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BENEFITS AND CHALLENGES OF FERTILIZER SUBSIDY FOR SMALLHOLDER FARMERS IN ETHIOPIA

M.Sc. THESIS

BY

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JUNE, 2014
ADDIS ABABA, ETHIOPIA

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SCHOOL OF GRADUATE STUDIES
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APPROVED BY BOARD OF EXAMINERS

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DEDICATION

I dedicate this thesis manuscript to my beloved mother, **Wordiwot Kereji**, who always instilling in the great value of education and her commitment in the success of my life. No words could express my gratitude and love to you. In deed she is exceptional and tremendous.

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DECLARATION

I, the undersigned, declare that this thesis is my original work, prepared under the guidance of Dr. Bekabil Fufa. All sources of materials used for the thesis have been duly acknowledged. I further confirm that the thesis has not been submitted either in part or in full to any other higher learning institution for the purpose of earning any degree.

Feta Zeberga Norche

Signature_______________

Saint Mary University, Addis Ababa

June 2014

ENDORSEMENT PAGE:

This thesis has been submitted to St. Mary's University College, School of Graduate Studies for examination with my approval as a university advisor.

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Name of Advisor	Signature	Date

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LIST OF ABBREVIATIONS AND ACRONYMS

ADLI	Agricultural Led Industrialization Development Strategy
AGRA	Alliance for Green Revolution in Africa
AISCO	Agricultural Inputs Supply Corporation
AISE	Agricultural Inputs Supply Enterprise
ARDPS	Agriculture & Rural Development Policy & Strategy
BFA	Bangladesh Fertilizer Association
CSA	Central Statistical Agency
CBA	Cost Benefit Analysis
DAP	Diammonium phosphate
DSA	Development Studies Associate
EDRI	Ethiopian Development Research Institute
EEA	Ethiopia Economic Association
EEPRI	Ethiopian Economic Policy Research Institute
ERHS	Ethiopian Rural Household Survey
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GTP	Growth & Transformation Plan
IADS	Institute for Agriculture and Development Studies
IFAD	International Food and Agriculture Organization
IFDC	International Fertilizer Development Center
IFPRI	International Food Policy Research Institute
ISFM	Integrated Soil Fertility Management
MoA	Ministry of Agriculture
MoFED	Ministry of Finance and Economic Development
NGO	Non Government Organization
NFIA	National Fertilizer Industry Agency
NFIU	National Fertilizer Input Unit
PA	Peasant Association
PADEP	Peasant Agricultural Development Program
PSU	Project Support Unit
SNNPR	Southern Nations, Nationalities and peoples Region
VCR	Value Cost Ratio

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ADVANTAGES AND DISADVANTAGES OF FERTLIZER SUBSIDY FOR SMALLHOLDER FARMERS IN ETHIOPIA

ABSTRACT

The study tries to assess the trends and profitability of fertilizer use and analyzes the effects of increasing trend of fertilizer costs on three main cereals namely Teff, Wheat, and maize for four main cereal producing regions of Tigray, Amhara, Oromiya and SNNPR based on secondary data. Instability in prices creates uncertainty that can adversely affect the decisions of smallholder farmers to apply fertilizer to their crops.

This study has presented a range of measures of profitability, and all points to fertilizer indeed being profitable. Many of the value-cost ratio (VCR) estimates in the literature and computed for this study are greater than 2.0. This high VCR is required primarily due to the high risks involved in rainfall-dependent agriculture and volatile output markets. If these risks are mitigated, fertilizer will be profitable as long as VCR is greater than 1.0. As a follow up to the VCR analysis, an assessment has been conducted for overall benefit-cost analysis of lowering fertilizer prices by 15%. The results suggest that such a scheme will result in subsidy bill of Birr 1,042 million. However, the benefits through increased production will be 1,347 million. In other words, a 15% reduction in fertilizer will give a benefit cost ratio of 1.29 suggesting overall social gains from the scheme.

Fertilizer subsidies for smallholder farmers need to be contemplated with caution, with a clear consideration of the costs and benefits compared with conventional best practice of addressing market failures directly and using social policies to address social objectives with respect to poverty and food insecurity.

The effect of fertilizer price on fertilizer consumption improvement is supported by simple correlation and regression techniques. The findings show that fertilizer use has a significant positive effect on the value of production.

1. INTRODUCTION

1.1 Background the Study

Ethiopia remains still a largely food insecure economy. The link between agriculture and the transformation of the national economy is weak. Ideas for transforming agriculture are donor influenced if not in some cases even donor dependent. There is doubt that the Agricultural Led Industrialization Development Strategy (ADLI) can overcome donor penetration and influence. There are a number of challenges that the agricultural sector faces. The major is the low productivity of agriculture to overcome the chronic food dependency by the Ethiopian economy (Zerhun Gudeta, 2009).

Exploring why the per capita cereal production is low and why yields are low and stagnant despite the large emphasis given to agriculture are among the basic questions that should be addressed. The answer to these questions is not straight forward. One way is to explore the effects of instruments used to improve agriculture. Fertilizer use is one instrument implemented as a means of raising production, yield and income of farm households. There are many studies on fertilizer use and agriculture in Ethiopia. Weeks and Geda (2004) studied fertilizer use as one factor affecting agriculture.

Fertilizer was first introduced to Ethiopia under the Freedom from Hunger Program of the FAO in the late 1960s. Despite successful field demonstrations and several deliberate policy attempts to increase fertilizer use in the late 1970s and early 1980s, fertilizer application levels remained very low. At the national level, total imports of fertilizer increased from about 3,500 tons in the early 1970s to 34,000 tons in 1985/86. With the introduction of the Peasant Agricultural Development Program (PADEP) in 1986, increasing numbers of farmers started using fertilizer and total imports reached about 145,000 tons by the time the central planning regime of the People's Democratic Republic of Ethiopia.

From the earliest days of field-level fertilizer demonstration plots to the end of central planning in 1991, fertilizer markets in Ethiopia were controlled by the government through its parastatal input marketing agency, called Agricultural Inputs Supply Corporation (AISCO), which was re-named as Agricultural Inputs Supply Enterprise (AISE) in 1992.

The AISCO had its own marketing network throughout the country, which included marketing centers and service cooperatives for distributing fertilizers to the farmers.

Through the New Marketing System, introduced in 1992 as part of its overall market liberalization policies, the transitional government articulated its desire to end government monopolies. However, private sector entry into the fertilizer sub-sector in Ethiopia was slow in the early years of liberalization. Only one private company, Ethiopian Amalgamated Limited, actively participated in fertilizer imports and distribution until 1996. Subsequently, three additional companies entered the market and actively tried to develop their own fertilizer marketing channels.

At around this time, regional government companies, mostly affiliated to the ruling party, began fertilizer business. The first such company to enter was Ambassel Trading PLC, owned by the Amhara regional government. Until 1995, Ambassel worked mainly as an agent of the AISE. However, it started importing fertilizer in 1996 on its own, while continuing to serve as the sole distributor and wholesaler of AISE in the Amhara region. Inspired by Ambassel Trading, other regional governments launched their own companies – Dinsho in Oromia, Wondo in SNNP, and Guna in Tigray. By 1998, the holding companies of all four major grain-producing regions were importing and distributing fertilizers alongside AISE and four private fertilizer companies.

Cooperatives have been involved in fertilizer distribution in Ethiopia for a long time, they became dominant from 2006. Starting in 2006, cooperative unions were provided with credit to import and distribute fertilizers. Their share in the fertilizer market grew rapidly, reaching 75 percent of total imports (about 300 thousand tons) in 2007/08. However, the situation took a different turn in 2008 when Ethiopia was faced with soaring inflation and balance of payment problems.

Yet, only a fraction of the Ethiopia's potential for enhanced agricultural productivity has been exploited. Only 30 to 40 percent of Ethiopian smallholder farmers use fertilizer, and those that do only apply on average 37 to 40 kg per hectare, significantly below recommended rates (MoA, 2012). Moreover, there have been high carry-over stocks of fertilizer nationally, in recent years, averaging 275 thousand tons annually between 2009 and 2012. While carry-over stocks have some beneficial effects in terms of enhanced availability and as a buffer against global fertilizer price hikes, the opportunity costs of holding excessively high volumes of fertilizer from one cropping season to the next is a manifestation of inefficiency in the fertilizer value chain.

Given very low level of inorganic fertilizer use and high carry-over stocks of fertilizer nationally every year in Ethiopia, an obvious policy choice in addressing this challenge is to increase fertilizer use to increase crop productivity. This is reflected in both the economic growth and the poverty reduction strategies that the country has pursued over the past two decades.

The study tries to assess the trends and profitability of fertilizer use and analyzes the effects of increasing trend of fertilizer costs on three main cereals namely Teff, Wheat, and maize for four main cereal producing regions of Tigray, Amhara, Oromiya and SNNPR based on secondary data.

In Ethiopia, chemical fertilizer is used mainly for the three major cereals – teff, wheat and maize – and prices of these cereals have been highly volatile in recent years. Instability in prices creates uncertainty that can adversely affect the decisions of smallholder farmers to apply fertilizer to their crops. That is why this study is focused on these three main food cereal crops how they are affected by continuous price rise.

1. 2 Statement of the Problem

High population growth rates continue to undermine Ethiopia's ability to be food secured and provide effective education, health and other essential social and economic services. Given that Ethiopia is a predominantly agrarian society, agriculture is found to be the starting point for initiating the structural transformation of the economy.

The increasing number in population means higher demand for food. Threats in agricultural production such as pests and loss of soil fertility may result in low percentage of plants to harvest. If these problems are not addressed, there would not be enough crops which compose a big fraction of food supply to sustain the needs of the people. Hence, the importance of using fertilizers rises.

In Ethiopia, agriculture’s poor performance is explained by its inability to feed the growing population, by the lack of structural transformation magnified by agriculture’s continued dominance in Gross Domestic Product (GDP), and by the limited role that agriculture has played in serving as an engine of growth in economic development.

Increasing food production will require intensive agriculture based on modern technologies, mainly fertilizers. Such changes are particularly crucial because many regions of Ethiopian are no longer land abundant specifically on the highlands where large proportion of the population is living and agricultural activities are practiced. In highlands land scarcity is coupled by low soil fertility, resulting from the shortening or elimination of the fallow period without concurrent efforts to increase soil nutrients through fertilizer application or other soil management practices.

In Ethiopia output per hectare will need to grow by raising the quantity and efficiency of yield enhancing agricultural inputs. Increased use of fertilizer has a key role to play in this process. Because of the high labor intensity and low quality of organic fertilizer, restoration of soil fertility increasingly requires the use of inorganic fertilizer. Ethiopia's consumption of this critical input is very low.

Ethiopian agriculture is dominated by subsistence and low income, where smallholder farming dominates the overall national economy. Small holder farmers are facing shortages of financial resources to purchase productive agricultural inputs particularly fertilizer.

The price of fertilizer is going up every year. Consequently, the dependence of the subsistence farmers on financial institutions for credit has become substantially higher nowadays. It is common to realize that smallholder farmers are unable to buy and repay their loans in time or not to repay at all is a serious problem facing both agricultural credit institutions performance and the amount and quality of smallholder farmer’s production and productivity. (Kassu, 2009)

The Ethiopian Development Research Institute (EDRI) indicates that the national level evidence shows incremental increases in total fertilizer imports as well as in the applied volume of fertilizer. The household level data show that the average number of farmers that apply fertilizer is high especially in Teff and Wheat. The percentage of farmers who apply Urea in particular is, however, low as it does not exceed 36% in any of cereal crops. The high price of fertilizer is the major constraint for about 47.6% of the farmers under consideration, followed by supply shortage and late arrival of fertilizer. (Kefyalew Endale, 2011)

The EDRI study further revealed that the effect of fertilizer use on the value of agricultural production and yield is positive. Partial correlations and panel regression results support the positive effect. However, the magnitude with which the value of production responds to a change in fertilizer use is low. The smaller marginal effects of fertilizer use might be due to problems arising from applying below recommended rates and failure to use the two nutrients (DAP) and Urea) in proper combination. The study identified priority areas of interventions to address the problem of fertilizer use and its consumption. The highest priority area of intervention in the supply side is the price of fertilizer. Almost 50% of the farmers reported the price as their biggest constraint. This necessitates thinking about alternative means like crop specific partial subsidies of fertilizer and cash transfers. On the farmers' side, they are not using the fertilizer as per recommended levels and also they are using only one of the two fertilizers, mainly DAP. This is again largely caused by the price of fertilizer. (Kefyalew Endale, 2011)

1.3 Basic Research Question

The pertinent research's questions will be addressed in this study are.

- Is there a relationship between fertilizer consumption and price of fertilizer with its implications on small holder farmer's decision to use fertilizer?
- Do the fertilizer price subsidies stimulate the smallholder farmers to increase agricultural productivity for the selected major crops (Teff, Maize and Wheat)?

- What are the persistent roots causes low level of fertilizer use for Ethiopian smallholder farmers?

1.4 Objectives of the Study

The overall objective of this study is to assess the benefit and challenges of fertilizer subsidy for small holder farmers in Ethiopia and to come up with possible recommendations that could be used by the government and development partners.

The specific objectives of this study are:

- To assess the impact of fertilizer price on the fertilizer consumption trend and intensity of its use
- To identify determinants of fertilizer use and their implications on productivity
- To identify if the fertilizer subsidies induce smallholder farmers to adopt the use of fertilizer and thereby increase agricultural productivity and their income.
- Based on the results of the study to suggest the policy implication of the fertilizer price subsidy for the small holder farmers.

