail points were established in areas which

hitherto had no private supply points for farmers and thereby increasing access to fertilizers for farmers in remote areas of possibly higher transaction costs. According to Duflo et al. (2011) crowding out or crowding in possibly depends on the nature of the subsidy. If the subsidy is extensive enough to cover a substantial proportion of the market demand, then it could curtail the need for private market participation.

Policy makers often assume that farmers who receive the sUbsidy will achieve yield responses that are similar to those obtained by farmers who pay commercial prices for the . input (Ricker-Gilbert and Jayne, 2011). Holden and Lunduka (2010) applies a linear probability model with household fixed effects to three rounds of household data to assess the impact of the subsidy of farm outputs in Malawi and finds that there is a significant positive trend in maize yields from 2006 to 2009 with an increase in mean yields of about 600 kg/ha from 1440 to 2040 kg/ha for hybrid maize and from 1120 to 1680 kg/ha for local maize. Although the authors do not directly tie the increment to the subsidy program, it can be in inferred from the fact that "access to subsidized fertilizer enhanced fertilizer use intensity on maize plots".

Ricker-Gilbert and Jayne (2011) also apply a polynomial approach to six years of panel data from Malawi to estimate how acquiring subsidized fertilizer over time impacts maize production and other indicators. The authors find that an additional kilogram of subsidized fertilizer inThe current year-boosts—maize production by 1.82 kilograms in that year on average. They also find that an additional kilogram of fertilizer acquired by households in each of the three previous years boosts maize production by 3.16 kilograms in the current year on average.

Chibwana et al. (2011) measure the impacts of Malawi's Farm Input Subsidy Program on how farmers allocate land of various crops. Using a double hurdle regression strategy they find that participation in Fertilizer Input Subsidy Programme (FISP) correlates positively with the land allocated for maize and tobacco. Recipient households allocated 16% extra land for maize cultivation than non-recipient households. The Tobacco case also saw increases in

land allocation for tobacco cultivation on the part of recipients. Also farmers who received coupons for both improved maize seed and maize fertilizer allocated 45 percent more land to improved maize than farmers who did not receive any coupons. Although their findings did not find any increase in overall land use, they conclude that subsidy recipients allocated more land to maize and less land to other crops such as groundnuts, soybeans, and dry beans.

Related to the issue of land use is the issue of crop diversification. If fertilizer subsidies encourage farmers to concentrate on a narrower portfolio of crops, and if this is viewed as detrimental, programs might have to be redesigned to avoid this unintended effect. From one perspective, crop diversification is an important strategy for resourceful households. By growing a mixture of crops, farmers can reduce potentially negative impacts of labour shortages, seasonal production needs, and uncertain climate conditions (Tripp, 2006).

In this sense, the shift toward more simplified cropping systems, dominated by improved varieties of maize, might increase the vulnerability of farm households to the weather, pests, diseases, and markets. Furthermore, the increase in maize acreage at the expense of relatively drought-tolerant crops, notably cassava and sweet potato, could exacerbate the impact of drought on food security (Holden and Lunduka, 2010).

Reduced allocation of Ian to legumes also has potentially negative consequences for soil __rtility. The inorganic fertilizer provided by the Fertilizer Subsidy Programme coupons could help increase the nitrogen content of the soil, but Akinnifesi et al. (2009) argue that the synergistic effects of fertilizer application and legume cultivation achieve better soil maintenance. Nevertheless, a move toward greater maize specialization is not intrinsically a bad thing, since maize provides labour savings and improved pest control as well as market opportunities, and flexibility in planting and harvesting times.

An issue that has received only limited attention in the literature is the potential for fertilizer subsidies to generate unintended off-site effects, either positive or negative. Because rural families engage in a wide range of activities in support of their livelihoods, labour allocation to some activities necessarily has implications for other activities (Ricker-Gilbert et al., 2012).

In an a study of Malawi's Starter Pack programme, Fisher and Shively (2005) found evidence that households receiving subsidized seed and fertilizer tended to intensify their maize production and, as a result, placed less pressure on the resources of surrounding forests (a positive externality associated with the program).

Lately there has been the need to extend the subsidies to other inputs especially seed. RickerGilbert et al (2012) duly note that "fertilizer use rates may nevertheless be profitably raised in many areas, but doing so will require the adoption of complementary practices that raise response rates of grain to fertilizer application". It has become obvious that "achieving higher returns to fertilizer use will require a more holistic approach to input intensification strategies in the region, paying attention to management practices and complementary inputs that can raise the profitable use of the input".

A key facilitator of all the studies across Africa has been the ability to have access to comprehensive and far reaching data on key variables which have also to a large extent facilitated themethods used>thesv-štúdies. For instance, the popularity of the double hurdle model is largely due to the availability of panel data. This current study suffers from a deficit of such information and for that matter has to make use of a single cross section of data to evaluate the impact of the Government ofGhana's Fertilizer Subsidy Programme.

Whilst most of the studies perceive possible endogeneity when commercial fertilizer is regressed on access to subsidized fertilizer, the issue is more of paranoia as the difference between ordinary least squares and two stage least squares coefficients shows no alteration in the significance of coefficients, an indication that such endogeneity has a rather mild impact on the results. This study will proceed on the assumption of no endogeneity and proceed accordingly.

2.5 Soil Fertility and Fertilizer Usage in Africa

Table 2.1: Nutrient balances of some sub-Saharan African countries

Country	N		P		K	
	1982-84	2000	1982-84	2000	1982-84	2000
	(kg/ha/year)					
Benin	-14	-16	-1	-2	-9	-11
Botswana	o	-2	1	o	o	-2
Cameroon	-20	-21	-2	-2	-12	-13
Ethiopia	-41	-47	-6	-7	-26	-32
Ghana	-30	-35	-3	-4	-17	-20
Kenya		-46	-3	-1	-29	-36
Malawi	-68	-67	-10	-10	-44	-48
Mali	-8	-11	-1	-2	-7	-10
Nigeria	-34	-37	-4	-4	-24	-31
Rwanda	-54	-60	-9	-11	-47	-61
Senegal	-12	-16	-2	-2	-10	-14
United Republic of Tanzania	-27	-32	-4	-5	-18	-21
Zimbabwe	-31	-27	-2	2	-22	-26

Source FAO (2003)

Fertilizer use in Sub-Saharan Africa increased at 6.3% per year during the 1970s and 5.5% per year during the 1980s (1980-87). However, in 1987/88 total fertilizer use decreased by about 1%. Of the three primary nutrients, phosphate use showed a relatively higher annual growth during the 1970-88 period. This is perhaps a result of relatively higher use of phosphate fertilizers on export crops than on food crops. In Ghana, the production of the main food crops removes almost 70,000 t of N and 25,000 t of P205 from the soil annually (MOFA, 1998).

According to the FAO (2003) there exists a general downward trend in soil fertility in Africa'. Densely populated and hilly countries in the Rift Valley area (Kenya, Ethiopia, Rwanda and Malawi) had the most negative values, owing to high ratios of 'cultivated land' to 'total arable land', relatively high crop yields and erosion. For the Sub-Saharan Area (SSA) as a whole, the nutrient balances were: -22 kg/ha in 1983 and -26 kg/ha in 2000 for N; -2.5 kg/ha in 1983 and -3.0 in 2000 for P; and -15 kg/ha in 1983 and -19 kg/ha in 2000 for.

In absolute amounts, total fertilizer use in sub-Saharan Africa increased from 373,000 tons in 1970 to 728,000 tons in 1980 and 1,212,000 tons in 1986.Total fertilizer use then decreased to 1,201,000 tons in 1987 and tons in1988. This decline in use is mostly a reflection of decreased imports because of foreign exchange shortages faced by many countries. The increased fertilizer prices due to the removal of fertilizer subsidies and bad weather also affected fertilizer use adversely in some countries.

2.5.1 Trends Fertilizer Use in Sub-Saharan Africa

Minot and Benson (2009) outline characteristics of fertilizer use in Sub- Saharan Africa as follows;

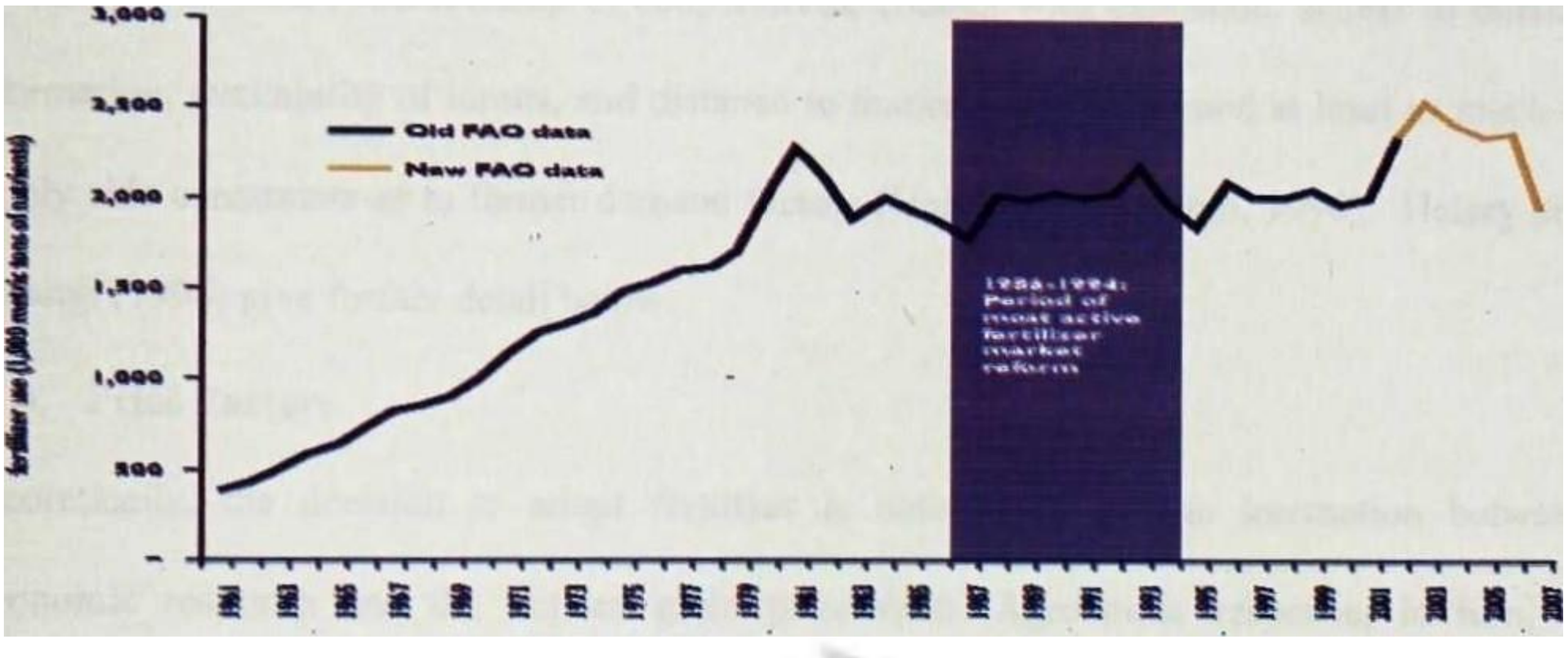
- They note that fertilizer use shows wide annual fluctuations, especially in the 1980s.

  Having increased rapidly in 1981 and 1982, it decreased in 1983, increased in 1984, and decreased in 1985. Likewise, fertilizer use increased rapidly in 1986 but decreased continuouslÿ in the next 2 years. Economic, institutional, and climatic changes seem to have produced these fluctuations .

- Also many countries use rather small quantities of fertilizer nutrients. In 1988, only 5 of thq40 countries used more than 50,000 tons of nutrients . Such a small size of

  the fertilizer market prevents many countries from investing in viable production facilities or benefiting from economies of scale in bulk imports. Consequently, many countries have to incur relatively higher costs in procuring their fertilizer imports.

