Addis Ababa University School of Graduate Study
Civil Engineering Department
Under
Road and Transport Engineering Stream

Analysis of Logistics Chain of Fertilizer from Port and Improved Seed from Production Area to Farmers

MSc thesis

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ABSTRACT

Ethiopia is a landlocked country and movement of the import and export commodities depends on neighboring coastal countries port. The country is challenged in traversing through the neighboring countries due to high port charges and less effective logistics systems in the inland activities of import –export commodities. The development of logistics concept is in an infant stage which has not given special concern till recent years. There is a larger gap between the industry development and the logistics concept nationally.

This thesis was to assess the logistics chain of fertilizer from Djibouti port and maize improved seed from production area, observe the seasonality of fertilizer flow, minimize the logistics chain costs and lead time, identification of barriers of fertilizer flow throughout the distribution network and make recommendations for efficient and effective logistics chain.

Logistics chain of fertilizer was not well coordinated between the stakeholders. Warehouse-transport interface was the main challenge in overall efficiencies of logistics chain. The challenges are mainly unloading problems due to uncoordinated cooperative unions with transporters and importers. Late delivery of fertilizer to farmers especially during the farming time affected the effective application to the farm. The maize improved seed price was observed incomparable with the selling prices of farmers' product of similar quantity.

Seasonality of fertilizer flow from port was checked with one way ANOVA comparison test using SPSS 15.0. Demand forecasting was done with time series method and the forecasted value was adjusted with seasonal index. Location analysis was done with center of gravity method using the annual consumption of fertilizer for each zone of the country. The coordinates of each zone for this method was determined from GIS 9.3 based on the mean center of woredas' population within the zone. To determine the dominant consumer level of fertilizer in Ethiopia, Cluster Mapping and hotspot analysis was made using GIS 9.3 based on the average six year consumption levels of each zone. Route optimization was also made with GIS 9.3 from Djibouti port to the central warehouses. The result might not be reliable for some routes as it was not used travel time for the optimization instead travel distance which provided the shortest possible distance for the un updated national digital road networks.

The pair wise mean comparison of the four quarters indicated that there were a significant different fertilizer flow during quarter 1 (September, October, November) with Quarter 2 (December, January, February) and Quarter 3(March, April, May) but not different with Quarter 4(June, July, August). Using location analysis, proposed warehouses were suggested for efficient distributions of fertilizer throughout the country. The optimum route obtained in some cases required to be checked accounting for road condition.

Table of Contents

List of Tables

List of Figures

ABREVATIONS

ABC- Activity Based Costing

AISCO- Agricultural Input Supply Corporation

AISE- Agricultural Input Supply Enterprise

ANOVA-Analysis of Variance

B/L-Bill of Lading

Br-Ethiopian Birr

C&F- Cost and Freight

DAP-Diammonium Phosphate

EAL- Ethiopian Amalgamated Limited

ECSA-Ethiopian Central Statistics Agency

EDI - Electronic Data Interchange

ERA -Ethiopian Roads Authority

ETB-Ethiopian Birr

ESRI-Environmental System Research Institute

FY-Fiscal Year

GPS -Global Positioning System

GDP -Gross Domestic Product

GIS-Geographic Information System

HR-Hour

Kg-Kilogram

Km-Kilometer

KPI -Key Performance Indicators

L/C-Letter of Credit

M-Metre

MAA-Maritime Affairs Authority

MoA-Ministry of Agriculture

MT-Metric Tone

MTSE-Maritime Transit Service Enterprise

NBE-National Bank of Ethiopia

OECD- Organization for Economic Cooperation and Development

RFID- Radio Frequency Identification Device

NCPDM -National Council of Physical Distribution Management

VRP- Vehicle Routing Problem

USD-US dollar

RSDP- Road Sector Development Program

TKm- Tone Kilometer

1. INTRODUCTION

1.1 Background of the study

Ethiopia is land locked country and the movement of the import and export commodities depends on parts of neighboring coastal countries. There are four main ports that are currently accessible to Ethiopia for foreign trade. Djibouti port is the primary port that currently comprises about 93% of the import–export flow of commodities (Afro Consult& trading plc, 2010). The other three, Berbera, Mombasa and Port Sudan are optional ports that are not as viable as that of Djibouti port in current situation.

MacKellar et al. (2002) explained the negative relationship between landlockedness and growth using a neoclassical theory. They highlighted that crossing a border implies higher transaction costs due to customs and handling costs. Due to their lack of territorial access to seaports and the prohibitive cost of airfreight, landlocked countries have to rely on the transport of goods by land through one or more neighboring countries. The additional costs incurred together with problems of distance, make imports more expensive and render exports less competitive, thus putting landlocked countries at a disadvantage in the global economy. Some of the major factors influencing the transit transport systems of landlocked and transit developing countries are poor quality of infrastructure, less availability of route choice, trade and transport facilitation and border crossing issues, lack of multimodal transport for relieving port congestion, lack of coordination in cross- border activities. Hence, transit transport is most heavily constrained by delays and costs incurred at borders due to time-consuming border crossing and customs procedures, complicated non-standard documentation, poor organizational structure and lack of coordination skills in the transport sectors.

The inefficiency of the country's trade system is also become rising due to lack of use of modern technologies to facilitate the coordination of commodities flow through foreign ports. The most important components to minimize port inefficiency of land locked countries comprise improvement of inland transport. This can be achieved through the use of different modes of transport and advanced technologies. Land locked developing countries have poor practice of using these advanced technologies due to high initial costs and less adaptability to the industries. Lengthy document processing can be minimized by using fully automated and integrated system as Electronic Data

Interchange (EDI) and reducing manual receiving of documents, manual processing of documents (Stephen, 2005).

In especial case, transport and storage industry of developing countries have less practice of using advanced technologies as automated links between ordering systems and tracking systems. Use of advanced technologies is encouraged to reduce transport time, costs and increase reliability. The most common technologies that can increase the efficiency of transport industry include on board weighing, in vehicle navigation systems (GPS), barcodes and RFID (Radio Frequency Identification Device) technologies (Stephen, 2005). In general, use of advanced technologies in trade industries is a key element in improving the logistics chain efficiency of flow of goods from point of origin to point of consumption.

Most of the Ethiopian imported and exported commodities reach to the end user using combination of uni-modal transport system. Industries rely on important form of goods movement to maintain commerce, which may range from large shipments of bulk commodities to overnight package delivery across the country as well as the national borders of the country. Hence, transportation has a valuable impact of linking the nodes of goods movement by creating time and place utility. In general, the goods we consume, our economic livelihood, our mobility and our entertainment are in some way or another way affected by transportation. Most import-export activities of Ethiopian commodities are mainly transported in the form of containerized and non- containerized through road mode of transport. Non-containerized commodities that Ethiopia imports include break bulk products, dry bulk cargos and liquid bulks. As transportation is part of a production process, it ensures that bits and pieces are assembled through the use of logistics chains, allowing for the delivery of the necessary inputs for production including the necessary material and labor and allows the finished products to be delivered to the end user.

Fertilizer is an important dry bulk cargo imported from abroad that have greater impact on economy of the country. Since Ethiopian economy is an agrarian economy in which the livelihood of about 85% of the population directly or indirectly depends on the agricultural sector, fertilizer is a key input for productivity of the sector. The recent release of FY 2008/09 GDP statistics revealed that the service sector now comprises 45.1 percent of GDP, followed by agriculture at 43.2 percent of GDP and the remaining accompanied by the industry sector (Ethiopian Macroeconomic handbook, 2010).

Agriculture has actually been overtaken by service sectors and shows in decreasing trend in the last decades. It is then important that increasing agricultural productivity is critical to stimulate the rate of economic growth in Ethiopia. The important contributories, fertilizer and improved seed, can significantly improve the productivity of agricultural sectors of the country with a key factors of availability of water. However, the efficiency of use of these commodities in the agriculture sector can be affected by their higher farm gate price which has a direct impact on a low income farmer. The high farm gate price can be contributed from less effective logistics chain which incur a higher total cost for end users. Since price of fertilizer in worldwide is showing an increasing trend, improvement of the whole chain efficiency is critical to maintain sustainable use of this commodity by the end user farmers.

1.2 LITERATURE REVIEW

1.2.1 Development of logistics

The modern concept of logistics incorporates activities (e.g. transport, storage) which date back to the earliest forms of organized trade (Lambert et. al. 1998). The term was initially developed in the context of military activities in the late 18th and early 19th centuries. However, over the years the meaning of the term has gradually generalized to cover business and service activities. The main background of its development was that the recession of America in the 1950s caused the industrialists to place importance on goods circulations (Yung and Wen, 2005). Before the 1950s, logistics was under dormant condition, production was the main part of the managers concern, and industry logistics was once regarded as "necessary evil" in this period. Since logistics advanced from 1950s, there were numerous researches focused on this area in different applications. Due to the trend of nationalization and globalization in recent decades, the importance of logistics management has been growing in various areas. For industries, logistics helps to optimize the existing production and distribution processes based on the same resources through management techniques for promoting the efficiency and competitiveness of enterprises. During the 1950s to 1960s, applying new ideas of administration on business was a tendency. Drucker's study (cited in Yung and Wen, 2005) in 2001, who thought logistics was the '*economy's Dark Continent*' regarded the procedure of physical distribution after producing products as the most possible development area in American businesses but also the most neglected area. Hence, Logistics has then been developed with changing definitions and concepts as it grows from military area to business industry.

Logistics in business context refers to the inbound and out bound flow and storage of goods, services, and information within and between organizations (Gundlack et al., 2006). They also emphasized that the early logistics management research only focused on the management of transportation and warehouse. However, the recent logistics management research is directed in to two perspectives 'supply chain logistics and service response logistics'. Supply chain logistics concerned with the flow of goods including transportation, warehousing and storage, inventory management, packaging and return goods handling, salvage and scrap disposal while service response logistics concerned with the coordination of non material activities necessary for the fulfillment of the service in a cost and customer service –effective manner such as order processing, information system, customer service and procurement. There are also a number of logistics definitions which are commonly accepted in business industry. A review of the literature indicated that there was no universal definition of logistics. Some of recent definition is shown in Table 1.1 below.

Table: 1.1 Recent definitions of logistics

Source	Definition	Components
Council of Logistics Managem ent	That part of the supply chain process that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services, and related information from the point of origin to the point of consumption in order to meet customers' requirements	Transportation, order processing and related distribution centre operations, inventory control, purchasing, production, and customer and sales services.
OECD	Management of flows along links in various kinds of networks, in particular involving the manufacturing and trading of goods and services (business logistics)	Transport flows/systems (transport networks), material flows/systems (buyer/supplier networks), information flows/systems (communications networks), money flows/systems (financial Networks).
Coyle,	To ensure the availability of the right product, in	Not provided

Bardi and Langley	the right quantity, and in the right condition, at the right place, for the right customer, at the right cost at the right time ("*seven R's of Logistics*")	

Source: Council of Logistics Management (2001). Langley (1992). OECD (1996).

1.2.2 Value chain

Several definition of value chain exists. Kaplinsky et al., (2000), describes a value chain as a full range of activities required to bring a product or service through the different phases of production, including physical transformation, the input of various producer services, and response to consumer demand. Keyser (2006) on the other hand describes a value chain as all of the factors of production including land, labor, capital, technology, and inputs as well as all economic activities including input supply, production, transformation, handling, transport, marketing, and distribution necessary to create, sell and deliver a product to a certain destination.

In summary, Logistics management activities typically include inbound and outbound transportation management, fleet management, warehousing, materials handling, order fulfillment, logistics network design, inventory management, supply–demand planning, and management of third-party logistics services providers. Hence, logistics management is an integrating function, which coordinates and optimizes all logistics activities, as well as integrates logistics activities with other functions including marketing, sales, manufacturing, finance, and information technology.

1.2.3. Theoretical framework of logistics chain

Components of Logistics cost and its economic impact

Logistics costs are an important factor affecting the competitiveness of both firms and nations. It is one of logistics performance indicators firms can enhance their market competitiveness by reducing their logistics cost, thus the total costs of goods and services. According to Frenceshin and Rafele (2000) total logistics cost analysis has been proven to be the key to managing the logistics functions, consequently, it is important that management considers the total of all logistics costs.

The Total Cost Model by Lambert and Stock (2001) presented six major logistics cost categories that are driven by a number of key logistics activities required to facilitate the flow of a product from the point of origin to the point of consumption as indicated in Figure 1.1

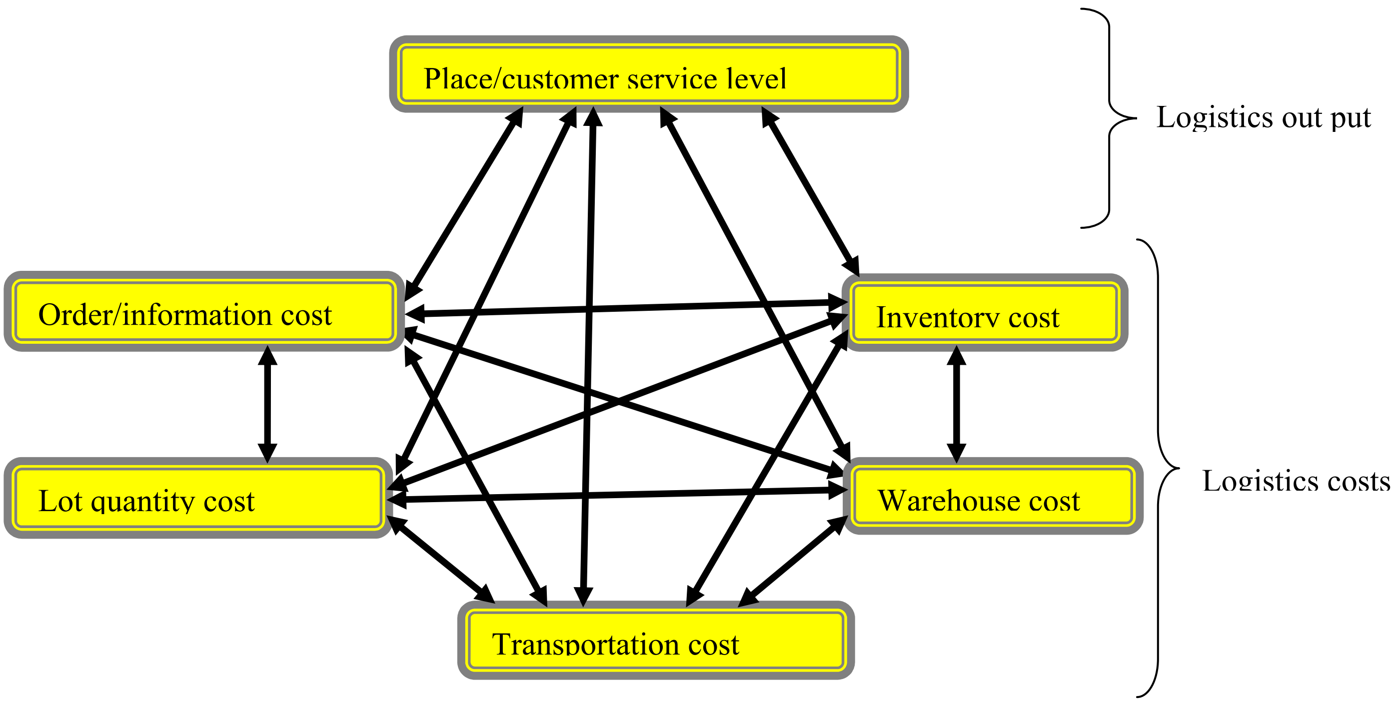


Figure 1.1: Total Logistics cost model (Lambert and Stock (2001))

Lambert et al. (1998) stated that what is included in total cost model varies depending on the outline of the logistics organization. In some situations components need to be removed from the model whereas in other situations more components are added to it. Apart from providing understanding to how different areas could be affected by changes within the organization, the Total Cost Model also provides a structure that helps identify activities that support the logistics process.

According to Lambert and Stock (2001) logistics involves the movement of products. A product produced will achieve its value after it has moved to the point where it will be consumed. Transportation does not only create utility, but creates time utility as well, since it determines how fast and how consistently products can move from one point to another. The transportation cost will also vary considerably with the mode of transportation chosen. Again, Lambert and Stock (2001) ascertained that, transportation costs depend on line-haul truck operations such as truck rental-purchased fees, fuel costs and driver cost.

After the product is transported, it needs to be stored in warehouse for later consumption unless the customer need them at the instant they are used. The greater the time is between production and consumption, the larger amount of inventory is needed. Warehousing can be used to support distribution and to subdivide a larger shipment to many customers (Lambert, 2001). Warehouse costs comprise rent, heat, personnel, depreciation on investments and necessary equipments.

Order processing and information system costs are related costs of logistics chain, for example, processing customer orders, distributions, communications and demand forecasting. Order processing costs include order transmitted, order entry, order verification, order handling and also related internal and external costs such as notifying carriers and customers of shipping information and product availability.

