Impacts of Farmer Input Support Programme on beneficiaries – The case of Gwembe District.

BY

SIANJASE ALFRED

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Cell: 0979-241 381

I, **Sianjase Alfred**, declare that this dissertation:

a) Represents my own work;
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APPROVAL

This dissertation of **Sianjase Alfred** has been approved as fulfilling the requirements for the award of the degree of Master of Arts in Economics by the University of Zambia.

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Abstract

Since 2002, the Government of Zambia has been funding a farmer input subsidy program that consumes a very large part of the resources allocated to the Ministry of Agriculture and Livestock. This survey examines if the program is producing commensurate impacts on maize production by the farmers who benefit from the program. Data for the study was collected through a structured questionnaire administered to a sample of 600 farmers in Gwembe District. Though 600 copies of questionnaire were administered, 570 copies were recovered for analysis. Analysis was done using quantile regression at the 5^{th}, 10^{th}, 50^{th} and 90^{th} percentiles of the maize production distribution in two phases - with and without control for endogeneity. The analysis reveals that the largest production impact is on the farmers at the 50^{th} percentile. There is also significant dependence on the subsidies by households at the 5^{th} and 10^{th} percentiles. These results cast doubt on the efficacy of the program to reduce poverty and improve household food security.

To my wife Lillian Muntanga Mwiinga Sianjase

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LIST OF ABBREVIATIONS AND ACRONYMS

CRE	Correlated Random Effects
FD	First Difference
FISP	Farmer Input Support Programme
FSP	Fertilizer Support Programme
GRZ	Government of the Republic of Zambia
HH	Household
LAD	Least Absolute Deviation
MAL	Ministry of Agriculture and Livestock
MT	Metric Tons
NAMBOARD	National Marketing Board
OLS	Ordinary Least Squares
POLS	Pooled Ordinary Least Squares
SEAs	Standard Enumeration Areas
SSA	Sub Sahara Africa
USD	United States Dollars

CHAPTER ONE

1.1 INTRODUCTION

Agriculture is a critical sector of any economy, especially the developing economies of the Sub-Sahara African (SSA) countries as it provides among other things raw materials to the secondary industries. Increased agricultural production is critical to increased household food security and consumption and this reduces vulnerabilities among the households. This means that SSA countries need to implement the pro-poor economic policies that target the majority rural poor. Household credit plays a vital role in agricultural production among the small scale farmers as most of these farmers are in the low income bracket. Credit stimulates investment, capital accumulation and economic growth that could lead to an improvement in the standard of living among the Zambian rural poor. Keider (2000) discusses three major benefits of credit. He argues that credit guarantees the availability of financial resources which can be used to buy the much needed agricultural inputs. It can also help households to smoothen crop production in the face of idiosyncratic and/or covariate risks such as drought or pest attack. Finally, provision of credit can complement existing reform packages for pro-poor growth.

Though credit is very important and gives many benefits, access to credit among the low income rural community is extremely low. In addition, the Zambian Government, in the early and mid 1990s embarked on heavy borrowing through Treasury Bills and Government Bonds from the banks for its budgetary support, Economic Association of Zambia (2008). This resulted in the “crowding out effect”, a situation where the resources that should have been used to provide credit to the private sector (which includes the rural poor whose livelihood is dependent on agriculture) were used for consumption purposes by the Government. In addition, Government abolished National Marketing Board (NAMBOARD) in 1989 to pave way for the private sector in maize marketing and to supply inputs to the small scale farmers, (Govereh, J. *et al* 2002). Throughout the reform process, the official objective was to encourage a vibrant private distribution system to service the needs of small-scale farmers. However, market failure resulted through the failure of the private sector in fertilizer distribution to the small scale farmers. This made access to agricultural inputs such as certified seed and fertilizers for the production of the staple food – maize to be a big challenge.

In view of the above, Government of the Republic of Zambia (GRZ) initiated a fertilizer subsidy programme. This led to the Government, although legalizing the private trade in fertilizer, throughout the liberalization programme to continue to distribute large quantities of fertilizer and seed (worth billions of Kwacha), initially as loans in the early years of the programme and later through substantial subsidies to small scale farmers. However, the loaning system had its own challenges and it later broke down. The government, as a mitigation measure, decided in 2002 to introduce Farmer Input Support Programme (FISP) that was aimed at subsidizing inputs to the small scale farmers. This programme was initially known as the Fertilizer Support Programme (FSP) which is today known as the Farmer Input Support Programme (FISP). The introduction of subsidies was premised on economic benefits subsidies have to both producers and consumers. The important question, however, is whether these subsidies have any significant impact on the benefiting farmers.

1.2 Statement of the Problem

Despite the continued support through subsidizing agricultural inputs largely for maize production to small scale farmers, the Programme has not helped to improve small scale farmers' maize production and household (HH) income, thereby leaving these farmers perpetually dependent on the subsidy facility, without which they are unable to grow a maize crop. Huge sums of resources are spent on the procurement and distribution of these subsidized inputs

(Dennis, C. *et al* 2010). This crowds out investment in the other sectors, thereby undermining the programme's long-term sustainability, given the ever increasing competing needs for national resources within the agricultural sector and other sectors. Therefore, the importance of this research goes beyond the purely academic.

It is however, worth noting that this study's major thrust is on the farmers' maize production in relation to the subsidized inputs received and not on the Programme's sustainability. The Programme's sustainability is on the ability by the supported farmers to continue producing maize at the same level as when they were being supported long after the Programme has phased out and not on whether the Government will continue supplying subsidized inputs to the farmers for a long time.

1.3 Objectives

1.3.1 General Objective

The general objective is to investigate the impact of Farmer Input Support Programme (FISP) on benefiting households.

1.3.2 Specific Objectives

- To find out the impact of input subsidies on maize output after controlling for the size of the household, the sex of the head of the household, the age of the head of the household, the education level of the head of the household,
- To find out the effect of the input subsidies on households' dependence on subsidies in maize production,
- To draw policy implications on the need to continue or to discontinue with input subsidies from the empirical findings.

1.4 Hypothesis

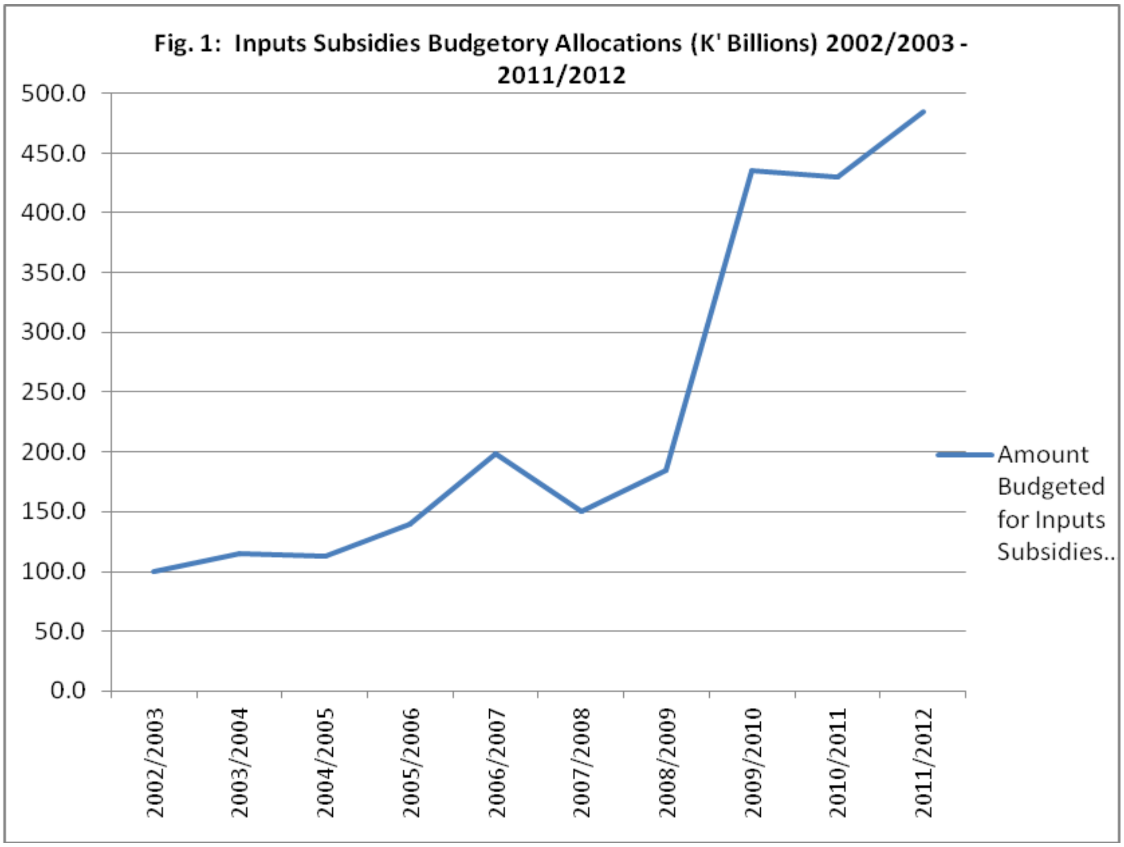
The null hypothesis is that there is no significant impact of the FISP on the farmers' maize crop output. This implies that the alternative hypothesis is that there is a significant impact. This is segregated into two hypotheses, namely;

- ❖ Subsidized seed and fertilizer have no significant impact on maize output,
- ❖ Subsidized seed and fertilizer have significant effect on the subsidy dependence.