1.5 Research Hypothesis

Based on the own observation the research hypotheses are stated as:

- There is no significant relationship between the amount of crop production by smallholder farmers and fertilizer prices.
- Fertilizer price does not significantly affect the productivity improvement of the three major cereals (Teff, Wheat and Maize)

1.6 Definition of Terms

1.6.1 Smart fertilizer subsidies

Input subsidy programs may have various objectives, including to increase agricultural productivity, improve food security, or provide income support for poor farmers. National and household food security objectives may be especially urgent in times of crisis, such as the current environment of rapid and major increases in fertilizer and food grain prices. Regardless of their objectives, the design and implementation of input subsidies should be "smart" in the sense that (a) their benefits in terms of agricultural productivity and food security exceed what could be achieved by investing the resources in other areas; and (b) they encourage farmers' purchases of fertilizer on commercial terms, or at least do not impede it, which could result if government input subsidy programs crowd out commercial transactions or undermine investment in fertilizer distribution by suppliers and agro-dealers.

1.6.2 Fertilizer adoption:

Negatu & Parikh (1999) review three groups of models on the adoption of agricultural technologies by smallholder farmers:

- The innovation-diffusion or transfer of technology model, in which technology is transferred from its source to the smallholder farmer through an intermediary such as an extension system, and the diffusion of the technology depends on the characteristics of the farmer
- The economic constraint model takes the view that farmers have different factor endowments and that the distribution of endowments determines the adoption of technology
- The technology characteristics-user's context model assumes that the characteristics of (he technology and the underlying agro-ecological, socio-economic and institutional circumstances of farmers play a central role in the adoption of technology.

1.6.3 Value cost ratio (VCR)

The VCR is an indicator of profitability of fertilizer use, measuring the value of additional crop output relative to the cost of a given application of fertilizer. In addition, an attempt is made to estimate farmers' reservation price of fertilizer.

In the absence of risk and transaction costs of acquiring fertilizer and selling output, a producer may be expected to operate up to the point at which the VCR = 1, i.e., marginal cost of the input equals its marginal revenue. However, because of risk and transaction costs a VCR greater than 1 is needed to induce farmers to buy fertilizers. In situations where production risks are considerable and market failures are prevalent, farmers may not adopt fertilizer unless the VCR is sufficiently high. The use of fertilizer may also result extra labor costs in the form of additional weeding, harvesting, threshing, interest, etc., and in nonmonetary transaction costs associated with procuring credit and/or fertilizer. Because of these additional costs, a VCR greater than 2 is often regarded as the critical threshold to make fertilizer profitable and convince farmers to use fertilizer (Heisey, P.W. and W. Mwangi, 1996).

The VCR highlights the fact that it is both expected revenue as well as input cost that determines the viability of fertilizer use. Expected revenue is not only related to the output price, but also the quantity sold. It is commonly felt that incentives to use fertilizer on grain crops may be depressed by low grain prices. However, if low grain prices occur as a result of favorable production, and farmers have more to sell than ordinarily, then the resulting revenue from crop sales may actually increase, and improve their ability to finance input purchases in the next season. In other words, low grain prices can be more than offset by increased output response due to good weather. Hence, fertilizer use may remain profitable or the VCR may not be adversely affected by low grain prices.

1.7 Significance of the Study

- The study attempts to provide evidence based inputs for the government of Ethiopia to revisit its fertilizer subsidy policy and there by promote fertilizer usage and increase productivity.

- The study tries to inspire researchers in the sector to conduct in-depth study on fertilizer subsidy.

- The study tries to provide necessary inputs for development partners for their decisions in financing development and humanitarian interventions in the agriculture sector.

- The study aims to strengthen the knowledge of the researcher and fulfill the academic requirements of Institute for Agriculture and Development Studies (IADS).

1.8 Delimitation/Scope of the Study

- The study is based on secondary data. The information is collected for other purpose other than the current research objectives. Therefore, it is not up-to-date for current research use. For this reason it may not precisely meet the needs of the objective.
- The study does not address how political manipulation which exacerbates inefficiencies of fertilizer subsidies.
- The study does not show empirically other factors that can affect the fertilizer consumption.

2. REVIEW OF RELATED LITERATURE

2.1 Factors Which Affect the Use of Fertilizers by Smallholder Farmers

Availability: An obvious but necessary condition for farmers to use fertilizers is that they should be readily available at the time when farmers want to buy and use them. Many farmers in developing countries will buy fertilizer (and other inputs) only if the shop or supply outlet is within easy walking distance (less than 2 km). Many smallholder farmers cannot afford to buy a 50 bag of fertilizer and so it is desirable in areas where smallholder farmers predominate that fertilizers should be sold in smaller quantities.

Accessible markets for farmers' produce: In order to pay for fertilizer, farmers must also have access to markets to sell their produce. For example, in order to buy a small bag of fertilizer, a farmer may need to sell one of his surplus chickens or a bag of rice. A major part of improving access is, of course, the provision of better roads, which is normally a government responsibility.

Profitability: Farmers will use fertilizer only if it is profitable; the three most commonly used measures of profitability are:

- The crop/fertilizer price ratio which measures the amount of produce in kilograms that is required to purchase one kilogram of fertilizer. This is fundamental to providing the economic incentives to farmers to use fertilizers that relate to government action

- The Value Cost Ratio (VCR), which is calculated by dividing the value of the yield increases due to fertilizer by the cost of the fertilizer used. This is an indicator of farmers' willingness to accept production risks.

- The Benefit Cost Ratio (BCR) which is calculated by dividing the value of the yield increase by all the costs that went in to producing it (fertilizer applied + cost of additional weeding + cost of high yielding seed + cost of collecting the fertilizer from the store etc).

Experience suggests that for small-scale farmers producing cereals or other food crops under irrigation, a VCR of 2 is generally satisfactory; where farmers are operating under favorable rain-fed conditions a VCR of about 2.5-3.0 is required. In more drought-prone areas where the risk is much higher, a VCR of over 3.0 may be necessary (FAO 1999).

Farmers' knowledge about the correct use of fertilizers: Lack of knowledge is widespread and is usually due to poor coordination between those working in research and those in the field working as extension officers. Local research work is required into soil and crop conditions, balanced fertilization, whether lime and micro-nutrients are required, the use of animal manure and compost, the use of improved seed, better cultivation and harvesting techniques, and the economics of fertilizer use. Extension workers must make use of demonstrations, preferably on farmers' fields and keep up a constant flow of information by farm visits and by the use of radio and television.

Lack of credit: Farmers often require credit at the beginning of the season to buy fertilizer and other inputs. They usually obtain it from Banks, through informal arrangements with local traders or through their membership of a co-operative. A crucial factor from the policy point of view is that credit will only be provided if the agricultural sector is profitable, otherwise it will not be worth the risk.

2.2 Factors Which Affect the Delivered Cost of Fertilizer

Price paid for fertilizers: Although the crop price is the most important factor affecting the demand for fertilizers, the price paid for fertilizers is also significant. Governments have a major part to play in ensuring that farmers receive fertilizers at the lowest possible cost commensurate with a reliable and timely supply.

Cost delivered to port/border: In countries where fertilizers or raw materials are imported, the most significant factor is the cost delivered to the port or border. A very important item is evidently the cost of fertilizer delivered to the port - the cost of the fertilizer fob, the cost of shipping, discharging, bagging and loading to truck at the port of delivery. There is usually scope for reducing costs and government policy can help in numerous ways:

- A stable exchange rate will stabilize import costs in local currency; also an adequate supply of foreign exchange will make it possible to import at the right time to meet demand.

- Import taxes, if necessary, should be kept to an absolute minimum and applied evenly to all imports, not just to fertilizers.

- Port and agency charges should be kept under constant scrutiny and compared with charges in other, similar ports.

- In most cases, a single buyer will obtain the best price and achieve economies of scale in ocean freight, port warehousing, bagging and transport.

- Donor financed fertilizer is almost invariably more expensive because of the rules that have to be followed and the length of time taken. European Development Fund procedures, for example, are extremely complex and usually take at least 5 months to complete. Where donor funding is available, policy makers should make every effort to ensure that these are applied to the general foreign exchange fund rather than being tied to a specific item such as fertilizer to keep costs down.

- Fertilizer companies producing for the domestic market already have an immediate supply advantage due to their geographic position and the fact that the brand name is usually well known. Unless there are compelling strategic reasons, they should not be given any further advantages (for example: extended tax holidays, the writing-off of debts, cheap feedstock), in order to foster competition with imports based on price and service to customers.

Internal transport cost: The next most important cost item is that of the internal transport cost, made up of labor costs; truck depreciation, maintenance and repair; insurance; fuel costs; taxes and duties. In many cases, costs increase due to high taxes, duties levied by the government itself and this may be an obvious area for policy action to reduce costs.

Competition: At the wholesaler/retailer level, policy should be directed to initiating or promoting a competitive market situation so that, at a minimum, farmers have a choice of two suppliers. While this may not always be possible in the outlying districts where the market is small and expensive to service, the main market areas, closer to the main towns, should provide good opportunities for competing suppliers to operate. In countries where fertilizer continues to be distributed by a single parastatal monopoly, it should be possible to open the market to private distributors to provide competition and choice and lower costs.

In order to promote this level of competition, the Ministry of Agriculture can provide a useful service by gathering and publishing reliable market prices for agricultural commodities and livestock at various locations around the country. Weekly prices of the main fertilizers and other inputs should also be published. This information can be circulated by newsletter to farmers and farmers' cooperatives and also by radio and television. In many countries there is a regular early morning radio programme covering topical farming issues and giving the latest market prices.

2.3 Policy Focus for a Dynamic Fertilizer Market

Allocation of foreign exchange: In numerous countries but particularly those in Africa and Latin America, foreign exchange and debt crises reduced the amount of fertilizer available during the 1980s and 1990s. In 1987, for example, 20 out of 40 countries in Africa were only able to use donor-assisted fertilizer. For some countries, the lack of foreign exchange also made it difficult to operate domestic fertilizer manufacturing capacity because of lack of raw materials and spare parts.

It is essential, therefore, that sufficient foreign exchange is allocated and that this is provided on time and in sufficient quantities so that farmers get the fertilizer that they need and local manufacturers operate efficiently. Foreign exchange allocated to the fertilizer sector can result later in the saving of foreign exchange by reducing food imports and the earning of foreign exchange from food exports.

Rapid inflation leading to devaluation: Rapid inflation normally indicates that the government's budget is in severe deficit and the government is overspending. Although the government may try to hold the exchange rate for as long as possible, devaluation is almost inevitable with devastating effects on the cost of imported goods such as fertilizers. Where rapid inflation is underway the government must give top priority to stabilizing the situation by reducing its expenditure and/or raising taxes and tightening monetary policy.

If devaluation occurs and domestic fertilizer prices increase, compensating increases in crop prices and the provision of additional credit must be allowed or the fertilizer market will collapse.

Import restrictions: Import restrictions have often been applied to protect infant industries but the result has frequently been to eliminate competition and permit gross inefficiency. In some cases, domestic state-owned fertilizer industries were protected in this way with annual trading deficits usually written off by the government at vast cost to the budget.

Studies have shown that tariffs rather than quotas are much more efficient in promoting industrialization. However, where industries are given protection they should be kept under close scrutiny and the protection should be gradually reduced so that growing import pressure keeps up a momentum for efficiency and cost saving.

Subsidy policy: Many developing countries have used fertilizer and other subsidies to encourage the use of fertilizer and to offset the effects of low crop prices, often set by the government or the crop-purchasing parastatal. In a survey of 38 developing countries, FAO found that 68% of them used fertilizer subsidies.

Although subsidies can be a useful policy tool during the introduction of fertilizers to the market, the danger is that they become entrenched. Subsidies are difficult to phase out at a later stage when they are no longer required.

Continuing with subsidies beyond the introductory phase encourages the wasteful use of fertilizers and it means that the bigger, wealthier farmers reap most of the benefits. Experience in Bangladesh shows that a well managed phasing out of fertilizer subsidies can be achieved without causing a major setback to fertilizer consumption. The key is to synchronize the subsidy removal with the development of a competitive market, which promotes increased efficiency and lower costs. Another consideration is to phase the policy change at the beginning of a general downturn in the international fertilizer prices.

The importance of improving farmers' crop prices in stimulating fertilizer use and higher yield per hectare (rather than the possible alternative policy options such as subsidizing fertilizer) is supported by recent research in Greece by Mergos and Stoforos (1997) who estimated the demand function for fertilizer.

Significant variables were the price of fertilizers, the price of labor, the price of other inputs, the price of crops and livestock products and the amount of irrigated land. The most significant factors were the price of fertilizers, the price of crops and the amount of irrigated land. It was highly significant; however, that change in the crop price had a far greater impact than changes in the fertilizer price. In other words, a 1% increase in the price of the crop will be far more effective than a 1% reduction in the price of fertilizer - in Greece about 35% more effective both in the short- and long-term.

Fluctuating world fertilizer prices: There is no effective way of isolating an individual country from the inevitable fluctuations in the international fertilizer market. However, government policy can help to minimize any consequent problems. The timely provision of foreign exchange will help importers to buy at the most opportune moment and realistic market pricing. The absence of pan-territorial or pan-seasonal pricing will give traders and dealers the incentive to build adequate storage and strategic stocks at up-country locations.

From time to time, the government may need to consider carefully targeted subsidies. For example, to outlying high cost areas or for subsistence farmers, particularly if a shortage of fertilizer is likely to lead to real hardship or to the even greater expense of importing and transporting emergency food supplies to isolated areas.