Figure 2.2: Trends in Fertilizer Consumption in Sub-Saharan Africa



Source: Minot and Benson (2009)

- Thirdly, fertilizer use is highly concentrated in a few countries. Nigeria, Zambia, Zimbabwe, Kenya, and Ethiopia are relatively large users of fertilizers. These five countries account for about two-thirds of the total fertilizer use in Sub- Saharan Africa.
- Fourth,,-many countries in sub-Saharan Africa depend on fertilizer imports to meet their domestic fertilizer requirements. Because of the debt crisis and foreign exchange shortages, a large proportion of fertilizer imports is donor financed.
- Fifth, export crops account for a large proportion of the fertilizer use in subSaharan Africa. Relatively higher profitability and better institutional and organizational arrangements and research and extension facilities for export crops have induced this skewness in fertilizer use in Sub-Saharan Africa.
- Sixth, compared with Asian and Latin American countries, many African countries use compound and complex fertilizer products, most of which are cust0P¼made abroad in small quantities. Thus, their use also lead to relatively higher fertilizer costs for these countries.

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2.5.2 Farmers' Adoption and Intensity of Fertilizer Use: Key Associated Factors

Demand and supply factors are hard to separate when evaluating farmers' decisions to adopt fertilizer and their subsequent decisions about application rates. Key influences such as farm

size, access to credit, membership in cooperatives, contact with extension, access to outside information, availability of inputs, and distance to markets may be related at least as much to supply side constraints as to farmer demand factors (Heisey and Mwangi, 1996). Heisey and Mwangi (1996) give further detail below.

- Price Factors

Theoretically, the decision to adopt fertilizer is determined by the interaction between agronomic response and the nutrient-grain price ratio. Agronomic response, in turn, is determined by soil characteristics and climatic factors. If the marginal agronomic response at a level of 0 kg/ha of applied nutrient is greater than the nutrient-grain price ratio, in theory the farmer should adopt fertilizer. In practice, other factors often prove important: the cost of operating capital for the cropping season; information and learning costs; and, perhaps, the effects of risk aversion (CIMMYT, 1988).

- Risk Aversion and Cre@it-Censtraints

Risk aversion is commonly assumed to play an important part in technology adoption decisions. Production risk is apt to be considerably more important in marginal areas, than in more suitable maize growing areas (McCown et al., 1992). Certainly output price instability constitutes a risk for fertilizer users In western Africa' (Vlek, 1990). In eastern and southern Africa, maize prices are probably more stable than prices for certain other cereals (e.g. Sorghum and millet), but less stable than maize prices in other developing regions of the world. These details suggest the need for more careful risk assessment in Africa as compared to those other regions. Constraints on cash or credit availability often cause farmer behaviour that looks like risk aversion (Masson, 1972; Binswanger and Sillers, 1983). For many African smallholder farmers, fertilizer expenditures can represent a considerable proportion of the total cash expense for crop production.

- Availability of fertilizer

Despite differences of opinion on other issues, many analysts of fertilizer use and policy in Africa and the rest of the developing world contend that basic problems of availability (i.e. getting the right fertilizer to the right place at the right time) are at least as important as

priceresponse interactions in determining fertilizer use (Fontaine, 1991; Pinstrup-Andersen, 1993; Blackie, 1995). Often referred to as non-price factors, these problems can be accommodated within a pricing framework by noting that, in effect, they raise the shadow price of fertilizers to farmers. Although the features of the African fertilizer economy that lead to high prices are often intertwined with those that constrain availability, policy makers have often focused solely on the one effect (high prices) rather than on availability, and ignored the underlying causes completely.

2.6 Ghana's Fertilizer Subsidy Programme

Fertilizer importation and distribution before 1990 was carried out by the Ministry of Food and Agriculture_(MoFA). The fgrtil.izermarket was liberalized in 1990, as part of a package structural adjustment programmes, and the importation and distribution since then is being carried out by the private sector. Except WIENCO, all the companies in the feltilizer import trade are multinational companies. Their involvement in the fertilizer supply chain is at various levels. YARA is a major supplier to most of the importers either through direct import order or through stock inventory credit.

On July 2, 2008, the government of Ghana announced details of a fertilizer subsidy to be instituted through the end of 2008 in response to dramatic increases in food and fenilizer prices. Between May 2007 and May 2008, the price of maize in Accra and Tamale rose by an average of 77% having reduced by 2.2% in 2006 - 07. 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.

Table 2.2: Total Fertilizer Subsidized and Total Cost to Government (2008-2011)

Year	Total Subsidized Fertilizer (Metric Tons	Total Subsidy Paid by Government GHC Million
2008	43,176	20,654
2009	72,795	34,400
2010	91,244	30,002
2011	176,278	78,746
Total	383,493	163,802

Source: MoFA, Ghana

The price of nitrogen-phosphorous-potassium (NPK) 15:15:15, the most widely used food crop fertilizer in Ghana increased from Ghana Cedis (GH) to GHÉ35 per 50 kilogram (kg) bag between June 2007 and March 2008 (Ministry of Food and Agriculture, 2008). The program entailed a country-wide subsidy on four specific types of fertilizers: NPK 15:15:15, NPK urea, and sulphate of ammonia (Benin et al, 2011).

The stated objectives of the programme are;

- To increase average application rate of fertilizer by farmers from 8 to 20 kg per hectare;
- To increase crop yields and production;
- To raise the profitability of farm production; and
- To improve private sector development.

2.6.1 Regione.l Distribution of Subsidized Fertilizer

According to Benin et al (2011) about half of the total amount of fertilizer is sold in the Northern, Upper East and Upper West regions. The largest allocation of subsidized fertilizer always goes t? the Northern region, accounting for 25 percent of the total subsidized fertilizer sales in 2012. This is by by tiE Brmg-Ahafo region with 16.2%, then the

Ashmti and Upper East and Weg regions, respectively. The westernregm the leøt allocation of about 1.4% shown by table

Table 2.3 Regional allocation of subsidized fertilizer in Ghana or2012

R ion	uanti mt	Percent* e
Greater Accra Re ion	7283.5	4.2
Ashanti	18471.2	10.7
Central	14750.3	8.5
Eastern	20008.7	11.6
Western	2366.3	1.4
Volta	8406.0	4.9
Bron Ahafo	28097.3	16.2

Northern	44482.0	25.7
U East	15787.0	9.1
U West	13347.0	7.7
Total	173000	100

Source: MoFA (2012)

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2.6.2 Programme Design and Implementation

- The voucher system (2008 and 2009)

The 2008 and 2009 fertilizer subsidy program took the form of vouchers, involving four major fertilizer companies, YARA (and WIENCO), CHEMICO, DIZENGOFF and GOLDEN STOCK. These companies provided information to the government on the total fertilizer consumption in the country, Including regional disawegation, which was used by the govsmment to estimate the quantities of four of fertilizer to be subsidized. Coupons were printed and allocated to Regional Agricultural Development Unas (RADUs), who in tun issued them to their District Agncultural Development Units (DADUs) bued on district fertiliEr consumption. In DADU, vouchers allocaed to apicultural extension aFnts (AEAs) who m urn issued them to fumets.

Upon receipt of a voucher, a fumet in .ddióo to vahg oft* subsidy to purchase fertilizer from the nearest participating retail fertilizer outlet. This sy•— wu repeated in 2009, with government absorbing additional cost of fertilizer to maintain the 2008 prices. The total amount of subsidized fertilizer was 43,176 MT and 72,795 MT in 2008 and 2009, respectively. Reported lessons emerging from the coupon system included high overhead and administrative costs, diversion of fertilizers from intended target beneficiaries, and large amounts of time spent by the Head Office and District Directors and the staff of MOFA in policing the distribution process (MOFA, 2010).

- The waybill system (2010, 2011 and 2012)

Following the lessons reported, the voucher system was replaced with a waybill system in 2010 and 2011. Under the waybill system, the government absorbs port handling, loading and transport costs as well as agents' commission and margins to arrive at prices that are affordable to the small scale farmers. The principal objective is to ensure the program reaches all farmers

at the agreed upon low prices in all regions. The operational details of the subsidy include determining the subsidy price, ensuring distribution, monitoring and oversight, and payments based on validated sales receipts.

To begin with, retail prices of fertilizer in the domestic market are set up-front, through negotiation between the importers and the Government of Ghana (GOG), taking into consideration the fluctuation of the fertilizer price in the international market, the different cost components along the domestic fertilizer supply chain and the expected exchange rate fluctuations. This may be regarded as a unique example of a public-private partnership in which the government consults heavily with fertilizer importers in the design stage and rely exclusively on the existing private distribution system to deliver fertilizer to farmers. For the companies involved, they are allowed a certain amount of subsidized fertilizers to be sent to each region based on historical fertilizer consumption patterns (Benin et al, 2011). Based on MOFA's Guidelines ofthe 2010 Subsidy program (MOFA 2010), the subsidy payable on each 50 kg bag of fertilizer is 15-17 GHS per 50-kg bag.

2.7 The Fertilizer Supply Chains

Fertilizer markets refer to buying and selling, the supply chain from the point of production/importation through distribution to the final consumer (the farmer). Figure 2 illustrates the physical flow of fertilizer from the overseas supplier to the farm gate in the typical fertilizer market in Africa. In doing so it depicts the players in the African fertilizer market (structure); the functions performed by these main actors (conduct) and the costs and margins generated as these functions are carried out (performance).

These functions are carried out within an enabling environment which is comprised of public policies, the regulatory framework, laws and institutions, the physical geography and climate of the country, and the infrastluctural set-up. The magnitude of the costs and margins generated by carrying out each function is influenced by the policy, regulatory and

institutional environment as well as the basic market conditions (size of the market, infrastructure) and physical conditions (climate, soils, land formations, etc.).

SCI represents the typical organization of fertilizer supply chains in Africa where markets have been liberalized. Importers procure fertilizer from overseas suppliers and sell it mainly to wholesalers/distributors but also directly to retailers/agro-dealers. The latter typically occurs in countries like Uganda where the wholesaler/distributor level does not exist or is insubstantial. Retailers/agro-deÞ_alsœsellfertilizers directly to small-scale farmers or sell it to stockists who then sell it to small-scale farmers. However, these supply chains are typically weak and undeveloped due to a number of supply- and demand-side constraints which will be elaborated on below.

SC2 represents a more mature organization of fertilizer market with domestic production of fertilizers and distribution via well-developed wholesaler/distributor and retail networks. However such systems only exist in North Africa and South Africa; there are few such systems in sub-Sahara Africa.

SC3 is commonly found in the export cash crop sectors of SSA such as tea and sugar in Kenya tobacco in Malawi, cotton in West Africa, and sugarcane in Mauritius. These companies either procure fertilizer directly from overseas suppliers or place orders with local importers for their

contracted out growers.