1.5 Rationale, Scope and Significance of the Study

The Zambian Government over a period of ten years from 2002/2003 agricultural season to 2011/2012 agricultural season has been funding and running the fertilizer and seed subsidies to support maize production among the small scale farmers. As figure 1.1 below shows, the allocation of the budgetary support to the Farmer Input Support Program from the central treasurery has been steadily increasing from the inception of the Program in 2002/2003 season through to 2011/2012 season.

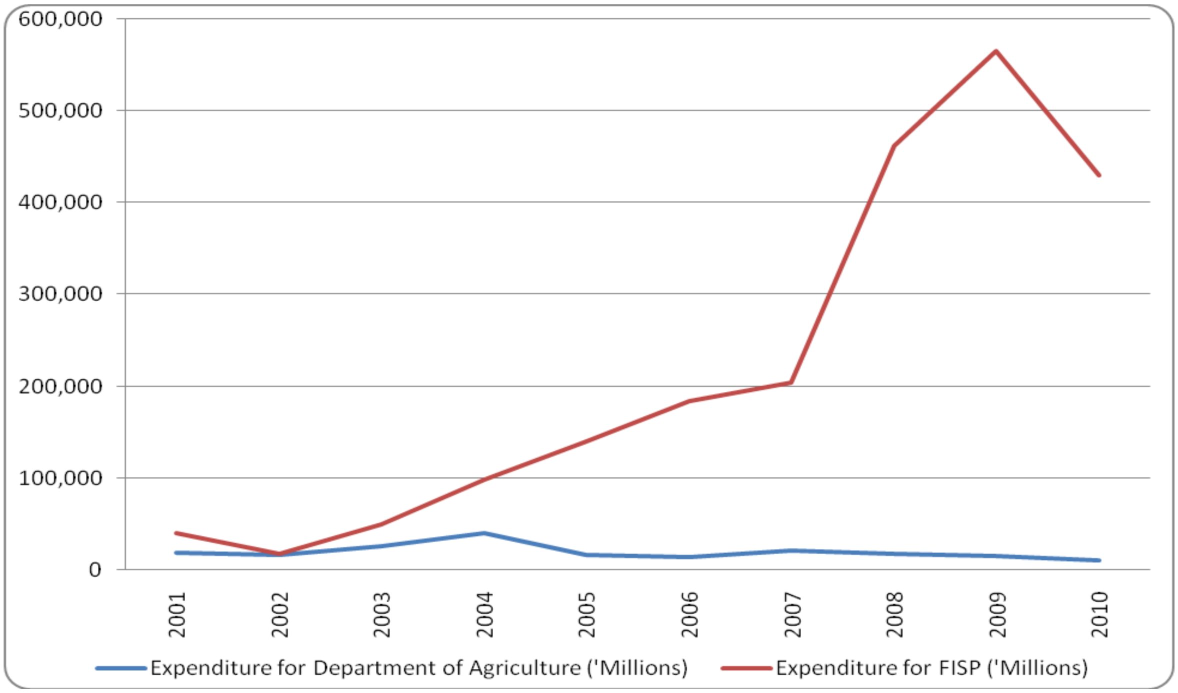
Figure 1.1: Input Subsidies Budgetary Allocations (K'Billions) 2002/2003 – 2011/2012



Source: MAL – Implementation Manual 2012/2013 Agricultural season

Figure 1.2 below compares the budgetary support to FISP and funding to the Ministry's core functions which are research and extension service delivery. It is observed from the figure that in the four year period from 2001 to 2004, the Department of Agriculture expenditure increased at an average annual rate of 26.5% in nominal terms. However, over the same period, the annual rate of increase in the funds budgeted and spent on input subsidy programme (Farmer Input Support Programme) increased much faster than the funds allocated to the Ministry's core functions which are research and extension service delivery (55.4%, compared with only 26.5% for the latter). This shows clearly that the Government of the Republic of Zambia placed greater importance on the implementation of the inputs subsidy programme, FISP, than on the other programmes and general operations of the Ministry of Agriculture and Livestock (MAL).

Figure 1.2: Proportion of MAL Expenditure on FISP Compared to Department of Agriculture – 2001 to 2010 - Zambia.



Source: Paper on Agriculture Case Study – Evaluation of Budget Support in Zambia – 2010.

Between 2005 and 2010, an average of 95.6 per cent of MAL expenditure was on the FISP inputs subsidy programme while only 4.4% of the total expenditure in the same period was on the Ministry's core functions. However, the proportions fluctuated significantly, building up from a low base in the two early years of the programme, 2001 and 2002 (Figure 1.2). Such pattern of expenditure which focused on the provision of subsidies is at variance with the National Agricultural Policy in place during the same period.

In view of the above, a study was conducted in Gwembe district to determine the impact of the Farmer Input Support Programme (FISP) among the benefiting households. Due to financial limitations, the research was restricted to FISP beneficiaries in Gwembe district

In recent years numerous countries in Sub Sahara Africa (SSA) including Ghana, Kenya, Malawi, Mali, Senegal, Tanzania, and Zambia have implemented such programs at substantial cost to government and donor budgets. For example, in 2008 Malawi spent roughly 70% of the Ministry of Agriculture's budget or just over 16% of the government's total budget subsidizing fertilizer and seed. In Zambia between 2004 and 2011, an average of 40% of the government's agricultural sector budget was devoted to fertilizer and maize seed subsidies each year (Nicole M. Mason *et al*, 2012).

Meanwhile, the genetic advances that Government viewed as the major factors affecting maize production growth in earlier decades through research and provision of effective and regular extension services to the smallholder farmers have gradually declined and faded away as funding to the core function of the Ministry, that is, research and extension service delivery by government has declined as shown in figure 1.2 above. As a result of poorly funded research and extension service, farmers' maize production and productivity has for a long time stagnated and in certain cases reduced significantly despite continuous and increased support to these small scale farmers in terms of subsidized inputs.

World Bank (2010) did a study on the "Impact Assessment of the Fertilizer Support Program, Analysis of Effectiveness and Efficiency" and the findings of the report No. 54864-ZM, suggest that somewhere in the range of 82,000 to 146,000 MT of incremental maize production could be attributed to the 2007/08 FSP. Compared with MAL's projection of 375,000 MT, this was equal to just 22-39% of the official production estimates. However, this report did not examine the impact of FISP on individual smallholder households in terms of maize output and subsidy dependence.

This study, therefore, intends to investigate the impact of Farmer Input Support Programme on the benefiting households in terms of maize output and subsidy dependence by the benefiting HH. It is important to examine the impact of the program on households so that policymakers can make informed decisions and the formulation of possible policy intervention to help stimulate maize production and sustain households' economic wellbeing which will lead to economic growth and improvement in the welfare of the Zambian people.

The remainder of the study is organized as follows: Chapter two discusses the background on Input Subsidy Programme and programme objectives in Zambia. Chapter three discusses briefly theoretical literature review on subsidies while chapter four discusses the methodology and gives a description of the econometric modelling, data and introduces explanatory variables and discusses the expectations. In chapter five, the estimation strategy is presented while the results and discussion are presented in chapter six. Chapter seven discusses the concluding remarks, some policy implications, limitations and recommendations for further research.

CHAPTER TWO

2.1 Background on Input Subsidy Programme in Zambia

Like in other countries, especially the SSA countries, the farmer input subsidy programs have a long and varied history in Zambia. Due to the Structural Adjustment Programme in the 1990s, these programs were partially scaled back due to pressure on the Zambian Government to scale down both consumption and production subsidies. In the 2002/03 agricultural season, the Government of the Republic of Zambia (GRZ) established the Fertilizer Support Program (FSP). FSP was initially envisaged to be a three-year program under which the subsidy level would start to reduce from 50% in the first year, to 25% in the second, to 0% in the third (Ministry of Agriculture and Cooperatives Implementation Manuel, Zambia 2002). However, FSP ended up running through from 2002/2003 agricultural year to date (2012/2013 agricultural season). In 2009/2010 agricultural season, FSP was slightly redesigned and renamed as the Farmer Input Support Program. This program has been implemented each year from 2009/2010 to present.

Initially, under Fertilizer Support Programme (FSP), benefiting smallholder farmers were receiving an input pack consisting of 400Kg of fertilizer (200Kg each of basal – Compound "D" and top dressing - Urea), and 20Kg of hybrid maize seed. The pack was for planting one hectare of maize. However, in the 2009/2010 farming season, the input pack size was halved with the inception of the Farmer Input Support Program. In theory, each benefiting smallholder farmer was to receive only one pack of inputs consisting of 200Kg of fertilizer (100Kg of basal dressing and 100Kg of top dressing). However, in practice, in Gwembe district where the study was conducted, the quantities of subsidized inputs received varied greatly across benefiting smallholder households. For example, based on the survey data that was collected from the field and used in this study, FISP recipients at the 5th percentile received a median of 50Kg of fertilizer (25Kg of basal and 25Kg of top dressing) and 2.5Kg of hybrid maize seed. Recipients at the 10th percentile received 66.7Kg of fertilizer and 3.3Kg of hybrid seed. Smallholder farmers at the 50th and 90th percentiles received 100Kg and 200Kg of fertilizer and 5Kg and 10Kg of hybrid maize seed respectively. These variations resulted from the farmers sharing the inputs with those that were not beneficiaries, especially the farmers in the 5th, 10th and 50th percentiles.