The major logistics costs are cost occurring in the context of production. Lot quantity costs vary with the changes in the production lot size. The costs include for example material handling. If the company stores material until a large amount of material is ordered, instead of delivering in smaller quantities, the customer service may suffer as order fulfillment declines. The inventory might go down to zero and creates stock out situation in between runs. Although, this is more related to inbound logistics, nevertheless, it is indirectly connected to customer service that is ultimate goal of logistics.

Customer service is described as 'fuel that drives the logistics supply chain engine' (Coyle *et al,* 1996). the core principle is to have the right product to the right customer in the correct quantity, without any damage. Customer service costs include order fulfillment costs and costs for parts as well as service support. They also include costs associated with return goods handling. The cost of lost sales includes lost contribution of the current sale and also potential future sales. It is interesting to note that each of the other five major logistics cost element work together to enhance customer service. There are three important elements of customer service from an outbound distribution point of view: *order cycle time*, *delivery time* and *reliability*.

Order cycle time is the total time from the placement of the order at the supplier until the customer receives the goods (Lambert *et al*., 1998) and the lead time for the supplier is from the time that the order is placed with the manufacturer until the goods are received. *Delivery time* is the time from the receipt of the order until the customer has received the goods (Gilmour, 1997). Measuring and controlling the time from the placement of the order until the customer receives the goods may be difficult if the seller uses contact carriers as he no longer has any direct control over the goods(Coyle *et al*., 1996). *Reliability* can be described as keeping promised delivery schedules. Any variation in the delivery schedule must be communicated to the customer (Gilmour, 1997). For some customers, reliability or dependability is more important than lead time. If lead time is consistent, the customer can keep lower levels of inventory and the costs of possible stock-outs can be discarded (Gilmour, 1997). An important element of reliability is to ensure the safe delivery of the product or consignment. A damaged shipment can lead to a claim from the customer, which will result in added transport costs for the seller to send a replacement (Coyle *et al*., 1996).

Role of Transportation in Logistics Chain

Coyle, Bardi and Novack (1994) define transportation as "the creation of place and time utility," where place utility means that goods are moved to a place where they have higher value than they had at the original place. Further, place utility is created when transportation costs are reduced, which encourages producers to purchase products or raw materials from more distant suppliers. Time utility means that the service of transportation takes place when it is needed and refers to the fact that the demand for certain goods only exists during limited periods of time. Hence, time utility is created by efficient transportation that makes sure that those products will be available at the appropriate location for customers when needed (Coyle, Bardi and Novack, 1994). Transportation system is the most important economic activity among the components of business logistics system. Around one third to two third of the expenses of enterprises' logistics costs are spent in transportation (Yong and Wen, 2005). According to the investigation of National Council of Physical Distribution Management (NCPDM) in 1982, (Chang, 1988), the cost of transportation, on average accounted for 6.5% of the market revenue and 44% of logistics cost.

Transportation includes both inbound movement from the sources of raw materials or parts directed to plants or through warehouses and outbound movement of finished products or components from plants to customers directly or through distribution centers. Transportation encompasses a wide spectrum of planning and operational problems. Planning problems include fleet sizing, vehicle routing, crew planning, network design and hub and terminal location. On the other hand operational problem include crew and vehicle scheduling, dispatching and reservation control. Hence to minimize the overall logistics cost it is essential to be a well planned transportation system.

Vehicle routing focuses on the determination of optimal routings for the various origin-destination traffic considering route structures, distance and route capacity. The main objective of vehicle routing problem (VRP) is minimizing the distribution costs for the individual carriers, and can be described as the problem of assigning a collection of routes from a depot to a number of geographically distributed customers, subject to certain constraints. The VRP was first introduced by Dantzig and Ramser (1959), and was developed by Clarke and Wright (1964). The most basic version of the VRP has also been called *vehicle scheduling*, *truck dispatching* or simply the *delivery problem* (Joubert, 2007). Vehicle routing in transportation problems arises frequently in planning for the distribution of goods and services from several supply locations to several demand locations. Usually the quantity of goods available at each supply location (origin) is fixed or limited and there is a specified amount needed at each user location (destination) with a variety of routes and differing costs for the routes. The objective is to determine how many units should be shipped from each origin to each destination so that all destination demands are satisfied and the total transportation costs are minimized (David et al., 1988).

In addition to vehicle routing algorithms, GIS has also developed in recent years in its interest as special analysis tool software to analyze logistics distribution system. It is used in distribution system to abstract, process and analyze geographic information from supply spot, demand spot and transportation route (ESRI, 2008). GIS also helps to choose distribution locations, determine transportation route, and realize visualization of distribution management and increase level and efficiency of distribution management. Dengdian (2003) mentioned that Wal-Mart supermarkets in America use GIS in the process of logistics distribution and have got great success. With the help of GPS and electronic map, vehicles and goods can be tracked, which is the system that can show the actual positions of vehicles and goods at any time, and can inquire the state of the vehicles and goods, which is convenient to dispatch and manage (Burrou, 1999). Vehicles equipped with GPS receiver and computer auto-guiding distribution system can probe digital service spot and show the serving result in dynamically monitoring computer terminal unit in distribution centers, the distribution centers implement real time dynamic monitor and control.

Performance measurement of logistics chain

Logistics management is recognized as a key opportunity to improve profitability and firms' competitive performance (Lambert et al., 1998). It is composed of nine key activities (Grant et al, 2006). These activities include: customer service &support, Demand forecasting& planning, purchasing & procurement, inventory management, order processing &logistics communications, material handling &packaging, transportation, facility site selection & warehousing, return goods handling & reverse logistics. All of these key activities are part of the overall logistics process that facilitates the flow and storage of a product from point of origin to point of consumption.

Other scholars, Sink et al. (1996), provided a list of all activities that logistics service providers typically perform. They categorized all these activities in to six functions as: Transportation, Warehousing, Inventory management, Order processing, Information systems, and Packaging. Mentzer et al., (1991) discussed that for any logistics system to be successful, both the efficiency and effectiveness dimensions of performance measurements needed to be addressed. Banomyong (2007) noted that Logistics performance need to be measured based on three key performance indicators (KPI): cost, time, reliability. These KPI reflect the output of any logistics system as well as its capability to meet customer requirements at the lowest cost, as quickly as possible and on time. Prioritizing the measure and the metrics in logistics is the key to the success by judiciously utilizing the available knowledge resources to stay focused on key performance measures and metrics. This would help management to easily understand and apply the metrics for improving the organization behavior (Gunasekaran et al, 2007).

Evaluating the performance of a subsector chain is not an easy task as there are wide range of performance measures and dimensions (Bain, 1968; Sosnick, 1964; and Brandow, 1977). Some of the key performance criteria of the fertilizer subsector are:

- reduced costs in the sector,
- price transparency,
- timely delivery,
- adequate supply,
- product suitability and
- adequate level of profit rates.

More broadly, production decisions should be responsive qualitatively and quantitatively to consumer demands (demand equals aggregate supply, and the sector is low-cost; operation of producers should be progressive; that is, there should be increased output per unit of input over time; operation of producers should facilitate stable, full employment of resources) (Scherer, 1980).

1.2.4. Fertilizer distribution structure in Ethiopia

General

Low agricultural productivity of Ethiopia due to declining soil fertility, population growth and low level of commercial input is threatening the livelihood of the country. The use of yield enhancing technologies to increase production can help increase rural incomes and lead to agricultural transformation from a low income, low productivity, subsistence-oriented economy to one characterized by specialized, high input agriculture and a rise in rural incomes (Timmer, 1990). An agricultural transformation is usually necessitated by increasing population growth and increased land scarcity, which both put pressure on agricultural sector to adopt intensive, high-input technologies (Boserup 1961, 1981). The rising incomes that generally accompany the use of high input technologies, in turn, stimulate consumer demand for market goods and thus facilitate a structural transformation of the economy (Mellor, 1990). For over a decade, the Sasakawa-Global 2000(SG) program, in partnership with African governments, has promoted the green revolution approach to development by introducing African farmers to high-input technologies such as improved seed and fertilizer. However, high cost of maintaining these input technologies became a constraint for promotion of productivity. The higher costs resulted from the increased transport cost and related charges to reach the final destination. Unlike fertilizer, improved seed is produced in country, which has no external port charges as that of fertilizer. Fertilizer is imported from abroad crossing neighboring coastal country which results in substantial increase from world price.

Structure of Fertilizer distribution in Ethiopia

Fertilizer importation, distribution, and pricing in Ethiopia were controlled by a government parastatal starting in 1984 (NFIA, 2001). Until 1992, the fertilizer market was entirely controlled by the state owned parastatal named Agricultural Input Supply Corporation (AISCO), recently renamed as Agricultural Input Supply Enterprise (AISE), Demeke,. *et al*, 1998. The task of clearing customs and forwarding also rested with monopolistic parastatal named Maritime and Transit Service Corporation and recently named as Maritime and Transit Service Enterprise (MTSE). They also said that, starting in 1993, the Ethiopian government began curtailing the operations of its official state marketing board under aid conditionality agreements with donors. The private sector was allowed to participate in fertilizer import and distribution following the issuance of the national fertilizer policy. A few importers and several retailers joined the market to provide an alternative private distribution channel.

Only two firms have joined the market for fertilizer import and distribution since 1992 reform. In 1993, Ethiopian Amalgamate Limited (EAL) became the first private company to import and set up its own fertilizer supply network. The second firm owned by Amhara regional government, started operation 1994 under the name, Ambasel trading house private limited company. It was mainly the wholesaler and distribution agent (Maritime and Transit service Enterprise) of AISE that collects the delivery from port. Demeke et, al., (1998) also stated that among the other distributor/wholesaler that joined the market in1996 and 1997 are Dinsho (owned by the Oromia regional government) and Guna (owned by Tigray regional government).

Fertilizer marketing in landlocked countries is a low margin and a high risk commodity. Fertilizer transport costs are high because it is a bulky product and distances transported are great. In addition, risks are high in investing in fertilizer due to seasonality of demand, storage costs and bank interest incurred. Due to these factors and political importance of the provision of low-cost and stable fertilizer prices has usually meant heavy government intervention in setting prices and organizing distribution system. The seasonality of demand is also basic condition that plays out in shaping market structure. Stepanek (1998) stated that fertilizer is consumed primarily during the larger, *meher* season (roughly July to November), but also during the earlier *belg* (April to July). Most fertilizer is actually applied between March and July. All fertilizer consumed in a given season cannot be off-loaded in the months immediately prior to distribution. Thus, coordination of imports required in order to ensure sufficient fertilizer supplies by scheduling over the quarters of a year.

Stepanek (1998) also sorted out that organizational fertilizer market structures of all regions were almost similar but differing only in the number of wholesalers and retailers. In 1998, nationally, there were 7 large wholesalers (AISE, EAL, Fertiline, Guna, Ambasel, Dinsho, and Guna-5) and also worked as importers. However, only one to three companies may have operated in any zone. Primarily one company in Amhara: two companies in south; three companies in Oromia and Tigray.

He also reported that, in Tigray, the organization of the system of fertilizer distribution was more monopolistic than other regions. In1998, Guna, the regional government affiliated company, did not distribute fertilizer to Tigray as it had in the past. In the same year, the Tigray Regional Government asked three importers AISE, EAL, and Guna, whether they should divide the region amongst themselves or issue tenders as in the Oromia region. Prior to 1998, fertilizer distribution in Amhara region was in the hands of several distributors, each with roughly equal designated share of market. However, in 1996 and1997, Ambasel, the regional government affiliated company, gained strength and by 1998 it was the sole distributor in the region. In Oromia region, fertilizer distribution shifted from a system of controlled prices and monopoly supply to relatively increased competition in 1998. In 1998, for the first time fertilizer auctions were held in which retailers competed on the basis of price for a given bid. Similar to Amhara region, in southern region, one supplier dominated the fertilizer market in 1998. Fertilizer distribution for the early, belg crop was carried out by one distributor, wendo, owned by the southern regional government, but AISE was invited to distribute for the later, *meher* crop. Stepanek (1998) overviews over all structure of fertilizer distribution market in Ethiopia as in Figure 1.2.

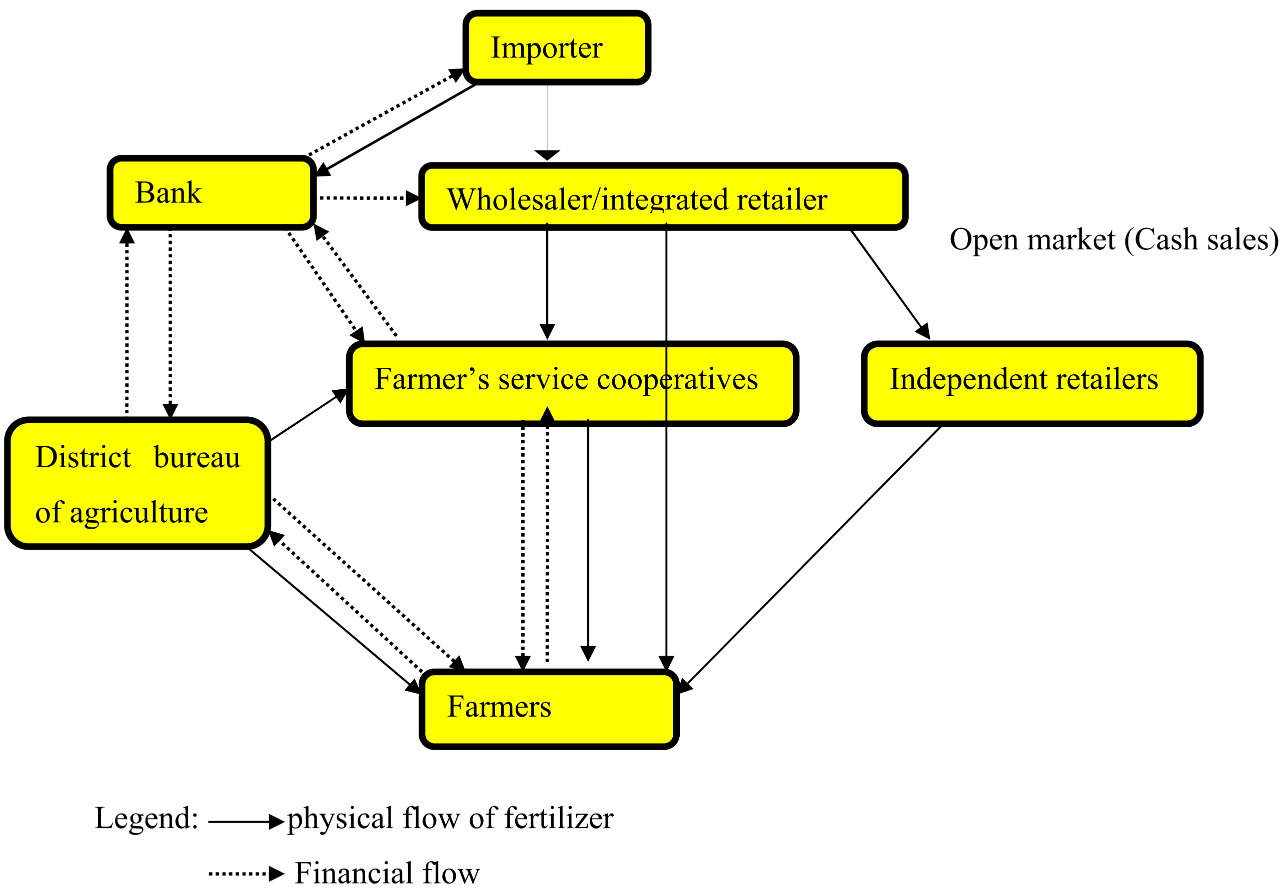


Figure 1.2. Structure of fertilizer distribution market in Ethiopia during1998 (Stepanek (1998))

The productivity of farmers not only depends on fertilizer application but also by use of improved seed to improve the yield significantly. When improved seed is combined with fertilizer and an appropriate plant density, yields can be further increased (Schulthess and ward, 1999). Hence, improved seed market needs to be improved to complement the fertilizer market for sustained productivity growth to be realized in Ethiopia. GMRP (1998) indicated that there was ample unreliable evidence that the hybrid maize seed was poor quality and also that there was a severe supply constraint. Improved seed distribution was dominated by the parastatal, the Ethiopian Seed Enterprise which supplied an estimated 47 percent of the total demand in 1999 (Howard, 1999). The only other distributor was pioneer hy-bred international Inc. which supplied an estimated 5 percent of the market in 1999 (Howard, 1999). The government was distributor of the seed through the NEP (National Extension Program), leaving little to no seed supply for the open market.

Conclusion

In general, logistics chain concept has developed from early periods in areas of military to recent years coming to business areas. However, in Ethiopia logistics concept can be considered at an infant stage and has not given much concern and the most neglected area in businesses till recent years. Hence, the review can give an insight for the definitions of logistics and the common cost components that need to be considered in most business areas. The cost components include the lot quantity costs, transportation costs, inventory costs, warehouse costs and information/order costs. Among these components, transportation cost holds larger share next to the lot quantity cost as every product is required to be delivered to the customer through transportation. Logistics chain of fertilizer and improved seed has not yet experienced in Ethiopia. Only the market structure of fertilizer distribution was made regardless of chain components of inventory, warehousing, transportation for efficient distribution.