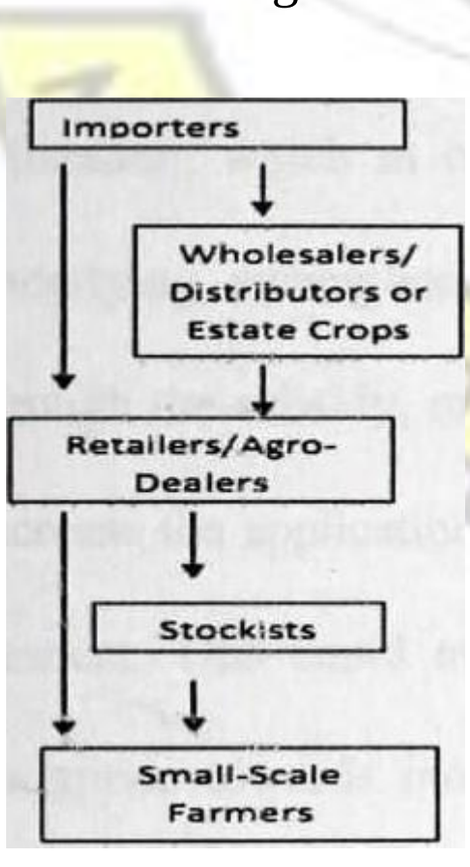
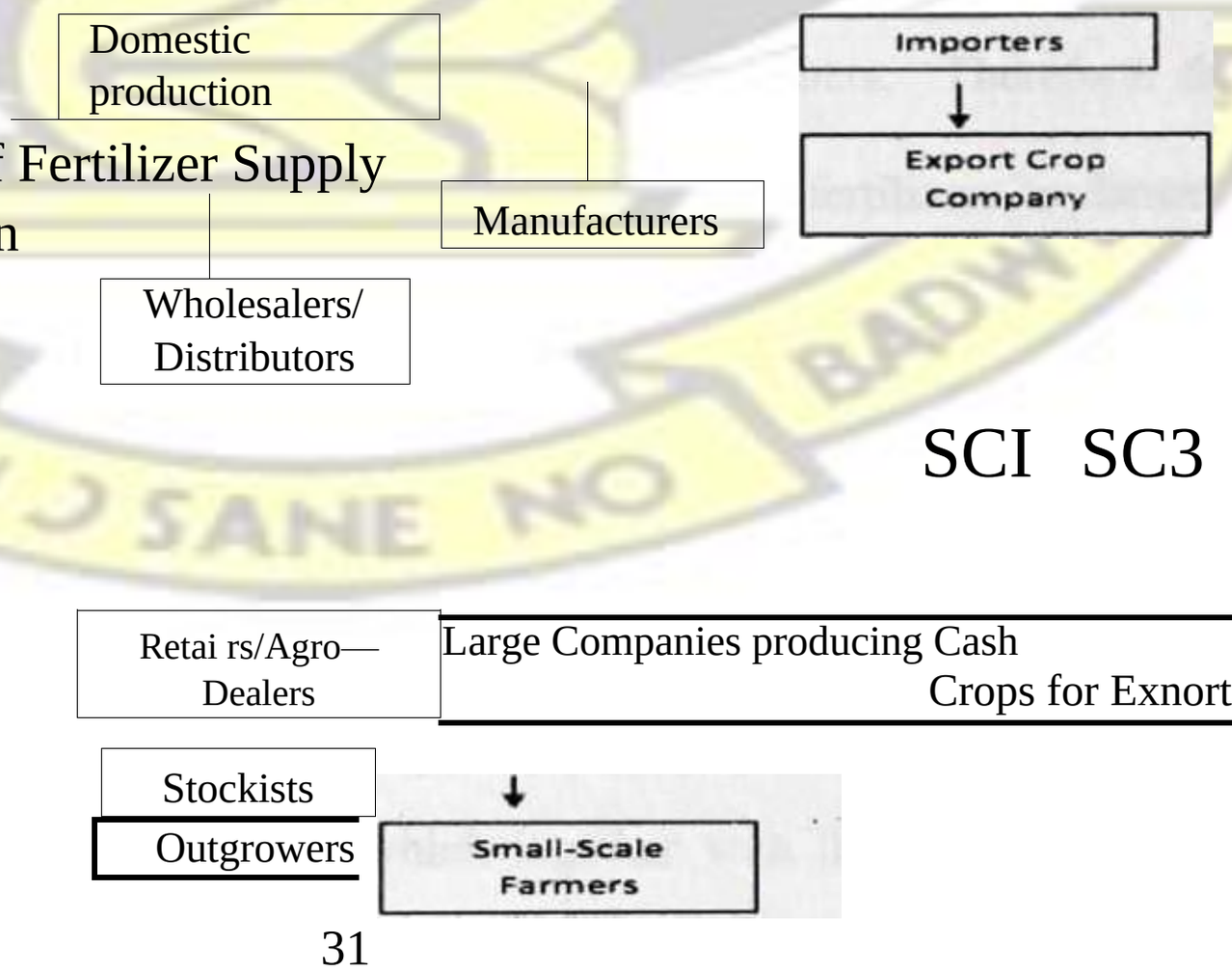


Figure 2.3: Types of Fertilizer Supply Chains in Africa



Source: Training Manual on Fertilizer Statistics in Africa (2012)

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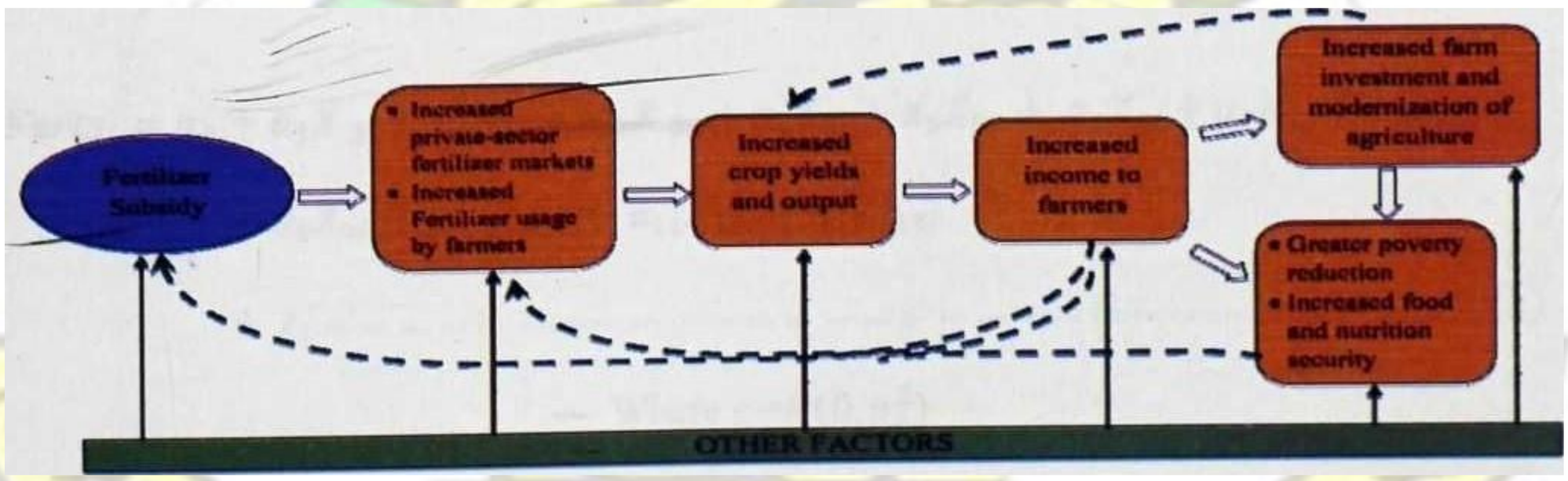
CHAPTER THREE

METHODOLOGY

3.1 Theoretical Framework

According to Benin et al (2011), the fundamental issue the fertilizer subsidy program seeks to address is the high cost of fertilizer in the open market leading to low fertilizer demand and utilization, which in turn leads to low yield and low income to farmers. Therefore, the underlying assumption in Figure 3.1 is that by reducing the cost of fertilizers to farmers through the subsidy, more famers would use fertilizer on their farms and that farmers would increase the application of fertilizer on their farms, leading to increased yields and income to farmers. This could eventually lead to re-investment of the surplus income into the farm enterprise towards modernization, which together with the increased income will lead to greater consumption, lower poverty, and increased food and nutrition security. Additionally, the subsidy is also meant to encourage greater private sector development and participation in fertilizer markets.

Figure 3.1: Impact Pathways of the Fertilizer Subsidy Programme



Source: Benin-et al (2011)

The literature and past studies show, the fulfilment of this chain of outcomes depends on other multiple factors, including complementary interventions beyond just fertilizer subsidy. For

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example, creating and expanding market access to farm produce as well as making othei agricultural in')uts like farm machinery easily accessible is important. Farmers' characteristics, including their endowments of human, physical, financial and social capital are also important. These affect among others the attitudinal orientation of farmers toward farming as a business, which has become the subject of inducing behavioural change among farmers.

3.2 Model Specification and Data Analysis

3.2.2 Estimation of factors associated with Access to Subsidized Fertilizer: Test for Propoorness and House Hold Considerations.

Earlier studies by SOAS et al (2008), Ricker-Gilbert (2008), Chirwa et al (2010) and Liverpool-Tassie (2012) have found factors such as house hold size, age of house hold head, house hold assets, male farm holders and connection to a person of influence to be key factors associated with access to subsidized fertilizer. Following from these earlier studies we estimate the factors which determine the quantity of subsidized fertilizer accessed by a farmer using both the Tobit model and Ordinary least squares regression. The use of the Tobit model is to cater to cater the censored or corner solution nature of the data, resulting from a situation where 0 observations were recorded for some variables:

$$QFertSi = + alX\ Ii + \alpha_2 X_{2i} + \alpha_3 X_{3i} + 3i + a4X4i + \alpha_5 X_{5i} + \alpha_6 X_{6i} + \alpha_8 X_{8i} + a9X9i + \alpha_{10} X_{10i} + C11X11i + C12X12i + \varepsilon_i \quad \ldots (1)$$

Where a;)

QFertsi is the bags of subsidized fertilizer accessed or purchased by the farmer. Xl is the age of the respondent, and (its impact) is expected to be positive. X2 is a dummy variable that takes on the value 1 if respondent is a male and az allows for a determination as to whether

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male farmers are on the same intercept as female farmers. X3 is the size of the respondent's household, the impact of which is measured by a3. X4 is the size of the area under cultivation by the respondent, which also proxies the resource endowment of the respondent. X5 is a dummy variable which takes a value of 1 if land is owned by the farmer and 0 if otherwise. X6 is a dummy variable which takes a value of 1 if farmer is related to an input retailer. X? is the years of education by respondent or household head, and is expected to be positive. X8. X9 and X10 are dummy variables for household access to credit, farmer's use of improved seeds and access to extension services respectively. Xll is the sum of goats and sheep owned by household which also like area under cultivation also proxy for resource endowment of the household. Ei is the stochastic error term which is normally distributed with 0 mean and constant variance.

3.2.3 Determination of Impact of the Fertilizer Subsidy on the Non-Subsidized Fertilizer Sales.

According to Ricker-Gilbert and Jayne (2008) when government and commercial input distribution systems operate together, three different outcomes are possible:

- Government subsidized fertilizer compliments private sector fertilizer and sales increase in both input channels. In this scenario the government fertilizer program "crowds in"commercial __ÃLbzer-purchases feby farmers.
- The subsidy program has no impact on commercial sales;
- Government fertilizer displaces national level sales and the total amount of fertilizer used by the farmer does not increase proportionally to the amount of subsidized fertilizer that enters the market. Some degree of displacement might be expected, but if displacement becomes too high, the incremental fertilizer used and its contribution to output may be insufficient to outweigh the costs of the program.

In the estimation of the impact of the fertilizer subsidy on the fertilizer market, these possibilities are taken note of, This study tests for the effect of the fertilizer subsidy programme on farmer participation in the private fertilizer market. Following Liverpool (2011) we express the fertilizer demand model as:

QFertp = f(QFerts , PFert, $P_{maize}, K, A, Z)$ ..... (2a)

Where QFertp refers to the quantity of fertilizer purchased from the private sector distribution channel by farmer i, QFerts refers to the quantity of subsidized fertilizer accessed by the farmer, and PFert and Pmaize refer to the prices of fertilizer and the major crop (maize) produced by majority of farmers. K and A are access to credit and land size, respectively, and Z refers to other household characteristics and socioeconomic variables. From the conceptual model above, we estimate the effect of subsidized fertilizer on private sector fertilizer demand as follows:

QFertpi = + ß1X + ß2X2i + ß3X + ß4X4i + ß5X5i + ß6X6i + ß7X7i + ß8X8i.
+ ß9X9i + ß10XIOi + ß11X11i
+ ß12X12i + ß13X13i + ß14X14i + ß15X15i + u_i

QFertp is the quantity of non-subsidized fertilizer purchased by the household. Xl is the age of the respondenE(householId heøarm—£ures the effect of age bpysehold fertilizer demand. X2is a dummy variable which takes a value of I if respondent is male. X) is the size of the area under cultivation by the household. It is expected that ß3 is positive since larger areas imply higher fertilizer requirements. X4 is a dummy variable which takes a value of if land is self-owned. X5 is the household size of respondent. X6 is the bags of subsidized fertilizer accessed by household, which is the key variable of interest for testing the hypothesis on the market. ß6 could be negative, positive or even equal to zero. X7 is the years of education by the respondent (Household head), the coefficient of which is expected to be positive. X8, X9, X10 and Xll are dummy variables for farmer's use of improved seeds, household access to

credit, access to extension services and farmer's use of hired labour outside household. X12 is the input-output price ratio of fertilizer (NPK.) to the price of a 100kg bag of maize. X13 Sum of goats and sheep owned by household. Pi is the stochastic which is normally distributed with zero mean and constant variance.