2.2 FISP Input Distribution - 2002/2003 to 2011/2012 Season

From table 2.1 below, it is evident that FISP has over the years distributed huge quantities of seed and fertilizer to the smallholder farmers in the country. So far, it seems the programme has achieved most of its objectives stated above. However, the objective of promoting private sector involvement in the distribution of agricultural inputs that include fertilizer and hybrid maize seed does not seem to be met as there is more Government involvement in fertilizer and seed distribution to the smallholder farmers than the private sector.

Table 2.1: FISP input Allocation and distribution from 2002/03 to 2011/12

Season	Fertilizer (MT)	Maize Seed (MT)	Subsidy Level (%)
2002/2003	48,000	2,400	50
2003/2004	60,000	3,000	50
2004/2005	46,000	2,500	50
2005/2006	50,000	2,500	50
2006/2007	84,000	4,234	60
2007/2008	50,000	2,550	60
2008/2009	80,000	4,000	75% for fertilizer, 50% for maize seed
2009/2010	100,000	5,342	76% for fertilizer, 50% for maize seed
2010/2011	178,000	8,790	76% for fertilizer, 50% for maize seed
2011/2012	182,454	8,985	79% for fertilizer, 53% for maize seed

Source: Farmer Input Support Programme Implementation Manuel – 2012/2013 Season

In addition, achieving the general objective of increasing household food security and income among the smallholder households seems not to have been achieved so far despite these huge quantities of subsidized seed and fertilizer that have been distributed since 2002/2003 season as shown in table 2.1.

CHAPTER THREE

3.0 Theoretical Literature Review on Subsidies

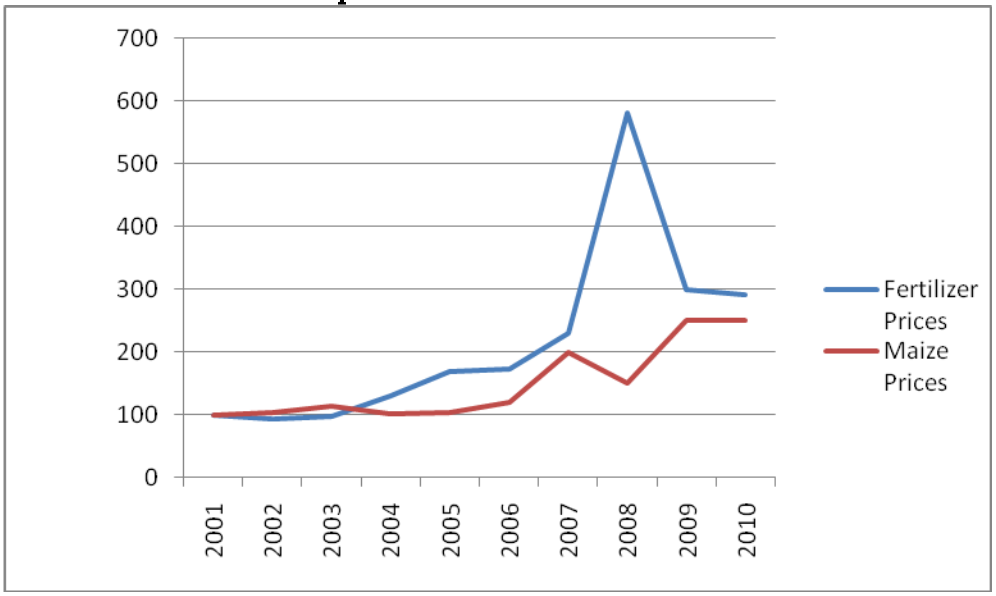
The characterization of subsidies discussed above suggests that the concept is based on the economic principles of efficiency, equity and sustainability. In this research, therefore, we will discuss these principles and relate them to effect of subsidies on maize production. In this Chapter, therefore, we will briefly discuss each principle in relation to the effect of input subsidies.

3.1 Efficiency

There is strong evidence to suggest that agricultural inputs raise productivity substantially, and that they are essential for sustaining intensive agriculture in the long run without depleting soil fertility (Crawford *et al*, 2006). The obvious question is, therefore, why are there so few farmers in the Sub-Sahara Africa who have adopted the use of agricultural inputs to capture some of these potential benefits. There are two possible answers to this question: 1) the economic costs of delivering agricultural inputs to the farmers are quite high and the benefits in terms of higher production are generally so low for adoption of agricultural inputs use to be a profitable investment; 2) barriers which economists call market failures, prevent farmers from realizing the economic potential of agricultural inputs. If the first reason is correct, then agricultural input subsidies are inefficient. Subsidies merely encourage the adoption of inputs, which are more costly to procure than the benefits they provide. Secondly, if the second reason is correct, subsidies may be efficient as they help farmers overcome the market distortions generated by the market failures. The first reason may be correct in some geographical areas and/or some periods of time. Due to poorly developed infrastructure such as the road network especially in the SSA, the costs of transporting inputs to remote areas are very high. Banful (2010) suggests that around 50% of market fertilizer prices across SSA can be attributed to transaction costs compared with other countries such as approximately 20% in Thailand. For example, the road infrastructure in Gwembe is so poor that these feeder roads are impassable particularly in the rain season. In addition, if farmer density is also low (as the case is in most areas of Zambia), the potential demand for expensive agricultural inputs may be so low that agro-dealers will find it hard to cover the costs of setting up a shop in such areas. Coupled with relatively low agricultural productivity, the investment could simply be unprofitable, demand for inputs may be so low and in certain cases not exist, and suppliers will generally be unwilling to offer access to inputs. In such a case, input subsidies could boost demand and encourage input suppliers to expand their presence to remote areas. However, the subsidies would be inefficient. Some of the costs of supply would shift from farmers to the state, but the costs would still outweigh the economic benefits. Funding for subsidies could be better spent on policies aimed at lowering the transaction costs, such as investment in the infrastructure development and market deregulation.

The profitability of agricultural inputs also varies significantly over time. Figure 3.1 shows the world market fertilizer and maize price indices from 2000-2010. From 2005-2008 the world market price of maize, one of the most important staple crops in SSA, almost doubled, which alone would make maize production more profitable. However, in the same period fertilizer prices rose much faster than output prices and reached record high levels in 2008. So if an investment in fertilizers more or less broke even in 2006, it would have become very unprofitable in 2008. Again, in this case an input subsidy would be inefficient as it would encourage unprofitable use of inputs.

Figure 3.1: Fertilizer and Maize prices 2000 - 2010



Source: *World Bank, Global Economic Monitor (GEM) Commodities database.*
Notes: *Prices are real USD indices of world market prices.*

The second possible reason to why agricultural input adoption in SSA is so low suggests that market failures exist to distort input markets and discourage farmers from using agricultural inputs. Dorward, (2009), identifies examples of market failures as the most frequently cited in the literature as credit constraints, imperfect competition and risk of crop failure:

- *Credit constraints:* If farmers are unable to obtain the necessary funding (or if credit costs are so high), they may not be able to make an otherwise profitable investment in agricultural inputs. This is what Dorward (2009) refers to as the affordability problem. A subsidy reduces the funding needs, but may not necessarily resolve the distortion completely, as farmers still have to cover the subsidized prices.

- *Imperfect competition:* If agricultural input markets are imperfectly competitive, input suppliers tend to charge higher prices in order to capture greater profits or to cover more inefficient business practices. This may result in farmers not being able to afford investments, which would be profitable with a more competitive market. In this case, an input subsidy can have both positive and negative consequences. It may increase aggregate demand, attract new entrants to the market and increase competition. However, if this does not happen, for instance if the demand impact is too weak or if the subsidies are implemented in a way that favours incumbents, the subsidy may largely benefit the imperfectly competitive firms.

- *Risk of crop failure:* Investing in agricultural inputs is a risky business, particularly since many hybrid seeds and fertilizers require a reasonably well timed application and stable water supply. A season of prolonged drought can largely wipe out the entire investment and generate significant losses. Particularly the poorest smallholders are very vulnerable to poor harvests and may not be able to absorb the costs of a failed investment. Rather than risk losing everything, they may choose not to apply agricultural inputs, settling for a smaller but more stable surplus. Agricultural input subsidies increase the expected benefits of the investment and reduce the costs of a failed investment.

It follows from this discussion that input subsidies may be efficient if they counteract distortions generated by market failures and are inefficient if they do not. However, market failures are hard to measure, and estimates of how subsidies affect their distortions are usually not available. In practise, it will be difficult to clearly distinguish between unprofitable input use and market failures. In this research, therefore, the main interest will be to look at the outcome of the results and explain to some extent the results. Anything else that is beyond this research shall not be discussed.

3.2 Equity

For countries implementing the pro-poor policies, agricultural input subsidies can be a useful instrument for promoting greater equality by targeting subsidies specifically at the poorest smallholder farmers. However, it is not entirely clear whether such redistributive objectives are compatible with the efficiency criteria. On the one hand, the poorest smallholders are most likely the ones that are most constrained by market failures, such as credit constraints and vulnerability to the risks of crop failures. On the other hand, poor smallholder farmers may lack complementary resources, such as skills, scale 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.