1.3 Statement of Problems

Ethiopia is a landlocked country which is served by underdeveloped road networks, none functioning low standard railway line which runs from port of Djibouti to Addis Ababa and a fairly well functioning Civil Aviation System (ERA Network Analysis, 2003). Road freight transport has a great impact on primary and secondary economic sectors of the country which requires an input imported from different countries. However, the country has very limited road network, both in respect to the main trunk road system radiating out of Addis Ababa, but also in respect to regional and local access for a large part of the country. In addition, freight transportation of the country was characterized by old-aged small sized vehicles, pack animals, carts, human backload with limited and poor quality storage facilities for the services of agriculturally dependable areas. Agricultural dependable areas require good transport systems for easily accessibility of productivity improving commodities (i.e. improved seed and fertilizer) and to easily transport their products to markets.

Most of the country GDP (Gross Domestic Product) depends on agricultural sector next to service sector contributing to about 43.2% of the total Gross Domestic Product (Ethiopian Macroeconomic handbook, 2010). Hence, increasing the productivity of agricultural sector is essential to sustain the livelihood of population and stimulating the economic growth of the country. Fertilizer and improved seed are the leading contributor agricultural inputs which improve the productivity of agricultural sector. However, obtaining fertilizer from port and improved seed from production area to agriculturally potential area is the country's challenge. The importance of fertilizer and improved seed input in agricultural production has increased and much attention is not given to reduce the distribution costs from the supply points to the demand points. The delivery of fertilizer and improved seed is characterized to be temporally continuous to different geographic locations while the demand for fertilizer and improved seed is more time specific and occurs at different places from the delivery points. The fertilizer and improved seed market attempts to distribute the fertilizer in adequate quantities, at the right place, at the right time and with minimum costs. But the most efficient distribution of fertilizer and improved seed is frequently limited by geographical locations, social and economic constraints (i.e. low level of farmers' productivity perception and less capacity of buying) and undeveloped logistics experience of the country. Therefore, developing the most efficient distribution systems and investigating the possible constraints affecting the effective distribution of the high input agricultural technologies is essential to attain the required development plan of the country.

The inefficiency of logistics chain of the flow of fertilizer from port and improved seed from production area to farmers is mainly due to lack of coordination of the chain, longer lead time and lower customer service. Proper coordination of the producers, carriers, shippers, suppliers with information technologies can reduce the cost of the chain. However, lack of using these technologies between stakeholders is the most key features of developing countries which results in unnecessary costs of handling, storing, moving, loading and unloading. Longer lead time is also a key feature for inefficiency which results in higher inventory costs without any value adding activity in getting farmers' dissatisfaction in poor delivery and increased price of commodities. Lack of infrastructure can also maximize the overall costs of commodities flow. Less density road network and poor conditions of the available non arterial roads in the country contribute the increased inland transportation cost to the high agricultural potential area. Hence, less accessibility to high agricultural potential area have a great influence on total logistics costs of the imported and locally produced high input technology of agriculture.

1.4 Limitation of the study

As wider nature of logistics chain of fertilizer from port to consumption areas, it was very difficult to collect data from all areas of the country. Hence, some selected areas were surveyed to have data from farmers. In addition, some stakeholders were reluctant in giving response and secondary data for the requested questions that may be due to different perceptions. The study for value chain of improved seed from producer to farmers was restricted to the value chain mapping out of maize seed only. It was because to collect data in complementary with fertilizer in Amhara region, the improved seed that was under processing was maize improved seed. The improved seed value chain distribution route was different from that of fertilizer logistics chain; it was difficult to handle both data independently in terms of time and finance. In addition, GIS digital map used for route optimization in connecting Djibouti port and the existing warehouses and new warehouses were not recent version. Obtaining recent digital road networks of the country was difficult that older version was used for this thesis.

2. OBJECTIVES

The main objective of the current work is to:

Analyze the logistics chain of fertilizer in Ethio-Djibouti corridor and improved seed from production area to various locations in Ethiopia and develop strategies for effective logistics chain.

The specific objectives are to:-

- assess the flow of fertilizer through the harbor and improved seed from production area and the bottlenecks
- find out on how to minimize the logistics cost and lead time (delivery time) of fertilizer and improved seeds throughout the distribution network.
- investigate whether there are seasonal variations in freight flow of fertilizer and develop strategies to minimize the effect of season on logistics cost.
- assess the proportion and the level of consumption of fertilizer in different Zones of the country.

- assess future demand and supply of flow of fertilizer to help the stakeholders in improving the logistics activity planning.
- identify the barriers of flow of fertilizer and improved seeds throughout the distribution network.
- identify existing and new central warehouses and optimize the route in the national road network for better distribution of fertilizer.
- develop recommendations for efficient and effective supply chain of fertilizer.

Scope of the Study

The research focuses on road transport flows of fertilizer imported through port of Djibouti to Ethiopia and locally produced improved seed to different region of the country by analyzing the lead time and cost of logistics system.

3. METHODOLOGY

The study is performed based on detail description of the logistics chain of fertilizer and improved maize seed and making analysis for development of efficient logistics system. Maize improved seed was selected as it was the only seed which was under processing during data collection of fertilizer. Maize improved seed supply chain differs from that of fertilizer and reaches the same point at cooperative unions. The chain routes of improved seed were then considered the same with fertilizer logistics chain starting from cooperative unions. Recommendations, improvements and strategies were then provided based on detailed description and analysis. Data collection relied on many sources of evidences. According to Yin (1994), there are six important sources: documentation, archival records, interviews, direct observation, participant observation, and physical artifacts. Therefore, the main research approaches included pertinent data collection and develop strategies. In general, there are two types of data: primary data and secondary data. Concept of primary data implicates the collection of information through direct observation, personal interviews, and conducting conversation whereas secondary data means that gathered through the study of documents; biographies, web-sites and other historical and documentary records relevant for the studied issue (Remeny, et al, 1999). The collected data were then summarized and analyzed to reach into a meaningful conclusion and recommendation.

3. 1 Primary data collection

The collection of primary data was conducted through personal interview, focus group discussion and direct observation to get more and accurate information. Since the size of the logistics chain stakeholder's complexity, it was difficult to find accumulated information for all system of the chain. It was then important to take a personal interview, focus group discussion and field observation of key persons who were in charge of the activity of logistics chain of fertilizer and improved seed to get the required information for the specified objectives. It helped to acquire the just-in-point information and precise pictures of what and how the chain works. The interviewees in this research included persons who have an in depth knowledge on marketing and operational activities. They include custom officials operation division, Maritime Affairs Authority, Maritime and Transit Service Enterprise, marketing manager in Ministry of Agriculture (MoA), Ethiopian Seed Enterprise, freight transport providers, Agricultural Input Supply Enterprise(AISE), Regional Agricultural Bureaus, farmers in Amhara region, Amhara regional farmers cooperative unions, primary farmers association, stevedoring service provider(STDV), Transport Authority.

Data obtained from interview of four major freight transporters, who are responsible for distribution of fertilizer from port mainly focused on load rate, means of obtaining loading, the way they plan routes, main destinations, seasonality of loading, the challenges for their getting on return trip to improve the load factor, directional imbalance of loading; infrastructure barriers as communication with drivers, road condition, terrain condition, availability of specialized warehousing and specialized storage facility; regulatory barriers as customs procedure and inspection, axle load limit on weigh bridge stations and border crossing permission; application of vehicle tracking technology like GPS. Interview questions comprising the above information were asked for individual transporter personnel and relevant data was obtained not only related to fertilizer transport but also other commodity flows. The four transporters were selected for interview as they made contract agreement and take responsibility and risks for the whole transport of fertilizer either with their full capacity or sub-contacting to others with no demurrage costs at the port.

Regarding customs related data, customs officials were asked to provide information on how they were operating for import and export. Relevant data that were asked during interview include: number of check points, number of documents required, and percentage of inspection applied on fertilizer, working time at the port, compatibility of Ethiopian customs working hour with Djibouti customs, application of modern technologies at check points for inspection as EDI, RFID, and coordination with the customers.

Agricultural Input Supply Enterprise (AISE), which is the only importer of fertilizer representing the country's demand, was asked with questions on how it distributed fertilizer among regional cooperative unions and over all activities performed during international bidding and selection of Suppliers. In addition, questions were asked as: the assignment of freight transporters to each lot shipment that were scheduled in the year, the current price of fertilizer, currency related problems, transporters, demurrage costs at the port, date of international contract signed and start of importation. The enterprise was also asked about the warehouse quality and the capacity of each central warehouse, however, sufficient information was not obtained regarding the capacity.

Farmers are the final customers of fertilizer distribution and improved seed. Hence, questions were asked for a group of farmers so that relevant information as the type of road they used for transport, availability of storage area near the farming area, the way they obtain fertilizer and improved seed, distance travel to get fertilizer and improved seed and methods used to transport. Before reaching to farmers, fertilizer and improved seed were passed through farmers' cooperative union and primary service cooperatives.

3.2. Secondary Data

Secondary data was collected from Ministry of Agriculture, Agricultural Input Supply Enterprise, Ethiopian Central Statistical Agency, primary farmers' cooperative, Ethiopian Roads Authority, National Bank of Ethiopian, Ethiopian Seed Enterprise and reports of national freight transport and logistics study. The data consisted of the flow of fertilizer and improved seed for recent years. The data obtained from these organizations were cost build up of fertilizer distribution, road network densities, historic data of fertilizer and improved seed zonal distribution, historic monthly imports of fertilizer.

3. 3 Data analysis

3.3.1 Logistics cost analysis

The data collected and observed were analyzed to meet the specific objectives. The analysis started from the description of logistics chain of fertilizer and improved seed that are currently applied in Ethiopia. Bartolacci (2004) emphasized that regarding the minimization of total logistics cost, Activity Based Costing (ABC) is a fundamental method to realize the required service at the lowest total cost and to analyze the logistics activities presents in the chain and the cost that these activities generate. Cost measurement associated with the logistics activity is fundamental since with this value it is to calculate the cost differentials derived from the cooperative organizations of the chain. He also defined ABC as a system of calculating the costs of individual activities and assigning those costs to cost objects of delivery channels on the basis of the activities undertaken to produce each service. The application of this analysis method to every point in the chain of distribution allows to measure the real cost sustained for every logistics operation of distribution channel; to link at every logistics activity cost to their respective performance, to reduce the wastes of the resources used in the logistics activities. The success of these attempts depends on the ability of the cost analysis system to identify the resources consumed for specific product, procurement channel or logistics activity (Pohlen and La londe, 1994). Hence, to correctly analyze the logistics cost, it was found essential to break down the processes to the activities creating a map of the logistics.

3.3.2 Seasonal variation of fertilizer flow

Statistical techniques were applied to clarify whether there were differences in the seasonal patterns between subgroups of a population. The statistical methods which compared the seasonal distribution of events between two or more categories of group variables were applied using one-way analysis of variance test by comparing the means of each categories' (Armitage & Berry 1987, Siegel & Castellan 1988).

To investigate whether there were seasonal variations in freight flow of fertilizer, monthly imported fertilizer obtained from National Bank of Ethiopia for the recent years was grouped in quarters and analyzed using one way ANOVA comparison test. The Analysis was made using SPSS 15.1 statistical tools. The basic descriptive statistics (the mean, standard deviation and standard error) were the basic information used in testing the typical hypothesis about the equivalence of means drawn from a population (yearly flow of fertilizer).

The null hypothesis was concerned with when testing the difference between four means (say H0: $\mu_{Q1} = \mu_{Q2} = \mu_{Q3} = \mu_{Q4}$) i.e. the null hypothesis asserts that the four quarterly means are equal, while alternative hypothesis H1 may be ($H1: \mu_{Q1} \neq \mu_{Q2} \neq \mu_{Q1} \neq \mu_{Q2}$). Rejecting the null hypothesis, results the acceptance of the alternative hypothesis. The hypothesis test was based on significance level of 5%.

The paired one way ANOVA test was a hypothesis test used to test the seasonal variations of the quarterly flow of fertilizer from port of Djibouti that were monthly recorded by NBE (National Bank of Ethiopia). The test helped in indication of whether there were any differences between the means of the four quarters in pair wise observation. Quarters were identified or categorized based on Ethiopian seasons: spring, winter, summer and autumn. The monthly record of flow of fertilizer from port obtained from Ethiopian National Bank was then categorized in quarters for pair wise comparison to test the equality between the means of the quarterly flow. The seasonality of fertilizer flow in turn affects the need of freight for each season. For the reliability of the comparison, a six year historical monthly recorded data was used for each quarter and the mean and variance were calculated for each quarter. The test for equality of mean quarterly fertilizer flow from port was paired and the results were summarized in analysis and result sections of this paper.

Mean flow in quarter one=mean flow in quarter two=mean flow of quarter three=mean flow of quarter four. Quarterly mean flow of fertilizer was compared with each other and results were evaluated to the significance difference. The null hypothesis of the test was that the mean difference is zero. The hypothesis is used to determine whether it is appropriate to reject or not to reject the null hypothesis. The four quarters used were: Quarter1 (Q1) = September, October, November: Quarter2 (Q2) =December, January, February: quarter3 (Q3) =March, April, May: Quarter4 (Q4) =June, July, August.

3.3.3 Demand and supply forecast

Future demand and supply of fertilizer flow was analyzed using forecasting techniques. Ghiani et.al, (2004) stated that forecasting is an attempt to determine in advance the most likely outcome of an uncertain variable. Planning and controlling logistics systems need predictions for the level of future economic activities because of the time lag in matching supply to demand. According to technique, typical decisions that must be made before some data are known consider virtually every aspects of the network planning process including facility location, inventory management, transportation planning and purchasing capacity. They also explained that forecast of product demand determine how much inventory is needed, how much product is available, how much product to purchase to meet the forecasted customer needs. This in turn determines the kind of transportation that will be needed and where warehouses and distribution centers will be located so that product and services can be delivered at the right time. Without accurate forecasts, large stocks of costly inventory must be kept at each stage of logistics chain to compensate for the uncertainty of customer demand. While accurate forecasts are necessary, completely accurate forecasts are never possible. However, the forecast will reduce uncertainty about the future as much as possible. The type of forecasting methods to use depends on several factors; including the time frame of the forecast (i.e. how far in the future is being forecasted), the behavior of demand, and the possible existence of patterns (trends, seasonality), the cause of demand behavior.   Hence, selection and implementation of the proper forecast methodology has always been an important planning and control issue for most firms.

According to Ghiani et.al, (2004), the general forecasting techniques in planning and control of logistics activities were classified as in Figure 3.1 below.

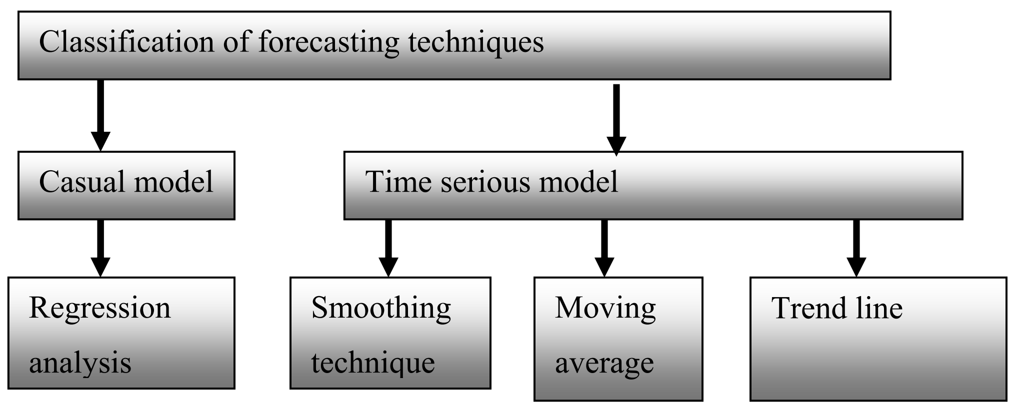


Figure 3.1. Classification of forecasting techniques (Ghiani et.al, (2004))

Casual methods (regression models) are based on the hypothesis that future demand depends on the past or current values of some variables. They include regression, econometric models, input–output models, life cycle analysis, computer simulation models and neural networks. In practice, single or multiple regressions are used for logistics planning and control. Casual methods exploit the strong correlation between the future demand of some items (services) and the past (or current) values of some casual variables. The demand for fertilizer may depend on the level of economic activities that can be related to the countries’ GDP. In several cases, it is difficult to identify any casual variable having a strong correlation with future demand. Moreover, it is very difficult to find a casual variable that leads a forecasted variable in time. For these reasons, casual methods are less popular than those based on the time serious extrapolation methods.

Time serious extrapolation presupposes that some features of the past demand time pattern will remain the same. The demand pattern is then projected in to future. This method assumes that what has occurred in the past will continue in the future. Historic data of fertilizer and improved seed applied on farms are used to develop forecasting models. Time serious method includes the moving average, exponential smoothening and linear trend line. The simple moving method uses several demand values during the recent past to develop the forecast. This method is used for forecasting demand that is stable and that does not display any pronounced demand behavior as trends and seasonal pattern.