Market friendly and market sensitive pricing policies: Policy decisions need to reinforce the market rather than undermine it. A market price is an indicator of the balance between supply and demand. Suppressing a high price does not remove, it merely blunts the market mechanism so that the problem (for example, inadequate food production leading to high food prices) is made worse.

Reduce the amount of bureaucracy and discretionary controls: Myrdal (1972) argued the need to reduce the amount of positive discretionary control and bureaucracy. Classic examples are the issuing of import licenses, licenses for new buildings or a change in location, endless government directives to industrial enterprises, powers given to tariff commissions to fix the prices of protected industries and limit profits.

The result of all these discretionary powers is that virtually few business decisions can be taken before obtaining permission from the relevant administrative authority and there is always the risk of government disapproval. This, of course, stifles any active entrepreneurship except by those businessmen who are well connected or who know their way round the system. As the controls multiply, so does the need to supervise those officials who administer them and in turn to supervise the supervisors.

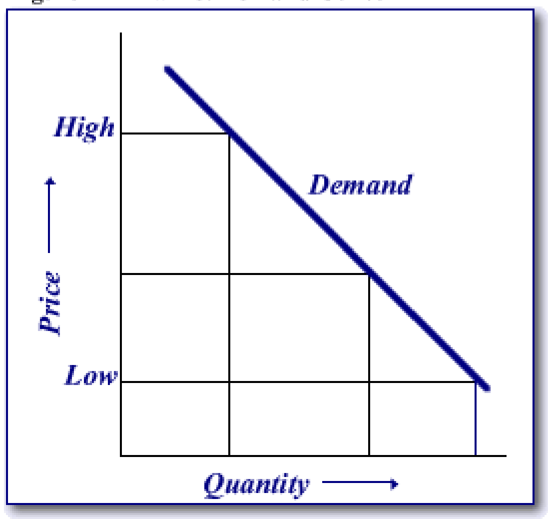
Areas for government support: The main areas for active government support and expenditure are:

- In encouraging and extending prudent banking services to rural areas;
- The development of an improved infrastructure - mainly roads, telecommunications and electricity;
- Agricultural research, particularly into new, more productive seed varieties and more productive cultivation practices given local conditions;
- Institutional support by introducing and enforcing a farmer-friendly legal framework. A specific legal framework is also required for the fertilizer sector.

2.4 Theoretical Framework

The Law of Demand states that, when the price of a good rises, and everything else remains the same, the quantity of the good demand will fall. Generally the relationship between price and quantity is negative. This means that the higher is the price level the lower will be the quantity demanded and, conversely, the lower the price the higher will be the quantity demanded. As it has been depicted below, demand is represented graphically as a downward sloping curve with price on the vertical axis and quantity on the horizontal axis.

Figure 1 Market Demand Curve



To identify a wider range of instruments, it is important to understand the key factors shaping demand for fertilizer at the farm level. The three most important are (a) the potential profitability to farmers of using fertilizer, (b) the willingness of farmers to purchase fertilizer, and (c) the ability of farmers to purchase fertilizer.

The potential profitability of fertilizer is generally considered to be the maximum profitability possible under a given price scenario when fertilizer is applied efficiently (that is, at the frontier of the fertilizer production function). It is determined mainly by four factors: (a) crop response to fertilizer, (b) fertilizer price, (c) prices of other inputs that substitute for or complement fertilizer, and (d) output prices (that is, the prices of crops on which fertilizer is applied). Increases or decreases in fertilizer price change the potential profitability of fertilizer and affect the quantity demanded; the change in quantity demanded depends on the price elasticity of demand, which is reflected in the slope of the demand curve. Changes in the other three factors increase or decrease the potential profitability and potential demand for fertilizer at a given fertilizer price level by shifting the demand function.

According to FAO (1999), given a relatively fixed amount of land, the expansion of food production depends on an interrelated package of improved policies and technologies leading to increased output per hectare of land. The necessary pre-condition is usually the provision of greater financial incentives to farmers - better farm gate prices for outputs and lower cost inputs. The technology package consists of:

- Better extension services, backed up by adequate local agricultural research into productivity boosting methods;
- The availability of improved inputs: more responsive seeds, fertilizers, plant protection products and, if possible, irrigation;
- Improved market access; and
- Increased credit availability and access

Fertilizers provide plants with the food they need for their growth and development. Plants live, grow and reproduce by taking up water and mineral substances from the soil, carbon dioxide from the air and energy from the sun.

Plants contain practically all (92) natural elements but need only 16 for good growth. Thirteen of these are essential mineral nutrient elements, which must be provided either by the soil or by animal manure or mineral fertilizer.

Apart from carbon, hydrogen and oxygen, plants take their nutrients essentially from the soil. These mineral nutrients are often classified into the “primary” plant nutrients, nitrogen, phosphorus and potassium, which are required by plants in large amounts; the “secondary nutrients”, calcium, magnesium and sulphur, which are need in smaller but still appreciable quantities; and the “micronutrients”, boron, chlorine, copper, iron, manganese, molybdenum and zinc.

Pinstrup-Anderson (1974), concerning cereal production in developing countries, estimated that fertilizers contributed 55-57% of the rise in average yield per hectare and 30-31% of the total increase in production.

2.5 Related Empirical Studies on Fertilizer

The price, shortage of supply and late arrival problems are more exogenous factors affecting the decision to use fertilizer and the extent of fertilizer application. However, there are also numerous household specific characteristics that affect the decision to use fertilizer. The section that follows will explore these points so as to understand the important policy lessons that encourage peasants' use of fertilizer for a sustained increase in yield and the value of production.

Firstly, it is necessary to mention some of the existing studies on adoption of technology in Ethiopia and their findings. Admassie and Ayele (2004) found that farm and farmer specific variables like land holding size, age of the head and access to information are among the crucial variables affecting technology adoption in subsistence agriculture of the four major regions Amhara, Oromia, Tigray and SNNP. Tekleweld et al. (2006) showed that better fertilizer use is associated with the use of improved varieties in the case of wheat production.

They further stressed that the improved seeds have to be adaptable to specific agroecological conditions. Bacha et al. (2001) studied the determinants of fertilizer and manure in two maize26 producing villages of Oromiya for the year 2000. The evidence from such district level evidence is less likely to have national representativeness. Gabriel and Demeke (2001) regresses the volume of fertilizer on three explanatory variables, land, livestock and household size, by using one round of data from the Ethiopian Rural Household Survey. The study showed that size of land is the major determinant of fertilizer use.

The above mentioned studies are static and hence cannot capture the dynamics in the decision to adopt or not to adopt fertilizer over time. Some of them also have a low degree of freedom and arise from few numbers of observations. A fairly rigorous study has been undertaken by Alem et al. (2008) using panel household data and examining the determinants of fertilizer adoption as well as the intensity of its use under rainfall variability.

But their study is limited to the highlands of Ethiopia and hence may not be representative for the farm households at large, as data are not employed from lowland producers.

This section aims to understand the determinants of fertilizer adoption by employing household level panel data from the ERHS. Major cereal producers from the four major regions are considered for the four rounds (1995, 1997, 2000 and 2004). Given that the samples are from the different agro-ecological zones, it is hoped that the evidence is closer to being representative at the national level than the aforementioned studies.

The dependent variable in adoption is a binary outcome that takes 1 if the household adopts fertilizer and 0 otherwise. Qualitative response models are applicable to analyze relationships with a discrete dependent variable (see Admassie and Ayele 2004; Verbeek 2000). Two common models in adoption studies are the Logit and Probit. The two models have statistical similarities and making a choice is difficult (see Verbeek, 2000, Greene, 2003). Admassie and Ayele (2004) mentioned some specific differences between the two in applied works. They stated that Probit analysis is useful for designed experiments while Logit is more appropriate for observational studies. Both models have been used, yielding more or less similar results.

There are many variables that can be included as factors affecting the decision to use fertilizer. Admassie and Ayele (2004) mentioned and employed many of them. The variables used in their study include farm resources such as land, labor, livestock, and credit facility; farmer characteristics, like education, age and gender of the head; ethnicity, religion and community factors and the wealth position of the farmer information (see Admassie and Ayele 2004). The variables used in most other studies mostly lie in these categories. This study also employed many of the variables used by Admassie and Ayele (2004). The findings are presented in Table

The insignificant coefficient of gender of the head is a reflection that there is no significant difference in the decisions to adopt fertilizer among male and female headed households.

This implies that females are also cautious about the importance of fertilizers. The number of family members with sub-compulsory education of the household head is positive and significant. The number of family members indicates the supply of labor and number of consumers. This increases the probability of adoption for at least two reasons. The first reason is that large family size ensures labor supply that needs to manage the output as a result of adoption. Secondly, large households need to produce more to feed their large family. This necessitates the adoption of technology. The other feature of this variable is the education of family members. Family members with education have better knowledge about the roles of fertilizer and this increases the probability of adoption.

Credit is positive and significant in the fertilizer adoption. Agricultural production has long gaps in between land preparation and the gathering of final output. Small farmers have difficulties in financing the lag between application of fertilizer and the generation of the return. Access to finance, partial as well as full, is useful to improve the adoption as well as the application rates. Livestock affects fertilizer adoption in many ways. The direct effect of livestock is that farmers can sell their livestock to purchase fertilizer. It is indirect effect on adoption is by serving as collateral for fertilizer credit.

2.6 Advantages of Fertilizer Subsidy

Many empirical evidences argued that fertilizer subsidies can lead to higher incomes, reduced poverty and improved food security is based on specific claims with respect to a range of underlying objectives. Most of these underlying objectives have either an economic efficiency rationale (*i.e.* reflect a market failure of some kind), or are concerned with reallocating income to a particular constituency (for reasons of social equity or political patronage).

The main economic objectives are compensates for high costs of transport from port to farms that raise costs of fertilizer. This in turn makes fertilizer affordable to farmers who cannot buy them, owing to poverty, lack of access to credit due to poverty, and inability to insure against crop losses.

Social equity to transfer income to farmers who are poor, live in remote disadvantaged areas, or both, this improves soil quality and combat soil degradation which stimulates agricultural production. This may sometimes be difficult to disentangle from the motive of political patronage – to win favor with voters and reward supporters.

Raising the level of output is not in itself an efficiency issue. However, this objective reflects the notion that output may be less than optimal because of underlying market failures, for example the sub-optimal use of fertilizer, and the possibility that higher output could lead to external economies of scale. The benefits of using input subsidies need to be compared with the costs of tackling those market failures directly.

Smallholder farmer lack the cash to buy inputs early in the crop season and cannot obtain credit. Banks or input dealers will not offer credit if they do not know enough about the competence and character of farmers seeking loans, or will only do so if they can get collateral and character references — requirements that many small farmers cannot meet. Farmers, moreover, may be reluctant to accept the risk of credit in any case, since they would be unable to repay the loan if the harvest fails. Formal insurance policies are usually absent in rural Ethiopia, since would-be insurers face similar problems to the bankers: the underlying risks are difficult to calculate, the character of farmers is unknown. Offering them insurance would be foolhardy without this information.

If market failures are severe, farmers could become locked into low levels of productivity, even when the technology and economic opportunity exist, since they cannot access and afford the fertilizer input to take advantage; and thus they remain trapped in poverty, too poor to work themselves out of this condition (Dorward *et al.*, 2004).

In this connection, African Union Special Summit of the Heads of State and Government declared that “With immediate effect, the African Union Member States must improve farmers’ access to fertilizer, by granting, with the support of Africa’s Development Partners, targeted subsidies in favor of the fertilizer sector, with special attention to poor farmers” (Abuja Declaration on Fertilizer, 2006, article 5).

This applies to many farmers, where the majority of rural households are poor, and then a household poverty trap becomes a major drag on national economic growth as well. It is not then surprising that there have been calls for governments to intervene to correct the failures, if necessary by subsidizing costs — and if necessary by providing fertilizer directly to farmers. A lively current debate in Ethiopia turns on how widespread and severe are these rural market failures; and whether there are other ways of remedying them than fertilizer subsidies.

Farmer demand for improved inputs may be low simply because they have too little experience of their advantages. There is a strong case for a subsidy in such cases, but since farmers can try out fertilizers and assess their advantages within a couple of seasons, a subsidy on these grounds would be short-lived. Moreover, since farmers tend to try out new ideas on limited areas, the subsidy need only cover a small amount of fertilizer per farmer: there is no need to a blanket subsidy in such cases. It is thus not surprising that a common alternative to a subsidy for learning is to distribute, free, starter packs with improved seed and fertilizer sufficient to plant quarter of a hectare or less.

The use of fertilizer subsidies to transfer income to poor farmers or those disadvantaged by location needs to be set against the effectiveness and economy of doing the same by direct payments, food aid distribution, or employment programs paid in cash or kind.

2.7 Disadvantages of Fertilizer Subsidy

Fertilizer subsidy may be ineffective in raising use of fertilizer and increasing yields. It is not always the case that the volume of fertilizer applied is sensitive to price. Studies in Sri Lanka, for example, report low elasticity of fertilizer application with respect to its own price: instead the volume of fertilizer applied corresponds more closely to the area under irrigated rice and to the price of rice. The corollary in these cases is that much of the subsidized fertilizer merely displaces fertilizer that would have been bought without the subsidy (Stein Holden and Rodney Lunduka, 2010).