Thus, there may be a trade-off between equity and efficiency objectives. If the primary aim of a subsidy programme is to achieve pro-poor growth, targeting the most vulnerable households may increase equality at the expense of efficiency. Similarly, an objective of increasing national self-sufficiency in food production will require the programme to target the most productive households, who may be somewhat less poor.

3.3 Sustainability

Subsidy programmes are sustainable if they can be maintained over the long term without draining the public resources, or if the outcomes in terms of wider adoption of agricultural inputs and improved agricultural productivity persist after their termination. The universal input subsidy programmes pursued by many SSA countries during the 1970's and 1980's largely failed on both of these accounts.

Long term subsidy programmes may be economically justified as long as they meet efficiency and equity objectives. There are, however, political economy reasons to be sceptical about long term programmes. Subsidies represent a significant value, which is transferred from the state to farmers, suppliers and other stakeholders. As such, stakeholders have a great and obvious interest in the continuation and expansion of subsidies. In particular, when subsidies are rationed and targeted at specific groups, the people controlling how subsidies are targeted may exploit their power for personal gain. Policy makers may also be inclined to expand the government support irrespective of its performance, as it signals leadership and willingness to act. The politics of input subsidization therefore carry a risk that the programme gains a life of its own, grows more inefficient and less equitable, and eventually becomes unsustainable.

To counter these effects, subsidies are meant to be a temporary measure designed with a clear exit strategy, detailing the termination of the programme. A sustainable subsidy programme seeks to affect a permanent impact by a short term boost, or in other words to “kick-start” the market for agricultural subsidies. The permanent impacts can be achieved by alleviating the market failures plaguing the input markets directly or by raising the productive capacity of poor smallholders to a sufficiently high level that the market failures are no longer constraining. For instance, if the subsidy programme succeeds at permanently developing a more competitive private input supply, the lower prices will make inputs more widely accessible to smallholders. Similarly, if the programme helps smallholders accumulate productive and financial assets from a few years of surplus harvests, the farmers may be able to finance full-priced inputs from their own savings after programme termination. On the other hand, if market failures simply manifest again once the programme ends, the effects are likely to prove short-lived.

3.4 Political economy of input subsidies in SSA.

While the evaluation study will primarily focus on the economics of input subsidy programmes, the political economy of input subsidies cannot be completely overlooked. Ideally, policies would be implemented to maximize national welfare, but it is naive to believe that personal political motivations do not play a role. In fact, Dorward (2009) argues that political economy difficulties are particularly problematic in poor rural societies, as 1) the potential personal and political gains from subsidy rents are very large relative to other income opportunities, so incentives for political manipulations are strong; and 2) fiscal resources are very scarce and costly to collect, so the adverse consequences of wasteful policies are great.

Irrespective of the economic justifications for large scale input subsidy programmes, their political benefits may be substantial. Input subsidies which are effectively transfers of value from the government directly to recipients, benefits are immediate and easily recognized. They may generate relatively fast and easily observable results in terms of greater food production, which allows policy makers to signal strong leadership and decisiveness. Subsidies can be narrowly targeted at specifically favoured constituents, while excluding others, and they may just as easily be taken away again if political objectives are not met. Thus, it is possible that the popularity of large scale input subsidy programmes in SSA is mainly due to their political attractiveness rather than economic superiority. Banful (2010b) suggests that historical evidence supports this view. The universal subsidy programmes were maintained for many years in spite of strong indications of their inefficiencies and unsustainable drain on fiscal resources. It took heavy pressure from outside donors and the threat of imminent fiscal collapse to push through liberalizing reforms.

3.5 Empirical Evidence

There is rich empirical literature on the analysis of impact of seed and fertilizer subsidies. Researchers have tried to estimate the impact of these subsidies in various studies in different countries in SSA. But each study differs in its underlying objectives and therefore in the model and the variables under examination.

However, the primary role of input subsidies in agricultural development should be to promote adoption of new technologies and accelerate agricultural production (Ellis, 1992). Despite the failure of past fertilizer subsidy programmes in many SSA countries, many agricultural experts still view fertilizer subsidies as a viable means to restore soil fertility and hence ensure food security and eliminate malnutrition and poverty (Morris *et al.*, 2007; Denning *et al.*, 2009). Yet, Crawford *et al.* (2003) noted that the huge fiscal burden of the earlier fertilizer subsidy programmes contributed to the macroeconomic crises. Moreover, Morris *et al.* (2007) hold that the past efforts to promote fertilizer in Africa were too narrowly concentrated on stimulating increases in fertilizer use without crowding in other complementary input needs.

An impact assessment based on household surveys by Chibwana *et al* (2010) on the impact of fertilizer subsidy in Malawi suggests that the programme increased maize yields of recipient farmers by 447 kg/ha (around 42%), of which just over half (249 kg/ha) can be attributed to fertilizers and the rest to improved subsidized seed. Such production increases are within the range estimated by Dorward *et al* (2010) on the same programme.

Although evidence suggests that in Zambia, FISP was less effective than anticipated by the government, it appeared to have had a substantial effect on maize yields and production of participating farmers. A survey conducted by World Bank (2010) at the end of the 2007/8 season showed that participants achieved an average yield of around 2 tons per hectare, with large regional variations. It estimated that on aggregate, maize production in Zambia increased by 146,000 metric tons in the 2007/8 season, corresponding to 89% growth in output as a result of the FISP. The increase in output can be attributed to provision of subsidized seed and fertilizer through FISP. This increase covers output due to higher yields (estimated as 82,000 tons or 50% yield increase) as well as expansion in the area cultivated by maize (around 64,000 tons). However, these estimates were characterized by considerable uncertainty due to lack of control of non-program factors such as family size, rainfall differences, etc. The World Bank (2010) report also estimated the total cost of the FISP amounted to ZMK183 billion, or about USD47 million, including direct costs of the inputs, administration and logistics, as well as the indirect costs of salaries paid to government staff in proportion to the resources spent on the programme and farmer contributions. The report further estimated that the increase in maize supply could have been made possible at a cost of around USD325 per ton at the farm gate. In comparison import prices fluctuated between USD295 and USD406 per ton during the same period (2007- 2009).

Kenneth Baltzer, Henrik Hansen (2011/2) concluded in their report, however, that although the findings presented on Zambia and Malawi seems to raise agricultural production, input subsidies are not the best. They argued that the programmes are too costly and inefficient. They also argued that the programs fail to properly utilize the efficiencies offered by the private input markets by channelling resources through parastatal entities (Malawi) or state-managed distribution network (Zambia).

CHAPTER FOUR

4.0 Methodology

4.1 Study Area and Sampling Method

Questionnaires were administered for the study (to collect data for the analysis) to small scale farmers in randomly sampled eight (8) of the agricultural camps in Gwembe district. This was after randomly selecting 600 farmers to whom the questionnaires were administered. Because of the missing responses to some items, the final sample dropped to 570 farmers, giving a participation of 95%. The questionnaire included questions about the socioeconomic variables such as the farmer's age, education of the head of household, household size, whether the head of the household was once employed or not and gender of the head of the household.

4.2 Data

The study is based on primary data that was collected from the eight (8) randomly selected agricultural camps in Gwembe district. The questionnaires helped to collect data from 2008/2009 to 2011/2012 farming season, targeting only those smallholder farmers who received subsidized seed and fertilizer from FISP.

The survey was used in order to model the variables of interest. It contains detailed sections on <u>input variables</u> (i.e. subsidized seed and fertilizer), <u>control variables</u> and households socioeconomic characteristics which are age of head of household, gender, education and whether once employed or not. Clustered random sampling was used as the population is dispersed across a wide geographical area of the district. Gwembe district, under agricultural administration is demarcated into 3 agricultural blocks which are further demarcated into 15 agricultural camps. These camps are each subdivided into 8 agricultural zones. The survey adopted the Square Root sample allocation method, (Leslie Kish, 1987). This approach offers a compromise between equal and proportional allocation. A sample of 8 Standard Enumeration Areas (SEAs) was drawn to cover approximately 600 households. In analyzing the data, sampling weights were used. Sampling weights were used because they play a critical role in estimating standard errors.

4.3 Rainfall Data

The rainfall data was obtained from the Meteorological Department in the district which was collected over the past four seasons. We include the average cumulative annual rainfall over the past four growing seasons from 2008/2009 season to 2011/2012 season to model farmer expectation. The standard deviation of rainfall over the past four years is also included to give an estimate of rainfall variability. We also include cumulative rainfall over the growing season to account for rainfall's impact on production.

4.4 Definition of explanatory variables

Suppose the yield function for maize is;

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_2 + \beta_4 X_1 * X_2 + \beta_5 D_1 + \beta_6 D_2 + \beta_7 X_3 + \beta_8 X_{23} + \beta_9 D_3 C_{i.........8}$$

Where $\boldsymbol{Y_i}$ is yield (i.e., output per hectare) for farmer $\boldsymbol{i} = 1,\ldots,n(= 570)$;

Input variables

X_1 is the amount of subsidized fertilizer and seed applied and planted per hectare in kilograms.