Linear trend line is the other type of time serious forecasting method which differs from linear regression forecasting method in that it explains when demand displays an obvious trend over time and relates demand to time. The method relates a dependent variable of demand and one independent variable of time in the form of a linear equation.

Seasonal adjustment of trend line demand forecasting is required when the demand pattern shows a seasonal trend. There are several methods for reflecting seasonal patterns in a time serious forecast. A seasonal factor is a numerical value that is multiplied by the normal forecast to get a seasonally adjusted forecast. It represents the extent of seasonal influence for the particular segment of the year. One method for developing a demand for seasonal factors is to divide the demand for seasonal period by total annual demand. The result of factor (index) indicates how much the average of the demand of the seasonal period tends to be below or above the mean of total annual demand. Hence, to get an accurate estimate for the seasonal index, computing of the average of each period of the cycle and dividing each by the overall average is important. The formula for computing seasonal factors is:

$Si=Di/D$

Where Si=seasonal index for i^{th} period

Di=average demand for i^{th} period,

D= average of total annual demand.

i= the i^{th} seasonal period of the cycle

Deseasonalized process (Seasonal Adjustment) is then important in removing recurrent and periodic variations over a short time frame. The deseasonalized data was then obtained by dividing each time frame observation by the corresponding seasonal index. Hence, incorporating seasonality in a forecast is useful when the time series has both trend and seasonal components. A simple way to forecast using a seasonal adjustment is to use a seasonal factor in combination with an appropriate underlying trend of total value of cycles. The seasonal factor (index) is then multiplied by the annual forecasted demand to yield adjusted forecasts for each season.

Seasonal index of fertilizer import using time series method was based on a quarterly and monthly data of 6 years which was obtained from annual 4^{th} Quarter, 2009/2010 report of NBE.

3.3.4 Facility location analysis

Based on the historical data of consumption of fertilizer by farmers for each zone of Ethiopia, additional locations of distribution centers were proposed to make the existing distribution system more effective. The selection of the distribution centers can be made based on different selection criteria and methods (Russelle&Taylor, 2006). The most important factors that should be considered during the selection of distribution centers include accessibility for delivery, availability of infrastructures, availability of labor, the proximity of suppliers and markets, service facilities and population.

Geographic information system (GIS) was used as the most important facility location and site selection software which is computerized system for storing, managing, creating, analyzing, integrating and digitally displaying geographic spatial data (ESRI,2008). GIS is a data base system as well as a set of operations for working with and analyzing data. As a tool specifically used for site selection, it allows searching and analyzing the type of data and information (i.e. location factors).

New distribution centers for each zone of Ethiopia were mapped based on the mean centers of the existing Woredas' population of the zones. Center of gravity methods of location analysis was applied using the mean centers of Woredas' as X and Y coordinate for the zone and annual consumption of fertilizer for each zone which was obtained from Ethiopian Central Statistical Agency as in Appendix-V. Considering the proximity of zones from each other, they were grouped and other new facility location was determined using Center of Gravity technique. The coordinates for the locations of the new facility were computed using the relation.

$$X=\sum (Xi*Wi)/\Sigma Wi \quad \text{and } Y=\sum (Yi*Wi)/\Sigma Wi$$

Where

X, Y= Coordinates of the new facility at center of gravity

X_i, Y_i=Coordinates of mean centers of the zone

W_i= Average annual weight consumed by each zone of the country

Using these coordinates the location of new facility was mapped using GIS 9.3 as in analysis part of this paper and the calculated Center of gravity values were indicated in Appendix-VI. In addition, clustering of the fertilizer consumption zones and existing central warehouses mapping were done with GIS 9.3 (ESRI, 2008). This clustering was made to identify potential consumer zones throughout the country and to plan the required logistics facilities in the zones.

The options available to identify regional clusters in ArcGIS 9.3 are available in spatial statistical tool boxes and include both statistical functions and general purpose utilities designed for regional clusters. The options available were grouped in some toolsets as measuring geographical distribution, mean center tools, mapping clusters and modeling spatial relationship.

The tools from geographic distribution toolsets were descriptive tools, helping to summarize the most important characteristics of a spatial distribution of economic, social and geographic data. Central feature tools identifies the most centrally feature in point, line and polygon feature class (i.e. point used for indicating towns, villages, seaports; line for road network and rail network and polygon for indicating a boundary region, zone and *woredas*). To create the zonal centers, *woredas* were used which were available within the zone. A directional distribution tool is the standard deviational ellipse and measures how concentrated features are around geographic mean, and whether or not they reveal a directional trend. Mean center tool identifies the geographic center for a set of features. For this thesis, mean center of each zone of regions was selected based on geographic mean concentration of zonal woredas' population. The centers obtained may be out of the existing towns and road alignment. Hence, for the purpose of accessibility, the centers found may be considered to the nearest town centers and of which the major road traverses. Standard distance tool measures the degree to which features are concentrated dispersed around the geographic mean center.

Mapping clusters

Tools from the mapping clusters toolset from GIS 9.3 identified where spatial clustering occurs, and where spatial outliers are located. The *Anselin's local Moran's I* and *Hot Spot Analysis* tools were used for a cluster and outlier analysis (ESRI, 2008).

The *Anselin's local Moran's I* tool was used for a cluster and outlier analysis, to identify regional clusters, based on the number of fertilizer consumption from zones of Ethiopia. The data of zonal consumption of fertilizer of the years from 2003/04-2008/09 were used for cluster mapping obtained from annual data of Central Statistical Agency of Ethiopia as in Appendix-V. The average consumptions of six years were used for the analysis. The tools were used to identify clusters of high or low values as well as spatial outliers using like a set of features the quantity of fertilizer consumption and the spatial locations of each zone.

Hot Spot Analysis tool was used to identify clusters with high values of fertilizer consumption, named hot spots, and clusters with low values named cold spots, based on given weighted features of zonal fertilizer consumption. Similar data of *Anselins local Moran's I* were used for the hot spot analysis.

3.3.5 Route optimization for fertilizer distribution to central warehouses

The most dominant challenges for import of fertilizer from port to the inland customer were the transport cost factors. This was mainly accompanied by distance and road conditions factor from origin to destinations. Two major existing routes are available to transport fertilizer from port of Djibouti to the main central warehouses of Ethiopia. Hence, to obtain the most economical route to deliver for central warehouses, road networks were optimized using GIS9.3 software by network analysis tools (ESRI, 2008).

GIS based route optimization

Weigel (2001) stated that unlike any other commercial routing and scheduling system, ESRI routing software uses GIS data management with the latest operations research techniques. While several competing systems utilize map display, non-take advantage of the true street network topology to accurately model time and distance. ESRI's GIS-based approach loads the geometric network (i.e. x, y coordinates representing major roads and minor roads) from a map data in to a logical network that can be accessed by optimization solvers. Weigel also mentioned that advanced optimization algorithms combined with a GIS street data base allow companies to realize increases in efficiency of between 15 and 20 percent over manual method system. Using GIS 9.3 software, the optimum route based on the digital road networks of Ethiopian to the main distribution centers was obtained.

The optimum route was made using port as origin and central warehouses as destinations. Since this thesis concentrated on the Ethio-Djibouti corridor, Djibouti port was used as origin and the fourteen warehouses as destinations. The digital road networks used in the optimization was within the boundary of Ethiopia. The road network to the port of Djibouti from Ethiopian boundary was not digitalized. Hence, an extension was made from this boundary to the port Djibouti and the optimization was made using this extension as a link and the port as origin. As the extension from the boundary did not indicate the actual distance between the port and the boundary, the actual distance between Djibouti port to Ethiopian boundary was obtained from Afro Consult reports on freight transport and logistics study.

ArcGIS network analyst can find the best way to get from one location to another or the best way to visit locations (ESRI, 2008). The route solver tool in the network analyst provided the shortest path between two stops using distance based cost attribute. Along with the best route, ArcGIS network analyst provides with turn by turn the total distance to travel between the stops. The total data required in selecting the best route analysis was the Ethiopian Road Network, towns, port Djibouti, the central warehouses location centers which was taken as the center of the towns. The road networks consisted the road condition as motarable, all weathered road and dry weathered road section by section throughout the country. All the data used were digitized and the coordinates for each element was sensed with the software. The outputs from route solver tools can be observed from the attribute tables by right clicking from the output tables of content.
General summary of methodological framework for this thesis is shown in Figure 3.2 below.

Framework of methodologies

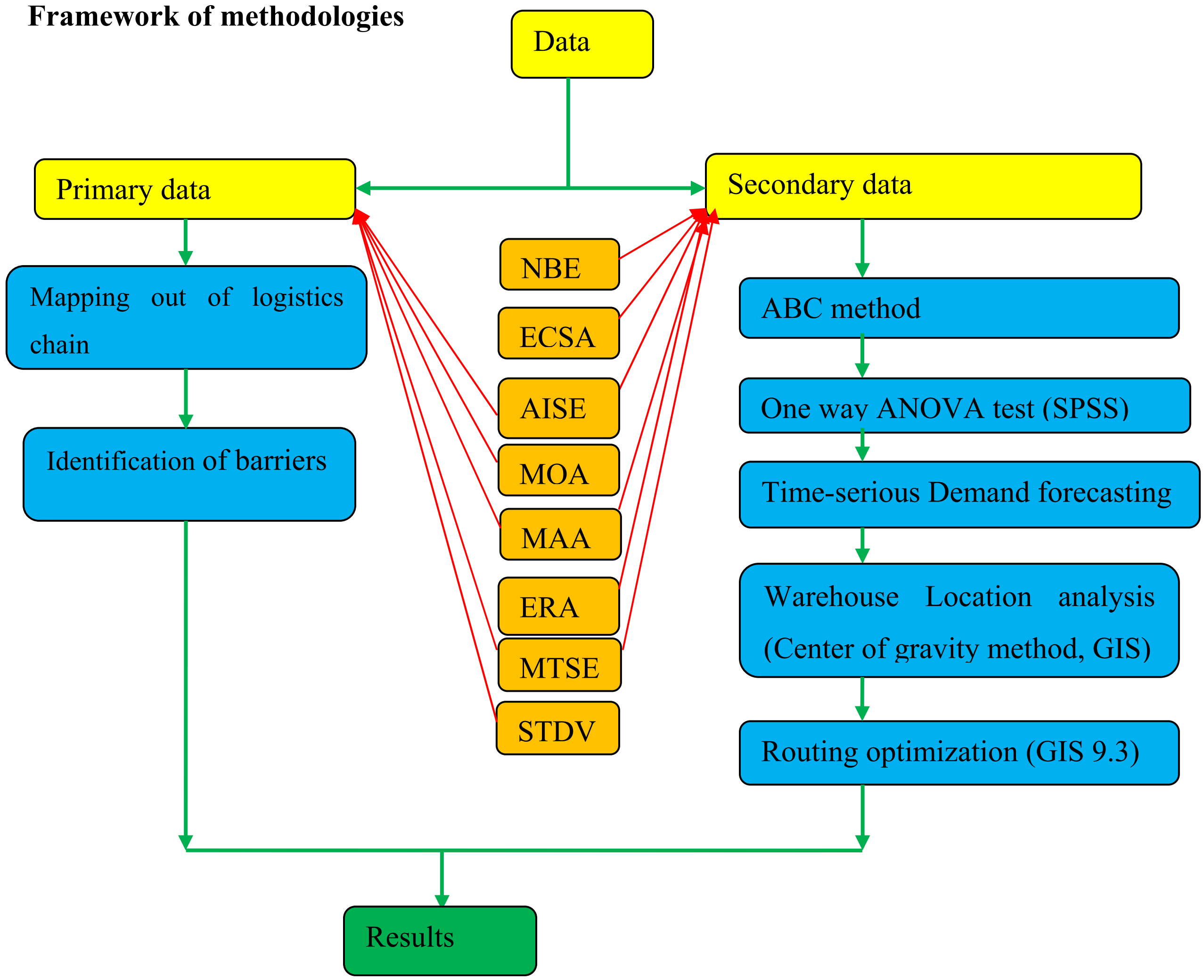


Figure 3.2: Framework of methodology

4. RESULTS

The results of the survey include the logistics chain of fertilizer from port of operation to the end users. For easily understanding or interpretation, the results of the data collected were outlined in the sequential process of the chain. In this chapter, data for flow of fertilizer to different geographic areas obtained from different stakeholders was analyzed. Description of logistics chains of fertilizer has an essential input for the understanding of the whole chain processes. Subsequently, the results of the survey was analyzed and displayed in line with the objectives of the thesis.

4. 1 Description of Logistics Chain of Fertilizer and Improved Seed in Ethiopia

Description of fertilizer logistics chain

Logistics chain of fertilizer from Djibouti port to the final consumer consists of a number of activities that could be categorized as port operation activities and inland operational activities. In the port operation activities, the operation starts unloading of dry bulk cargoes from ship and bagging for direct loading to trucks. These unloading from ship, bagging and loading to trucks of bulk commodities in Djibouti port were handled by STDV of MIDROC Company. The company served as a drop of point for grains and fertilizers from international aid agencies and local importers to different countries including Ethiopia, Somalia and Djibouti. These stevedoring activities of dry bulk cargo have been held in the port for more than 30 years with traditional and manual systems. However, in 2006 the new grain and fertilizer terminal construction was completed to serve as a new and state-of- the art terminal whose main criteria are to unload and load cereals and fertilizer efficiently, minimizing port congestion and waiting times of vessels, increase the development of port authority operations, expedite food aid cargoes and fertilizer shipment to the neighboring countries, controlling air pollution and reducing the spillage and losses during unloading processes. The new terminal has already received several dry bulk cargo ships since the inauguration on December 21, 2006. According to Eng.Hussein Mulugeta, head of facility of STDV, the new terminal has discharged around six million metric tons dry cargoes since the inauguration day.

In the process of unloading from ship and loading to trucks, sequential processes are required to make the whole system of the stevedoring services effective.

Discharging fertilizer from ship

The discharge of bulk commodities from vessels was fully automated under very close monitoring process in the control room which operates twenty four hours daily. Discharge operations of fertilizer was managed by one shore crane having capacity of lifting 69 tones, operating with a grab of approximately 21MT per scoop achieving 600MT/Hr, with a guaranteed average quantity of dispatching 4000MT up to stack on truck by using six bagging lines respectively taking cargo through a mobile shore hopper in to the conveyor belt. Figure 4.1 shows how mobile shore crane operated in discharging fertilizer from ship to mobile shore hopper. The conveyor system is fully flexible from vessel to silo, from vessel to bagging, vessels to silo and bagging, silo to bagging. The total length of the conveyor belt was approximately 950 meters designed to carry a capacity of 600MT/Hr.

Figure 4.1. Discharging of fertilizer from ship to mobile shore hoppers

Bagging service

STDV terminal bagging section is set up on a higher platform subdivided in to two sections each running six bagging lines respectively with the main purpose of dispatching either of the two different commodities (grain and fertilizer) from different points and without contamination. Figure 4.2 below indicates how bagging of fertilizer made and direct loading of trucks from bagging machine. By design the bagging system was calibrated to control bagging at 50kgs net quantities for both grain and fertilizer. The production of the bagging station is 15-20 bags of 50kgs per minute per line. In bagging stage, trucks were made available by the Maritime Transit Service Enterprise (MTSE) for direct delivery to trucks. The MTSE inspector inspected the plate of the trucks ready for loading were the permitted trucks of having registered the gate pass of Djibouti customs and made available records for Ethiopian Customs Djibouti branch to prepare clearing documents for inland customs. In addition, Agricultural Input Supply Enterprise's (AISE's) inspector controlled the type and total amount of fertilizer loaded and report daily to the head office in Addis Ababa.

Figure 4.2. Bagging and loading to trucks of fertilizer to six bagging lines

STDV dry bulk terminal facilities

The terminal activities were synchronized to allow ongoing discharging operations to serve two functions concurrently of loading the bagging hoppers for final dispatches on to trucks by bags of 50kgs while at the same time diverting some quantities in to the flat silo shed. Figure 4.3 below indicated that the dispatching of fertilizer from hopper to bagging machine and flat silo shed simultaneously. Terminal consists of cereal flat silo shed with storage capacity of 30,000MT and fertilizer flat silo shed with storage capacity of 40,000MT. Bagging plant consists of 12 bagging lines (6 for grain and 6 for fertilizer) each with capacity to bag 20 bags per minute thus 1200 bags per hour per line for a 50Kgs bag. Conveyor system for unloading in to warehouses and /or directly to bagging plant. The silo/warehouse was equipped on the top central area with conveyor trippers which distributes the cargo all around and evenly to maximize voluminous holding capacity space in the shed.