Subsidies intended to benefit specified groups of farmers, or to stimulate particular crops, may be less effective than intended as leakages occur. When subsidy programs allow discretion to local officials and field workers in allocating subsidies inputs, there is the danger that they will use their power to extract bribes. The same local discretion may be used to divert subsidized inputs from intended beneficiaries to others, such as local elites and political supporters. In some cases this arises since field workers have different priorities to policy-makers. For example, in Malawi some field staff reportedly prefers to allocate subsidy vouchers to farmers they consider most likely to make good use of the input, rather than those who cannot afford fertilizer at commercial prices (Dorward and Chirwa, 2011).

Once in place, fertilizer subsidy can be difficult to remove. It can be seen as a political signal of support to farmers, around which farmers sometimes form electorally powerful lobbies for their continuation.

The often high costs of fertilizer subsidy program need to be set against the benefits it create and counted in terms of the missed opportunities to use public funds for other purposes. There cannot be a general judgment on the balance between potential benefits and disadvantages of subsidies: so much depends on particular circumstances and the design of the program.

2.8 Experience of Fertilizer Subsidies from Other Countries

Evidence from case studies of India, Malawi and Sri Lanka suggests that subsidies have had an impact over the short to medium term, promoting input use, raising output and thus reducing poverty. The programs have been costly, although the absence of a counter-factual makes it difficult to evaluate whether the same benefits could have been achieved at a lower cost with alternative instruments. It is also possible that, because of high budgetary costs, the pursuit of other objectives, for example in the areas of health and education, has been compromised (Stein Holden and Rodney Lunduka, 2010).

A major question mark hangs over whether the benefits of the programs have been enduring, in the sense that they have led to a sustained increase in incomes that would survive removal of the subsidy. Experience from India is that there were early returns during the Green Revolution, but the subsidies became increasingly ineffective as they were not complemented by deeper investments to improve agricultural productivity and strengthen the rural economy. Hence there was relatively weak progress in facilitating the agricultural transformation and raising rural incomes. In general, for subsidies to have had any long-term effect, they require complementary investments to make input use profitable, for example in rural roads, agricultural research and extension, and in some cases irrigation. Indeed, the extent of adoption of high-yielding varieties and use of irrigation may have more influence on the amount of fertilizer used than the price of fertilizer.

There is also evidence that the benefits of fertilizer subsidies are higher in the early stages of provision, as farmers increase their use of external inputs from a low base. They are markedly lower once a certain level of use has been achieved, agricultural production is greater and markets have become wider. Furthermore, the tendency is for costs to rise, for the subsidies to increasingly displace government spending in other areas, and for them to become a source of income transfer from which the government has difficulty extracting itself. Hence they can pass from being a help to becoming a hindrance to agricultural development.

The effectiveness of input subsidies will depend on specific market conditions and the way in which the subsidy program is implemented. Evidence from Sri Lanka suggests that fertilizer use might not be sensitive to price (in which case the subsidy simply replaces commercial sales) (Stein Holden and Rodney Lunduka, 2010). An open-ended subsidy is also favors larger producers, making it a poor instrument for tackling poverty. Effectiveness may also be constrained by design features. For example, the state‘s distribution of vouchers in Malawi has led to a diminished role for private dealers. Issues relating to the design and operation of input subsidy programs are taken up in the next section (Stein Holden and Rodney Lunduka, 2010).

2.9 Ethiopian Experience on Fertilizer Use

According to Nigusie et al. (2012), in Ethiopia there are only two types of fertilizer, urea (46:0:0 1) and Diammonium Phosphate (DAP – 18:46:0), are used in Ethiopia. Both have shown steady growth in use by farmers over time. There are three distinct patterns of use of fertilizer in Ethiopia. First, the intensity and prevalence of farmers' use of fertilizer varies across regions. Between 2005 and 2010, Oromia and Amhara accounted for 70 percent of total fertilizer consumption, with Oromia alone accounting for about 40 percent. Of the other two major cereal growing regions, the shares of SNNP and Tigray were only 10 and 3 percent, respectively.

Second, most fertilizer is used in cereal production, particularly maize, wheat, and teff. According to CSA estimates, about 90 percent of fertilizers are applied to these three major cereal crops. According to the IFPRI more teff area appears to receive fertilizer than do the other cereal crops. For instance, in 2010/11 about 385 thousand hectare of land allocated to teff in Amhara region were fertilized (38.2 percent of 1.01 million ha), compared to only about 241 and 243 thousand hectares of maize and wheat, respectively. The other regions show the same patterns.

Finally, relative to the expansion in cultivated area, in most regions the proportions of land under fertilizer use has declined between 2000/01 and 2010/11. For example, in the case of maize in Oromia, almost 383,000 ha (44 percent of the total area in maize of 871,000 ha) were fertilized in 2000/01. However, in 2010/11, while the total area under maize had almost tripled to 1.11 million ha, only 22.5 percent (or about 243,000 ha) of this area received fertilizer. If Oromiya farmers had maintained the same proportion of fertilized maize area in 2010/11 as they did in 2000/01, a further 250,000 ha of maize would have been fertilized across the region. Assuming that fertilizer application on maize generates an extra metric ton of grain, Oromiya alone would have contributed an additional 250,000 tons of maize to the nation's food basket in 2010/11. The overall impact of this additional production on the national economy would have been even larger, as it would have contributed to increased economic activities through multiplier effects, e.g., value addition and employment generation in processing and marketing.

Use of chemical fertilizer in Ethiopia has grown remarkably since the official elimination of subsidies in the 1990s. This growth has occurred under various policy regimes, but it accelerated under the new set of policies adopted in 2008. Two key components of this policy reform are (1) granting monopoly control over fertilizer imports to the Agricultural

Input Supplies Corporation, the government's input marketing agency, and (2) carrying out marketing and distribution of fertilizer exclusively through farmers' organization.

The National Fertilizer Policy, introduced in 1994, calls for the gradual elimination of fertilizer subsidies and the current system of pan-territorial pricing, the expansion of the private sector's role in the fertilizer trade, and the establishment of the National Fertilizer Industry Agency (NFIA). According to the Policy, NFIA was the major instrument for the fertilizer sector.

Despite the aggressive promotion of fertilizer use by the Government a significant increase in the amount of credit allocated for the purchase of fertilizer by farmers, national fertilizer consumption has lagged well behind annual targets of the Government. For instance, of the total 406,565 tons of fertilizer (DAP and urea) made available through government and private distribution channels in 1995/96, only 241,649 tons or 59.4 percent was actually sold. Carryover stock amounted to 164,916 tons. The output foregone due to the unutilized fertilizer is estimated at 0.73 million tons of cereal (8.8% of the meher cereal output or 33.8 % of the total cereal marketed)

The government increased fertilizer imports from 440 thousand tons in 2008 to about 891 thousand in 2012. However, fertilizer availability (import plus change in stocks) far exceeded total consumption resulting in large carryover stocks reaching almost half a million tons—worth roughly US$350 million—sitting in the cooperative warehouses throughout the country in 2012.

Following liberalization, there were concerns that a withdrawal of subsidies would make fertilizer use by smallholders unprofitable. While VCRs were larger than 2.0 for all major cereal in 1992, by 1997 they had fallen below 2.0 (Demeke et al. 1998).

Yet, fertilizer use in the country is low. Only 30–40 percent of Ethiopian smallholders use fertilizer, and those who do apply on average only 37–40 kilogram per hectare (ha), significantly below recommended rates (Spielman, Alemu, and Kelemwork 2013). Therefore, the growing problem with carry-over stocks implies a mismatch between the government's targets and the effective demand of fertilizer under the current policies, infrastructure, and institutions.

Finally, fertilizer use in other cereals (for example, barley, sorghum, rice, and millet) is miniscule relative to the three major cereals and the land allocated to them. Since 2003/04, about 2.6 million ha, equivalent to 35 percent of total planted land, has been allocated to these cereals; but only about 4 percent of this land is fertilized.

Furthermore, in high-potential regions of Amhara and Oromia, the share is even smaller—of the 1.9 million ha allocated to these crops, only 102,000 ha are fertilized. Since these crops are non-tradable and account for smaller share of domestic consumption, the economics of fertilizer use in other cereals has not been favorable.

Recently, the Ministry of Agriculture and the Agricultural & Transformation Agency launched a national fertilizer blending program. The program aims to popularize new high-yield blended fertilizers and to create Ethiopia's first in-country blended fertilizer production facilities. Four blending plants planned, one in each of the four main agricultural regions. Each of the plants will be operated by a farmers' cooperative union, including Enderta in Tigray, Merkeb in Amhara, Woliso in Oromia, and Melek in SNNPR. These four plants, which will have a cumulative production capacity of nearly 250,000 ton a year, are expected to start producing fertilizers in time for the year 2014 planting season.

3. RESEARCH DESIGN AND METHODOLOGY

3.1 Research Design:

This chapter includes research design, procedures of data collection and methods of data analysis will be discussed in detail. The research design considers both descriptive and non-experimental hypothesis testing research.

3. 2 Types of Data and Instruments of Data Collection

The research is based on quantitative data. The sources of this quantitative data collected are secondary in nature. At this study three major areas of data sources were used.

First, it relies on secondary data from government entities that include the Ministry of Agriculture (MoA), the Agricultural Inputs Supply Enterprise (AISE) and Ethiopian Grain Trade enterprise, Ministry of Finance and Economic Development (MoFED), Ethiopian Economic Association (EEA), and Ethiopian Economic Policy Research Institute (EEPRI). All are focused on analyses of fertilizer and crop prices, consumption and prices of fertilizer by four main regions. Agronomic results from agricultural experiment stations are based on data from these sources.

Second, information on farm-level behavior with regard to fertilizer use and crop production came from 10 consecutive years of Annual Agricultural Sample Survey conducted by Ethiopian Central Statistical agency (CSA). In order to select the sample a stratified two-stage cluster sample design was implemented by CSA. Enumeration areas (EAs) were taken to be the primary sampling units (PSUs) and the secondary sampling units (SSUs) were agricultural households. The sample size for these agricultural sample surveys was determined by taking into account of both the required level of precision for the most important estimates within each domain and the amount of resources allocated to the survey. In order to reduce non-sampling errors, manageability of the survey in terms of quality and operational control was also considered. All regions were taken to be the domain of estimation for which major findings of the survey are reported.

The agricultural data for these years was collected from sedentary rural peasant households by interviewing the selected agricultural holders and physically measuring their fields to obtain data on crop yields and other items of interest. The data obtained were recorded in various forms designed for this purpose.

Instruments like measuring tape; compass, kitchen balance, scientific calculators, GPS (Oromiya region only) and others were used during data collection for a timely and smooth acquisition of accurate data. The procedures for measuring area under crop and area of non - crop fields operated by the holders were performed for the 30 selected households from each sampled E.A. using measuring tapes, compasses as well as GPS.

Third, information on farm-level behavior with regard to fertilizer use and crop choice come from the 2008 Ethiopia Agricultural Household and Marketing Survey (EAHMS), jointly conducted by the International Food Policy Research Institute (IFPRI) and the Ethiopia Development Research Institute (EDRI). A three-stage stratified random sample was used for this survey. In the first stage, woredas from four cereal growing regions were selected from a list of woredas ordered by the degree of cereal commercialization. In the second stage, Kebele Administrative Offices were randomly selected from each selected woreda. In the final stage of sampling, 25 households were randomly selected from a list provided by the Kebele Administrative Office of all households in the Kebele.

Finally, the information obtained from the Impact Evaluation of Fertilizer Usage study aimed at improving the efficiency and effectiveness of fertilizer procurement and distribution to smallholders in 2009/10 conducted by Development Studies Associate (DSA) in 2009/10. The study employed a mix of quantitative and qualitative methods. A stratified four-stage cluster sample design was employed in order to identify required households. Zones, woredas, kebeles and households were chosen as the 1st, 2nd, 3rd and 4th stages of sampling respectively.

Moreover, to complement data gathered from the household survey and also to prepare pseudo- benchmarks (whenever possible) quantitative data was collected from every likely secondary source. Among others, secondary was collected from MoA, regional, zonal and woreda agriculture offices, Agricultural Inputs Supply Enterprise (AISE), relevant research documents, and other selected national and international institutions.

3.3 Methods of Data Analysis

In this study, using different statistical methods used to analyze the collected data, such as value cost ratio to discus profitability of fertilizer; cost benefit analysis to examine the results of fertilizer subsidy and econometric model were used to test the significance of relationship between fertilizer price and fertilizer consumption.

3.3.1 Statistical Analysis

Findings of quantitatively description are made on the main features of a collection of information, or the quantitative description itself. This section explored the extent of fertilizer price and the amount of fertilize used in major cereals production for the period 1988-2013.

The data that is to be collected has rich socioeconomic and other data and allows to model production functions of farm households through descriptive and econometric approaches. Quantitative data analysis and submission of final outputs of the survey were employed using the most frequently used statistical software package of analyses – SPSS (version 16.0) and STATA software (version 10) where it is needed.

3.3.2 Value cost ratio

There are different ways of measuring the profitability of fertilizers. One of the most commonly used methods is the value-cost ratio (VCR). Results of this study are based mainly on the derivation of value-cost ratios (VCRs) for the use of DAP and Urea fertilizer on selected crops four cereal production regions of Ethiopia. The VCR is an indicator of profitability of fertilizer use, measuring the value of additional crop output relative to the cost of a given application of fertilizer.