Control variables

X_2 is the average annual rainfall in millilitres (ml).

X_3 represents the amount of land cultivated and managed using subsidized inputs by the farmer.

D_1 is a dummy variable that takes the value of 1 if the field has fertile good soil and 0 otherwise.

D_2 is a dummy variable that takes the value of 1 if the farmer hired labour to tend the field and 0 otherwise.

D_3 controls for the year effect on yield.

C_i is the time constant unobserved household level heterogeneity such as management ability and risk aversion that influences yield.

β_k is the vector of the $k = 0,\ldots,9$ parameters to be estimated; and $\mu_i \sim N(0,\sigma^2)$ is a normally distributed error term. The selection of control variables was made taking into account the various factors affecting maize yield other than seed and fertilizer.

The vector of explanatory variables includes input variables (i.e. subsidized seed and fertilizer) and control variables which are annual rainfall received in the district as captured by The Meteorology Department in the district, household size, level of education of head of household. Table 4.1 below summarizes the definition of the variables.

Table 4.1: Definition of explanatory variables

Explanatory variables	Description
SUBSF	Subsidized seed and fertilizer in kilograms
HHSIZE	Household size
MALEHH	If the household head is a male or not (Yes=1)
AGE	Average Age of the household head
TOTALLAND	Size of cropland planted by the household in hectare
SOTYP	Soil type =1 if soil is sandy loam and 0 otherwise
EDUC	= 1 if head of household attended school
EMPLT	If the household head was employed or not (Yes=1)
RAINFALL	Annual rainfall figures in millimeters (mm).

Source: Author‘s illustration

4.5 Seed and Fertilizer Subsidy Variable

From the literature, it is evident that seed and fertilizer subsidies are possible determinants of increased maize yield. In considering maize yield, the following expectations are adopted;

The relationship between quantity of subsidized inputs received and total maize yield may, however, not be that straightforward. On the one hand, receiving of subsidized inputs may create a dependence syndrome among the recipient farmers and this have a negative relationship. On the other hand, receipt of subsidized inputs may provide additional capital which the household may not have had, thereby producing the crop that the household could otherwise not have produced. In both cases we use the actual quantities of subsidized inputs farmers received as independent variables. It is assumed that there is a strong relationship regarding maize seed and fertilizer subsidy to the household’s increased maize yield. Seed and fertilizer subsidies correlates very strongly with higher maize yields and hence, the larger the quantity of subsidized inputs the farmer receives, the higher the maize yields. Therefore, it is assumed that the quantity of subsidized inputs positively affects maize yields.

4.6 Household Size

It is also assumed that household size correlates strongly with maize yield and hence, the larger the household with more economically active children and adults that provide labour to the farming household, the higher the maize yields. Therefore, it is assumed that household size positively affects maize yields, as larger households are likely to have more labour supply for agricultural activities.

4.7 Age of Head of Household

In addition, a negative relationship is presumed with regard to age of the household head. This is because the need for increased maize yields is likely to decrease when the household head advances in age. This could be that as the household head advances in age, the less the economic importance he/she attaches to profitable farming, particularly maize production.

4.8 Male/Female Headed Households

Further, gender is taken into account by controlling for female headship of the head of the household. The likelihood of maize yield is assumed to be lower in female-headed households, as these are often poorer and with few farming assets than their male headed counterparts.

4.9 Education characteristics

In order to capture the education level of the head of household, three main categories of education, namely, primary level, secondary level or tertiary level were considered as an indicator for the human-capital development and hence the ability to adopt new farming technologies of the whole household. It is assumed that lower levels of education will reduce chances of adopting new farming technologies, thereby contributing to reduced crop yield. In addition, low education levels are often correlated to low skills and hence less productive labour supply and lower incomes for the household.

4.10 Farm size

In line with the literature, it is expected that the bigger the farm size, the higher the crop yield and that the opposite may be true. Therefore, there is a positive effect of farm size to maize yield. It is assumed, therefore, that households with larger farm sizes are more likely to produce more maize as they have larger land to work with. Furthermore, the theory of diminishing returns postulates that households are more likely to produce more when they have more inputs to be used on larger piece of land as diminishing returns is not reached easily.

4.11 Employment status

A dummy variable indicating the employment status of the household head was created. The dummy takes the value of 1 if the household head was/is employed and 0 otherwise. It is assumed that households with a head who was/is employed are more likely to have a strong capital base and have sufficient agricultural assets such as work oxen and ploughs to use which results in increased maize production than households with the head who had not been in employment.

4.12 Rainfall

Rainfall affects maize yield. The relationship between amount of rains received and total maize yield may, however, not be that straightforward. On the one hand, too much rains or too little rain in a season may reduce the maize yield.

However, there is an optimum amount of rainfall that has a positive relationship to maize yield. Therefore, the sign of the coefficient of rainfall as an explanatory variable may not be easy to predict. In addition, the annual rainfall figures that were recorded by The Meteorology Department in the district were used as actual figures.

Table 4.2 below shows the summary of the expected signs of the coefficients of the explanatory variables.

Table 4.2: Expected signs of coefficients of the Explanatory variables.

Explanatory Variable	**Expected Sign of the Coefficient**
Seed and Fertilizer Subsidy Variable	Positive (+ve)
Household Size	Positive (+ve)
Age of Head of Household	Negative (-ve)
=1if Male Headed Households	Positive (+ve)
Education characteristics	Positive (+ve)
Farm size	Positive (+ve)
Employment status	Positive (+ve)
Rainfall received	Not defined, effect depends on amount of rain received

CHAPTER FIVE

5.1 Empirical Model Specification and Data

Chapter Four in 4.2 discusses data and how it was collected. Chapter Five, therefore, presents the empirical model used in this study in analyzing the data.

We can assume the maize yield for farmer (i) on field (j) at time (t) as being a function of the following factors.

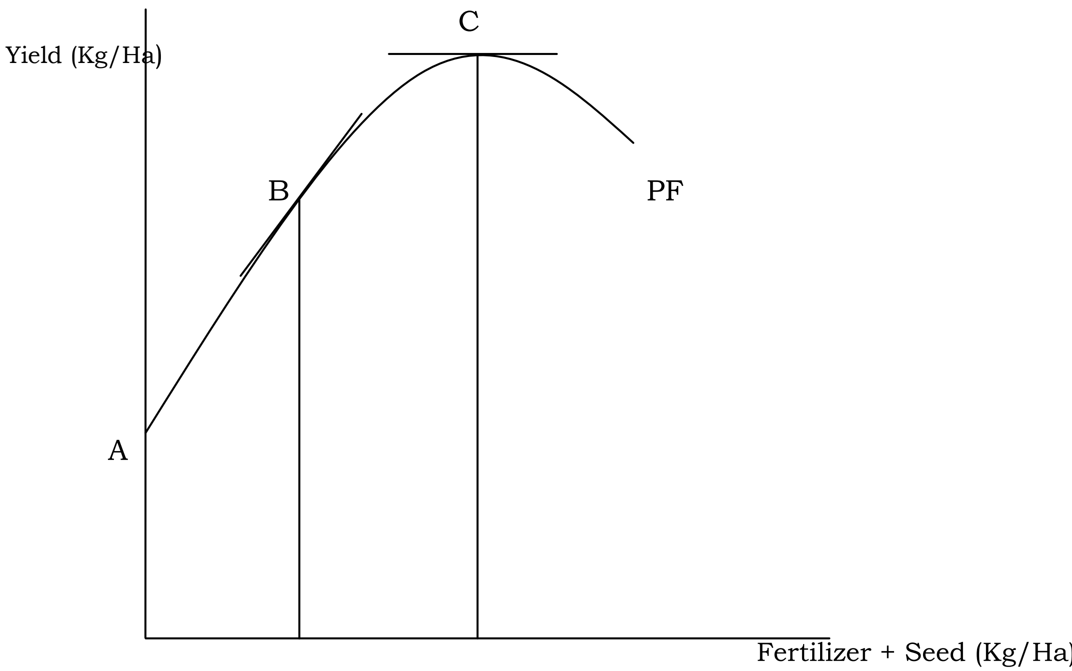
$$\mathbf{Y}_{ijt} = f\left(F_{ijt}, S_{ijt}, O_i, L_{ijt}, \middle| C_i\right) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots .9$$

Where F_{ijt} represents a vector of subsidized quantities of seed and fertilizer in kilograms used in field *j* in time *t* by farmer *i*. S_{ijt} is a vector of agronomic conditions on the field that vary over time. These include rainfall. O_i indicates agronomic conditions on the field such as soil type, and nutrient content that stay roughly constant over time. L_{ijt} represents the labour that farmer i used on field j in time t. This labour was used on various practices that include weeding and pest and disease management.

All of the factors that influence yield are represented in C_i, which represent factors like the farmer's management ability and risk aversion. Ability is a function of factors like experience and education while risk aversion may cause a farmer to under-apply an input like seed and/or fertilizer if he/she feels that it will not be profitable in a bad season. When other factors like soil type, farm size, rainfall, and management ability have been controlled for, farmers should all be on the same production function.