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3.2.4 Estimating the Impact of Fertilizer Subsidy on Fertilizer Use Intensity

Earlier studies by Isham (2002) and Chirwa (2005) found farming system, crop variety, education, family headship, farm size, credit access, and income from off-farm employment as factors that were associated with fertilizer use. Following Chibwarna et al (2010) the study estimates the effects of fertilizer subsidy on fertilizer use intensity. The dependent variable is the total quantity in kilograms per •acre of fertilizer that the farm holder applied to his maize farm:

$$FertUse_i = + \text{Ø}IX1i + \text{Ø}2X2i + \quad + \text{Ø}4X3i + \text{Ø}5X4i + \text{Ø}6X5i + \text{Ø}7X6i + Vi$$

Fertusei = the fertilizer application rate per acre (Kg/acre) on maize farms. Fertusei is the fertilizer application rate per acre (Kg/acre) on maize farms. Xl is a vector of house hold characteristics including the age of the household head, gender of the household head, level of education of house hold head and the size of the household. X2 is the Size of the respondents' farm land holding. This is included under the assumption that farmers that have move-land (and are therefore wealthier) might use more fertilizer (Doss and Morris, 2001; Feder 1980). It can also be argued that the incentive to intensify by using fertilizer would be greater for households that are land constrained. A squared term for land size is also included to test for potential non-linearities in the relationship. X3 is the input-output price ratio of fertilizer to maize price which is expected to have a negative effect on fertilizer use. X4 represents a vector of other characteristics such as access to extension services, use of improved seedlings and hired labour. X5 is a vector of agronomic conditions faced by the household including soil type and rainfall patterns. X6 is a dummy variable for a household

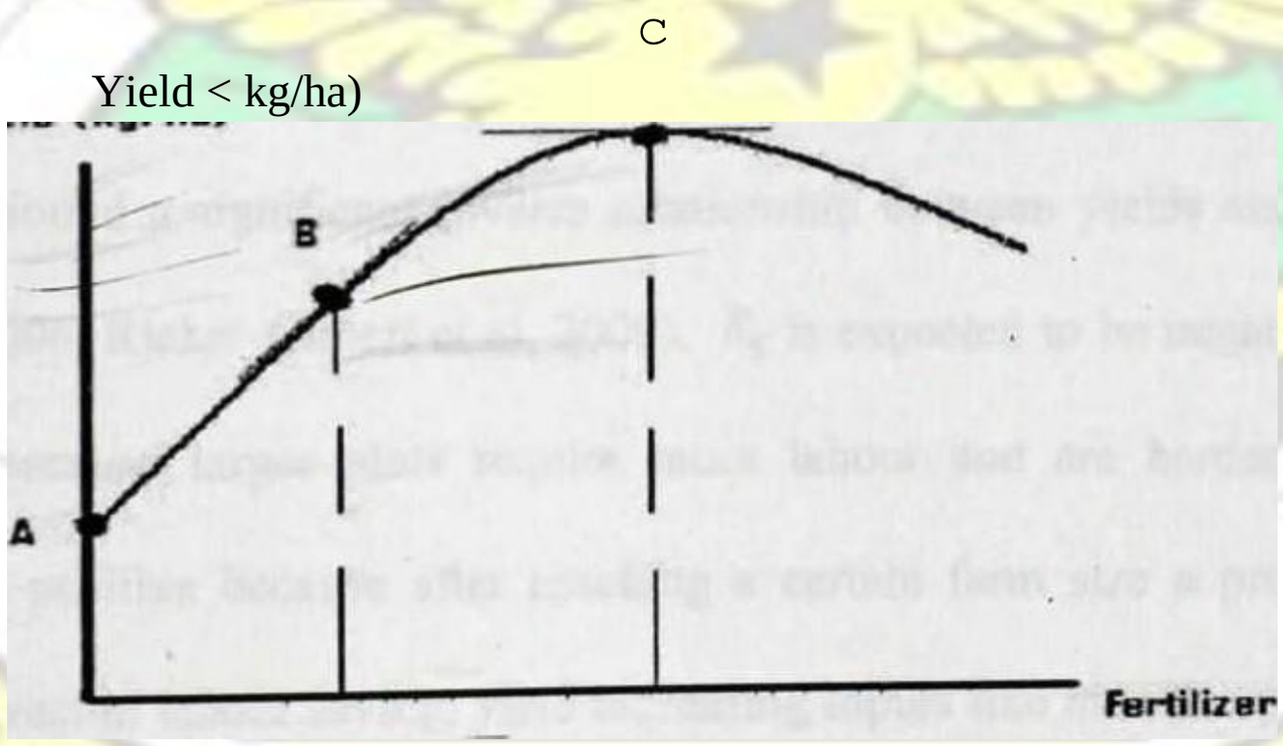
which accessed to subsidized fertilizer. This is the primary variable of policy interest and it is expected to be positive, thus households which had access to subsidized fertilizer should be on a higher intercept of fertilizer use. Vi is the stochastic error term with the characteristics of which is normally distributed with zero mean and constant variance.

3.2.5 Estimating the Impact of Subsidized Fertilizer Access on Farm Output

The yield of a farm per plot is a function of several factors, including input use of the farmer such as fertilizer, time varying agronomic conditions such as soil quality and rainfall and a host of other factors. All of these factors are conditioned on the farmer's ability and other such factors as the land available for cultivation (Ricker-Gilbert et al, 2009).

On a simple yield response function for maize to fertilizer where factors like soil quality, seed and management ability have been controlled for farmers should all be on the same production function.

Figure 3.2: Yield response of maize to fertilizer use.



Source: Ricker-Gilbert et al (2009)

When subsidized fertilizer is offered to farmers it is expected to motivate non-fertilizer users

(point A) to use fertilizer, and also increase the usage of those who already use fertilizer (point B), i.e. change the profit maximizing positions of both non-users and users in this case (Ellis 1992). Following Ricker-Gilbert et al (2009), we estimate the following polynomial model to test for the yield response to fertilizer and the impact of subsidized fertilizer on maize output:

Farm Yieldi = ðo + ð1X1i + ð2X12i

+ + ð4X2i *Xli + + + ð7X4i+ + ð9X6i + $\delta_{10}X_{6i}$

Xli + ð11X7i + ð12X8i + ei

Farm Yield refers to the maize per acre of farm holding. Xl is the kilograms of fertilizer applied per acre. This is expected to impact positively on output. ð2 measures the quadratic effect of fertilizer use on farm output. This is in view of the fact that an input like fertilizer has a diminishing marginal effect on output. X2 is a dummy variable which assumes a value of 1 if the household accessed subsidized fertilizer and allows for a test as to whether subsidized fertilizer recipients are on the same intercept as non-recipients. allows for a test of the marginal impact of subsidized fertilizer. The impact of subsidized fertilizer on output can be established through its interaction with fertilizer use intensity. X3 is the size of the respondent's farm land holding or are under cultivation. This has been included because earlier studies founða significant inverse relationship between yields and farm size (Feder

1985, Kimhi 2006, Ricker-Gilbert et al, 2009). ð5 is expected to be negative initially as plot size—increase because larger plots require more labour and are harder to manage. 56 is expected to be positive because after reaching a certain farm size a producer may find it profitable to invest in labour saving, yield increasing inputs like machinery. In this way farm can be used as a proxy in the model for some of the labour practices that a farmer applies to the plot at time (Ricker-Gilbert et al, 2009). X4 is an estimate of the number of rainfalls per ten day periods. X5, X6, X7 and X8 are dummy variables for access to extension services, use

of improved seeds, use of hired labour outside household and pro-sandy soil. et is the stochastic error term which is normally distributed with zero mean and constant variance.

3.3 Censored data and the Tobit Model

The nature of the data could at best be described as censored because the sample include households which did not have access to subsidized fertilizer and did not purchase nonsubsidized fertilizer i.e. the presence of several zero observations, which makes the data sensitive to ordinary least squares (OLS). In the presence of censorship, OLS underestimates the effects of the independent variable on the dependent variable, a problem which is cured by Tobit model (Greene, 2005).

The Tobit model describes the relationship between a non-negative dependant variable Y and an independent variable X. The model suggests that there is a latent or unobservable variable Y• which linearly depends on the independent variable X via a parameter which determines the relationship between the independent variable and the latent variable. Additionally there is also a normally distributed error term to capture the random influences on this relationship.

The observable variable is defined to be equal to the latent variable whenever the latent variable is above zero, i.e.

$$Y_i = Y^* \; if \; Y^* > 0$$

$$Y_i = 0 \; if \; Y^* \leq 0$$

is the latent variable such that:

$$Y_i^* = ßXi + ui,$$

$$u_i \sim N(0, \sigma_u^2)$$

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The Tobit model would be applied to equations 3.3.2 and 3.3.3 where the study seeks to estimate the equity and welfare implications, and the effects of access to subsidized fertilizer on the market for commercial fertilizer.

3.4 Discussion ofvariables and Priori Expectations

Age of respondent was used as a proxy for farming experience in the fertilizer demand and use models (Owuor and Shem, 2009). According to Coelli (1996), farming experience increases with increase in age, it is expected that the age of the farmer would have a positive effect on fertilizer use and farm output. This is the case even though older farmers could be more traditional and conservative and hence show less willingness to adopt new practices.

Age is therefore expected to have a positive impact in all cases.

Men are associated with being in command of productive resources. Even where women play key roles in farming decisions, they may lack access to inputs, cash incomes, credit and technical information Gayne et al. 2003). It is expected that male-headed households will be positively associated with fertilizer use, or in this case be on a higher intercept.

Household size measures the number of people (adult men, women and children) who were living with the farmer during the 2012 cropping year. The household is the basic unit in which econonÞproduction and consumption are carried out (Havilland, 2003). The house hold in this study is used as coefficient of vulnerability, and helps to access the welfare implications of the subsidy programme. The expected sign for household size is mixed. A positive sign indicates that the larger households were able to access more fertilizer in each case and hence less vulnerable to food insecurity. A negative sign shows otherwise.

Land Size/Area under cultivation to a large extent determines the fertilizer input requirement per household. More land cultivation means more fertilizer requirements by a particular farmer. The expectation is that farmers with more land are more likely to acquire more

fertilizer in general. However it is also assumed that to a large degree farmland holdings also give an indication of household wealth especially given the importance of farming in the communities under study.

Farmer households either rent land or own the land themselves. Land ownership status is therefore a binary variable which assumes a value of 1 if land is self-owned and 0 if rented. This will also aid in isolating the difference in programmes impacts between self-owned farmers and tenant farmers. The empirical result of land tenure on efficiency is mixed. A positive relationship with is consistent with the hypothesis that with a higher lease payment requirement, farmers are expected to work harder to meet their contractual obligations (Coelli . et al, 2002). A negative relationship on the other hand is linked with agency theory, reflecting monitoring problems and adverse incentives between the parties involved in diminishiné business performance and preventing long term investments (Giannakas et al, 2001; Reddy, 2002).

Livestock Holdings just like land also represents the resource base, hence the wealth of the household. It is a measure of a farmers ability to afford fertilizer with the expectation that wealthier households are likely to participate in the fertilizer subsidy programme, and are likely to be give'1Þrity on account of likely utilization of the subsidy.