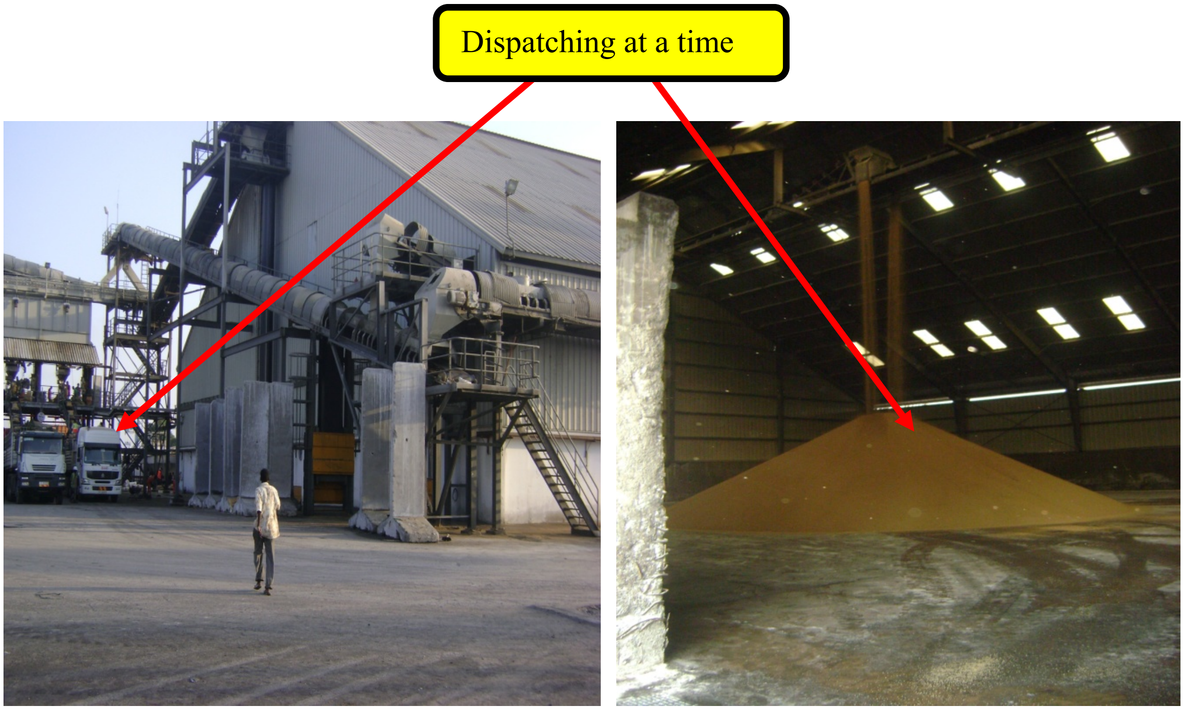


Figure 4.3. Loading and storing of fertilizer to the trucks and silo at the same time

Figure 4.4 below shows the general activities of fertilizer dispaching when ship arrived on the port of Djibouti to clearance of trucks from port to the inland. STDV terminal would always serve as aconduit for the transit dry bulk cargoes with no room for storage practice so that to encourage users to clear cargoes as fast as possible to create space for other expected vessels due to call of the port of Djibouti. The terminal in general, berth 14/15 , has a total length of 390 meters and laid on atotal area of 42,000M^2 of which berth 14 was dedicated for fertilizer dispaching.

The bulk fertilizer stored in the silo was ready for further bagging through the pit which was connnected to the conveyor for direct delivery to the bagging plant. The silo was used as a buffer system to increase the turn round time of ships and as a temporary storage when there were ashortage of trucks.

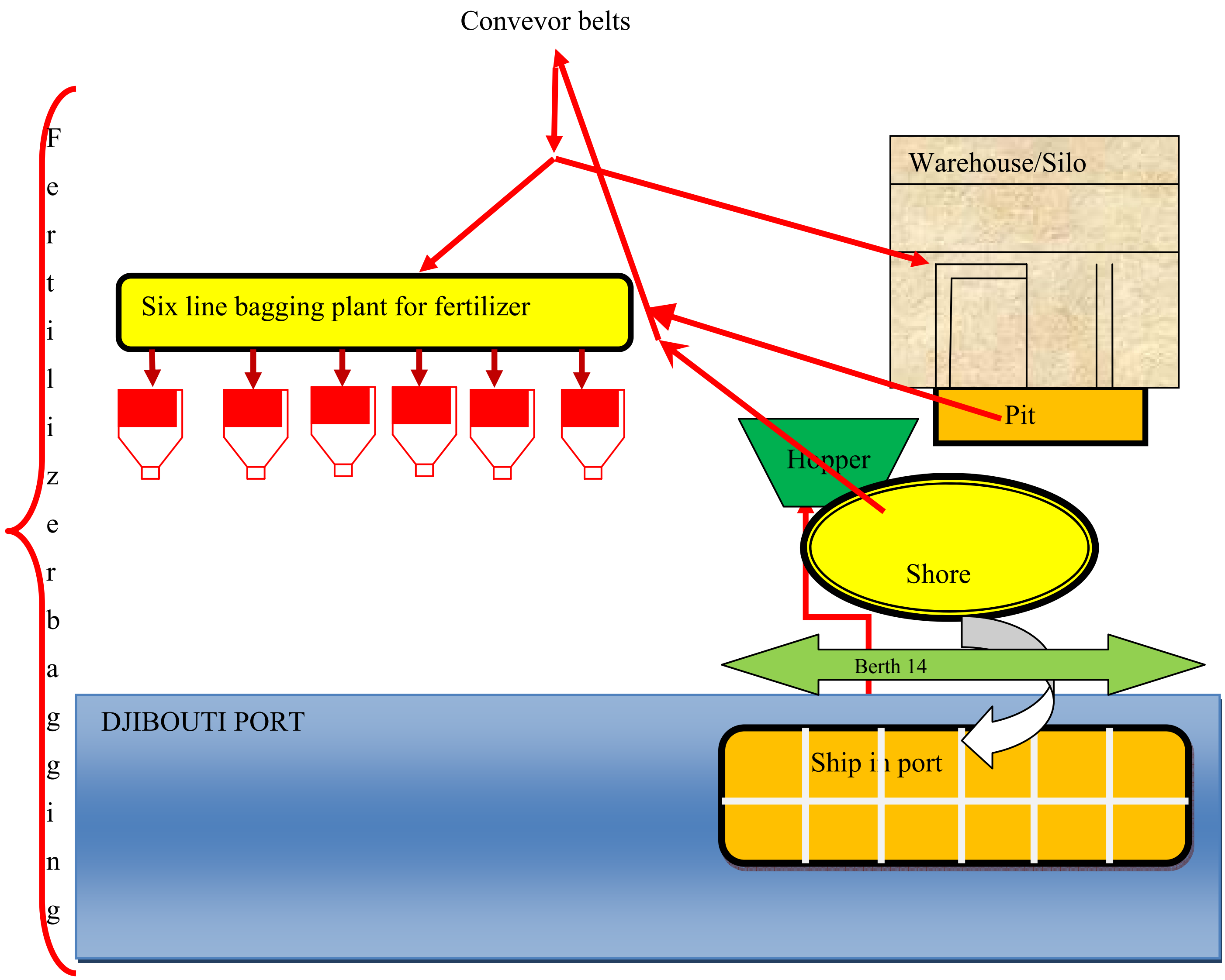


Figure 4.4. Dispatch of fertilizer from ship to trucks in port

The loading of fertilizer from ship to trucks follows to lines through direct shipment and through silo as shown in Figure 4.5 below. Fertilizer flow from ship to silo requires additional loader machine to push to the pit for further bagging. It was also observed that fertilizer placed in flat shed silo was moisturized.

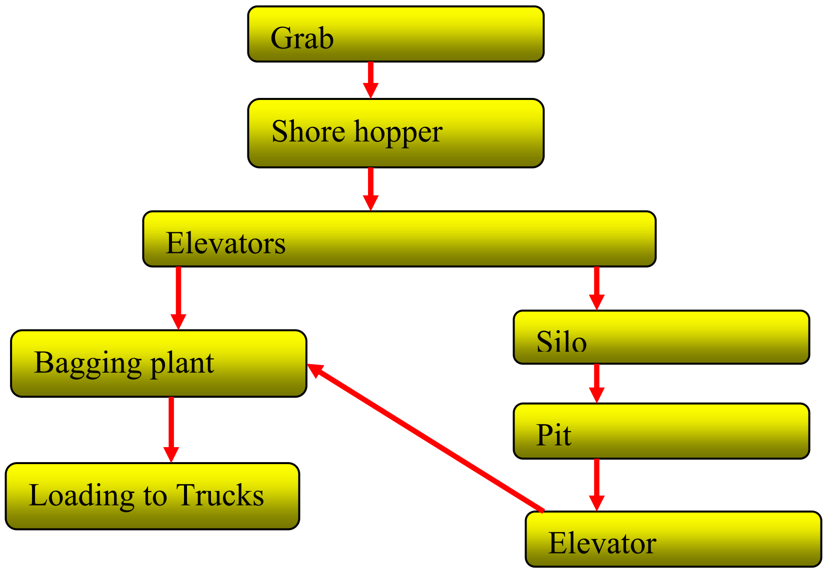


Figure 4.5. Loading lines of fertilizer from ship to trucks in STDV terminal

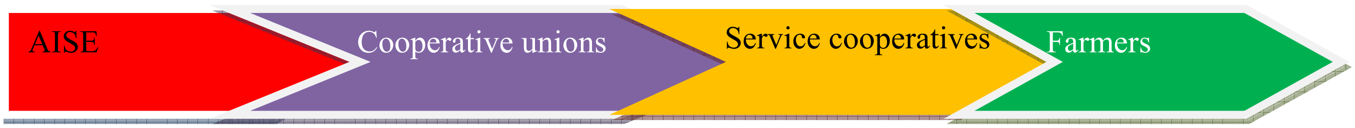
The offloading bulk fertilizer was carried out in Djibouti which shipside bagging by STDV followed by direct loading onto trucks for transport to any of the country's central warehouses based on the contract made with Agricultural Input Supply Enterprise(AISE) through clearing agents. Total international fertilizer market in Ethiopia by the year 2010/2011 fiscal year was made based on two international competitive biddings. The first bid was already done in August 2010 and amounts 500000 MT and second bid was not made during the survey which amounted around 100000MT. In most cases, Agricultural Input Supply Enterprise personnel indicated that, an international contract is signed between August-September and delivery occurs from December to May.

Since, Fertilizer industry has economies of scale in procurement, higher scales of procurement yields lower costs for a single buyer. Hence, According to AISE personnel, the import activity of fertilizer was recommended to be held by a single organization for economies of scale. The distribution of fertilizer in Ethiopia was done by a number of farmers' cooperative union from the respective regions collectively representing one organization to take the import activity selected by them in which coordination was handed by Ministry of Agriculture. In the current year, unions of regions requested the import of fertilizer to be undertaken by them by forming one Regional Federation. However, Ministry of Agriculture on the side of national economy decided import of fertilizer to be undertaken by a single agent instead of three or more federations for better economy of scale. Hence, regional farmers' cooperative unions collectively reached a decision in the import activity of fertilizer to be laid on experienced organization. Hence, Agricultural Input Supply Enterprise (AISE) was selected as the sole importer of fertilizer on behalf of farmers' cooperative union for the country's demand to the central warehouses. AISE is experienced organization in import and distribution of fertilizer since 1984 and has a capacity of importing fertilizer by making an international bidding, delivery to the central warehouse of the respective unions and storing to their own warehouses. The major activities performed by AISE are international bidding, coordination of fertilizer flow to central warehouse, port clearance activities through the agents and sometimes delivery to final customer.

AISE has delegated Maritime and Transit Service Enterprise to take clearing activities at the port of Djibouti and also assigned inspectors at the port to report the amount of fertilizer loaded and transported to the country. Port related activity was handled through the agent with effective dispatching of vehicles to the required central warehouses. Transport service was given to four national transporters which have assumed a capacity to handle the given assignment. These four transporters, Comet transport share company, Bekelcha transport, TikurAbay transport and TransEthiopia transport, have taken the responsibility and risk of the given distribution assignment based on the contract made with AISE. AISE also served as a wholesaler in regions, where transport service was difficult to deliver to respective customer, using their own trucks.

When direct shipment to unions was required, AISE informs the regional farmers' cooperative union whether they were ready to receive and required demand for each shipment from port. The location of the warehouse to be delivered was then identified with the available capacity by the union. This direct delivery from port to the respective unions minimizes the loading and unloading costs and inventory costs. When the unions were not ready for the direct receiving, AISE stocked into its warehouses and rental warehouses for later distribution. Hence, delivery channel of fertilizer from port was made on direct delivery with no intermediate warehouse storage or indirect delivery with intermediate warehouse systems to the respective regional unions and service cooperatives. After unions in each region received the demand from either direct delivery or indirect delivery, they started to distribute to the primary service cooperatives from which farmers can get direct access to buy. In regions with no unions like Tigray regional state and areas difficult for freight transport, Agricultural Input Supply Enterprise (AISE) prepared to deliver fertilizer to primary service cooperatives acting as wholesaler.

The distribution channel and distribution chain of fertilizer flow from port to the end user are shown in Figure 3.6.



Importer Wholesaler Retailer Consumer

Delivery channel of fertilizer through the farmers' cooperative union

Importer/wholesaler Retailer Consumer

Delivery channel of fertilizer with no involvement of farmers' cooperative union

Figure 4.6. Delivery channel of fertilizer from port.

The mapping out of Ethiopian fertilizer distribution chain

Figure 4.7 below shows the inter-relation of fertilizer flow from port to final customer. The overall flow of fertilizer includes physical flow, information and document flow, financial flow. Since logistics encompasses a broader range of activities than merely the transport of goods from port to farm gate, it includes activities of documentation, bagging, inventory management and communication. The overall activities of fertilizer dispatching from port to final customer comprises two major components. These components are the port activities and the inland activities as explained in description section of this chapter. Port activities are key elements which are stimulators of economic growth and are critical links of inland logistics chain of landlocked countries. Inside Djibouti port, there are a number of stakeholders working in a complex environment. The stakeholders

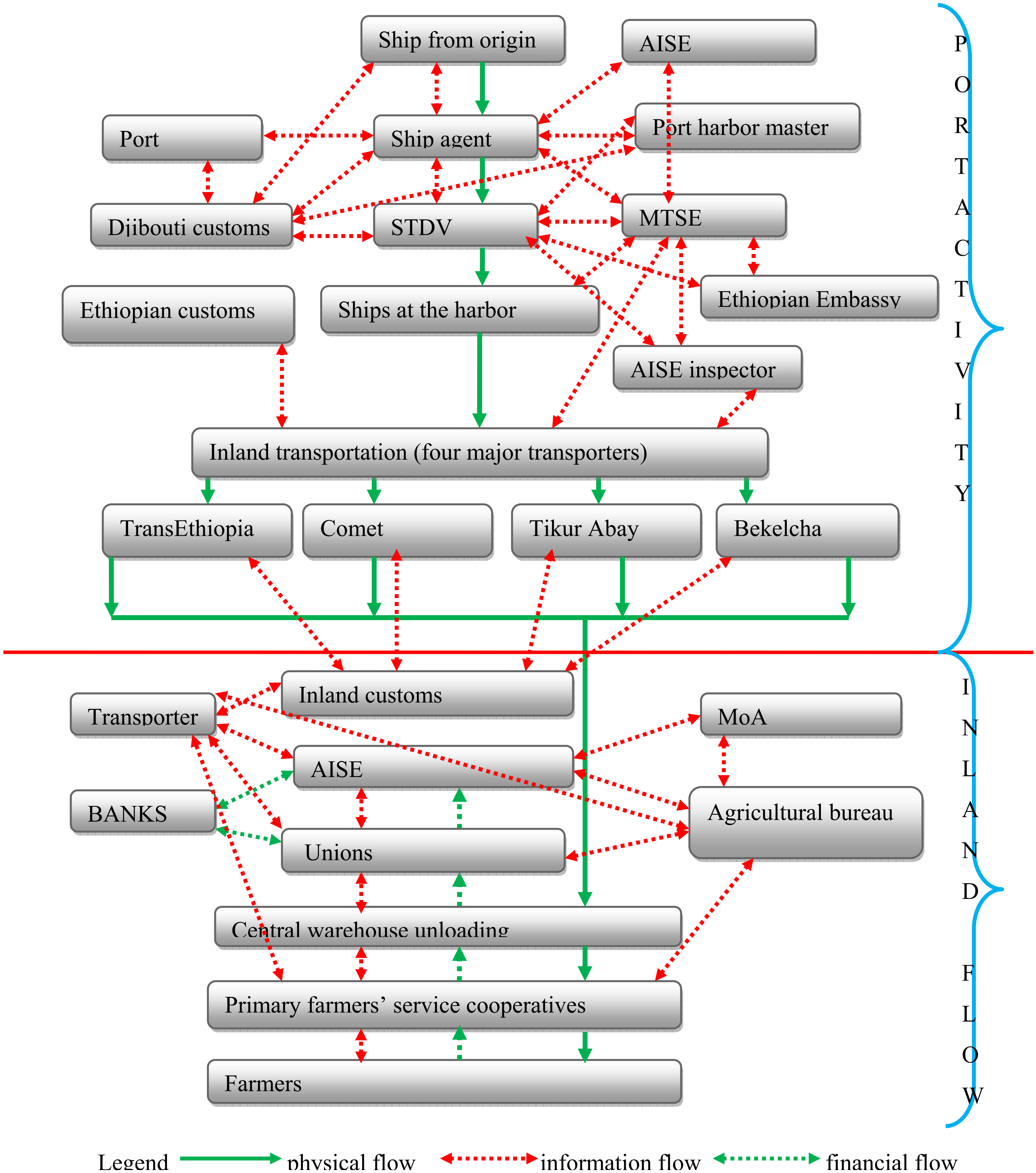


Figure 4.7. Mapping out of Ethiopian Fertilizer Distribution Chain

in the port is port authority, ships' agent, clearing agent, security, transporters, customs, and importer agencies, stevedoring providers. Transport representatives, port harbor masters and Ethiopian embassy port coordinator, transport authority representatives were also facilitators in the import and export activities.