The most commonly used guideline for the profitability of fertilizer use is the value-cost ratio (VCR). This ratio is defined as follows:

$$\text{VCR} = \frac{\text{Incremental crop output X Unit value of due to fertilizers crop output}}{\text{Cost of fertilizer}}$$

$$\text{VCR} = \frac{P^c X - P^c (X - \alpha)}{P^f Q^f}$$

$$= \frac{P^c \alpha}{P^f Q^f}$$

Where:

X = Total output that received fertilizer

$X - \alpha$ = output that did not receive fertilizer

P^f = Price of fertilizer

P^c = Price of crop

Q^f = amount of fertilizer applied

In the absence of risk and transaction costs of acquiring fertilizer and selling output, a producer may be expected to operate up to the point at which the VCR = 1, i.e., marginal cost of the input equals its marginal revenue.

The VCR highlights the fact that it is both expected revenue as well as input cost that determines the viability of fertilizer use. Expected revenue is not only related to the output price, but also the quantity sold. It is commonly felt that incentives to use fertilizer on grain crops may be depressed by low grain prices. However, if low grain prices occur as a result of favorable production, and farmers have more to sell than ordinarily, then the resulting revenue from crop sales may actually increase, and improve their ability to finance input purchases in the next season. In other words, low grain prices can be more than offset by increased output response due to good weather. Hence, fertilizer use may remain profitable or the VCR may not be adversely affected by low grain prices.

3.3.3 Cost Benefit Analysis

Cost-benefit analysis (CBA), sometimes called benefit–cost analysis (BCA), is a systematic approach to estimating the strengths and weaknesses of alternatives that satisfy transactions, activities or functional requirements for a business. It is a technique that is used to determine options that provide the best approach for the adoption and practice in terms of benefits in labour, time and cost savings etc. (David, Ngulube and Dube, 2013). The CBA is also defined as a systematic process for calculating and comparing benefits and costs of a project, decision or government policy.

Clearly, policy objective is to increase the adoption of fertilizer and thereby increase crop production. One can estimate the increase in fertilizer use that will result from a reduction in price if the price elasticity of demand is known.

The elasticity of demand is given by

$$\frac{\%\Delta Q_d}{\%\Delta Q_p}$$

Where

ε is the price elasticity of demand

$\%\Delta Q_d$ is Percentage change in the fertilizer quantity demanded

$\%\Delta Q_p$ is percentage change in the fertilizer price

3.3.4 Econometric approach and model specification

This section shows how fertilizer affects agricultural production with a single factor production function. The model specification, method of estimation is Karl Pearson's coefficient of correlation (or simple correlation):

This approach is the most widely used method of measuring the degree of relationship between two variables. It can be worked out as:

$$r = \frac{\sum (X_i - \bar{X})(Y_i - \bar{Y})}{(n-1).S_X.S_Y}$$

Where:

R = Correlation coefficient

Y_i = Dependent variable

X_i = Independent variable

s_x = Standard deviation of independent variable average total fertilizer price

s_y = Standard deviation of dependent variable f total fertilizer consumption

n = Number of observation

Correlation coefficients reveal the magnitude and direction of relationships. Pearson's correlation coefficient varies over a range of +1 through 0 to -1. The sign signifies the direction of relationship.

3.3.5 Regression analysis

The statistical tool with the help of which we are in a position to estimate (or predict) the unknown values of one variable from known values of another variable is called regression. Regression model shows the extent of dependent variable influenced by independent variable.

$Y_i = a + b_1x_1 + b_2x_2 + \ldots + b_ix_i + e_i$

Where:

- y = Dependent variable
- x_i = Independent variables
- a = y intercept
- b = the slope of the line
- e_i = error term

Variables in the study:

Dependant variables:

- Total fertilizer consumption,

Independent variable:

- Average total fertilizer price

To see the association of explanatory variables with response variable, Pearson correlation analysis for continuous variables is used.

4. RESULTS & DISCUSSION

This chapter describes the results and findings of analysis and discussion of findings for value cost ratio, cost benefit analysis and econometric analysis of the study.

4.1 Fertilizer use

Only two types of chemical fertilizer, Diammonium Phosphate (DAP) and Urea are used in Ethiopia. Both have shown steady growth in use by farmers over time. There are three distinct patterns of use of fertilizer in Ethiopia. First, the intensity and prevalence of farmers' use of fertilizer varies across regions. Between 2004 and 2013, Oromyia and Amhara accounted for 89 percent of total fertilizer consumption, with Oromyia alone accounting for about 49 percent. Of the other two major cereal growing regions, the shares of SNNP and Tigray were only 6 percent each. This calculation shows that for the past 10 years 95 percent of the DAP and Urea was consumed by this four regions (Table 1).

Table1: Regional Percentage Distribution of Fertilizer Use in Ethiopia, (2004 – 20013)

Regions	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Weighted Average
Tigray	7.6	5.3	4.3	5.6	4.9	4.2	5.4	5.5	11.1	8.8	6.3
Amhara	31.5	36.8	38.1	44.0	48.2	43.6	47.7	44.9	22.9	42.0	40.0
Oromiya	51.8	51.9	52.3	56.0	48.7	44.2	37.9	39.6	63.0	41.6	48.7
SNNP	5.8	5.0	3.9	4.1	8.3	7.6	8.4	9.4	3.0	7.0	6.3
Total fertilizer (000 mt)	291.4	321.6	339.5	351.9	376.7	368.6	515.5	521.5	601.0	969.3	

Source: Ministry of Agriculture several years report

Most of the fertilizer is used in cereal production, particularly maize, wheat, and teff. According to CSA estimates, about 90 percent of fertilizers are applied to these three major cereal crops. In absolute term, more teff area appears to receive fertilizer than do the other cereal crops. For example, in 2013 about 500,889 hectare of land allocated to teff in Oromiya region were fertilized (40 percent of 1,256,565 hectare), compared to only about

270,404 and 326,852 hectares of wheat and, maize respectively. The other regions show the same patterns (Table 2).

Table 2: Total Area Cropped and Fertilized by Region (2010 – 2013)

Region	Year	2010			2013		
	Area	Total Area in Hectare		% of Cropped Area Fertilized	Total Area in Hectare		% of Cropped Area Fertilized
	Crop	Cropped	Fertilized		Cropped	Fertilized	
Ethiopia	**All Grains**	11,503,249	1,593,079	13.8	12,282,930	3,098,991	25.2
	Cereals	9,233,025	1,401,114	15.2	9,601,035	2,844,818	29.6
	Teff	2,588,661	597,851	23.1	2,730,273	1,151,018	42.2
	Wheat	1,683,565	420,411	25.0	1,627,647	646,366	39.7
	Maize	1,772,253	242,639	13.7	1,627,647	669,087	41.1
Tigray	**All Grains**	856,330	162,789	19.0	877,506	334,168	38.1
	Cereals	693,967	160,813	23.2	730,756	310,117	42.4
	Teff	187,859	65,590	34.9	161,798	87,660	54.2
	Wheat	113,596	42,759	37.6	111,846	71,071	63.5
	Maize	64,649	10,222	15.8	69,026	21,633	31.3
Amhara	**All Grains**	3,997,750	742,416	18.6	4,366,386	1,230,706	28.2
	Cereals	2,986,622	712,488	23.9	3,254,156	1,139,359	35.0
	Teff	1,001,028	313,070	31.3	3,254,156	514,555	15.8
	Wheat	548,315	206,766	37.7	498,192	259,113	52.0
	Maize	355,508	151,673	42.7	434,642	243,781	56.1
Oromiya	**All Grains**	5,348,593	545,900	10.2	5,598,772	1,317,655	23.5
	Cereals	4,466,528	402,958	9.0	4,486,163	1,211,194	27.0
	Teff	1,182,811	191,970	16.2	1,256,565	500,889	39.9
	Wheat	857,603	121,952	14.2	872,972	270,404	31.0
	Maize	1,000,056	40,385	4.0	1,115,957	326,852	29.3
SNNP	**All Grains**	1,006,725	135,715	13.5	1,092,584	201,155	18.4

Region	Year	2010			2013		
	Area	Total Area in Hectare		% of Cropped Area Fertilized	Total Area in Hectare		% of Cropped Area Fertilized
	Crop	Cropped	Fertilized		Cropped	Fertilized	
	Cereals	837,850	120,181	14.3	866,341	172,329	19.9
	Teff	196,702	27,102	13.8	202,376	47,680	23.6
	Wheat	155,661	48,728	31.3	138,351	45,664	33.0
	Maize	278,928	37,335	13.4	305,205	67,770	22.2

Source: CSA Crop production Agricultural Survey

4.2 Crop productivity

Increasing crop productivity is the only realistic option of improving food availability in Ethiopia. At present, cereal yields are among the lowest in the world. The average yield of teff, barley, wheat, maize and sorghum is 8, 11, 12, 16, and 14 quintals per hectare, respectively.

Yield stagnancy seems to have characterized crop production in Ethiopia, especially with smallholder farmers which account for over 90% of its grain production. There is strong disputation that it is possible to break the stagnancy and the start is already in view. CSA sources indicate that crop yields have progressively been on the rise over the last several years, even though the change seems considerably below the potential (Table 3).

Table 3: Yields of selected cereal crops in 2003/04-2012/13

Crop	(100kg/ha)									
	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13
Teff	8.43	9.48	9.69	10.14	9.69	12.20	12.28	12.62	12.81	13.79
Wheat	14.69	15.57	15.20	16.71	15.20	17.46	18.27	18.39	20.29	21.10
Maize	18.60	17.19	21.87	22.29	21.87	22.24	21.99	25.40	29.54	30.59

Source: CSA Crop production Agricultural Survey (2004/05 – 2012/13)

It was one of the specific objectives of the Growth and Transformation Plan to keep the increasing yield momentum in 2014/15 crop year. Comparing 2012/13 from GTP base year 2009/10, generally crop yields kept on showing increasing trend in 2012/13. Accordingly, Teff yield increases significantly by more than 12.3% and wheat by 15.5% over that of 2009/10. Maize yield increased considerably by more than 39.1%.

4.3 Profitability of Fertilizer Use

Experimental plot-level data in Ethiopia suggest that fertilizer is profitable. Following liberalization, there were concerns that a withdrawal of subsidies would make fertilizer use by smallholders unprofitable. While Value Cost Ratios (VCRs) were larger than 2.0 for all major cereal in 1992, on the contrary, by 1997 they had fallen below 2.0 (Demeke et al. 1998). Spielman et al. (2011), provides a summary of VCR estimates with Incremental yield due to fertilizers application changing fertilizer and output prices across several years, but using the same set of agronomic results. According to these estimates, VCRs for maize generally were above 2.0 in 2008, while for teff they were about 2.0.

4.3.1 Incremental yields

The analysis focused on teff, wheat and maize in the four study regions. These crops were chosen because of their dominant share of farmers' fertilizer budget in 2012/13. Based on DSA, 2010 survey results, incremental yields indicated in table 4 below have been used to compute VCR.

Incremental yield as a result of using 100 kg of DAP/ha (under farmers' management) obtained from IES on Fertilizer Usage; DSA, March 2010. The figures were obtained through a group discussion which asked each group to estimate the incremental yield from the use of 100 kg of DAP, drawn from Tigray, Amhara, Oromiya and SNNPR Region.

Table 4: Incremental yield due to fertilizers application (100 kg/ha)

Region	Teff	Wheat	Maize
1 Tigray	2.2	8.2	4.1
2.Amhara	3.4	5.8	12.1
3 Oromia	3.9	12.4	10.2
4. SNNP	3.1	7.3	6.4

Sources: DSA, March 2010

4.3.2 Value Cost Ratio

Spielman, Alemu, and Kelemwork (2011) have re-estimated the VCRs for teff and maize for 2004 and 2008, and according to their estimates VCRs are 2.12 and 1.91 for maize and teff, respectively. In 2010, the World Bank commissioned a larger study to assess the fertilizer profitability in the country. This study reported that VCR of fertilizer in Ethiopia is at least 1.7 for all cereals in all four cereal-growing regions. However, the variation across crops and regions is high; estimates range from 1.7 to 4.2 for teff, 2.0 to 6.5 for wheat, and 1.7 to 5.3 for maize (Annex 5).

Table 5: VCR in 2012/13 crop year for major cereals in four major regions

Crop by Region	Incremental Yield (100kg/ ha)	Produce Price (Birr/100kg)	Value of incremental yield (Birr/100kg)	Fertilizer (100kg/ ha)	Fertilizer Price (Birr/100kg	DAP Cost Total (Birr/Ha)	VCR
1. Teff							
1.1 Tigray	2.2	1192.00	2622.40	1.9	1,549.42	2,943.90	0.89
1.2 Amhara	3.4	1169.67	3976.87	1.7	1,300.90	2,211.53	1.80
1.3 Oromia	3.9	1094.67	4269.20	1.2	1,322.32	1,586.78	2.69
1.4 SNNP	3.1	1087.33	3370.73	1.1	1,634.79	1,798.27	1.87
2. Wheat							

Crop by Region	Incremental Yield (100kg/ha)	Produce Price (Birr/100kg)	Value of incremental yield (Birr/100kg)	Fertilizer (100kg/ha)	Fertilizer Price (Birr/100kg	DAP Cost Total (Birr/Ha)	VCR
2.1 Tigray	8.2	779.00	6387.80	1.8	1,549.42	2,788.96	2.29
2.2 Amhara	5.8	763.00	4425.40	1.6	1,300.90	2,081.44	2.13
2.3 Oromia	12.4	661.67	8204.67	1.1	1,322.32	1,454.55	5.64
2.4 SNNP	7.3	628.67	4589.27	1.4	1,634.79	2,288.71	2.01
3. Maize							
4.1 Tigray	4.1	541.00	2218.10	1.8	1,549.42	2,788.96	0.80
4.2 Amhara	12.1	519.00	6279.90	2.4	1,300.90	3,122.16	2.01
4.3 Oromia	10.2	412.00	4202.40	1	1,322.32	1,322.32	3.18
4.4 SNNP	6.4	395.00	2528.00	0.6	1,634.79	980.87	2.58

Source: Authors' own calculation based on DSA (2010).