Years of Education measures the number of years of schooling of a farmer. Education as a human capital variable is a relevant factor in technology adoption. Educated farmers easily adopt improved farming technology and therefore should have higher input use than farmers with low leve! of education (Seyoum et al, 1998). The expected sign for education is positive for all cases where it is used.

Access to Credit is a binary variable used to capture the effect of credit on fertilizer access and use by farmers. This variable is measured as a dummy, 1 if farmer had access to credit, 0 otherwise during the 2012 cropping season. A farmer having access to credit include both

partial and adequate credit level needed received. The availability of credit will enable farmers to purchase inputs in a timely manner and hence is supposed to increase input use. The coefficient estimate is expected to be positive (for all cases) as indicated by Owuor and Shem (2009) and Chukwuji et al (2007).

Extension Services indicates whether the farmer had access to extension services during the 2012 cropping year. This variable is measured as a dummy, 1 if farmer had access to . extension service and 0 otherwise. Extension agents are responsible for teaching farmers new and improved methods of farming. If farmers receive visits by extension agents they learn more about the farm operations and the farm business. The expected sign for extension is positive is positive.

Improved seed use is a variable cápturing special crop species (genetically modified) and high-yielding. It is a dummy variable indicating 1 if the farmer cultivates hybrid seed and 0 otherwise. This is expected to have positive impacts in all cases.

Rainfall as a biophysical factor is included since agriculture in Ghana is mostly rain fed. Rainfall enhances efficiency as it improves the soil's capacity and' enables it to use fertilizer and other inputs effectively _____ (Tchale and Suaer 2007). A positive relationship with output is expected..

Finally, the farmer's purchasing power is dependent on two factors: affordability and cash liquidity (FAO, 1994). The input-output price ratio is the number of kilograms of produce required to buy a kilogram of fertilizer/nutrient. This variable is included as a price determinant of input demand. This is therefore expected to have a negative relationship with fertilizer demand and fertilizer use.

3.5 DATA

3.5.1 Data Needs

This studý involves mostly the analysis of primary data. The primary data will include household demographic information, farm characteristics, access to credit, participation in the

fertilizer subsidy programme, purchases of non-subsidized fertilizer, fertilizer use and farm output. The survey also gathered information on farmers' perception of the fertilizer subsidy programme and how it has helped with their farming activities. Then there was information from sources such as the district fertilizer desk officer, agricultural extension agents and fertilizer retailers who all play diverse roles in facilitating the distribution of the subsidized fertiliser. The secondary data will be used to buttress the findings from the primary data (farmer responses).

3.5.2 Data collection

The research employed both primary and secondary sources of data. The primary data employed was obtained through a cross-sectional survey conducted in the rural divide of the Wenchi municipal administrative enclave, which is home to 51% of the total population. A survey was conducted on farmers across 8 farming communities (See Appendix 7). These communities were purposefully chosen for their agricultural potential, accessibility, high level of maize -production and-fertitîŽëFû£] The sample size of 350 was arrived at using Yamane[4] (1967) sample selection criteria which provided a fair idea of what number to use for the study..

The final stage involved a random but systematic selection of questionnaire respondents to ensure that both recipients and non-recipients of subsidized fertilizer were included in the sample for control purposes. Under the systematic sampling approach we followed the rule that for every four respondents at least one must be a non-recipient of subsidized fertilizer.

where n=sample size, N = Sample Frame= 52618, and e —error level= 0.05.

Sü•uctured questionnaires were then distributed following the enumeration strategy as outlined. This method of sampling was used because of the need to include both recipients and non-recipients of subsidized fertilizer for the purpose of assessing impacts.

Face-to-face interview sessions were held with fertilizer retailers and officials of the ministry of food and agriculture officials on their role in the implementation of the fertilizer subsidy programme. The data gathering was done by the researcher with the help of two assistants who were all given requisite briefing on what to do.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSION

This chapter presents the results and discussion of the study. It begins with the description of the variables used in the study and then to the empirical, which were obtained from the STATA statistical package and are subsequently presented in both tabular and equation form:

4.1 Descriptive Statistics

Table 4.1 presents descriptive statistics of the variables used in the econometric analysis. The data shows that about 65% of the sampled households were able to purchase subsidized fertilizer 2012/2013 crop season. On average, households purchased four 50kg bags of subsidized fertilizers using the participant's card, which was slightly higher than the average non-subsidized fertilizer purchased. The sample is also dominated by male farmers

accounting fo.- 82%. Average land area cultivated for the period is 6 acres. The average intensity of fertilizer use for the 2012/2013 crop season was 64kgs per acre, with an average yield per acre of 600kgs (six 100kg bags) of maize for the sample. The average purchase of subsidized fenilizer is 4.29 bags (50 kg), which is greater than the average purchases of commercial fertilizer of 3.77 bags (50 kg). Only about 10% of respondents said they knew a fertilizer a retailer.

Table 4.1 Descriptive Statistics of Study Variables

Variable	Mean (Std. Deviation)	Min	Max
Age of Respondent	43.29 (11.52)	22	75
Years of Education	9.08 **(4.9)**		19
Livestock Units	15.1 (20.5)	0	150
Access to Credit	0.302 (0.46)	0	1

Source: Field Survey, 2013

Table 4.1 Continued

Credit Accessed	205 (490)	0	4200
Farmer Household Size	5.03 (3.62)	1	21
Extension Visits	1.26	0	3

Extension Visits 1.26

	(1.3)		
Farm Size	6.3 (5.9)	1	35
Self-Owned Land	0.63 (0.48)	0	1
Male(1/0)	0.82 (0.4)	0	1
Pro-Clay Soil(1/0)	0.46 (0.49)	0	1
Use of Hybrid Seed(1/0)	0.53 (0.5)	0	1
Extension Services(1/0)	0.52 (0.5)	0	1
Use of Hired Labour(1/0)	0.95 (0.2)	0	1
Relationship with Retailer(1/0)	0.098 (0.297)	0	1
Fertilizer Purchased	7.99 (6.5)	0	40
Commercial Fertilizer Purchases	3.77	0	40

Extension Services(1/0)

Relationship with Retailer(1/0)

Commercial Fertilizer Purchases 3.77

	(4.9)		
Access to Subsidized Fertilizer(1/0)	0.65 (0.47)	0	1
Subsidized Fertilizer Purchases(Bags)	4.29 (5.2)	0	30
Intensity of Fertilizer Use(Kg/Acre)	64.08 (35.8)	0	266.7
Yield Per Acre (100kg bags)	6.14 (3.5)	0.6	20

Source: Field Survey, 2013.

4.2 Empirical Results and Analysis

4.2.1 Factors Associated with Access to Subsidized Fertilizer

The results on Table 4.2 give an indication of the characteristics of the farmers who were able to purchase fertilizer under the fertilizer subsidy scheme in the 2012 cropping season. The

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study effectively tests for the equity and welfare implications of the fertilizer subsidy programme from these results.

Table 4.2: Results of quantity of subsidized fertilizer accessed and associated factors.

Bags of Subsidized Fertilizer	Tobit		OLS	
	Coefficient (Std Error)	P > t	Coefficient (Std Error)	P > t
Age of Respondent(years)	0.028 (0.034)	0.407	0.020 (0.023)	0.380
Male(1/0)	-2.198* (1.032)	0.034	-1.534 (0.719)	0.034*
Farm land holdings (Acres)	0.456*** (0.068)	0.000	0.397*** (0.048)	0.000
Self-Owned Land(1/0)	-0.497 (0.773)	0.521	0.616 (0.533)	0.533
Farmer's Household Size	-0.378** (0.111)	0.001	-0.233** (0.072)	0.001
Relationship with Retailer(1/0)	1.870 (1.213)	0.124	1.300 (0.850)	0.127
Years of Education	0.067 (0.082)	0.413	0.043 (0.055)	0.432
Access to Credit(1/0)	-1.141 (0.817)	0.164	-0.688 (0.560)	0.219
Uses Improved Seedlings (1/0)	0.721 (0.778)	0.355	0.593 (0.534)	0.267
Access to Extension Services(1/0)	1.418 (0.750)	0.059	0.920 (0.517)	0.076
Livestock Units	0.018 (0.018)	(0.341)	0.0089 (0.013)	0.490
Constant	3.310* (1.648)	0.045	4.333*** (1.137)	0.000
N	350		350	
Pseudo R-Sqnared	0.0401		0.2360	
	0.018	(0.341)	0.0089	0.490 018) (0.013)

Source: Field Survey, 2013.

* ** *** denotes levels of significance at the 10%, 5% and 1% significance levels.

Due to the censored[5] nature of the data, the results are presented in both Tobit and Ordinary Least Squares (OLS) regressions, both of which produce similar results although with varying magnitudes. Only three variables, Male, land area under cultivation by the household and the household size, were significantly associated with the quantity of subsidized fertilizer accessed. Whilst farmland holdings was significant up to the 1% significance level, the association of farmer house hold size was significant at the 5% level of significance. Again whilst the size of farmland holding (area under cultivation) showed a positive average marginal effect (association) of 0.456 or almost half of a 50 kg bag for an extra acre of land under cultivation, the average marginal effect of farmer house hold size was a negative 0.378 of a 50 kg bag of fertilizer. Male respondents were also found to be on a lower intercept than their female counterparts, and accessed 2.198 bags less. This was found to be significant at the 10% level of significance.

The indication of these two coefficients is that whilst larger farmland holders benefitted from more subsidized fertilizer, larger households had less subsidized fertilizer. Quantile regression results (see appendix 2c) also shows that both farmer house hold size and land area under cultivation were significant at the 50^{th} and 75^{th} quantiles, but insignificant at the 25^{th} quantile of the distribution. The results of the quantile regressions give further details of the significance of the variables across the various quantiles. The implications of these results are discussed in further in detail within the context of welfare, equity and distributional impacts.

First of all it is difficult to come out with an equitable benchmark for an equitable distribution of a particular public good. A key justification for fertilizer subsidies is to ensure equity

improve the well-being to the most vulnerable groups in society (Crawford et al., 2006). For the rural folk access to land and household size have serious implications for their welfare,

The data could be sensitive to OLS being an aggregate of recipients and non-recipients of subsidized fertilizer, i.e. the presence Of several zero observations.

and hence a distribution of subsidized fertilizer in a manner which does not take these variables into consideration could further widen the gap between different socioeconomic groups.

It would be preferred that for a government programme the distribution of benefits should favour vulnerable and resource-poor[1] households. Elsewhere in Nigeria, Liverpool-Tassie (2011) found that that land area under cultivation and quantity of subsidized fertilizer accessed was negatively correlated with the amount of land cultivated by households, and therefore concluded that the Nigerian fertilizer subsidy programme was pro-poor.

Resource-rich farmers likely represent farmers who are already into fertilizer use, and when seemingly wealthy farmers with large areas of land under cultivation end up capturing the bulk of subsidized fertilizer the sale of non-subsidized fertilizer could possibly slump and thus hinder the development of the private fertilizer markets which hitherto is an objective of the fertilizer subsidy programme.

Whilst it may be argued that small holders may benefit by supplying casual labour to resource-rich farmers, it should also be emphasized that small holder farmers need to be food self-sufficient to ensure that they are less vulnerable to the effects of fluctuating food prices and hence it is necessary that small holders get to directly access incentives to the agric sector rather than seek to benefit at a secondary level..

Secondly larger households are the most vulnerable to poverty and food insecurity

(Novignon, 2010; Adepoju and Yusuf, 2012). It is therefore a matter of importance that support from the public purse seeking to improve on welfare will target such vulnerable

[1] Resource poorness include poor access to land and finance (FAO, 2012)

groups as larger households. The negative association between access to subsidized fertilizer and farmer house hold size suggests a rather inequitable distribution of the subsidized fertilizer and could have far reaching implications for especially poorer households. In a situation where larger households have little access to fertilizer, such households may face food constraints and may have, to buy food from other farmers, probably at a higher cost.