4. 2 Documentation procedure and information flows

For the inland dispatching of fertilizer from port of Djibouti to Ethiopia, number of documents and information flow was required to clear the formalities of port regulations. Clearing and forwarding agents of AISE (i.e. Maritime and Transit Service Enterprise) who operated in liaison with the shipping agents, the consignees, the stevedore provider and customs officers to facilitate the clearing and transportation of fertilizer from port to landing. The flow of documents and procedures was considered complex which involved many steps to clear transport from port to Ethiopia despite fertilizer cargo clearing system was less complex than other cargo clearing systems.

Once the ship was loaded in the countries of origin, relevant documents were sent to the importer, or his appointed clearing and forwarding agents, or to his bank. These documents comprise the Bill of Lading (B/L), commercial invoice and a packing list. Three original Bills of Lading are required one for Djibouti customs and two for the agent. Since the ship took longer days to the port of destination, the documents were sent to the importers or its representatives through **DHL**. All documents received by the importer should immediately be given to the importers appointed clearing and forwarding agents (MTSE). Vessels arriving at the port of Djibouti carrying fertilizer have a shipping agent, being the intermediary between the ship owners and the cargo owners. The ship agents announces continuously the expected arrival date of each ship to the port harbor master, port authority and the stevedore provider, customs and clearing and forwarding agents. The announcement was based on fax and websites and telephoning.

Maritime and Transit Service Enterprise presents the documents received from the importer to the ship's agent so that the original Bill of Lading (B/L) can be released, auctioned through the signature of an approved person and a stamp, indicating that all sea freight and incidental charges have been paid. The signature of the approved person was then circulated to Djibouti port customs. Unfulfilment of this procedure of original Bill of Lading may result considerable delay of cargo clearing which affects over all logistics chain of fertilizer.

Hence, the Ethiopian customs branch in Djibouti port prepares the document in collaboration with maritime transit service enterprise for the inland customs branch to allow the fertilizer movement to final destination.

The information flows in importing activities are from point to point with no central coordination units. Figure 4.8 indicate that the information flow was more complex to obtain the overall activities of the port.

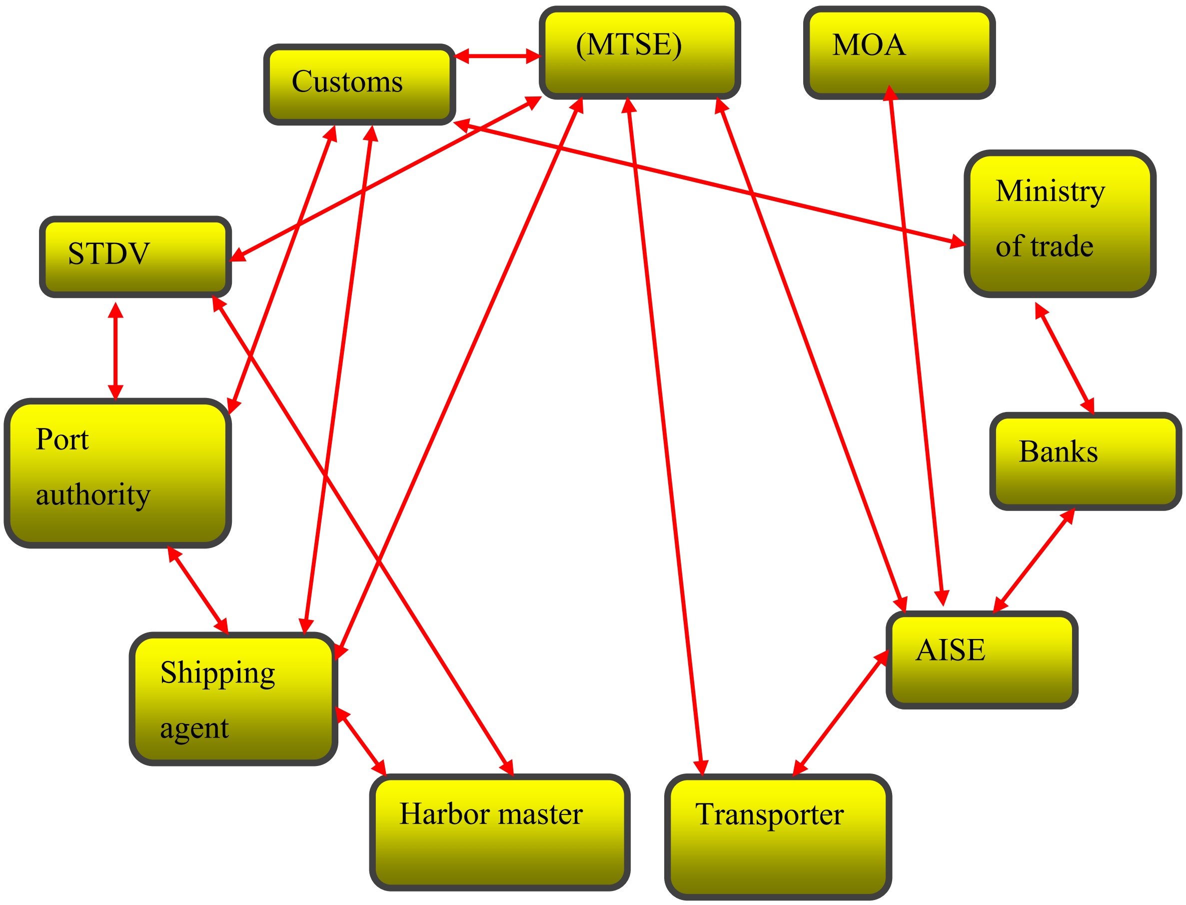


Figure 4.8. Point to point information flow of fertilizer clearing.

AISE initially agreed with NBE for opening Letter of Credit **(L/C)** for the procurements of fertilizer and for payment terms that are arranged between the buyer's and seller's banks. It is a bank document issued to safeguard the interest of both sellers and buyers. The seller makes booking request with the shipping line, supplying information that is eventually made up in to a Bill of Lading **(B/L)** (quantity, vessel, voyage, notify party and commodity) document type. The **B/L** is the authentic receipts delivered by the carrier, confirming that the goods there in specified have been loaded or taken in charge for loading on a designated vessel for carriage to a specified port. This **B/L** is established in two or three "originals ", signed and stamped by the carriers or their agents.

In general, the total obligatory documents which should be presented in the counter for the purpose of clearing fertilizer and in accordance with the customs laws includes original invoice, invoice of the port charges, invoice of handling charges, original packing list, original bill of lading, original of electronic gate pass, exempted form of tax payment, certificate of origin. In addition, Tin, Vat and trade license is required for the bank for letter of credit (L/C) opening.

4.3 Results of interview of logistics chain

For the better understanding of logistics chain of fertilizer from port of Djibouti to the end users, data were collected from different stakeholders in the form of primary data as interview and observation and secondary data as in the form of numerical figures. Hence, the collected interview result is then presented according to the stakeholders' response as in Figure 4.9 below.

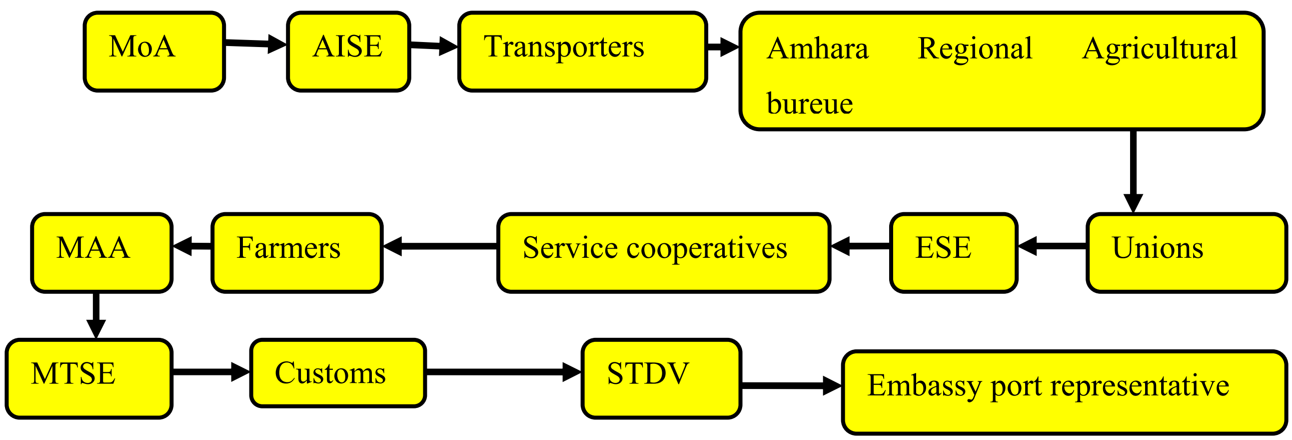


Figure 4.9. Interviewed stakeholders of fertilizer logistics chain

Ministry of Agriculture (MoA)

The results of the stakeholders response was then presented according to Figure 4.9 above.

According to the marketing manager of MoA, the main function of the ministry in the logistics chain of fertilizer was coordination of regional cooperative unions in selection of one importer among themselves to improve the marketing policy of fertilizer as a nation. In addition, the manager explained that there was no government intervention in the marketing structure of fertilizer. However, for the overall national benefits of fertilizer, government has been involved in minimizing the overall costs of fertilizer importation by changing the marketing structure and policy. Hence, according to the marketing manager response, the current fertilizer market policy is free market system. Although the fertilizer importation, distribution and pricing were controlled by a government in early 1980s, the government allowed private sectors to participate in fertilizer importation and distribution following the issuance of the National fertilizer policy in 1993.

Ministry of Agriculture delivers the total quantity of fertilizer that was going to be imported for the selected importer based on the regional fertilizer demand. The total demand of fertilizer requirement was identified from regional agricultural bureau. Based on the regional demand requirement, the Ministry aggregates all regional requirements and deducting from the stock outs of the previous year available in every regional warehouses reported from the importer and regional agricultural bureau. The net volume of fertilizer was then delivered to be procured for the coming year demand. The marketing manager also emphasized that there were fluctuations of demand requirements based on late coming of rainfall. Nationally, there are large amount of stock outs every year throughout the country. According to the manager response, the stock outs were mainly due to the allocation of more fertilizer than the requested amount for different regions. In addition, considerable stock outs were resulted from the late announcement of fertilizer price to farmers.

In summary, the manager explained that, Ministry of Agriculture was not involved in fertilizer marketing rather in coordination of importers and wholesalers as national benefits to minimize the overall costs of fertilizer.

Agricultural Input Supply Enterprise (AISE)

According to Yibeyin's explanation, marketing coordinator of Agricultural Input Supply Enterprise (AISE), has been working as an importer, wholesaler and retailer since it has established in 1985. He also explained that there were another importers as Ambasel, Guna, Fertiline, Dinsho, Wondo and Amalgamates working with AISE till recently. However, in the last few years, they withdrawn from fertilizer marketing industry as they cannot capable of continuing for fertilizer importation leaving AISE as a sole importer for national fertilizer demand. Yibeyin also stated that in the current year each region requested the Ministry of Agriculture (MOA) to import fertilizer in the form of Federations. However, the Ministry was intervening to be imported by a single importer for better economy of scale to buy large amount of fertilizer for national demand with minimum price. Hence, the regional farmers' union collectively select Agricultural Input Supply Enterprise as a sole importer for the national demand.

AISE planned the number of vehicles for each shipment based on the contracts made between the transporters. In current year, the transporters were required to load 2500MT per day from ship based on the contact agreements made between transporters and AISE. Hence, for ship loading of 25000MT required to be cleared in 10 days even though the Figure didn't determine the actual condition. Agricultural Input Supply Enterprise paid for Maritime and Transit Service Enterprise about 4Birr/quintal for clearing of fertilizer from port. The marketing coordinator also stated that the demurrage costs were incurred on transporters based on the agreements if the transporters were not available before reaching the grace periods. Based on Yibeyin's explanations, the demurrage costs incurred on transporters were 16,000 USD/day. Subsequently, the cost increased by 0.20USD/Mt for the first 10 days and 0.40USD/Mt for next days of ships stopping in the port. According to the contract agreements of transporters and AISE, the transporters were responsible for any loss or discrepancies of fertilizer by charge of 20% more than the lost loadings price. AISE had also a responsibility of allocating the imported fertilizer to the respective farmers union to prepare for warehousing unloading.

Yibeyen also emphasized that during the import activities there were constraints throughout the countries. Most farmers unions were not ready for the arrived fertilizers for unloading due to lack of warehouse capacities and daily workers. The schedules for direct delivery of fertilizers for regional unions were not available before the arrival of the shipments at the port which resulted challenges for importer in calling for every unions of regions to announce them. For these reasons, the Enterprise was forced to rent warehouses for final distributions.

Freight transport providers

Transport companies that were involved in fertilizer transportation were Trans Ethiopia, Tikur Abay transport, Bekelcha transport, Comet transport companies which had a contract agreement with Agricultural Input Supply Enterprise(AISE). These transporters had different capacities of trucks of which mostly a 40 ton trucks were used for transporting fertilizer from port to central warehouses of the country.

According to the four major transporters response, main challenges faced during transportation of fertilizer from port to central warehouses were similar in most cases. These four major transporters replied that they got their loading businesses through telephoning, negotiations and usually using contractual basis. The loading capacities varied from one transporter to other transporter. The trucks were planned to transport fertilizer from port based on the contract made with the importer which was every transporter should transport 2500MT per day. Hence, subcontract was made to fill the gap if the capacities of trucks already available by the selected transporters were less to transport daily required fertilizer to be loaded from bagging machine. However, the challenges of shortage of trucks were contributed due to less efficiency of regional warehouse unloading. These problems were mainly happened in warehouses out of Addis Ababa and Nazareth warehouses which had lesser holding capacities incompatible with the truck loading capacities. Ermais, Branch manager of Tikur Abay Transport Share Company, stated that trucks were forced to stop for a maximum of 8-10 days in regional warehouses to unload fertilizer which influenced the trucking industry utilization. This was mainly due to lack of daily laborers and warehousing space. He also emphasized that the average unloading of fertilizer in most regional warehouses were 2-3days. The inefficiency of transport and warehouse interface was mainly due to the minimum coordination of the importer and the regional farmers unions. In addition, warehousing and unloading were handled by the third parties of cooperative unions rather than the contract owner (AISE). This made the coordination between the transporter and warehouse interface less effective.

Relating to the findings of return load to the port, most transporter marketing managers replied that they preferred to go with no loading to increase the turn round time to port. Most of the four transporters replied that despite the availability of load to the port especially coffee from Addis Ababa, the high risk for theft and longer time for inspection lead to not load coffee to the port. Hence, usually transporters who involved in fertilizer transport contract were moving to the port with empty back loading and carrying empty container.

Roads are in good condition for most central warehouses from port of Djibouti except the road for Tigray regional state from port of Djibouti (i.e. Mille-Chifra) roads which is under construction. The communication system between the transporter and drivers were mostly with telephone and radio communication. Trans Ethiopia has been applying the GPS (Global Positioning System) for truck tracking. The branch manager in Addis Ababa explained that GPS tracking was the key for controlling the truck position in order to plan for the next loading. The challenges they faced during communication was the low coverage of network areas to check the positions of trucks. GPS tracking helped to control when truck stop in any position and out of the actual route to minimize the fuel consumption which is one of the key driver of high transportation cost.

Regulations and enforcement procedures during fertilizer transportation had not much problems compared with other commodities. However, transporters marketing mangers explained that the gate pass problems of Djibouti port entrance were the difficulty of the major transporters which was valid for only 24 hours. If trucks were late above 24 hours, anew gate pass was required for entrance to port. At mille customs trucks faced inspection problem of on average 2-3hours. Weigh bridges along Ethio-Djibouti corridor at awash and Mojo have no significant problems on fertilizer loadings.

Their origin destination (O-D) was based on the importers requirement of central warehouses demand. Usually, trucks from port were required to go to the central warehouses throughout the country by the importer. However, most trucks were moved to Nazareth warehouse as most wholesalers were concentrated to these areas and also there were numbers of warehouses to the town. Most loadings were undertaken starting in the month of December to the end of May.