Figure 5.1 below shows a simple yield response function for maize to fertilizer and improved seed. The tangent lines to the production function represent the input/output price ratio of fertilizer and hybrid seed to maize. Point C represents the yield maximizing level of fertilizer and hybrid seed per hectare. Before a subsidy is introduced, point A represents the profit maximizing level for fertilizer and hybrid seed for a farmer who does not use fertilizer and hybrid seed while point B represents the profit maximizing level of fertilizer and hybrid seed for a farmer who uses fertilizer and hybrid seed a positive quantity of fertilizer and hybrid seed.

Figure 5.1: Yield Response to Fertilizer and Hybrid Seed



Giving fertilizer and seed to farmers at a subsidized rate lowers the input output price ratio. We would expect this price change to cause a farmer to apply more fertilizer and plant more improved seed and move up the production function towards point C (Ellis 1992). Because the input/output price ratio becomes flatter once the subsidy is implemented we would expect the farmer who is at point B before the subsidy to receive a lower yield response from fertilizer and seed as he moves up the production function. However, the farmer who is at point A before the subsidy gets no response to fertilizer and seed. If the subsidy causes him to use positive amounts of fertilizer and seed, we would expect him to get a positive response to the inputs as he increases his use and moves up the production function. According to this scenario the overall effect of subsidized fertilizer and seed depends on the quantity of fertilizer and seed the farmer used before the subsidy was introduced.

5.2 Model Specification

5.2.1 Methods

Consider the following empirical specification for the factors affecting maize production or crop income for household (*i*) in district (*j*) at time (*t*):

$$Y_{ijt} = \beta_0 + \beta_1 S_{ijt} + \beta_2 X_{ijt} + \beta_3 T_t + C_i + \mu_{ijt} \ldots\ldots\ldots\ldots\ldots\ldots\ldots 10$$

where Y represents maize production estimated via supply response. The quantity of subsidized inputs that a household receives in time t is represented by S. Subsidized seed and fertilizer enter into the equation as quantity acquired by household *i* at time *t* in kilograms. Other factors that affect maize production, such as household demographics, assets and rainfall are denoted by the vector **X**. Shocks that are observable to the researcher such as rainfall are also included in **X**. Level of education for the household head is also included in **X**, in order to partially proxy for management ability. Soil quality is also partially controlled in **X** by including dummy variables for whether or not the household had a plot with sandy, clay or mixed soil, and dummy variables for whether or not the household had plots that were flat or sloped that were used to grow maize from subsidized inputs. Year dummies are denoted by T_t.

The error term in the equation has two components. First, c_i represents the time constant unobserved factors that affect maize production. Any factors affecting management ability not captured by the level of schooling variable and any soil quality factors not captured in the soil composition and field slope dummies end up in c_i. Second, μ_{ijt} represents the time-varying shocks that for the purposes of this research are assumed to be i.i.d. normal. Subsequent sections will address how correlation between the covariates and c_i, are dealt with in this research.

5.2.2 Quantile Regression Framework

The theory of Quantile regression was first developed by Koenker and Bassett (1978), and since then it has been extended to a variety of applications. Some examples of Quantile regression applications include wage distribution in the United States (Chamberlain 1994; Buchinsky 1994; Chay 1995), maternity factors affecting birth weight (Royer 2004; Abrevaya and Dahl 2008), and how clean water affects infant mortality rate (Gamper-Rabindran *et al.* 2010).

Quantile regression uses a Least Absolute Deviation (LAD) estimator that minimizes the sum of absolute residuals rather than the sum of squared residuals as in OLS regression. As such quantile regression is less susceptible to extreme values in the sample than is OLS (Wooldridge 2011). This research estimates the equation for maize production as a linear model via quantile regression and compares those results with conditional mean estimates from OLS. Quantile regression allows seeing how subsidized inputs affect maize production. This helps in addressing the question of whether or not input subsidy programs can significantly boost maize production for those at the bottom of the maize production distribution.

As discussed in Chapter Four on pages 19 and 20, the complication that arises from the application of quantile regression procedure is taken care of in section 5.2.3 below.

5.2.3 Controlling for Endogeneity with Quantile Regression

The challenge of obtaining consistent parameter estimates in this research is that the observed covariates such as S_{it} may be correlated with the unobserved heterogeneity c_i in the maize production model. It is important to note that subsidized inputs are not distributed randomly. For example, it is possible that Co-operative Leaders may target the subsidy towards people who are better managers, or worse managers. In addition perhaps households with better soil quality, or worse soil quality could have been targeted to receive the subsidy. If management ability and/or soil quality affect maize production and at the same time these factors are correlated with receiving subsidized inputs, then the coefficient estimate on β in equation 2 above will be biased.

The first difference and fixed effects regression techniques control for correlation between covariates and unobserved heterogeneity in OLS estimation. Unfortunately these estimation techniques have the problem of incidental parameters when using the quantile regression, so they cannot be used in this application (Wooldridge 2011). In this case we use the Correlated Random Effects (CRE) estimators to deal with c_i in the context of non-linear estimators (Mundlak 1978; Chamberlain 1984). Recently, several studies have used a CRE related framework to control for unobserved heterogeneity using Quantile regression in a panel context. Abrevaya and Dahl (2008) used a framework related to CRE to estimate the effects of smoking and prenatal care on birth weights in the United States. Gamper-Rabindran et al. (2009) used a similar framework to estimate the effects of piped water on infant mortality in Brazil.

In this research, we implement the CRE framework to control for c_i by including a vector of variables containing the means for household i of all time-varying covariates in equation 10 above. These variables denoted as $\overline{X_i}$ have the same value for each household in every year but vary across households. We estimate the equation above with $\overline{X_i}$ included via Quantile regression in STATA.

CHAPTER SIX

6.1 Results and Discussion

Table 6.1 displays the descriptive statistic for the variables used in this analysis. The table shows that the mean maize production increased from 57 Kilograms per household in 2008/2009 farming season to 112 Kilograms per household in 2011/2012 farming season.

Table 6.2 displays the results for factors affecting household-level maize production. Viewing the columns of table 3, it reveals that the Column to the left of the table shows that conditional mean estimates using Pooled OLS (POLS), and the columns to the right display the coefficient estimates at different points in the maize production distribution using Pooled Quantile Regression. Bearing in mind that the Pooled OLS and Pooled Quantile estimates assume that all covariates are uncorrelated with unobserved heterogeneity, c_i in equation 10, the conditional mean estimate of subsidized seed and fertilizer is positive and statistically significant at the 1% level, indicating that an additional kilogram of subsidized seed and fertilizer increases maize production by 3.77 kilograms on average. The mean effect of subsidized seed and fertilizer is much higher than the median effect of 2.87, and is close to the marginal product estimate of 3.91 at the 90th percentile of the distribution. This result indicates that there is wide variation in the response to subsidized seed and fertilizer across the maize production distribution. Households at the 5th percentile of the distribution only gain a 0.87kg marginal production of maize, per kilogram of subsidized inputs, while households at the 90th percentile gain a marginal product of 3.91kg per unit of subsidized inputs acquired.

The results in table 6.2 also show a negative coefficient for the age of the head of the household. This implies that an increase in age of the head of the household by one year reduces the maize yield by 4.94Kg. This could probably be that as the household head advances in age, the less the economic importance he/she attaches to profitable farming, particularly maize production. However, household head's education, household size and whether the household head was once in formal employment all have a positive relationship to maize production. The results show that an additional year of schooling by the household head increases maize yield by 22kg and this is statistically significant at 1% level. The results also indicate that there is wide variation in the response to various demographic variables across the maize production distribution. For households at the 5th percentile only gain a 5.58kg for each additional year of schooling by the head of the household, 2.61Kg for male headed household, 6.32Kg for additional larger households and 3.21Kg for households whose household head was once in formal employment and loses only 0.47Kg marginal production of maize for each additional year to the age of the head of the household respectively, while households at the 90th percentile gain a marginal product of 69.65kg from an additional year of schooling by the head of the household. Similarly, households at the 10th and 50th percentiles gain by 9.24Kg and 29.78Kg respectively for each additional year of schooling by the head of the household and both are statistically significant at 1% level.

Households with more land also produce more maize, as an additional hectare of land boosts maize production by 133.2 kilograms on average and by 112 kilograms at the median, *ceteris paribus*.

Table 6.3 also displays the results for factors affecting household maize production, but controls for correlation between covariates and unobserved heterogeneity using First Difference (FD) in conditional mean estimation, and Correlated Random Effects (CRE) in Quantile estimation. Two interesting findings come out when comparing results for the marginal product of subsidized seed and fertilizer in table 7 where unobserved heterogeneity is controlled and in table 6 where it is not controlled. Once unobserved heterogeneity is controlled, the impact of subsidized seed and fertilizer on maize production is much lower than when not controlled. Conditional mean estimates using FD demonstrates that on average each additional kilogram of subsidized seed and fertilizer boosts maize production by 2.24Kg. This is significantly lower than the 3.77Kg on average in table 6.2. The quantile regression results in table 6.3 are also significantly lower across the maize production distribution than they are for the pooled quantile regression results in table 6.2.