Contrary to several studies which find female headed households at a disadvantage in terms of resource capture, the results here indicate that male headed households were significantly disadvantaged, receiving an average of 2.198 bags less subsidized fertilizer than their female counterparts. This is an indication that female headed households are being prioritized over male headed households. It is actually an objective of the programme to prioritize female access to subsidized fertilizer since they are less resourceful and are more vulnerable to high fertilizer prices.

Being related to a retailer also shows a positive relationship with bags of fertilizer purchased although not significant. Hybrid seed use is also positively related to bags of subsidized purchased although insignificant. In the year 2012, the subsidy programme was extended to cover seed inputs and hence the relationship between hybrid seed as indicated by the results was expected. All other variables although insignificant met the priori expectations.

4.2.2 Impact of the Fertilizer Subsidy on Purchases of Non-Subsidized Fertilizer:

Test for market effects.

The focu$0f the results on Table 4.3 is on the effects of the fertilizer subsidy programme on farmer participation in the private or non-subsidized fertilizer market. The results are again presented both Tobit and OLS regressions. Issues of "possible" endogeneity, due to what has been described as non-random distribution of subsidized fertilizer, have been raised in the literature. It is however not expected to affect the statistical results since the effects of

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endogeneity has been found to be rather benign[2] and has little effect, if any, for which reason it is ignored.

Table 4.3 Results of quantity of non-subsidized fertilizer purchased and associated factors.

Bags of non-subsidized fertilizer	Tobit		OLS	
	Coefficient (Std Error)	P > t	Coefficient (Std Error)	P > t
Years of Education	0.003 (0.063)	0.959	-0.004 (0.050)	0.935
Age of Respondent(years)	0.041 (0.027)	0.127	0.026 (0.021)	0.215
Male(1/O)	-1.259 (0.840)	0.135	-0.630 (0.662)	0.342
Farm Size (Acres)	0.565*** (0.061)	0.000	0.491*** (0.048)	0.000
Self-Owned Land(1/0)	-0.746 (0.614)	0.225	-0.519 (0.486)	0.287
Farmer's Household Size	-0.110 (0.084)	0.190	-0.089 (0.066)	0.186
Bags of Subsidized fertilizer	-0.522*** (0.065)	0.000	-0.364*** (0.049)	0.000
Access to Credit(1/0)	0.566 (0.644)	0.381	0.698 (0.508)	0.170
Uses Improved Seedlings (1/0)	0.730 (0.615)	0.236	0.535 (0.486)	0.271
Access to Extension Services(1/0)	1.168 (0.604)	0.054	0.734 (0.476)	0.124
Uses Hired Labour(1/0)	-0.812 (1.403)	0.563	-0.695 (1.089)	0.524
Ratio of Fertilizer Price to Maize Price	-1.877* (0.853)	0.028	-1.306* (0.619)	0.036
Liyyfock Units	-0.006 (0.015)	0.705	-0.004 (0.012)	0.725

[2] Greene(2005)

Constant	4.55* (2.255)	0.044	4.461** (1.689)	0.009
N	350		350	
R-Squared	0.0592		0.2769	

Source: Field Survey, 2013.

* ** *** denotes levels of significance at the 10%, 5% and 1% significance levels.

The results indicate that three variables, household farm size, bags of subsidized fertilizer purchased and input-output price ratio, were found to be significantly associated with the household purchases of commercial fertilizer. Household farm size was found to be significantly and positively associated with purchases of non-subsidized or commercial fertilizer to the effect that on average an additional acre of land increases the purchase of commercial fertilizer by 0.565 or a little over half of a 50 kilogram bag. Bags of subsidized fertilizer purchased, which estimates impact of the fertilizer subsidy programme on the private fertilizer market, was found to be negatively associated with bags of commercial fertilizer purchased, with an average marginal effect of -0.522 nearly the same effect as farm land holding(area under cultivation). This means that averagely the households reduces its purchases of commercial fertilizer by half for every one bag of subsidized fertilizer accessed. It is also found that the input output-price ratio is also negatively significant at 10% confidence level. All other variables were found to be insignificant. These results are discussed in further detail in the next few lines.

The results suggest that the private fertilizer market is being crowded out by the fertiliz& subsidy programme, i.e. Access to subsidized fertilizer displaces sales of commercial fertilizer, and leads to a negative development for the private fertilizer market and thereby making it impossible-to witÞB4he—subsidies in future. A stated objective of the government of Ghana fertilizer subsidy programme is to develop the private fertilizer market. But that cannot be the case especially when retail joints at the village level remain largely

undeveloped and retailers have not the capital be able to partake in the fertilizer retail trade. This result contradicts findings inNgeria where Liverpool (2012) finds that the subsidy programme rather crowds in the private market through the development of community level retail joints. This study found that Farmers travel several kilometres to urban areas before they could access subsidized fertilizer even when retailers have been registered at the community levels. Also community level retailers end up selling otherwise subsidized fertilizers at rather unsubsidized rates due to the lack of an effective monitoring mechanism and a lack of education on the part of farmers.

Crowding out is the most likely result of a programme that benefits wealthier farmers instead of targeting poorer farmers. The Ghana fertilizer subsidy programme is untargeted and hence allows every Ghanaian with a farm to access subsidized fertilizer. Resource-rich farmers who have the purchasing power to purchase commercial fertilizer but are able to have access to subsidized fertilizer are likely to suspend their purchases of commercial fertilizer or even reduce the quantity of commercial fertilizer they would have purchased.

Other factors which were affect farmer participation in the private fertilizer market were farm size (in acress and input-output price ratio, which were quite expected. Larger landholdings indicate potentially large quantity of fertilizer needed to cultivate larger tracts of land. This study also uses a constant observed market price for compound fertilizer, against the price the farmer expects to get for a 100kg bag of maize. Farmers with higher output price expectations will use more fertilizer whilst those with lower output price expectations will use less fertilizer.

4.2.3 Impact of he Fertilizer Subsidy Programme on Fertilizer Use

Table 4,4 presents results on the intensity of fertilizer use regression using a simple ordinary

least squares regression. Fertilizer use is measured by the kilograms applied per acre. The questionnaire gathered separate responses for total fertilizer purchases and fertilizer actually used on the field.

Access to subsidized fertilizer, age, gender, and farm size (area under cultivation) and soil type were found to be significantly associated with fertilizer use (intensity). A dummy variable was used to evaluate the difference between farmers who had access to subsidized

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fertilizer and those who did not have access. It was found that farmers who had access to subsidized fertilizer were on a higher intercept using 1 1.04 kg of fertilizer per acre than those farmers who did not access subsidized fertilizer.

Table 4.4 Impact of subsidized fertilizer on fertilizer use

Intensity of Fertilizer Use (Kg/Acre)	Coefficient Std Error	
Age of Farm holder	0.41* (0.167)	0.015
Male (1/0)	-11.05* (5.23)	0.029
Farmer House Hold Size	-1.004 (0.53)	0.058
Livestock Holdings (Units)	0.05 (0.095)	0.610
an rze :res		
Land Size(Acres)	-3.98*** (0.98)	0.000
Land Size(Acres Squared)	0.08*	0.015
Uses Improved Seedlings(1/0)	1.83 (3.72)	0.623
Had Access to Extension Services(1/0)	6.79 (3.70)	0.068
Rainfall per ten day periods	-0.90 (2.09)	0.668
Input-Output price ratio of fertilizer	-5.19 (4.89)	0.289
Pro-Sandy Soil(1/0)	-7.35* (3.73)	0.050
Accessed Subsidized Fertilizer(1/0)	11.04** (3.83)	0.004
Constant	81.04*** (12.90)	0.000
Number of Observation	350	
R-Squared	0.165 0.165	

Source: Field Survey, 2012.

* ** *** denotes levels of significance at the 10%, 5% and 1% significance levels.

It is however worth mentioning that the difference here is small compared to the results from other places where access to subsidized fertilizer was associated with larger increases in fertilizer use. This is likely the result when it turns out that subsidized fertilizer is being

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received by households which already use fertilizer rather than being targeted at households that do not use. When such occurs, subsidized fertilizer mostly just displaces other fertilizer sources which only keep the rates at lower levels as before.

Farm size had a negative association of 3.979 kg on fertilizer use intensity which was found to be significant at 99% level of confidence. Despite the earlier findings that a farm holding was positively associated with fertilizer purchases, it could still be that larger farm holders have a difficulty in meeting the optimum requirements for fertilizer. There is however a 10% significant positive association of 0.084 between the square of farm size and the intensity of fertilizer use suggesting that households with smaller lands are more motivated to use more fertilizer to increase the yield of the land. Another significant variable is the dummy variable for soil type, which showed that farmers who responded that the farms had pro-sandy soil used a little over 7kg less than farmers with other soil types.

It was also found that male headed households use less fertilizer than female headed households, a result consistent with our earlier finding that male headed households received less fertilizer than female headed households.

4.2.4 Impact of Subsidized Fertilizer on Farm Output

The analysis so far done was Ithin the framework of the impact pathways of the subsidy pro£)me which suggest that subsidized fertilizer would increase private sector participation in fertilizer markets, increase fertilizer use and ultimately increase crop yields and output.

Finally, to place the Fertilizer subsidy programme into a productivity context by estimating a very simple plot-level yield response function for maize to fertilizer to measure the potential gains from the subsidy program, the results of which have been displayed in table 4.5.

Fertilizer use was found to be significantly and positively associated with maize output. As expected the squared term of fertilizer use was also found to be negatively related to maize output, an indication of diminishing marginal impact. As expected the results indicate that intensity of fertilizer use is significantly positive with a coefficient of 0.71, whilst its square

is negative indicating that fertilizer use exhibits diminishing returns to maize output.

Table 4.5 Impact of Subsidized fertilizer on Farm Output (Maize)

Maize Yield (Bags/Acre)	**Coefficient**	**P > t**
Coefficient		
	(Std. Err.)	
Fertilizer Use (kg/acre)	*	0.000
	08	
Fertilizer Use (kg/acre squared)	-0.002**	0.000
Accessed Subsidized Fertilizer(1/0)	-2.29	0.589
	(4.23)	
Interaction of Fertilizer Intensity with Subsidy	-0.08	0.176
	(0.06)	
Farm Size(Acres)	7.09***	0.000
	(0.52)	
Farm Size (Acres Squared)	-1.13***	0.000
	(0.02)	
Rainfall per ten day periods	0.007	0.995
	(1.080)	
Accessed Extension Services (1/0)	-0.45	0.819
	(1.96)	
Uses Improved Seed (1/0)	-8.86*	0.030
	(0.590)	
Interaction of Hybrid Seed with Fertilizer Use	0.12*	0.039
	(0.0005)	
	•2.2	

Accessed Extension Services (1/0)		0.819
	(0.06)	
Uses Hired Labour	-3.96	0.391
	(4.61)	
Pro-Sandy Soil (1/0)	1.64	0.397
ProSandy Soil (1/0)	1.64	
	(1.93)	
Constant	26.70***	0.000
	(6.86)	
N	350	
350 R-s uared 0.57		

Source: Field Survey, 2013

* ** *** denotes levels of significance at the 10%, 5% and 1% significance levels.

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Access to subsidized fertilizer which is the variable of policy interest turned out to be negatively related to output although insignificant. It was also found that access to subsidized fertilizer interacts negatively with the intensity of fertilizer use and indication that the marginal product of subsidized fertilizer was negative, although it was also insignificant. This result is unexpected as subsidized fertilizer was expected to significantly have a positive impact on maize output by raising fertilizer use. This could be attributed to the fact that the subsidized fertilizer often comes late, sometimes when plants are at an advanced stage of growth. Farmers expecting subsidized fertilizer for their farms end up delaying in applying fertilizer. In some cases farmers actually prefer to postpone the use of the fertilizer to another season when the delivery is delayed, and hence not applying the fertilizer at all even when they eventually have it.

Farm size is negatively related to farm output per are as expected, but its square is positive; an indication that smaller farms are more efficient and easy to manage. Rainfall although insignificant was positively related to farm output. Use of improved seeds also interacts positively with fertilizer use, a situation which does not meet the a priori expectation of the study.