In table 5 above the cost values are that of DAP, weighted average of DAP and Urea was not reliable due to weight to actual of each of the farmers who used fertilizer and not used fertilizer for their respective crops. Using DAP cost might lower a bit the VCR.

In 2012/13 the VCRs are less than 2 in Tigray, Amhara and SNNPR for teff. The VCR for Teff and Maize in Tigray is considerably below 2. The calculation implies that teff and maize cultivation in Tigray will not be profitable unless fertilizer application increased more than current practice. Fertilizer is absolutely essential to produce subsistence crops; hence profitability may not be of serious concern for smallholder farmer. As it is shown at the VCR table the opportunity cost of grain is very high for Tigray farmers, because they may be net buyers of grain.

As Shahidur Rashid and et al, 2012; described since most of the above VCRs are calculated based on data from experimental plots, they do not account for household-specific behavioral, institutional, and agro climatic conditions. As a result, these estimates are generally considered to represent the higher bounds. While they have their own difficulties, estimates from well-designed household surveys can better represent the realities of the farming households.

However, because of risk and transaction costs a VCR greater than 1 is needed to induce farmers to buy fertilizers. In situations where production risks are considerable and market failures are prevalent, farmers may not adopt fertilizer unless the VCR is sufficiently high. The use of fertilizer may also result extra labor costs in the form of additional weeding, harvesting, threshing, interest, etc., and in nonmonetary transaction costs associated with procuring credit and/or fertilizer. Because of these additional costs, a VCR greater than 2 is often regarded as the critical threshold to make fertilizer profitable and convince farmers to use fertilizer (Heisey and Mwangi, 1996).

4.4 Policy scenarios to enhance profitability and affordability

In the table 6 below, the researcher begin by calculating the VCR at current market prices of crop and fertilizer for 2013, but keep the fertilizer dose at incremental yield same as DSA (2010). These estimates are presented in the second column of the table and we consider them as the base VCR. Then the price of fertilizer is change by 10%, 15%, and 20% to re-calculate the VCRs for each region by crops.

Table 6: Fertilizer profitability under various policy options, for the year 2013

Crop by Region	Base VCR	Alternative VCRs through subsidized fertilizer price								
		10%			15%			20%		
		Fertilizer Price (Birr/100 kg	DAP Cost Total (Birr/Ha)	VCR	Fertilizer Price (Birr/100 kg	DAP Cost Total (Birr/Ha)	VCR	Fertilizer Price (Birr/100 kg	DAP Cost Total (Birr/Ha)	VCR
Teff										
Tigray	0.89	1,394.48	2,649.51	0.99	1,317.01	2,502.31	1.05	1,239.54	2,355.12	1.11
Amhara	1.80	1,170.81	1,990.38	2.00	1,105.77	1,879.80	2.12	1,040.72	1,769.22	2.25
Oromia	2.69	1,190.09	1,428.11	2.99	1,123.97	1,348.77	3.17	1,057.86	1,269.43	3.36

Crop by Region	Base VCR	Alternative VCRs through subsidized fertilizer price								
		10%			15%			20%		
		Fertilizer Price (Birr/100 kg	DAP Cost Total (Birr/Ha)	VCR	Fertilizer Price (Birr/100 kg	DAP Cost Total (Birr/Ha)	VCR	Fertilizer Price (Birr/100 kg	DAP Cost Total (Birr/Ha)	VCR
SNNP	1.87	1,471.31	1,618.44	2.08	1,389.57	1,528.53	2.21	1,307.83	1,438.62	2.34
Wheat										
Tigray	2.29	1,394.48	2,510.06	2.54	1,317.01	2,370.61	2.69	1,239.54	2,231.16	2.86
Amhara	2.13	1,170.81	1,873.30	2.36	1,105.77	1,769.22	2.50	1,040.72	1,665.15	2.66
Oromia	5.64	1,190.09	1,309.10	6.27	1,123.97	1,236.37	6.64	1,057.86	1,163.64	7.05
SNNP	2.01	1,471.31	2,059.84	2.23	1,389.57	1,945.40	2.36	1,307.83	1,830.96	2.51
Maize										
Tigray	0.80	1,394.48	2,510.06	0.88	1,317.01	2,370.61	0.94	1,239.54	2,231.16	0.99
Amhara	2.01	1,170.81	2,809.94	2.23	1,105.77	2,653.84	2.37	1,040.72	2,497.73	2.51
Oromia	3.18	1,190.09	1,190.09	3.53	1,123.97	1,123.97	3.74	1,057.86	1,057.86	3.97
SNNP	2.58	1,471.31	882.79	2.86	1,389.57	833.74	3.03	1,307.83	784.70	3.22

Source: Authors' own calculation based on DSA (2010).

Note: Base VCR is taken from table 5 - VCR in 2012/13

Alternative VCRs through subsidized fertilizer price indicates that at the 2013 market prices, fertilizer is profitable in all four cereal growing regions for wheat; and all but Tigray for teff and maize. In particular, a 10-15% decrease in fertilizer can increase the VCRs to 2 in all regions, except maize and teff in Tigray.

From a policy standpoint, central questions are: (i) how would farmers respond to lower price of fertilizer? And (ii) how much would it cost to the government to supply fertilizer at subsidized prices? Clearly, policy objective is to increase the adoption of fertilizer and thereby increase crop production.

Tefera and Rashid (2012), using data from the IFPRI-EDRI 2008 household survey, have estimated the price elasticity of demand for fertilizer for all major cereals in Ethiopia. Except for barley, fertilizer use in the main cereals is price responsive in a statistically significant way. The estimates of the elasticities of fertilizer demand are -0.64 for teff, -0.30 for wheat; and -0.48 for maize.

Using these estimates, we can assess how lower prices would contribute towards increasing fertilizer consumption. Suppose policy makers want to know to what extent teff farmers in Ethiopia will increase their fertilizer use if fertilizer is sold at a 15% subsidized price.

Clearly, given the elasticity estimates, lowering fertilizer prices will lead to increase in fertilizer use and hence total production. At this stage, critical policy questions are (a) what would be costs of providing subsidy? (b) What benefit will a 15% price subsidy generate? We first provide some estimates of costs at current market prices for crops and fertilizers indicated as in table 6.

Here is how these numbers are calculated. From CSA data, we know the share of fertilizer use by crops (Appendix 3). Using the consumed fertilizer by the small holder farmers' 729,244 tons in 2012/13 and the elasticity estimates, we can calculate the total fertilizer use by crops and additional demand due to subsidy, respectively. Finally, using the weighted retail price of fertilizer, we calculated total subsidy bills for providing a 15 % subsidy on fertilizer.

Table 7: Costs providing a 15% subsidy on fertilizer for 2013*

Crop type	Crops' share in fertilizer use	Fertilizer use before subsidy	Increase in demand due to subsidy (MT)	Total qty after subsidy	Average Retail price	Total subsidy bills (ETB)
Teff	0.34	328,026.06	31,491	359,516.56	16,380.28	515,823,083.01
Wheat	0.25	244,445.78	11,000	255,445.84	16,380.28	180,184,010.96
Maize	0.30	292,733.18	21,077	313,809.97	16,380.28	345,243,604.14

Crop type	Crops' share in fertilizer use	Fertilizer use before subsidy	Increase in demand due to subsidy (MT)	Total qty after subsidy	Average Retail price	Total subsidy bills (ETB)
Other cereal crops	0.11	104,101.20	31	104,132.43	16,380.28	511,561.89
Total	1.00	969,306.23	63,599	1,032,904.81		1,041,762,260.00

Source: Authors' calculations based on MoA and CSA data and authors' estimates of elasticity based on Tefera and Rashid (2012).

From the table 7 we can understand the following information.

- Subsidizing fertilizer is expensive. Assuming a total fertilizer consumption of 969,306 tons, Just a 15 percent price subsidy will cost government an estimated ETB 1,041,762,260 in subsidies.
- Due to the responsiveness to price, fertilizer use will increase by about 63,599 tons. This implies that, if the productivity enhancement is the consideration, fertilizer consumption will have to increase significantly, which will require very large subsidies.
- On the other hand, if affordability is the consideration, subsidy should be given only to the smallholder farmers who could not afford at market prices. In such cases, subsidy bills will be smaller but it is unlikely to lead to substantial increase in production.

For the completeness of the exercise, now analyses of benefits have been conducted that such a subsidy program can generate through increased production. For this analysis, we use the yield response coefficients, elasticity estimates, and the CSA crop production statistics for 2012/13. For illustration, consider the case of teff for which estimated yield response coefficient is 0.15; price elasticity of demand for fertilizer is -0.64; and teff total production in 20012/13 was 3,765,241tons. The price elasticity estimates suggest that a 15 percent price subsidy will lead to an increase in fertilizer demand by 9.6 percent (-0.64x-15) for teff. Next we ask to what extent 9.6 percent increase in fertilizer use will increase production. From yield response analysis, we know that the coefficient is 0.15—that is, a 10 percent increase in fertilizer will lead to a 1.5 percent increase in teff production.

So a 9.6 percent increase in fertilizer should lead to about 1.44 percent increase in teff production (1.5x9.6/10 = 0.144). Given that the total production was 3,765,241 tons, increase in teff production due to increased fertilizer is 54,422 tons, which at the existing market price (11,059.2 per ton) is worth Birr 599,622,186.2 (Table 8).

Table 8: Benefit-Cost of 15% subsidy on fertilizer for the year 2013***

Crop type	Fertilizer yield response coeff. *	Cereal Production in 2012/13 (Mt)	Additional output due to increase in fertilizer (Mt)	Price of production /ton	Value of extra production (ETB)	Benefit-Cost Ratio
Teff	0.15	3,765,241	54,219.47	11,059.2	599,622,186.2	1.16
Wheat	0.22	3,434,706	34,003.59	6,380.8	216,971,244.4	1.20
Maize	0.28	6,158,318	124,151.68	4,267.5	529,817,306.0	1.53
Other cereal crops	0.11	6,292,887	20.77	14,970	310,874.9	0.61
Total		19,651,151.55			1,346,721,611.5	1.29

Source: Authors' calculations.
* Data obtained from Fertilizer in Ethiopia, IFPRI, 2012
** Benefit-cost ratio is derived by dividing the value of increased production by the subsidy bills from Table 7.

Carrying out similar analysis for all other crops suggest that a 15% reduction in fertilizer will lead to a total benefit of ETB 1,346,721,611.5, which is about 29 percent higher than the costs of subsidy, ETB 1,041,762,260.00 shown in Table 7. Based on this calculation, which do not account for logistic challenges and some economic aspects, providing a 15% subsidy appears to be cost-effective policy option.

However, several factors need to be considered in interpreting the results in Table 8. First, note that benefit-cost ratio can change due to any of the four factors—yield response, price elasticity, prices of fertilizer, and price of output—which will increase (decrease) the cost-effectiveness of a given commodity. It is not surprising that the benefit cost ratio is lower than 1 in case of other crops, which in general use very little fertilizer and has a very low yield response and price elasticity of demand for fertilizer.

4.5 Econometric Approach and Model Specification

The method of ordinary least squares is attributed to Carl Friedrich Gauss, a German mathematician. Under certain assumptions the method of least squares has some very attractive statistical properties that have made it one of the most powerful and popular methods of regression analysis. The method of OLS our objective is not only to obtain $\hat{\beta}1$ and $\hat{\beta}2$ but also to draw inferences about the true β_1 and β_2.

4.5.1 Evaluation for normality

The normality assumption states that Zero mean value of disturbance e_i. Given the value of X, the mean, or expected, value of the random disturbance term e_i is zero.