One other important observation we can make from table 6.3 is that households at the lower end of the maize production distribution obtain a significantly lower response to subsidized inputs than do households at the top end of the distribution. The mean response of 2.24Kg of maize per Kg of subsidized seed and fertilizer is higher than the median response of 3.11Kg. Households at the 5th percentile of the maize production distribution obtain a marginal product of just 0.69Kg of maize per Kg of subsidized seed and fertilizer, compared to a response of 2.58Kg for households at the 90th percentile. It is also important to note that households at the 50th percentile of the maize production distribution obtain a higher response than households at the 90th percentile which gets 2.58Kg per additional Kg of subsidized seed and fertilizer. This could probably be that households at the 90th percentile obtain a lower response than people at the 50th percentile because households at the top of the maize production distribution most likely hire additional labour besides family labour and probably have work oxen and could be engaged in production of other crops such as sorghum, cotton and other crops. Therefore these households may not be interested in the management effort required to obtain the high marginal return to subsidized inputs.

Table 6.4 below shows the percentile groups of interviewed households. The table indicates that at the 5th percentile, 36.2% of the interviewed households may not be able to continue with their maize production at their current level without the help from FISP. However, at the 90th percentile, only 4.3% of the respondents indicated that they may not be able to continue with maize production without the help of the programme while at the 10th and 50th

percentiles, 29.1% and 16.7% of the respondents respectively indicated they would not be able to continue produce maize without the help from the programme. This indicates the levels of dependence the programme has created among the various percentile groups.

Table 6.1: Distribution of Variables Used in the Analysis

	2008/2009					2009/2010					2010/2011					2011/2012				
	5th	10th	50th	90th	mean	5th	10th	50th	90th	mean	5th	10th	50th	90th	mean	5th	10th	50th	90th	mean
Maize qty produced by hh (in 50kg)	20	35	44	61	57	22	48	64	99	83	44	57	82	91	90	56	98	119	122	112
Kg subsidized seed & fertilizer acquired by hh	420	420	420	420	0.965	210	420	420	420	0.5	210	210	210	210	0.5	210	210	210	210	0.5
total land cultivated for maize in ha	0.25	0.75	1.5	2	1.58	0.5	1.5	1.75	2.5	2.14	1.0	1.75	2.0	2.5	2.5	0.75	1.0	2.0	2.5	1.5
Average Age of hh head in each year	58	51	41	38	44.9	67	49	44	39	45.2	43	36	48	52	45.3	61	51	45	37	46.012
=1 if household head attended school	0	0	1	1	0.5	0	0	1	1	0.7	0	1	1	1	0.9	0	0	1	1	0.6
=1 if household is male headed	1	0	0	1	0.28	0	1	1	1	0.36	1	0	1	1	0.41	0	1	1	1	0.9
=1 if hh head was once employed	0	0	1	1	0.21	0	0	1	1	0.22	0	0	1	1	0.23	0	0	1	1	0.26
Average annual rainfall over past 4 growing seasons in ml	1,110.2	1,110.2	1,110.2	1,110.2	1,110.2	890.9	890.9	890.9	890.9	890.9	731.9	731.9	731.9	731.9	731.9	1,081.9	1,081.9	1,081.9	1,081.9	1,081.9

Note: Variable distribution weighted by inverse probability weights*population weights

Table 6.2 Pooled Quantile Regression Results for Maize Production (in Kilograms)

	POOLED OLS, CONDITIONAL MEAN ESTIMATION		POOLED QUANTILE REGRESSION							
			5%		10%		50%		90%	
COVARIATES	Coeff.	P-value	Coeff.	P-value	Coeff.	P-value	Coeff.	P-value	Coeff.	P-value
Kg subsidized Inputs acquired by hh	3.77***	(0.00)	0.87	(0.00)	1.78***	(0.00)	2.87***	(0.00)	3.91***	(0.00)
total land cultivated for maize in ha	133.2***	(0.00)	29***	(0.00)	48***	(0.01)	112***	(0.00)	437***	(0.00)
log of Age of hh head in each year	-4.94	(0.78)	-0.47	(0.89)	-0.71	(0.93)	-0.92	(0.96)	-0.63	(0.98)
=1 if household head attended school	22***	(0.00)	5.58	(0.19)	9.24***	(0.00)	29.78***	(0.00)	69.65***	(0.00)
=1 if household is male headed	62***	(0.00)	2.61	(0.28)	7.36	(0.39)	8.60	(0.49)	37.13***	(0.00)
Household Size	26.14	(0.71)	6.32	(0.67)	9.49	(0.86)	15.18	(0.51)	21.38	(0.89)
=1 if hh head was once employed	16.2**	(0.03)	3.21	(0.16)	4.78	(0.21)	9.29	(0.74)	11.27**	(0.02)
Average annual rainfall over past 4 growing seasons in ml	0.61***	(0.00)	0.10***	(0.01)	0.29***	(0.00)	0.17**	0.02)	-0.36	(0.18)
cumulative rainfall over the current growing season in ml	0.04	(0.81)	0.03	(0.36)	0.01	(0.73)	0.00	(0.80)	1.02	(0.44)
Std deviation of the average long run rainfall	-0.06	(0.74)	0.06	(0.49)	0.08	(0.17)	0.12	(0.15)	-0.19	(0.58)
Intercept	-1.93***	(0.00)	-114***	(0.00)	-214***	(0.00)	-692***	(0.00)	-1362***	(0.00)
Soil quality dummy variables included	Yes		Yes		Yes		Yes		Yes	
Num of Observations	570		570		570		570		570	
R^2	0.41		0.06		0.18		0.26		0.31	

Table 6.3: CRE Quantile Regression Results for Maize Production (in Kilograms)

COVARIATES	FIRST DIFFERENCE, CONDITIONAL MEAN ESTIMATION		CORRELATED RANDOM EFFECTS QUANTILE REGRESSION							
			5%		10%		50%		90%	
	Coeff.	P-value	Coeff.	P-value	Coeff.	P-value	Coeff.	P-value	Coeff.	P-value
Kg subsidized Inputs acquired by hh	2.24***	(0.00)	0.69***	(0.00)	1.10***	(0.00)	3.11***	(0.00)	2.58**	(0.02)
total land cultivated for maize in ha	241***	(0.00)	35***	(0.00)	55***	(0.00)	98***	(0.00)	337***	(0.00)
log Age of hh head in each year	NA	NA	-1.41	(0.88)	1.56	(0.83)	4.69	(0.61)	-2.63	(0.94)
=1 if household head attended school	NA	NA	10.08	(0.24)	24***	(0.00)	31.40***	(0.00)	49.27*	(0.08)
=1 if household is male headed	51	(0.45)	18	(0.49)	-15	(0.50)	-18	(0.58)	-56.10	(0.63)
Average annual rainfall over past 4 growing seasons in ml	-0.54***	(0.00)	-0.09***	(0.00)	-0.12**	(0.05)	-0.16***	(0.01)	-0.34	(0.11)
Household Size	18.11***	(0.00)	4.38	(0.29)	7.45	(0.49)	10.61	(0.82)	12.19	(0.14)
=1 if hh head was once employed	11.36*	(0.01)	-1.89*	(0.01)	3.46	(0.51)	5.26*	(0.03)	9.18	(0.21)
cumulative rainfall over the current growing season in ml	-0.02	(0.63)	0.06**	(0.03)	0.05**	(0.02)	0.04	(0.27)	0.13	(0.31)
Std deviation of the average long run rainfall	-0.22	(0.23)	0.03	(0.25)	0.05	(0.41)	0.07	(0.58)	-0.16	(0.13)
Intercept	-8.79	(0.96)	-23	(0.80)	-44	(0.76)	385	(0.34)	-1,004	(0.52)
Soil quality dummy variables included	Yes		Yes		Yes		Yes		Yes	
Num of Observations	228		570		570		570		570	
R^2	0.21		0.09		0.17		0.28		0.36	

Table 6.4: Levels of dependence by various percentile groups

	Percentile Groups			
	5^{th}	10^{th}	50^{th}	90^{th}
Level of Dependence on FISP	36.2%	29.1%	16.7%	4.3%

CHAPTER SEVEN

7.1 Conclusion

Fertilizer and seed subsidies are gaining support as a policy tool to foster improved agriculture production as a pro-poor policy approach, particularly for ensuring household food security in most African countries. The reported goals of agricultural input subsidy programs are often to reduce poverty and boost staple crop production among smallholder farmers (Kelly, Crawford and Ricker-Gilbert 2011). This research used panel data collected from the smallholder farmers in Gwembe district in the four seasons to estimate how an additional kilogram of subsidized fertilizer and seed affects maize production across the distribution of these smallholder farm households.

The results from this study demonstrate that it may in fact be difficult for subsidy programs to achieve the joint goal of reducing poverty and boosting staple crop production. Using quantile regression with a correlated random effects estimator to deal with endogeneity, we find that households at the 5th percentile of the maize production distribution obtain a response of just 0.69Kg of maize per Kg of subsidized seed and fertilizer acquired. In addition, it is observed that a Kg of subsidized fertilizer and seed is found to produce no significant return to crop production.