Amhara Regional Agricultural Bureau

The main contribution of the agricultural bureau was coordination of unions in marketing structure up to the farmers. According to Mulat, coordinator of marketing of fertilizer in Amhara region, demands of regional fertilizer were sent to the Federal Ministry of Agriculture based on the demand requirements of Kebele-woreda-zone and region. Mulat also explained that the major challenges in distributions of fertilizer to the final farmers were lesser availability of trucks during the rainy season which increased the transport cost. In addition, primary farmers service providers might not ready to receive fertilizer in direct delivery request from AISE. Transport contract for distribution of fertilizer from unions' warehouses has been handled by regional agricultural bureau. The bureau had a good communication with unions in the region and the importer (AISE). The price decision of fertilizer in the region was made in the agreement with unions to avoid unnecessary price increment to farmers. The coordination was made daily with all farmers union in the region.

Challenges were faced during distributions to farmers especially zonal coordination's were minimum and reports were not obtained in the required type and time. There were variable quantities of stock out reports in most zones and also delivery information was not continuous.

Farmers' Cooperative Unions

Farmers' union were the direct receiver of fertilizer shipment from port of Djibouti. Hence, regionally every union received its demand from the central warehouses based on the cost build up cost of AISE. Unions explained that there were shortages of warehouse capacity to handle their required demand from direct delivery system. Hence, AISE stored to its warehouses and finally the unions were required to pay the unloading, warehouse rent, interest and loading charges to AISE to obtain the required demand during distribution.

The surveyed unions claimed that the billing system was not clear in that unions who paid for their overall demand were required to pay for others. Primary service cooperatives have not been ready for their demand warehouse storage which resulted claim of transporters in their delay in the warehouse loading and unloading. In addition, primary service providers were not agreed with the demand allocated from regional bureau and they were complaining to attain the unions' delivery to them. The warehousing problem has faced throughout the distribution of fertilizer. The warehouse keepers were selected by public who were not available at every time in the warehouses and it made difficulty when trucks arrived to unload and load easily which resulted delays of trucks. Due to the seasonality of fertilizer, loading and unloading workers for the warehouse were temporarily employed in daily bases and it was not always simple to get them when trucks ready to unload and load to warehouse and from warehouse. The unions also emphasized that the fertilizer price cost build up from AISE was not transparent.

Road infrastructure barriers were the major concern in distributing fertilizer from central warehouses to the primary service especially during the rainy season. The contractual procedures for transporters resulted in delay of fertilizer distribution to the retailers warehouses. The contract winner of transport providers diverted to other loading business without announcing which resulted delay of distributions. In general, obtaining transport was difficult task during distribution of fertilizer to the retailers.

Primary service cooperatives

The surveyed primary service cooperatives in Amhara region explained that the late distribution of fertilizer and improved seed during farmers' productive period influenced the working efficiency. The late distributions were mainly happened due to the late announcement of fertilizer and seed price from farmers' union. The fertilizer price for distribution was announced usually in the month of May which was the busy months of farmers. They also emphasized that the fertilizer started to arrive in December and farmers were ready to buy in the month of December and January. However, late announcement of fertilizer price resulted the late delivery to farmers which increased fertilizer price by interest of 13% per quintal per month and warehouse renting.

Warehouses capacity and quality was also a major barrier of the service cooperatives distribution of fertilizer. The fertilizer delivered for service cooperatives from farmers' unions were more than the demand capacity requested which has a significant effect on warehousing service. Service cooperatives in Meshenti, West Gojam Zone, explained that unions were not ready to return unusable fertilizer. Caked unusable fertilizer occupied the warehouse for the new arrival fertilizer. The primary service cooperatives claimed that unusable Dap of 494 quintals were in the warehouses occupying space for the new arrival of fertilizer and it made a problems of storage for new arrival fertilizer. Distributions of fertilizer to the farmers were made mostly in cash and to some cases in credit. There were lacks of farmers' union coordination with the service providers for the distribution systems of fertilizer from retailers to farmers. In summary, the challenges faced and strategies were outlined as follows.

Challenges faced in primary service cooperatives according to Meshenti's primary service coordinators include:

- Lack of returning wasted fertilizer due to caking out by the cooperative unions
- Late announcement of the price of fertilizer at the same time with the farmers' productive period, usually the price was announced in the month of May.
- Overburdening of activities during fertilizer distribution due to late announcement of the price of fertilizer.
- The occupancy of the warehouses by the unusable fertilizer due to unresponsiveness of the cooperative unions to remove the wasted fertilizer.
- The allocation of fertilizer was above the capacity of the warehouses and their demand request.
- In previous years, there was underweight of fertilizer bags although recently it has shown improvements.
- The longer time of fertilizer stocking in warehouses resulted an increase of distribution cost due to the additional costs of bank interests.

- Insufficient distribution network and the increment of fertilizer price from year to year were the major challenges of service cooperatives.

Strategies suggested in minimizing the constraints by the primary service cooperatives coordinators in West Gojam Zone.

- The actual requested demand should be delivered in order to minimize the overall stocking of fertilizer and risk of damage in summer season due to moisture.
- The price of fertilizer should be announced in early of the fertilizer arrival time
- Unusable fertilizer in the warehouse should be moved out by the respective cooperative unions before the arrival of the New Year fertilizer.

Farmers

The main challenges faced by farmers were late delivery of fertilizer by the service cooperatives. Poor accesses to the remote areas were resulting transporting fertilizer for longer distances with donkey and mules. In addition, farmers in Meshenti and Gozamin wereda claimed that they faced a shortage of improved seed and the allocation of the available improved seed was not fair. They also emphasized that the price of improved seed was much higher than that of the local seed. The major challenges faced during collection of improved seed and fertilizer from service cooperative was the unknown delivery time. Most surveyed farmers explained that it takes up to four days to get fertilizer and improved seed from the service cooperatives.

Maritime Affairs Authority (MAA)

Maritime Authority Affairs is a government body under Ministry of Transport which was established in coordinating maritime related activities managed by different sectors in an organized manner. Eshetu, Maritime Authority representative, explained that in current situation the authority has been mainly working on the operations of multimodal transport systems. The main objectives of the authority are to ensure that the transport operations and movement of goods in import and export of the country are economical; plan, coordinate and enforce such operation. In addition, the authority have a main duty to reduce the transit time of import- export of goods, and coordinates the concerned governments to care for goods at port. The authority also have negotiates for the variability of tariffs incurred by the port authority.

Maritime Service Enterprise (MTSE) activities, problems and strategies

Maritime Service Enterprise was the clearing agents of fertilizer for AISE and all port activities related to fertilizer were handled by the enterprise. The main activities performed by Maritime transit service enterprise comprised preparing the port entry get pass paper and clearing and forwarding of goods. In addition, the enterprise also provided loading and unloading of goods and as a ship agent.

The branch manager of MTSE in Djibouti port explained the main problems faced by the MTSE and strategies applied to manage the problems during operation activities.

The main challenges reported during the survey include:

- Lack of trucks when the ships arrived at the same time to the port.
- Longer turn round times of trucks required to transport to central warehouses
- Some truck drivers' unwillingness to the assigned destination away from central warehouses was the problems of fertilizer and grain transport.
- Increarment of warehouse rent and demurrage costs in Djibouti ports
- Arrival of documents to the port from the cargo owners sometimes results in delay of ports clearance regulations.

Strategies suggested by MTSE to improve the above problems

Although Ethiopian Embassy port representative were coordinating the port activities, the recent established Maritime Affairs Authority (MAA) should also have coordination office in Djibouti port to easily alleviate the controversies between different parties of the port. In addition, nationally the annual shipment of imported and exported commodities should be submitted to Maritime Affairs Authority and a schedule should be arranged based on the existing infrastructure capacity to optimize the service and reduce port congestions concentrated in few months. Hence, Ships arrival to the port of Djibouti should be in schedule for maximum benefit of port operations. The Maritime Affair Authority should announce the importers schedule and the arrival of cargoes to the port and MTSE in advance the start of the year. Ethiopian government should make an agreement with port administrative to stable tariff increment of warehouse costs and demurrage costs.

The enterprise also suggested that it is better if central warehouses are established near the port of Djibouti in Semera dry port which reduces the turn round times of trucks. The minimum turn round time of trucks help for fast clearing of the arrived ships in port and to reduce warehouse and port charges occurred due to long turn round time of trucks in the existing system.

Stevedoring Service Provider (STDV)

The capacity of dispatching of bagging of STDV facilities was in proportionate with the available loading trucks. According to Michael, the operation manager of STDV Company, dispatching of fertilizer from port to the bagging machine can be done on the company capacity for a maximum of two days which have adequate trucks. Hence, the availability of trucks ready for loading during bagging was the main bottlenecks for the efficiency of the company. In addition, the less quality and capacity of trucks was also the challenges to facilitate the loading activities. The longer turn round times of trucks affected the operation of the company as most trucks travelled longer distances up to the central warehouses which resulted a lesser efficiency of the operation of the bagging activities.

The other key problems faced and resulted lesser efficiency of the port operation was the arrival months of fertilizer in the port which were in the hottest season resulting caking out and melting of fertilizer. Moreover, the fertilizer also becomes moisturized when it arrived after the month of April resulting more difficult for easily handling of it from ship. These resulted longer times for discharging fertilizer from ships to the silo and trucks. The cranes of most ships which loaded fertilizer was mostly ineffective as their ages are older so that it was difficult to use the crane of ships to unload to the hopper.

There was also lack of coordination of ship agents with port harbour master in providing the right documents for master harbour at the right time. In addition, the schedule of the ships arrival times to the port was not coordinated and there was a congestion of the port when grains and fertilizer ships arrived at the same time in resulting a shortage of trucks and terminal congestion.

Strategies suggested by STDV to improve the bottlenecks

- Trucks transporting cargoes from port to the inland should be evaluated by the respective authority by the quality and quantity for the assigned load from port.
- To improve the efficiency of trucks turn round time problems, warehouses near Djibouti port may be the best solutions or utilizing the available trucks which are idle in the terminal may be the other option which may improve both the port operation and inland transport operation.

- If the contracts and arrival of fertilizer made at the right season, it may improve the efficiency of port and reduces the wastages happen to the fertilizer due to melting and moisturizing.
- Good quality ships should be selected which have a good quality crane
- Ship agents in the port of Djibouti should announce the exact arrival time of ships to the harbour master and provide relevant documents for clearance.
- If Ethiopian government annual scheduled is delivered to the port harbour master early of the year, the company may schedule the available resources to minimize the port congestion at peak periods.

Ethio-Djibouti corridor customs activities, challenges faced and strategies

Ethiopian customs branch in Djibouti port has been made a number of activities for the entrance of cargoes to Ethiopia from Djibouti. The customs prepared documents for the exit of trucks from port to the inland customs and checking of commodities based on the declaration and the exact commodities that would be entered to Ethiopia.

Mille customs branch also provided a service whether the imported goods were based on customs manifest and checking of drivers licence to transport imported goods. Gallafi customs office additionally provided checking of trucks for entrance of Djibouti and checking the driving licence of the driver. The office also checked the permission of the imported goods by the drivers.

The major problems faced by the customs office

According to the customs office, it usually faced the following problems:

- Most importers delay in declaration of goods in Addis Ababa
- Most imported goods was not in scheduled based which resulted a congestion of activities at some time.
- Indirect contact or through brokers with the importer and the transporter resulted in an increase of transport costs.
- Ethiopian and Djibouti customs working time difference. Ethiopian customs closure in early time than Djibouti customs resulted the stoppage of trucks in Ethiopian customs branch in Gallafi.

- The problem of electric power in Gallafi resulted in not working the customs office for twenty four hours.

Strategies suggested by the customs office that may improve the major problems include:

- Avoiding the entrance of brokers between the importer and transporter reduces the cost of transport for the importers.
- Making a schedule for the ships arrival to the port may reduce the port congestion
- Making good port facilities for drivers who come to load and transport goods in the port.
- Improving the capacity of Transport Authority in Djibouti with personnel, offices.
- Permitting the transporters to have representative office in Djibouti to improve the coordination of the transporter with the port community.

To improve the congestion of roads in Mille customs office,

- It may better if trucks from Ethiopia to Djibouti use the older road and from Djibouti to Ethiopia use the new road.

Central warehouses activities, challenges and strategies

The major activities performed in the central warehouses when the fertilizer arrived from Djibouti ports were:-

- Receiving of fertilizer by counting,
- inspecting underweight bags,
- finding fertilizer unloading labour from trucks and performing payment,
- renting of warehouses and
- performing payment.

Main challenges faced in central warehouses according to farmers cooperative unions of Gozamin and Merkeb in Amhara region include.

- Fertilizer purchasing and distribution by farmers were usually at the same time with farmers' production time.

- Fertilizer procurement and distribution were not scheduled so that shortage of warehouses happened frequently.
- Some defects of fertilizer bagging in the port resulted for unnecessary cost for warehouse receivers.
- The increment of warehouse rental cost from time to time and undefined fertilizer arrival time resulted for the unnecessary rental cost.
- Most warehouses have only one gate for loading from warehouse to trucks or unloading from trucks to warehouses which resulted difficult operation in warehouses.

Strategies suggested by the farmers' cooperative union in central warehouses include:

- Underweight bags identification should be made by the receiver of fertilizer at the warehouses
- Information sharing with the importer and warehouse rent activities to be at the same time with the loading activities.
- warehouses should be two gates to facilitate the warehouse operation
- Bagging of fertilizer at the port should be inspected by Agricultural Input Supply Enterprise (AISE) representative.

4.4. Description of value chain of maize seed

Seed has been an important agricultural commodity since the first crop plant was domesticated by pre-historic man. For thousands of years, man cleaned seed of his food crops by winnowing. This is still an important process, but it is no longer adequate to supply the kind of seed needed by farmers.

Improved seed value chain in this study referred to the entire sequence of actions necessary to create, sell, and deliver to the farmers concentrating mainly on maize value chain. The value chain of maize improved seed started from production stage to the final customer, including all economic activities as input supply, production, transformation, handling, transport, marketing, and distribution necessary to create, sell, and deliver a product.

4.3.1 Seed production and processing as value adding activities

Ethiopian seed enterprise production of improved seed has been undertaken on three bases; contracting the actual production of seed from farmers land, their own farming land and large farm holder's land. Supervision of the production was adhered to ensure the certification standard and receiving the raw seed based on the contract as 15% of the total product with the current market price of the same product as with extra benefit of 15%. The production strategy there fore plans the flow of this process to ensured that sufficient quantities of quality assured seed were produced at each stage of the seed multiplication process and that the certified seed was processed in time for the marketing strategy to be achieved. Seed production comprises a serious of related and sequential components that begin with seed multiplication and lead to the warehousing of seed ready for sale. This process was long and integrated which required careful planning. It takes up to three to six months from planting to harvesting for most crops. The multiplication of seed from the initial quantity that comes from the hands of the breeder through to the certified seed that is to be sold to farmers is a multi-season, multi generation process. Based on this generation process, seeds have given classes as pre-basic seed, basic seed and certified seed. Figure 4.10 below shows the multiplication of maize seed from breeder to farmers. Pre-basic seed is produced from breeders' seed, basic seed from pre-basic seed and certified seed from basic seed. Hence, each generation from breeders' seed on wards will decline in genetic purity to some degree.

Certified seed is seed of a constantly high and known quality (Genetic and physical quality) that has been produced according to the rules and regulation of an official seed certification scheme and for which proof of certification is available. The aim of seed certification is to produce seed with a minimum acceptable genetic purity and specified physical quality in terms of germination percentage, seed moisture and seed physical purity.

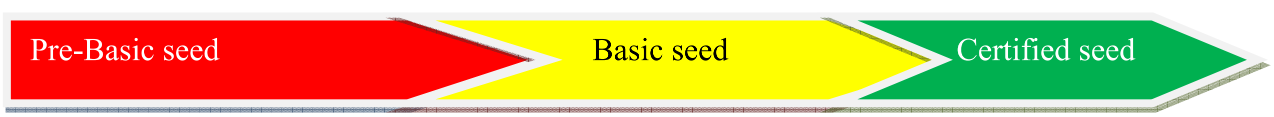


Figure 4.10. Multiplication of maize seed from breeders to farmers

4.4.2 Maize seed Harvesting and Processing

The Ethiopian Seed Enterprise branch personnel in Amhara region stated that maize seed harvesting was the critical activity in optimum seed yield**.** If the field certifications have been followed correctly, the variety will be genetically pure. How ever, from harvest onwards, the handling of the seed has a major influence on the physical and biological quality of the final product. The stage was the most critical period in the seed business as it pertains the seed quality. Hence, seed business must pay particular attention for harvesting and processing including storage and transport to be assured of quality seed. All operations from harvesting onwards therefore have to be done in such a manner that cause the seed viability, while ensuring that healthy seed was separated inferior seed and impurities (extraneous matter and weed seeds) to achieve the specified standards for certified seed. The quality of seed will decline if environmental conditions become adverse, with high temperature, high moisture, seed diseases and grain borers having the most negative impact on seed quality. Thus harvesting of the crop must be timed to ensure that the seed has the highest quality, which is as soon after physiological maturity as possible and feasible.

Hand harvesting of maize was common and enables the elimination of diseased cops at the time of reaping. Since this is labour intensive process, it requires good management and supervision. Various methods are devised to make it simple. The simplest is reaping cobs in to sacks, which are carried out of the field by hand or trailers. Reaping out put may be increased if the cobs are thrown on to the adjacent trailer in the field rather than filled in to sacks.