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CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter include the major findings from the data analysis, the overall conclusion and recommendations.

5.1 Summary of Discussions

This study sought to assess the distributional impact of fertilizer subsidies on rural farmers in Ghana, using rural areas in the Wenchi Municipal District as study area. The study tested four hypotheses on the welfare and equity implications of policy, the impact of the subsidy on the private fertilizer market, the impact of the subsidy on household fertilizer use and finally the impact of the subsidy on farmer productivity.

The study used a sample size of 350 maize farmers systematically and randomly drawn from 8 rural communities under the Wenchi Municipal administration. The study used Tobit regression models to analyse the responses of farmers. The Tobit model in particular was necessary because of the censored nature of the responses, and thus takes care of censored characteristics of the data which the OLS might overlook.

The first regresston accepted he null hypothesis that the distribution of subsidized fertilizer was not equitable. The regression sought to assess the equity and welfare implications of the distribution of the subsidized fertilizer found area of land under household cultivation and the size of the household to be significantly associated with access to subsidized fertilizer. The revelation was that resource-rich farmers (farmers with larger acreages of land) benefitted from the programme and were able to purchase more bags of fertilizer than farmers who owned less acreage. The regressions also revealed that the bags fertilizer purchased was inversely related to the size of the household. The conclusion was that the nature of the

distribution was neither equitable nor improved the welfare of seemingly vulnerable households.

Following from the impact pathways diagram, the second set of regressions tested for the impact of the fertilizer subsidy policy on farmer participation in the private fertilizer market, and rejected the null hypothesis that access to subsidized fertilizer does not displace commercial fertilizer sales. In other words the distribution of subsidized fertilizer was crowding out the sale of non-subsidized fertilizer, thus the policy had a negative impact on the private fertilizer market contrary to the expectations of the programme. The aim of developing the private fertilizer market was met as the fertilizer distribution channels remain largely centred in major urban centres amidst large capital requirements for participation in the distribution of fertilizer.

This result was most likely especially under the condition that the subsidy programme turned out not to target resource-poor farmers who are more likely to have incremental effects than resource-rich farmers who are already at a higher threshold of fertilizer use.

The third regression tested the impact of the subsidy programme on fertilizer use, and also rejected the null hypothesis that access to subsidized fertilizer does not raise fertilizer use intensity. Farmerywho had subsidized fertilizer used 11.04 kg more fertilizer per acre than

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their colleague farmers who could not purchase subsidized fertilizer. Although this result was sigtfifrCánt, it could have been higher if the subsidized fertilizer was targeted at resource-poor farmers who are more likely to cause incremental effects than resource-rich farmers who are already at a higher threshold of fertilizer use. This buttresses the earlier conclusion that the programme in its current form does not improve the welfare of rural households. Other factors which affected fertilizer use were the farm size of the farmer (which was found to be negatively related to fertilizer use) and access to extension service (the impact of which was

positive). also related positively with fertilizer use whibt farmers whose lands were pro- clay used less fertilizer than whose were pro-sandy.

Finally the study tested the impxt of the programme on farmer F0ductivity, xccøing the null hypothesis that Ecess to subsidized fertilizer has no impact on yieW. The of subsidized fertilizer on farm outputs out to be rather insignificant. in spite of the higher fertilizer use demonstrated by farmers who were able to $NJrchase subsidized fertilizer, a situation likely to be attributed the lateness with which the programme consignment of fertilizer arrives. This study particularly an evaluation of the 2012 programme, and the farmers did admit that as at the time the fertilizer arrived it was already late for them to apply fertilizer since the plants had grown to a stage where it will useless to apply fertilizer. Instead they keep the fertilizer and apply it during the minor farming season. At the time of gathering the data for this study, farmers were yet to harvest the output of the minor season, and hence we could not extend our evaluation to cover the minor season output. which we suspect benefitted from the subsidized fertilizer purchased in the major scuon.

5.2 Conclusion

The fertilizer subsidy programme is government's policy to stimulate fertilizer among farmers and increase úrrn ~~productivity.~~ Agriculture provides livelihood for several poor households hence the need for government to target sector its bid to poverty. It should however noted in chumelling to the agricultural sector, interventions r. moda!ities need to in place to ensAre that the who help most how distribution gets it. Succes of poverty allevutioa Fogrunmes would IZFly dCF0d oa benefits take pixe and hence the need for efficient tuFting

C___ of low correlation coefficients have been found to be predominant in the regressions

The predominance of low correlation coefficients is however not belaboured in be predominant in the regressions

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view of the fact that this study is an ex-post impact evaluation study of a government intervention which seeks to evaluate impacts or association of the explanatory variables on or with the dependant variable rather to predict a certain outcome. It should therefore be noted that this study puts more emphasis on the significance of the individual independent variables and their association with the dependant variable, rather than their combined effect on the dependant variable. Also the statistical insignificance of most of the variables used in all estimations suggest that these factors are not substantially associated with the various dependent variables on which they were regressed and that other factors not included in the model could be responsible. Whilst misspecification is not being downplayed, it should however be noted that all the variables included in the various regressions have both empirical and theoretical basis.

The fertilizer subsidy programme is government's policy to stimulate fertilizer use among farmers and increase farm productivity. Agriculture provides livelihood for several poor households and hence the need for government to target the sector in its bid to alleviate poverty. It should however be noted that in channelling interventions to the agricultural sector, modalities need to be put in place to ensure that the people who need the help most gets it. Success of poverty alleviation programmes would largely depend on how distribution ofbenefits take place and hence>-need-forefficient targeting.

C low correlation coefficients have been found to be predominant in the regressions estimated. The predominance of low correlation coefficients is however not belaboured in view of the fact that this study is an ex-post impact evaluation study of a government intervention which seeks to evaluate impacts or association of the explanatory variables on or with the dependant variable rather to predict a certain outcome. It should therefore be noted

that this study puts more emphasis on the significance of the individual independent variables and their association with the dependant variable, rather than their combined effect on the dependant variable. Also the statistical insignificance of most of the variables used in all estimations suggest that these factors are not substantially associated with the various dependent variables on which they were regressed and that other factors not included in the model could be responsible. Whilst misspecification is not being downplayed, it should however be noted that all the variables included in the various regressions have both empirical and theoretical basis.

In all whilst farmers who are the primary beneficiaries of the fertilizer subsidy programme have lauded the programme as being helpful despite the lateness with which the subsidized fertilizer tend to arrive for farmers' use, village level retailers continue to lament of an inability to participate in the distribution process because of their inability to raise the required capital. Also, the waybill scheme which replaces the voucher programme has turned out to be more complicated for the farmers as they complain of getting around it. Farmers complain of the black of education on the subsidy programme and how it operates.

5.3 Recommendations

Quantitative analysis of government policies has increasingly become the basis for policy formulation in many countries. These analyses come in many forms and include attempts to measure economies of scale, pr'duce¥s—responsiveness to product and input price changes and relative efficiency of resource use. This study made a quantitative evaluation of the 2012 government of Ghana fertilizer subsidy programme using rural communities under the Wenchi Municipal administration.

Following from the findings of this study the following proposals are made:

- There is a need for the fertilizer subsidy policy to be reformed. The programme in its

current form does not provide any targeting guidelines and hence it has led to rather pro-wealthy programme where people who could otherwise have afforded the non-

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subsidized fertilizer tend to purchase more subsidized fertilizer. The government of Ghana needs to emulate the subsidy programme as it is implemented in other countries and successfully led to the opening of more distribution channels and also led tcv an increase in sales of non-subsidized fertilizer. In Nigeria for instance, Liverpool-Tassie (2012) reports that by targeting the subsidized fertilizer at poorer and needy farmers they are motivated to purchase more and that helped a lot in the crowding in that took place under the Nigerian programme, Targeting also ensures that wealthier farmers who are hitherto in a position to purchase subsidized fertilizer do not make their way into purchasing subsidized fertilizer, and hence holds the key to a programme which seeks to develop the private fertilizer market.

- The programme also needs to put mechanisms in place to cater for vulnerable households, since they are more vulnerable to the effects of food security. In its current form, larger households tended to accessed less of both subsidized and nonsubsidized fertilizer. Mechanisms should therefore be put in place by the subsidy programme to offer more subsidized fertilizer to vulnerable households in other to cushion such families from food insecurity. Efforts should be made to prioritize such families in the alternative scheme run by the ministry of food and agriculture where subsidized inputs are offered to farmers on credit to be paid after the harvest.

- There is also the need for a monitoring group for the programme to ensure that issues of leakages of subsidized fertilizer. The monitoring group should be made-up of all stake holders including representatives of farmers. This should help curb suspicion by farmers that retailers do hoard the subsidized fertilizer even when it is available and only sell on preferential basis.

- There should also be mechanisms to register and sell the subsidized fertilizers to farmers in groups, rather than the individual sales which characterize the subsidy

programme. This will ensure that vulnerable farmers who otherwise on their own may not be able to purchase subsidized fertilizer get access to the fertilizer through the influence of other farmers perhaps an extension agent assigned to the group. .

- Furthermore, there need to a bit more decentralization of the supply channels of the subsidized fertilizer. Supply outlets should be established at the community levels with quotas assigned to communities based on a needs assessment. As it stands now people travel from far to purchase fertilizer from urban areas; some retailers have reported that people come from as far as villages in the Upper West Region to purchase fertilizer in Wenchi, thereby causing earlier shortages in the Wenchi area. Establishing outlets at the community level and deepening stakeholder participation will go a long way to ameliorate leakages of subsidized fertilizer into neighbouring countries.

5.4 Limitations of the Study

- The study considers only a single crop and single period to estimate the impact of subsidized fertilizer due to the lack of a comprehensive panel data. In practice, however, decisions are made on the basis of whole cropping pattern and crop rotation.

- In Ghana, most farmers have lower educational level and many do not keep records of the inputs ancoutputs. This study suffers from the weakness associated with survey interviews when data accuracy depended heavily on the respondent's ability to recall past information and to answer survey questions accurately.

5.5 Suggestions for Future Research

The scope of the impact of the fertilizer subsidy programme is vast and cannot all be captured in single study. However, on the basis of the present study I make the following suggestions for further research:

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- The study proposes that further research be conducted into the impact of the subsidy across different ecological zones;
- It will also be of interest to know the impact of the subsidy programme on rural employment with respect to the hiring a casual labour;
- A study into how the subsidy programme is affecting crop diversification;
- A study into how the programme is impacting on forest lands; and
- Finally there is the need to make an assessment of the subsidy programme on rural non-farm economic activity.