Since the goal of the subsidy program is to boost staple crop production and increase household food security, then it may be reasonable to target people at the higher end of the maize production distribution. Results from this study indicate that an additional kilogram of subsidized fertilizer and seed boosts maize production by 2.58Kg at the 50th percentile of the maize production distribution and by 2.11Kg at the 90th percentile of the maize production distribution. Therefore, it seems to be reasonable for Government to target more productive farmers in order to boost maize production (at the 50th percentile). Evidence from this study seem to suggest however, that farmers at the 90th percentile who may produce the most maize do not get as high a marginal response to subsidized seed and fertilizer as do households at the 50th percentile. This could be because households at the 90th percentile are able to hire additional labour and grow other crops instead of concentrating on maize production. In addition, these households may decide to use part of if not all the subsidized fertilizer on other crops such as yellow maize meant necessarily for livestock feed other than on the seed for which it was meant, hence obtain a lower marginal product of subsidized seed and fertilizer on maize compared with people at the 50% percentile. If more productive households are targeted to receive the subsidy, government should be aware that when wealthy, more productive households receive subsidized fertilizer they are likely to use it in place of some of their commercial fertilizer purchases (Ricker-Gilbert, Jayne, and Chirwa 2011).

From the data collected using the questionnaire, it was also observed that at the 5th percentile, 36.2% of the interviewed respondents heavily depend on the subsidy for them to produce maize crop as they will not be able to produce the maize crop once the subsidy is withdrawn, while at the 10th and 50th percentile, 29.1% and 16.7% also depend on the programme for their maize production. However, at the 90th percentile, only 4.3% depend on the programme. It is evident from the above analysis of the interviewed households that somehow the Programme seems to have created a dependence syndrome among the subsidy receiving households.

7.2 Policy Implications

Ultimately if the Zambian government wants to increase household food security and reduce poverty among its rural population, targeting fertilizer and seed subsidies to resource limited farmers who produce small quantities of maize is likely less effective. Perhaps social cash transfer to such households may be more effective. This is because returns that resource limited household obtain from subsidized inputs is small, most likely due to poor soil quality of their fields, low management ability, and other factors. Therefore, if the

Zambian government wants to use agricultural inputs subsidies to increase maize crop production, then it would be plausible to carefully target households who can obtain a positive higher return from these subsidized inputs, but will be less likely to use the subsidized inputs in other ventures of crop production or sale them. Such households may be those smallholders who have between 1 to 2 hectares, have enough family labour to be able utilize the subsidized inputs and are located far from private input suppliers and thus have trouble accessing fertilizer and seed on the commercial market.

7.3 Limitations of the study and the need for further research

Owing to limitations of time and finances, the data collected and analyzed in this study was only for Gwembe district. In addition, labour was not included in the function as one of the independent variables affecting the farmer's maize production together with subsidized inputs. As such, the results obtained may not be representative of the country as whole and do not include the effect of labour on maize output. There may, therefore, be value in extending this study to cover more districts from across the country and also to include labour to determine its effect on maize yield together with subsidized inputs.

REFERENCES

Abrevaya, J. and Dahl, C. M. (2008) The Effects of Birth Input on Birthweight: Evidence form Quantile Estimation on Panel Data. *Journal of Business & Economic Statistics* 26(4): 379-397.

Andrew, D. (2009) Rethinking Agricultural Input Subsidy Programmes in a Changing World, Paper prepared for the Trade and Markets Division, Food and Agriculture Organization of the United Nations, School of Oriental and African Studies, University of London.

Banful, A. B., and Olayide, O. (2010) Perspectives of Varied Stakeholders in Nigeria on the Federal and State Fertilizer Subsidy Programs. IFPRI Nigeria Strategy Support Program Working Paper. Washington, DC: International Food Policy Research Institute.

Buchinsky, M. (1994) Changes in the U.S. Wage Structure 1963-1987: Applications of Quantile Regression. *Econometrica* 62:405-458.

Chamberlain, G. (1984) Panel data. In Grilliches, Z., Intriligator, M.D., eds. *Handbook of Econometrics*, Vol. 2 North Holland, Amsterdam. 1247-1318.

Chamberlain, G. (1994) Quantile Regression, Censoring, and the Structure of Wages. In Sims, C.A., eds. *Advances in Econometrics: Sixth World Congress.* 171-205.

Chay, K. Y. (1995) Evaluating the Impact of Civil Rights Act of 1964 on the Economic Status of Black Men Using Censored Longitudinal Earnings Data. Working Paper, Princeton University, Department of Economics.

Chibwana, C., Fisher, M. and Shively, G. (2010) Land Allocation Effects of Agricultural Input Subsidies in Malawi. (in press) *World Development.*

Crawford, E., Kelly, V., Jayne, T. S. and Howard, J. (2003) Input Use and Market Development in Sub-Saharan Africa: An Overview. *Food Policy* 28: 277–92.

Denning, G., Kabembe, P., Sanchez, P., Malik, A., Flor, R., Harawa, R., Nkhoma, P., Zamba, C., Banda, C., Magombo, C., Keating, M., Wangila, J. and Sachs, J. (2009) Input Subsidies to Improve Smallholder Maize Productivity in Malawi: Toward an African Green Revolution. *Plos Biology*.

Dennis, C., Martin, F., Humphrey, E., Hurrell, A. and Jack W. (2010) Agriculture Case Study – Evaluation of Budget Support in Zambia, Oxford Policy Management: 27

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

http://www.plosbiology.org/article/info%3Adoi%2F10.1371%2Fjournal.pbio.1000023, 23/11/2012.

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

Economics Association of Zambia Submission (2008) Submission to the Committee on Economic Affairs and Labour on Various Economic Issues, Lusaka, Zambia.

Ellis, F. (1992) Agricultural Policies in Developing Countries. Cambridge, UK: Cambridge University Press.

Gamper-Rabindran, S., Khan, S. and Timmins, C. (2010) The Impact of Piped Water Provision on Infant Mortality in Brazil: A Quantile Regression Approach. *Journal of Development Economics* 92: 188-200.

Govereh, J., Jayne, T., Shawa, J., Haantuba, H., Belemu, A. and Ngulube, E. (2002) "Developments in Fertilizer Marketing in Zambia: Commercial Trading, Government Programs and the Smallholder Farmer." Working Paper No.4. Lusaka: Food Security Research Project.

Holden S., and Lunduka, R. (2010) Too Poor to be Efficient? Impacts of the targeted fertilizer subsidy program in Malawi on farm plot level input use, crop choice and land productivity. Unpublished Manuscript, Depart. of Econ. and Resource Management. Norwegian University of Life Sciences.

Keider, A. (2000) Determinants of Access to credit and Loan Amount: Household level Evidence from Ethiopia, Ethiopia.

Kelly, V., Crawford, E. W. and Ricker-Gilbert, J. (2011) The New Generation of African Fertilizer Subsidies: Panacea or Pandora's Box? Food Security Group Policy Synthesis Number 87. Department of Agricultural, Food and Resource Economics, Michigan State University.

Kenneth, B. and Henrik, H. (2011/2) Agricultural input subsidies in Sub-Saharan Africa, Evaluation Study, Institute of Food and Resource Economics, University of Copenhagen Rolighedsvej 25, 1958 Frederiksberg C.

Koenker, R. and Bassett, G. Jr. (1978) Regression Quantiles. *Econometrica* 46: 33-50.

Marenya, P. and Barrett, C. B. (2009) State-Conditional Fertilizer Yield Response on Western Kenyan Farmers. American Journal of Agricultural Economics 91(4): 991-1006.

Mbozi, G. and Shawa, J. J. (2009) Report on Proposed Reforms for the Zambian Fertilizer Support Programme, Ministry of Agriculture and Co-operatives HQ, Lusaka.

Ministry of Agriculture and Livestock (2012) Implementation Manual 2012/2013 Agricultural Season, Famer Input Support Programme (FISP), Mulungushi House, Lusaka, Zambia.

Morris, M., Kelly, V., Kopicky, R. and Byerlee, D. (2007) Fertilizer Use in Africa: Lessons Learned and Good Practice Guidelines. Washington, DC: World Bank.

Mundlak, Y. (1978) On the Pooling of Time Series and Cross Section Data. *Econometrica* 46: 69-85.

Nicole M. M. and Ricker-Gilbert J. (2012) Disrupting Demand for Commercial Seed: Input Subsidies in Malawi and Zambia, Working Paper No. 63, Indaba Agricultural Policy Research Institute (IAPRI), Lusaka, Zambia

Nkonde, C., Nicole, M. M., Sitko, N. J. and Jayne, T. S. (2011) Who Gained and Who Lost from Zambia's 2010 Maize Marketing Policies? FSRP Working Paper #49, Department of Agricultural, Food and Resource Economics, Michigan State University.

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

Ricker-Gilbert, J. and Jayne, T. S. (2011) What are the Enduring Effects of Fertilizer Subsidy Programs on Recipient Farm Households? Evidence from Malawi. *Staff Paper 2011-09*; Department of Agricultural, Food and Resource Economics, Michigan State University.

Royer, H. (2004) What All Women (and Some Men) Want to Know: Does Maternal Age Affect Infant Health. Working Paper 68, University of California, Berkeley Center for Labor Economics.

Sachs, J. (2004) The Case for Fertilizer Subsidies for Subsistence Farmers. Working Paper, the Earth Institute at Columbia University.

Suri, T. (2011) Selection and Comparative Advantage in Technology Adoption. *Econometrica* 79(1): 159-209.

World Bank (2010) Zambia, Impact Assessment of the Fertilizer Support Program, Analysis of Effectiveness and Efficiency: 42 - 43

Wooldridge, J.M. (2011) *Econometric Analysis of Cross Section and Panel Data, 2nd Edition.* London: MIT Press.