Table: 9 SPSS output to evaluate normality

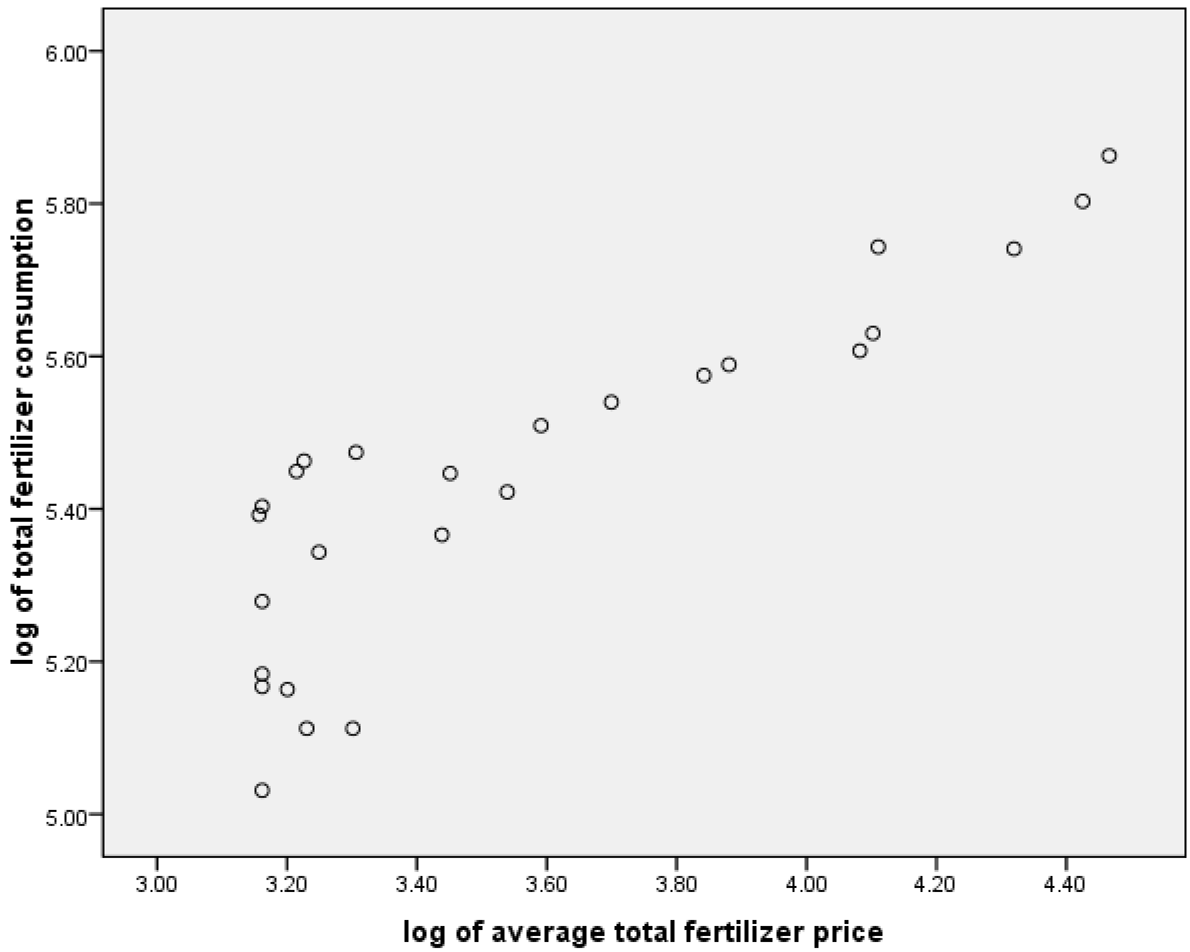
Source	N	Minimum	Maximum	Mean		Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error	Statistic	Std. Error
log of average total fertilizer price	26	3.16	4.47	3.5631	0.0868	0.44259	0.850	0.456	-0.691	0.887
log of total fertilizer consumption	26	5.03	5.86	5.4388	0.04398	0.22427	-0.003	0.456	-0.651	0.887

4.5.2 Evaluating for existence of homoscedasticity

Scatter plot

The simple linear regression assumes that the relationship between the independent variable average total fertilizer price and the dependent variable total fertilize consumption is linear. The assumption is usually evaluated by visual inspection of the scatter plot. Violation of the linearity assumption may result in an understatement of the strength of the relationship between the variables.

Figure 2: Scatter plot



The simple linear regression assumes that the range of the variance for the dependent variable is uniform for all values of the independent variable. For an interval level independent variable, the assumption is evaluated by visual inspection of the scatter plot of the two variables. With such a small data file it is hard to assess the homogeneity assumption with a scatter plot. Violation of the homogeneity assumption may result in an understatement of the strength of the relationship between the variables.

If the plot of residuals shows some uneven envelope of residuals, so that the width of the envelope is considerably larger for some values of independent variables than for others, a more formal test for heteroscedasticity should be conducted.

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity: The Breusch-Pagan test is designed to detect any linear form of heteroscedasticity. You run a regression, and then give the estat hettest command (or, hettest alone will work).

Ho: There is constant variance

Ha: There is no constant variance

Variables: fitted values of total fertilizer consumption

chi2 (1) = 6.13

P-value = 0.0733

Breusch-Pagan / Cook-Weisberg test the null hypothesis that the error variances are all equal versus the alternative that the error variances are a multiplicative function of one or more variables. We accept the null hypothesis that there is constant variance, indicating heteroskedasticity is not a problem.

4.5.3 Evaluation for serial correlation

To carry out time series data analysis the problem of temporal autocorrelation of residuals which often occurs in the analysis of time series data and represents single most common violation of the independent residual assumption in regression modeling should be addressed. The Durbin Watson test statistics is proposed as a diagnostic tool for identifying the presence of autocorrelation and a two-stage regression procedure is proposed as a possible method for removing this effect.

To examine for serial correlation, using the Durbin-Watson Statistic test:

Ho: There is no serial correlation in data set ($\rho = 0$)

Ha: There is serial correlation n in data set ($\rho \neq 0$)

Results of the Durbin-Watson Statistic test using STATA software:

Durbin-Watson d-statistic (2, 26) = 0.6102641

The STATA output indicated that DW < 2, the null hypothesis rejected, which means there is positive serial correlation.

4.5.4 Correcting the regression for the serial correlation

Applying the natural logarithm of values of total fertilizer consumption and average total fertilizer price as a dependent variable correction is made for autocorrelation using STATA. Running is made using analysis with the Prais-Winston command, specifying the Cochran-Orcutt option procedure. The Cochrane-Orcutt procedure involves a series of iterations, each of which producers a better estimate of ρ than does the previous one. The estimated ρ is used the generalized differencing transformation process. To examine for serial correlation, using the Durbin-Watson Statistic test:

Ho: There is no serial correlation in data set ($\rho = 0$)

Ha: There is serial correlation n in data set ($\rho \neq 0$)

Table 10: Prais-Winsten AR (1) regression -- iterated estimates

```
Prais-Winsten AR(1) regression -- iterated estimates

      Source |       SS       df       MS              Number of obs =      26
-------------+------------------------------           F(  1,    24) =  566.09
       Model |  3.78849134     1  3.78849134           Prob > F      =  0.0000
    Residual |  .160618183    24  .006692424           R-squared     =  0.9593
-------------+------------------------------           Adj R-squared =  0.9576
       Total |  3.94910953    25  .157964381           Root MSE      =  .08181

------------------------------------------------------------------------------
ltotalfert~m |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ltotalfert~e |   .4128575   .0856686     4.82   0.000     .2360463    .5896687
       _cons |   3.958914   .3114433    12.71   0.000     3.316127    4.601702
-------------+----------------------------------------------------------------
         rho |   .6563948
------------------------------------------------------------------------------
Durbin-Watson statistic (original)    0.610264
Durbin-Watson statistic (transformed) 1.787223
```

The null hypothesis for no serial correlation is accepted. Before transformation takes place $\rho = 0.656$, which shows us that there was positive serial correlation. After transformation using correction for serial correlation $\rho = 1.787$. The transformed result that is substantially different from the original results is in acceptance region.

4.5.5 Evaluation for the existence of a relationship

To determine whether or not there is a relationship between the independent variable and the dependent variable by examining the significance of the regression in the ANOVA table.

Using 2-tailed hypothesis at alpha of 0.05 our hypotheses is stated as:

H_0: $r = 0$. There is no relationship between fertilizer consumption and retail price of fertilize.

H_1: $r \neq 0$. There is a relationship between fertilizer consumption and retail price of fertilize.

Table 11 a: Existence of relationship

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	0.960	1	0.960	77.371	0.000**
	Residual	0.298	24	0.012		
	Total	1.257	25			

a. Predictors: (Constant), log of average total fertilizer price

b. Dependent Variable: log of total fertilizer consumption

When doing regression analysis we determine whether or not there is a relationship between the independent variable and the dependent variable by examining the significance of the regression in the ANOVA table. The probability of the F statistic for the regression analysis is 0.000, less than the level of significance of 0.05. We reject the null hypothesis that there is no relationship between the independent and the dependent variable. Therefore there is a significant relationship between fertilizer consumption and retail price of fertilize.

Table 11 b: Strength of relationship

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	0.874[a]	0.763	0.753	0.11137	0.763	77.371	1	24	0.000**

a. Predictors: (Constant), log of average total fertilizer price

The strength of the relationship is based on the r- statistic, which in a simple two variable regression is the same as the correlation coefficient. In this case, the R statistic is 0.874, indicating a very strong relationship. This indicates that there is strong relationship between between fertilizer consumption and retail price of fertilize.

The r^2-is the proportion of variability in amount of total fertilizer consumption accounted for by total amount of average total fertilizer price expended. That is, the variability in total fertilizer accounted for by total fertilizer price reported as a proportion of the total variability of total fertilizer consumed.

In this study, $r^2 = 0.763$. This means that 76.3% of the variability in the fertilizer consumption can be accounted for by price of fertilizer. This coefficient r^2 is often referred to as the coefficient of determination. This means that $1 - r^2$ is the proportion of variability in fertilizer consumption that is not accounted for by price of fertilizer using for fertilizer usage. In this case 1 – 0.763 = 0.237. Therefore, 23.70% of variability in total fertilizer consumption is not accounted by price of fertilizer.

Table 11 c: Direction of relationship

Model		Un-standardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.861	0.181		21.375	0.000**
	log of average total fertilizer price	0.443	0.050	0.874	8.796	0.000**
a. Dependent Variable: log of total fertilizer consumption						

The direction of the relationship is based on the sign of the β coefficient for the independent variable. Since 0.443 is positive, there is a direct relationship between average total fertilizer price and total fertilizer consumption.

The intercept is referred to as the Constant in SPSS. It is the point on the vertical Y axis where the regression line crosses the axis. Or, we could say it is the predicted value for $\hat{Y}$ when X is 0. The β coefficient of the independent variable is the slope. It represents the amount of change in the dependent variable for a one-unit change in the independent variable. This result suggested that if total average total fertilizer price goes up by 1 percent, on average, the consumption of total fertilizer goes up by about 0.443 percent.

4.5.6 Ordinary List Squares Estimates (OLS)

$$Yi = \beta_1 + \beta_2 Xi + ei$$

Therefore, what is needed is some measure of reliability or precision of the estimator's $\hat{\beta}_1$ and $\hat{\beta}_2$. In statistics the precision of an estimate is measured by its standard error.

On the basis of the given data, we obtained the following the estimated regression line:

$$\hat{Y}i = 3.861 + 0.443Xi$$

Let the test of hypothesis that the total average fertilizer price has no influence on the consumption of fertilize using point estimate approach.

H0: $\beta_2 = 0$

Ha: $\beta_2 = 0$

From the t-table for 24 d.f. and for two tailed test, if there is no relationship between the variables, the slope would be zero. The hypothesis test of the slope tests the null hypothesis that the β coefficient or slope is zero. The significance of this test matches that of the overall test of relationship between total fertilizer consumption and total average fertilizer price.

As expected, there is a positive relationship between total fertilizer consumption and total average fertilize price. If total fertilizer price went up by a one percent, on average, total fertilizer consumption increased by about 0.443 percent. If total average price fertilizer were zero, the average fertilizer consumption would be about 3.861 tones. The r^2 value of about 0.763 means that 76.30 percent of the variations in total fertilize consumption is explained by average total fertilizer price.

The result of study indicates that when average total fertilizer price went up total fertilizer consumption increased. This is inconsistent that the relation of price and consumption. This because for some small farmers there may be no alternative to using fertilizer in these densely populated and intensively cultivated areas where traditional soil fertility restoring techniques such as fallowing cannot be practiced. The opportunity cost of fertilizer may thus be very high. As pointed out by DSA 2010, it is possible that many households may go hungry without fertilizer.

From a policy standpoint, knowledge about price responsiveness is central to designing appropriate policies. If the affordability of fertilizer is an issue, government can address this by providing a subsidy on fertilizer prices. However, the effectiveness of such a subsidy will depend on the responsiveness of smallholder farmers in terms of increased fertilizer application to the reduction in fertilizer prices. Using an econometric model, this study has estimated price elasticity of demand for selected crops.

5. CONCLUSSION AND RECOMMENDATIONS

5.1 Conclusion

Fertilizer profitability critically depends on the ratio of fertilizer prices to output prices. Instability in prices creates uncertainty that can adversely affect the decisions of farm households to apply fertilizer to their crops. In Ethiopia, fertilizers are used mainly for the three major cereals – maize, wheat, and teff – and prices of these cereals have been highly volatile in recent years.

This study has presented a range of measures of profitability, and major points to fertilizer indeed being profitable. In 2012/13 the VCRs are less than 2 in Tigray, Amhara and SNNPR for teff. The VCR for Teff and Maize in Tigray is considerably below 2. The calculation implies that teff and maize cultivation in Tigray will not be profitable unless fertilizer application increased more than current practice. Fertilizer is absolutely essential to produce subsistence crops; hence profitability may not be of serious concern for smallholder farmer. As it is shown at the VCR table the opportunity cost of grain is very high for Tigray farmers, because they may be net buyers of grain.

As a follow up to the VCR analysis, an assessment has been conducted for overall benefit-cost analysis of lowering fertilizer prices by 15%. The results suggest that such a scheme will result in subsidy bill of Birr 1,042 million. However, the benefits through increased production will be 1,347 million. In other words, a 15% reduction in fertilizer will give a benefit cost ratio of 1.29 suggesting overall social gains from the scheme.

Fertilizer subsidies for smallholder farmers need to be contemplated with caution, with a clear consideration of the costs and benefits compared with conventional best practice of addressing market failures directly and using social policies to address social objectives with respect to poverty and food insecurity.

The rationale for using a fertilizer subsidy for smallholder farmers needs to be kept clear. Despite the attraction, there is a fundamental difficulty in using a single instrument to address multiple market failure (i.e. long-term development) and social objectives. With respect to market failures, there needs to be an exit strategy. With respect to social objectives, on the other hand, there has to be a standing commitment to provide support until such a time as other social safety nets are put in place.

In order to achieve these benefits, there will be a need for complementary spending on public goods. For agriculture, these usually consist of rural roads, agricultural research and extension, education, primary health care, and clean water.