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APPENDIX 1: Table of Descriptive Statistics

vari abl e	Obs	Mean	std. Dev.		Max
Ageofrespo—t	350	43.28571	11.53063	22	76
Yearsofedu—n	350	9.051429	4.901632		19
Li vestock	348	14.56322	19.72766		150
Genderofre—2	350	.8314286	.3749089	1	

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FarmersHou.•	350	5.025714	3 .619736		1 21
UseofHi red-2	350	• 9485714	.2211865	0 0 0 0 0	1 20
Extensions~2	350	4.274286	2.513955		
QtyofHi red—r	350	.5171429	.5004214		1
Hyb ri dSeed2	350	.5314286	.4997257		
Rai nfal Pa-s	345	2.611594	.8726357		1 7
soilType1	350	.4571429	.4988731	o	1
credi tAcce—2	349	.2951289	.4567555		1
credi tAmt	350	196.4943	475.3084		4200
Total Fertp-d	350	7.991429	6.518428		40
FertUse	350	6.934286	5.945668		40
SubsFertsP~d			5.225211		30
Comerci al —	350	4.294286	4.858687		40
d	350	3.765714	26.49077		180
Yeild	350	31.96286	5 .275019	3	35
Landsi ze	350	6.171429	.3674551	1	5.066667
pri ceRati o	350	1.627256		1.266667	
Expectedsa-e	350	47 .78286	5 .098316	15	60

Source: Field Survey, 2013

regression results

APPENDIX -la: Tobit of access to subsidized fertilizer

T0bit regression Number of obs 350 LR chi2(11) 70.30 prob > chi2
Log likelihood = -841.08116 pseudo R2 o. o. 00000401

subsvertsp—d	coef.	std. Err.	t	P>ltl	[95% conf.	Interval]
Ageofrespo—t	-. 0280713	.0337952	-0.83	0.407	0945461	.0384035
Gender ofre—2	-2.197924	1.031527	-2.13	o.034	—4.226924	-.1689247
Farml andH0—g	.4564616	• 0683822	6.68	o. 000	.3219547	.59œ)685
L andowners—l	4969472	.7727541	-o. 64	o. 521	-2.016944	1.02305
F armersHou—e Relationsh—r	-. 3778559	.1106309	-3.42	o. 001	5954654	-. 1602464
yearsofedu—n	1.869917	1.212703	1.54	0.124	-.515452	4.255287
credit Access	.0672333	.0820233	0.82	0.413	-2.749106	.228572
Hybri dseed	-1.141052	.8175215	-1.40	o. 164	8091602	.4670017
Extensions—s	.7209491	.7778952	0.93	o. 355	0570003	2.251058
Livestock	1.41861	.7501885	1.89	o. 059	-.0187089	2.894221
_cons	.0176038	.0184611	0.95	o. 341	.0672204	.0539166
	3.309791	1.648497	2.01	0.045		6. 552361
/s i gma	6.343866	.3199696			5.71449	6.973242

Obs. summary: 123 1 eft—censor ed observations at SubsFertsP~l
227 uncensored observations O
right-censored observations

Source: FieldSurvey, 2013

APPENDIX 2b: OLS regression results of bags of subsidized fertilizer accessed

source		df	MS		
Model	2249.10299	11	204.463908	Number of obs — 350 11, 338) 9.49 prob > F - 0.0000 R-squared o. 2360	
Res dual	7279. 58558	338	21.5372354	Adj R-squared = o. 2112	
Total	9528.68857	349	27.3028326	Root MSE	4.6408

SubsFertsP~d	coef.	std. Err.	t	P>lti	[95% conf.	Interval]

regression results

Ageofrespo£t	0204625	.0232885	-0.88	o. 380	0662712	.0253462
Gendernf r	-1.534263	.7190828	-2.13	0.034	-2.948704	1198214
F arml andH0—g	.396902	.0482951	8.22	o. 000	.3019052	.4918988
Landowners—	616276	.5335337	-1.16	0.249	-1.665741	.4331886
I Farmer st-	-.233237	.0723383	-3.22	o. 001	-.3755269	0909471
iou—e Re1 at i ons	1.300321	.8506108	1.53	0.127	-. 3728364	2.973479
yearsofedu—n	.0433405	.0551246	o. 79	0.432	06509	.1517711
creditAccess	6880611	.5590779	-1.23	0.219	-1.787771	.4116493
Hybr i dseed	.5934374	'3339102	1.11	o. 267	-.4567679	1.643643
Ext ens ions—	.9195368	.5171428	1.78	o. 076	-0976868	1.93676
s Livestock	.0088773	.0128581	0.69	0.490	-. 0164146	.0341693
_con;	4.333705	1.136686	3.81	o. 000	2.097835	6.569574

Source: Field Survey, 2013

Appendix 2c: Quantile for access to subsidized fertiliser

Bags of Subs'dized Fertilizer	antiles		
	25tb	SOth	75th
Age or Respmdent(years)		0.006 (0.028)	-0.018 (0.029)
Male(1/0)		-1.467 (0,973)	-2.636* 1.284
Farm Size (Acres)		O.342" o. 124	0.7••• 0.18)
Self Owned Land(1/0)	0	0.318 0.884)	-1.51 1.23
Farmer's Household Size		—O.207 • • (0.073)	-0.25* (0.12)
Relationship with Retailer(1/0)	0	.647 (1.128)	1.739 (1.375)
Years or Edu:ation		0.099• (0.042)	0.069 (O. 102)
Access to Cr·dit(1/0)	0	-1.172 0.751	-0.25t• 0.801

regression results

Uses Improvd Seedlings (1/0)		0.434 (0.639	o. 768 0.723)
Access to Extension Services(1/0)	**0**	1.44 • (0.682)	I .33 (0.71)
Livestock Units		0.004 (0023)	0.00') (0.025)
Constant	**0**	.153 1.748 _	180 298
Pseudo R-Sq•aared		0.0963	0.2176

APPENDIX Tobit of purchases of non-subsidized fertilizer

Tobit regression

Number of obs 350 LR chi2(13) - 108.'7

prob > chi2 - 0.0000 pseudo R2 o. 0592

cog likelihood - -862.11252

comercial—d	coef.	std. Err.	t	P>ltl	[95% conf. Interval)	
	regression results					
years of edu—r.	.0032736		o. 05	o. 959	-. 1211147	
Ageofrespo—t	.041266		1.53	o. 127	-.0118087	.1276619
Gender of re—2	-1.259385	.0632367	-1.50	0.135	-2.911895	.0943406
Farml andH0—g	.5651063	.0269822	9.31	0.000	.4457151	.3931237
andOwn	-.7458664	.8401044		o. 225	-1.953979	.6844975
Farmers	1103377	.06069Q	-1.21	0.190	2755853	.462246
Hou—e	5229992	.6141815	-	o. 000		
SubsFertsp--d	. 5657839	.0840088	1.31	o. 381	-. 7016208	.0549099
creditAccess	.7297257	.0645468	-	o. 236	4801538	.3960338
Hybr idseed	1.167645	.6443246	8.10	0.054	0218887	1.833189
	8117618	.6150799	o. 88	o. 563	-3. 572589	1.939605
Ext ens	-1.877172	.6047364	1.19	0.028	-3. 554922	2.357179
ons—s	005678	1.403552	1.93	o. 705	-. 0351136	1.949065
useofHired—	4.558673	.8529366	-o. 58		.1239594	199421
r priceRatio		.0149645	-2.20			.0237576
Livestock		2.254525	-o.38			8.993387
—cons			2.02			
/si gma	5.08353	.2319113			4.627354	5.539706

Obs.su90 left-censored observations atCommercial~d<=0
260 uncensored observations O
right-censored observations Source: Field Survey, 2013

APPENDIX 3b: OLS regression results of purchases of non-subsidized fertilizer

		df	MS	of. Obs 350 F (13, 336) - 9. 90
Model	2281.08863	13	175.468356	prob > F - o. 0000 R—squared - o. 2769
Residual	5957.	336	17.7312498	Adj R-squared - o. 2489
Total	8238.78857	349	23.606u4	Root MSE - 4.2108

Commercial~d	coef.	Std. Err.	t	P>ltl	[95% conf. Interval

regression results

year sofedu—n		.0500181	-o. 08	o. 935	10244	.0943361
Ageof r es po—t			1.24			
Gender of r	-. 0040519	.0213208		o. 342	0154751	.0684031
F arml	. 026464	. 6624049	-o. 95	o. 000	—1.933474	.6724925
LanðOwner	-. 6304906	.0481965				
F ar mer S	.4914119	.4864345	10. 20	o. 287	—1.475793	. 5862168
Hou—e			—1.07	o. 186		.4378884.
subsgertsp—	-. 5189523	.0668538	—1.32	0.000	-.2200159	
d	-.0885112	5083308	—7.40	o. 170	—-4612996	299
creditAccess	.3644696	.485919	37	o. 271	3010329	2676395
Hybr i dseed	.6988788	.4756515	1.10	o. 124	4206073	1.698791
	.5352193	1. œ9124	1. 54	o. 524	-.2015654	1.491CN6
E tens ons—	.73-40646				—2.83695	1.669694
s us eofHi r		-.6194705	—o. 64	o. 036	—2. 524296	1.447773
ed—r pr	-. 945885	.0117655	—2.11	o. 725	—.0272803	(*72379
ceRati o L i	—1.305767	1.6893c»	—o. 35	o. 009	1.138428	.0190066
vestock	. oc»1369		2.64			7.784317
_cons	4.461372					

Source: Field Survey, 2013

APPENDIX 4: Results for Impact of Subsidized fertilizer on Fertilizer Use

Source: Field Survey, 2013

APPENDIX 5: Impact of Subsidized fertilizer on Farm Output (Maize)

source		df	MS	Number of obs = 350 F(12, 337) = 38. 54
Model	141681.482	12	11806.7901	prob > F = o. 0000 R—squared = o. 5785
Residual	103233.036	337	306.329482	Adj R-squared = o. 5635
Total	244914.517	349	701.760794	Root MSE = 17.502

Yi el dofmai ze	coef.	std. Err.	t	P>ltl	[95% conf.	Interval]
Intensityo—e	.7096869					
Int ens i tys—d	-. 0023793		9.44			
Accessedsu—t	-2.286816	.0751536	-5.77	o. 000	.5618577	.8575161
Inter actsu—y	0824724	.0004122	-o. 54	o. 000	0031902	0015685
Farml andH0--g	7.097225	4.232282		o. 589	-10.61184	6.038203
Landsi zesq—e	1344161	.060867	-1.35	o. 176	2021991	.0372547
Rai rtf.al	.0070887	.5226735	13.58	0.000	6.069111	8.125338
Ipe—s	-.4505889	.0181934	-7.39	o. 000	170203	0986292
Extens i ons—s	-8.864394	1.080393	0.01	o.995	-2.118075	2.132252
Hybr i dseed —i	.1176165	1. 963004	-o. 23	o.819	—4.311873	3.410696
dlntensity useofHi	-3.958868	4.067394	-2.18	0.030	-16.86507	.8637152
red—r soi 1	1.64119	.0568443	2.07	0.039	.0058022	.2294307
Type — cons	-26.6968	4.607359	-o. 86	o. 391	-13.02167	5.103938
		1.933702	o. 85 -	o. 397	-2.162456	5.444836
		6.861282	3.89	o.000	—40.19314	-13.20047

Source: Field Survey, 2013

APPENDIX 6: Questionnaire for Farmers

ID code• _____ Location•.....

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KUMASI

1. Age of respondent: .....

2. Gender of Respondent: Male [I Female [ ]

3. What is your house hold size?.....

4. How many years did you spend in school, if any?.....

5. What is your total farm land size?.....acres

6. Is your farm land "Self owned" or "rented"? . . . .

7. What is your estimation ofthe number rainfalls within ten day periods? .....

8. Do you have access to hired labor? yes [ ] no [I

9. If yes in 8 above, how many hands do you engage at a time? .....

10. Do you access to extension agents? Yes [ ] No [ ]

Il. If yes in 10 above, how many visits per season... .....

12. Are YO'.I able to access credit for your farming activities? Yes [ ] No [ ]

13. If yes in 12 above, how much credit do you access?.....

14. Pest control activities: Yes [ ]

15. Texture of Soil: Pro-Sandy [ ] Pro-Clay [1

ou use improved seedlings? Yes [ ]

16. Do you No [ ]

17. Do you relate, in any way, to an input to a retailer? Yes [ ] No[ ]

____._What is your total lives stock holding (Ruminants and Pigs only) if any?.....

19. How many bags of fertilizer did you apply on your farm, if any?.....

20. How many bags of subsidized fertilizer did you access, if any?.....

21. How many bags of non-subsidized fertilizer did you purchase, if any?.....

22. What is the status of your farm with respect to maize output?.....

23. What price do you expect to sell a 100kg bag of maize, if you do sell?.....

KNUST

24. What challenges do you face in purchasing commercial fertilizer?

.....

.....

.....

.....

25. How has the fertilizer subsidy affected your fertilizer use?

.....

.....

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26. Please outline the challenges you have with the subsidy programme:

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.....

.....

.....

APPENDIX r: Breakdown of Communities Sampled for the Study

Communi	Number of Res ondents Sam led
Buoku	45
Tromeso	50
Nkonsia	56
Be oso	51
Yo oano	51
N oase	31
A ubie	
Ayaiyu	31
Total	350