The effect of fertilizer price on fertilizer consumption improvement is supported by simple correlation and regression techniques. The findings show that fertilizer use has a significant positive effect on the value of production. The law of demand states that, when the price of a good rises, and everything else remains the same, the quantity of the good demand will fall. Generally the relationship between price and quantity is negative. This is inconsistent that the relation of price and consumption. This because for some small farmers there may be no alternative to using fertilizer in these densely populated and intensively cultivated areas where traditional soil fertility restoring techniques such as fallowing cannot be practiced.

In this study, the effect of fertilizer on productivity improvement is supported by simple correlation and regression techniques. the significance of the regression was examined, accordingly we found that there is a significant relationship between fertilizer consumption and retail price of fertilize. The strength of the relationship is based on the r- statistic, which in a simple two variable regression is the same as the correlation coefficient. In this case, the R statistic is 0.874, indicating a very strong relationship. This indicates that there is strong relationship between fertilizer consumption and retail price of fertilize.

Furthermore, the study showed that $r^2 = 0.763$. This means that 76.3% of the variability in the fertilizer consumption can be accounted for by price of fertilizer. This coefficient r^2 is often referred to as the coefficient of determination. This means that $1 - r^2$ is the proportion of variability in fertilizer consumption that is not accounted for by price of fertilizer using for fertilizer usage. In this case $1 – 0.763 = 0.237$. Therefore, 23.70% of variability in total fertilizer consumption is not accounted by price of fertilizer.

Finally, the β coefficient of the independent variable is the slope. It represents the amount of change in the dependent variable for a one-unit change in the independent variable. This result suggested that if total average total fertilizer price goes up by 1 percent, on average, the consumption of total fertilizer goes up by about 0.443 percent.

5.2 Recommendations

The recommendations outlined below, are only the highlights of some of the policy implications that clearly comes out of the analysis.

Given under developed and poor management of rural micro finance institutions for credit and insurance, supplying fertilizer to the smallholders at lower prices can be a justifiable intervention. Our analysis suggest, *ceteris paribus*, such an intervention is cost-effective, with a benefit cost ratio of 1.29, when fertilizer is supplied at a price that is at least 15% lower than existing market prices.

On the other hand, if affordability is the consideration, subsidy of fertilizer should be given only to the farmers who could not afford at market prices. In such cases, subsidy bills will be smaller but it is unlikely to lead to substantial increase in production. Therefore, targeted subsidy requires more complicated program design and implementation.

Clearly, given the elasticity estimates, lowering fertilizer prices will lead to increase in fertilizer use and hence total production. Therefore, government intervention on fertilizer subsidy is suggested whenever there is market failure.

Smart subsidies as those involving specific targeting to farmers who would not otherwise use purchased inputs or to areas where added fertilizer can contribute most to yield improvement, measurable impacts, achievable goals, a results orientation, and a timely duration of implementation, i.e., being time-bound and having a feasible exit strategy.

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7. APPENDICES

A-1: Tables Fertilizer Consumption and Average Price

Year	DAP Price	Urea Price	Total Fertilizer Price	DAP Consumption	Urea Consumption	Total fertilizer Consumption
1988	850	850	1700	107108	22404	129512
1989	1163	839	2002	107011	22460	129471
1990	890	697	1587	117866	27843	145709
1991	814	637	1451	117392	29573	146965
1992	814	637	1451	135467	17191	152658
1993	814	637	1451	90109	17348	107457
1994	814	637	1451	170000	20000	190000
1995	798	637	1435	202312	44410	246722
1996	814	637	1451	209883	43269	253152
1997	966	809	1775	168623	51808	220431
1988	888	751	1639	193395	87976	281371
1999	910	773	1683	195345	94919	290264
2000	1071	953	2024	197345	100562	297907
2001	1498	1328	2826	181545	98057	279602
2002	1434	1312	2745	155941	76329	232270
2003	1780	1680	3460	157955	106394	264349
2004	2000	1900	3900	210837	112105	322942
2005	2580	2424	5004	224819	121735	346554
2006	3745	3204	6949	251156	124561	375717
2007	4048	3548	7596	259020	129121	388141
2008	7117	4961	12078	265768	138988	404756
2009	7312	5340	12652	278239	148437	426676
2010	7444	5451	12895	352309	201576	553885
2011	11708	9158	20865	350234	200345	550579
2012	14669	11953	26622	401817	233526	635343
2013	16425	12822	29247	456618	272625	729243

Source: Ministry of Agriculture

A-2: Total Area Cropped and Fertilized by Region (2006 – 2013)

Region	Year	2006			2010			2013		
	Area	Total Area in Hectare		% of Cropped Area Fertilized	Total Area in Hectare		% of Cropped Area Fertilized	Total Area in Hectare		% of Cropped Area Fertilized
	Crop	Cropped	Fertilized		Cropped	Fertilized		Cropped	Fertilized	
Ethiopia	**All Grains**	10,170,911	1,632,747	16.1	11,503,249	1,593,079	13.8	12,282,930	3,098,991	25.2
	Cereals	8,081,401	1,553,734	19.2	9,233,025	1,401,114	15.2	9,601,035	2,844,818	29.6
	Teff	2,246,017	621,848	27.7	2,588,661	597,851	23.1	2,730,273	1,151,018	42.2
	Wheat	1,459,540	440,620	30.2	1,683,565	420,411	25.0	1,627,647	646,366	39.7
	Maize	1,526,125	339,466	22.2	1,772,253	242,639	13.7	1,627,647	669,087	41.1
Tigray	**All Grains**	708,350	113,454	16.0	856,330	162,789	19.0	877,506	334,168	38.1
	Cereals	585,847	111,743	19.1	693,967	160,813	23.2	730,756	310,117	42.4
	Teff	138,346	47,166	34.1	187,859	65,590	34.9	161,798	87,660	54.2
	Wheat	76,776	20,399	26.6	113,596	42,759	37.6	111,846	71,071	63.5
	Maize	46,192	6,036	13.1	64,649	10,222	15.8	69,026	21,633	31.3
Amhara	**All Grains**	3,570,812	603,043	16.9	3,997,750	742,416	18.6	4,366,386	1,230,706	28.2
	Cereals	2,714,489	578,137	21.3	2,986,622	712,488	23.9	3,254,156	1,139,359	35.0
	Teff	907,057	244,705	27.0	1,001,028	313,070	31.3	3,254,156	514,555	15.8
	Wheat	431,486	171,085	39.7	548,315	206,766	37.7	498,192	259,113	52.0

Region	Year	2006			2010			2013		
	Area	Total Area in Hectare		% of Cropped Area Fertilized	Total Area in Hectare		% of Cropped Area Fertilized	Total Area in Hectare		% of Cropped Area Fertilized
	Crop	Cropped	Fertilized		Cropped	Fertilized		Cropped	Fertilized	
	Maize	341,084	134,780	39.5	355,508	151,673	42.7	434,642	243,781	56.1
Oromiya	**All Grains**	4,720,123	827,786	17.5	5,348,593	545,900	10.2	5,598,772	1,317,655	23.5
	Cereals	3,835,235	787,158	20.5	4,466,528	402,958	9.0	4,486,163	1,211,194	27.0
	Teff	985,666	311,401	31.6	1,182,811	191,970	16.2	1,256,565	500,889	39.9
	Wheat	816,572	219,474	26.9	857,603	121,952	14.2	872,972	270,404	31.0
	Maize	858,096		0.0	1,000,056	40,385	4.0	1,115,957	326,852	29.3
SNNP	**All Grains**	876,693	74,156	8.5	1,006,725	135,715	13.5	1,092,584	201,155	18.4
	Cereals	708,276	63,245	8.9	837,850	120,181	14.3	866,341	172,329	19.9
	Teff	193,193	14,890	7.7	196,702	27,102	13.8	202,376	47,680	23.6
	Wheat	119,118	25,486	21.4	155,661	48,728	31.3	138,351	45,664	33.0
	Maize	206,397	18,839	9.1	278,928	37,335	13.4	305,205	67,770	22.2

Source: CSA Crop production Agricultural Survey

A-3 Fertilizer Consumption /Sales by Region MT

Year	Region	DAP	Urea	Total
2003/04	Oromyia	101,571	45,252	146,823
	Amhara	61,263	41,027	102,290
	SNNP	27,270	6,111	33,381
	Tigray	5,395	3,438	8,833
2004/05	Oromyia	118,454	54,397	172,851
	Amhara	61,828	43,255	105,083
	SNNP	25,814	4,257	30,071
	Tigray	7,670	5,889	13,559
2005/06	Oromyia	117,548	53,027	170,575
	Amhara	70,998	45,972	116,970
	SNNP	37,523	5,431	42,954
	Tigray	5,125	3,880	9,005
2006/07	Oromyia	132,390	48,843	181,233
	Amhara	74,392	52,855	127,247
	SNNP	25,125	3,534	28,659
	Tigray	9,612	5,119	14,731
2007/08	Oromyia	117,066	54,735	171,801
	Amhara	93,536	56,619	150,155
	SNNP	35,405	4,828	40,233
	Tigray	8,907	5,606	14,513
2008/09	Oromyia	109,143	48,946	158,089
	Amhara	86,270	56,706	142,976
	SNNP	42,285	7,375	49,660
	Tigray	10,692	7,220	17,912

Year	Region	DAP	Urea	Total
2009/10	Oromyia	146,523	59,351	205,874
	Amhara	118,320	80,215	198,535
	SNNP	63,734	17,642	81,376
	Tigray	17,169	12,101	29,270
2010/11	Oromyia	129,503	59,163	188,666
	Amhara	116,316	85,254	201,570
	SNNP	71,292	24,785	96,077
	Tigray	21,083	14,143	35,226
2011/12	Oromyia	172,231	82,905	255,136
	Amhara	130,677	97,550	228,226
	SNNP	52,241	13,824	66,065
	Tigray	30,593	21,027	51,620
2012/13	Oromyia	197,459	95,015	292,474
	Amhara	147,182	108,516	255,699
	SNNP	80,432	39,889	120,321
	Tigray	36,445	24,305	60,751

Source: Ministry of Agriculture

A-4 Share of Fertilizer by Region

Tigray			
Year	Teff	Wheat	Maize
2003/04	0.33	0.24	0.10
2004/05	0.31	0.28	0.06
2005/06	0.36	0.26	0.06
2006/07	0.33	0.31	0.05
2007/08	0.34	0.27	0.07
2010/11	0.28	0.30	0.06
2011/12	0.23	0.36	0.07
2012/13	0.25	0.27	0.07
Amhara			
Year	Teff	Wheat	Maize
2003/04	0.32	0.32	0.32
2004/05	0.35	0.33	0.28
2005/06	0.32	0.34	0.30
2006/07	0.34	0.34	0.29
2007/08	0.36	0.27	0.34
2008/09	0.35	0.27	0.34
2009/10	0.35	0.30	0.31
2010/11	0.32	0.28	0.36
2011/12	0.43	0.34	0.03
2012/13	0.38	0.25	0.29
Oromiya			
Year	Teff	Wheat	Maize
2003/04	0.33	0.25	0.33
2004/05	0.34	0.32	0.26
2005/06	0.32	0.31	0.28
2006/07	0.37	0.32	0.23
2007/08	0.36	0.36	0.24
2008/09	0.35	0.38	0.23
2007/08	0.36	0.36	0.24
2008/09	0.35	0.38	0.23
2009/10	0.44	0.28	0.12
2010/11	0.38	0.25	0.33
2011/12	0.60	0.34	0.32
2012/13	0.02	0.25	0.34
SNNPR			
Year	Teff	Wheat	Maize
2003/04	0.17	0.38	0.40
2004/05	0.17	0.47	0.30
2005/06	0.13	0.42	0.38
2006/07	0.23	0.38	0.33
2007/08	0.14	0.28	0.54
2008/09	0.13	0.30	0.51
2009/10	0.12	0.39	0.42
2010/11	0.26	0.27	0.40
2011/12	0.24	0.33	0.20
2012/13	0.21	0.28	0.45

Source: CSA Crop production Agricultural urvey

A-5: VCR in 2009/10 Crop year for Major Cereals Growing Regions

Crop by Region	Incrementa l Yield (100kg/ha)	Produce Price (Birr/100kg)	Value of incremental yield (Birr/100kg)	Fertilizer (100kg/ha)	Fertilizer Price (Birr/100kg	DAP Cost Total (Birr/Ha)	VCR
1. Teff							
1.1 Tigray	2.2	1000.7	2201.5	1.9	692.2	1323.5	2
1.2 Amhara	3.4	699.8	2379.3	1.7	820.3	1433.1	2
1.3 Oromia	3.9	709.7	2767.8	1.2	744.4	865	3
1.4 SNNP	3.1	712.4	2208.4	1.1	773.2	835.1	3
2. Wheat							
2.1 Tigray	8.2	669.5	5489.9	1.8	692.2	1248	4
2.2 Amhara	5.8	449.9	2609.4	1.6	820.3	1312.48	2
2.3 Oromia	12.4	442.8	5490.7	1.1	744.4	848.6	6
2.4 SNNP	7.3	445.9	3255.1	1.4	773.2	1050.8	3
4. Maize							
4.1 Tigray	4.1	523.4	2145.9	1.8	692.2	1245.96	2
4.2 Amhara	12.1	357.3	4323.3	2.4	820.3	1996.6	2
4.3 Oromia	10.2	337.5	3442.5	1	744.4	749.6	5
4.4 SNNP	6.4	401.3	2568.3	0.6	773.2	486.3	5

Source: DSA (2010)