Shelling of maize seed was done after harvesting which determines the quantity and quality of final processed seed. For maintenance of high quality seed, hand shelling was ideal but not always economically feasible. There were also many types of mechanical shellers with varying impact on shelling quality. Aggressive, abrasive and high speed shellers will likely cause seed chipping and breakage. Mechanical damage to seed was due to abrasion and impact. Abrasion damage mainly affected the seed coat and resulted from seed rubbing against rough surfaces. Impact damage may affect the entire seed, and was a function of the force applied to the seed, usually resulted in seed chipping or cracking.

Seed storage was the next step after having shelling of seeds. Once shelled, the raw seed might be stored until processing, or enter directly in to the processing system. Raw seeds were stored either in bag or bulk till the entrance of processing unit. Seeds were stored in bags for lengthy periods, provided the seed has a moisture content of which the storage condition were favourable for maintaining seed viability (cool and dry), the seed was protected from the storage pests, the bags enabled gaseous exchange, and the bags were stacked in an orderly manner. Normally raw seeds were stored in one quintal (100kg) bags prior to processing and repacking. Once seed had been processed, seeds stored in smaller bag usually in 12.5 kg bags. Sometimes raw seeds were stored in bulk after shelling process, which had an advantage of storage space consumption. However, if the seed was to be waiting for a longer period for processing, number of conditions should be maintained in the storage. Hence, no seed should be stored unless the moisture content that was low enough to maintain seed quality. But in the observed warehouses, the first in first out rule not followed, so that seed remains for too long in the storage and also poorly ventilated storages. The over all process of value chain of improved maize seed can be overviewed using Figure 4.11 below.

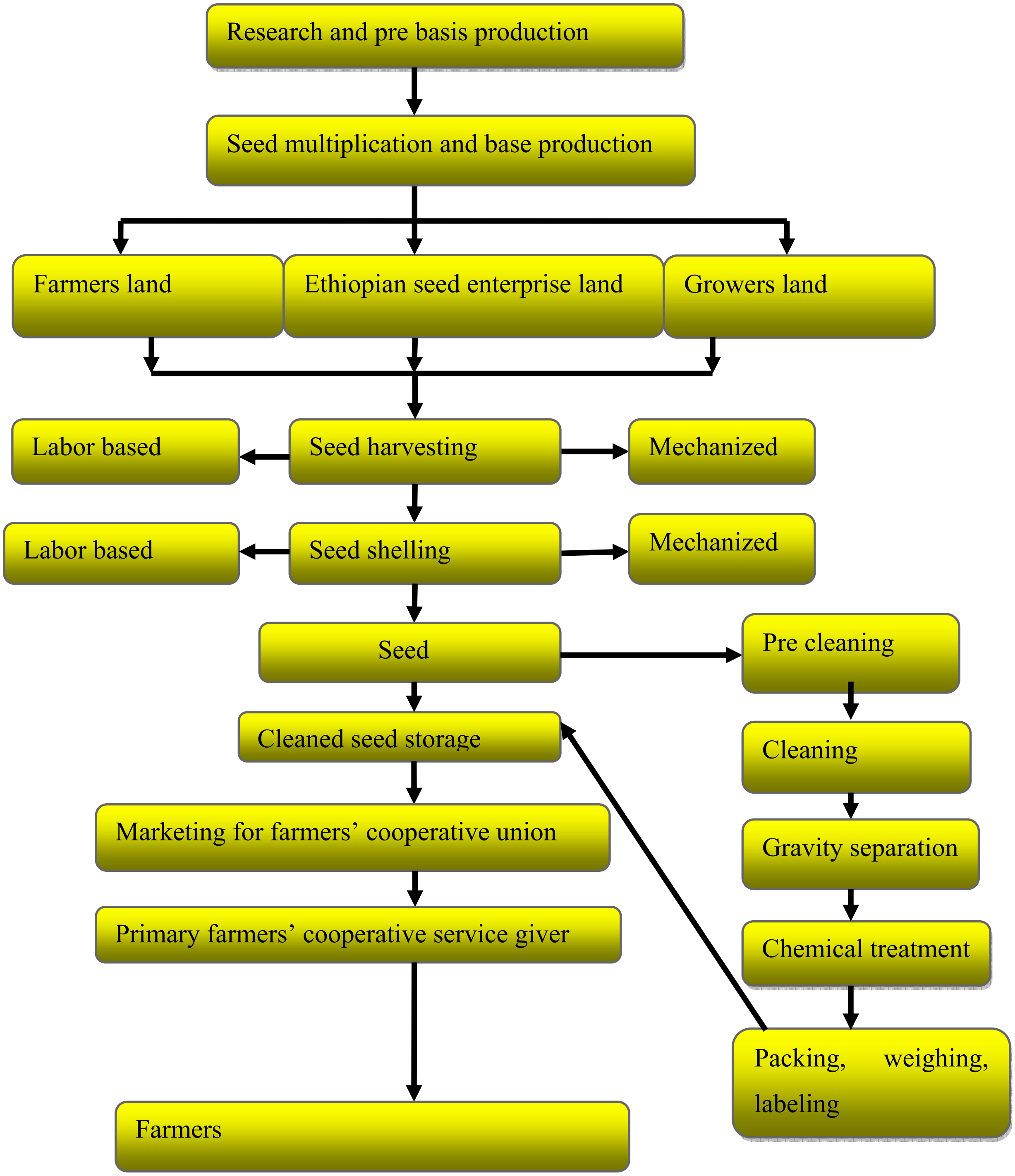


Figure 4.11. Value chain of maize improved seed

Protection of seeds from storage insects was done through fumigation which is effective in killing live storage pests. It was then supplemented insecticidal grain protectants applied directly to the seed and sprayed on to bag exteriors and building interiors. Seeds to be fumigated were enclosed in air tight plastic sheet that will prevent the escape of phosphine gas from the seed stack.

4.4.3 Maize Seed Processing (Value Adding Activities)

Raw seed might not meet the physical standards of standard purity and germination for certification. Furthermore, the size and the shape of the raw seed might not have the uniformity required by the farmers. It was also essential to add chemicals and colorants to the seed coat as a means of identification, to protect the seed from insects and disease, and/or to enhance the performance of the seed at germination or during early growth. Seed processing involved a number of mechanical steps to take raw seed in to through standard quality expected by farmers. Pre cleaning of raw seed contained varying amounts of extraneous matter, damaged seed and weed seeds depending on production and harvesting methods. The precleaning operation attempted to improve the seed physical purity. The better the pre-cleaning, the better all the subsequent operations will proceed. The most basic methods of pre-cleaning were by hand, either by hand-picking unwanted material and seeds from the true seed, or with the use of simple winnowing baskets.

Once seed has been pre-cleaned and separated according to size, it might still contain unwanted grains of the same size but which differ only by their specific weight. The unwanted grain might be stones, diseased grains, and seed of other crops, all of which have the same size but differ in mass. These similar sized grains differing in mass might be separated on a gravity table that used a combination of pneumatic and mechanical action. Seed was fed on in continuous and regulated manner on to the lowest corner of the table and it spread out evenly over the table by the oscillating action. Air was blown up through the seed, which separated the grain in to horizontal layers, with the heavier seed at the bottom, and the lighter grains suspended at the top. The heavier seed was in contact with the oscillating table surface, which mechanically moved the seed to the top end of the table, where it was discharged through the outlets. The lighter seed which was in suspension, was not affected by the oscillating table surface and so moved laterally downwards over the heavy seed to the lower side of the table, from where it was discharged through outlets. Gravity table was a very slow process, and might often be the bottleneck in seed processing line.

Seed might be treated with various kinds of chemicals to improve its appearance, protect it from pests, disease and weeds. The chemicals were applied with special machinery that ensures thorough mixing of the seed and chemicals. Seed treatment might increase the moisture content of the seed at the time of applications, particularly if the chemicals are diluted with too much water.

4.4.4 Seed packaging and labelling

After processing, the seed was packed. Bagging was usually the slowest and most costly operation that was considered in a seed processing plant. Bagging required filling the bag to an exact weight, closing and labeling the bag. These operations were done either with hand or with manually operated machines, like weighing scale and bag closer.

Bagger-weighers are simple machines and are very accurate, easy to adjust and can fill 5 to 6 or more bags per minute. The label was attached to the seed bag. The label contained all-important information about the seed. Label information included during labelling was the crop, variety name, and class of seed, seed grade, and germination and purity results. Complete processing records need to be maintained to trace the seed from the time it was received at the plant until it was sold with full details of operations. Ethiopian seed enterprise usually packaged maize seed with a 12.5 bag.

4.4.5. Warehousing of seed

The store keeper of Ethiopian Seed Enterprise branch office in Amhara region explained that seed was a bulky and living commodity and storing and regulating seed movement in to and out of the store was a daily business in a seed company. Warehouse space was required for storing raw seed up on delivery, and for storing the seed that has been processed and ready for dispatch. Seed warehouses need to be spacious, well ventilated and an impervious floor. The sides of the warehouse should be enclosed to reduce rainfall penetration and to provide security.

The layout of the warehouse should facilitate efficient loading and unloading of seed, fumigation and monitoring of seed in storage. Cleanness was absolutely in seed warehouse, as any loose seed lying around will be a source of food for vermin and storage pests.

4.4.6 Major challenges faced in improved seed production

The production manager of Ethiopian seed enterprise stated that they faced a number of problems during their production period. The main problems faced to produce a quality and adequate improved seed include:

- lack of experienced man power and in sufficient of field cars for inspection of seed production quality control.
- external problems including weather change, seed quality problem, seed production contract violation and raining problem during seed collection season.
- seed disease problems

4.5. Logistics Chain Cost Analysis of Fertilizer from port to central warehouses

Logistics costs are an important factor affecting the competitiveness of nation's firm globally or internally as these determine the total costs of goods and services. The cost of getting fertilizer from port to the farm accounts for substantial proportion of the farm delivered cost when all items of the chain were taken in to account. The imported fertilizer supply cost comprised international procurement, shipping transportation, port operations, bagging and warehousing, inland transportation, wholesale and retail operation cost. One of the main constraints in using fertilizer by the smallholder farmers in Ethiopia was the total cost incurred on it. In recent years, procurement cost has been increasing and it has great influence in using fertilizer by farmers. Transport cost is the largest single item in the total logistics chain of fertilizer. In fertilizer distribution for the year 2010/2011, the percentage of transport costs in total logistics costs was 72% for delivered cost to Addis Ababa central ware houses for Diammonuim Phosphate (DAP) fertilizer excluding the unloading cost from truck. In this survey, transport cost referred to the cost of transporting a quintal of fertilizer from port to different central warehouses excluding unloading charges. Fertilizer was transported by single mode of transport from port to the final destination. The transport cost varied from warehouse to warehouse based on the distance from port. The cost build up of fertilizer price to central warehouse for the year 2011 is shown in Appendix-I. The cost build up was obtained from Amhara regional agricultural bureau for the year 2010/11 up to the central warehouses. The main components of the cost build up are calculated as:

Fertilizer procurement cost (C&F)

In fertilizer cost build up, procurement cost (C&F) contributed the largest portion of the total cost. The cost of this component for a quintal was calculated based on the total fertilizer cost requiring foreign exchange per fertilizer type (DAP or UREA) for forecasting of buying USD dollar during the payment of Letter of Credit(L/C) changed to Ethiopian birr and divided by the total quantities of fertilizer.

Hence, the total procurement costs(C&F) of DAP (3000000 quintal) and urea (2000000 quintal) were 1008.33 Birr/quintal and 758.55 Birr/quintal respectively.

Insurance cost

The imported fertilizer shipping insurance was purchased from Ethiopian insurance company by Birr. This insurance cost estimation was made from the company based on fertilizer buying price. Hence the cost estimation was equal to fertilizer (C&F) cost +10% of (C&F) multiplied by 0.0018. Based on this estimation, for the year 2010/2011, the insurance costs of DAP and UREA were 2 Birr and 1.5 Birr per quintal respectively.

Clearing and transit cost

Clearing and transit service tariff obtained from Ethiopian maritime and Transit Service Enterprise was 2.75 USD per ton. On average, changing the USD to local currencies (Ethiopian Birr) **17**Birr for **1** dollar, service cost was obtained to be 4.68 Birr per quintal.

Transport cost from port to central warehouses

Central warehouses selected for recieval of imported fertilizer from port are 14 in number. These central warehouses are located in Addis Ababa, Kombolcha, Nazareth, Mojo, Mekele, Shashemene, Woliso, Debreziet, Assela, Bahirdar, Dejen, Dessie, Nekempte and Hosina. AISE delivered the imported fertilizer to the respective unions and the cost is established considering that unions were ready to receive directly at the warehouses from the transporter. The transport cost varied based on the distance of the warehouses from port, the road condition and the terrain conditions. Hence, the unit transport costs to Addis Ababa, Nazareth, Shashemene, Debreziet, Modjo, Woliso, Hosina, Nekempte, Dejen and Assela was based on 0.087 Birr per quintal per kilometer tariff and costs to Kombolcha, Bahirdar, Dessie and Mekele was based on 0.112 Birr per quintal per kilometer was undertaken.

Hence, as it is observed on Figures 4.12 and 4.13 , the cost of transport was the single most items in total distribution costs from port of Djibouti to the central warehouses excluding the unloading charge acounting about 60-70% of the total distribution logistics costs. This logistics cost estimation was based on the distribution of a quintal of fertilizer to central warehouses. Higher transport costs were insistent to available fertilizer to the remote areas from port. Farmers that were far from good condition road network were penalized due to their location to absorb the costs associated with transport to and from remote areas. From the chart below, the dominant logistics cost of DAP fertilizer to reach central warehouses of Addis Ababa included administrative cost, insurance, bank interest, transport cost, clearing and transit, quality control and bank commission. Transport cost was the leading cost which comprises about 72% as shown in Figure 4.12. Bank commission, clearing and transit, quality control, insurance and administrative costs also contributed significant effect on total costs. Bank commission was the next highest cost which contributed about 19% of the logistics cost of DAP fertilizer from port to Addis Ababa central warehouse. The component costs of logistics of fertilizer to different central warehouses from Djibouti port was obtained from the importer as shown in Appendix-I. These cost components were obtained from survey of Agricultural Input Supply Enterprise (AISE) and explained the method of calculating the costs as shown in Appendix-II.

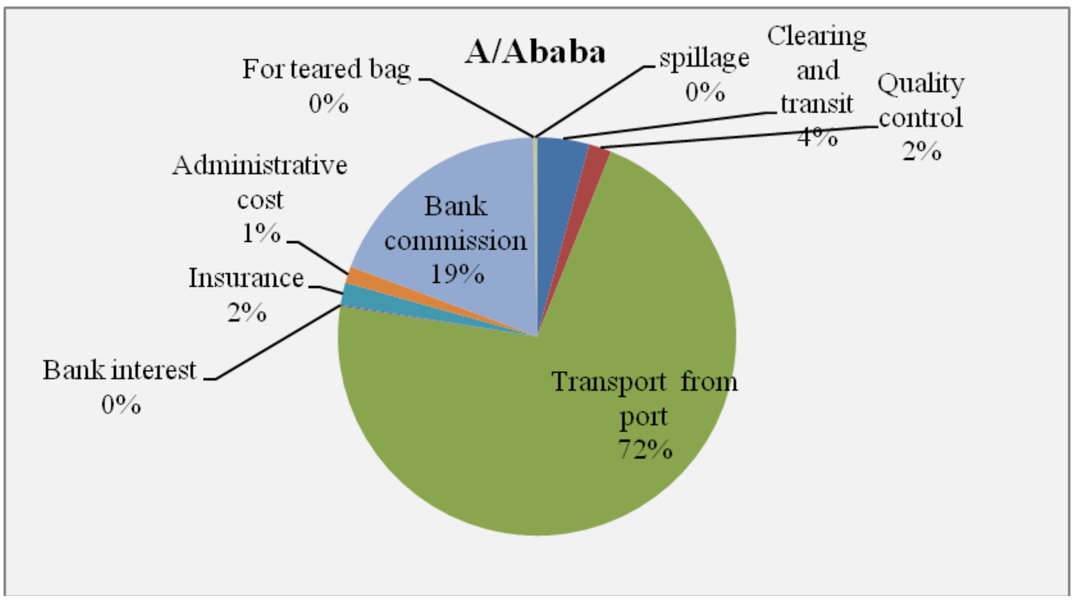


Figure 4.12. DAP logistics cost to Addis Ababa central warehouse from Djibouti port

Similarly, the cost of UREA to central warehouses was dominated by transportation cost which comprised about 77% for Addis Ababa central warehouse from port of Djibouti. The other cost components were as shown in Figure 4.13 below. To observe the cost components of logistics from port to the existing central warehouses excluding the unloading charge, it was observed general road condition and distance affect the total cost. For both DAP and UREA fertilizer, Bahirdar was the higher cost receiver than other central warehouses as indicated in Appendix-I of distribution cost components of fertilizer.

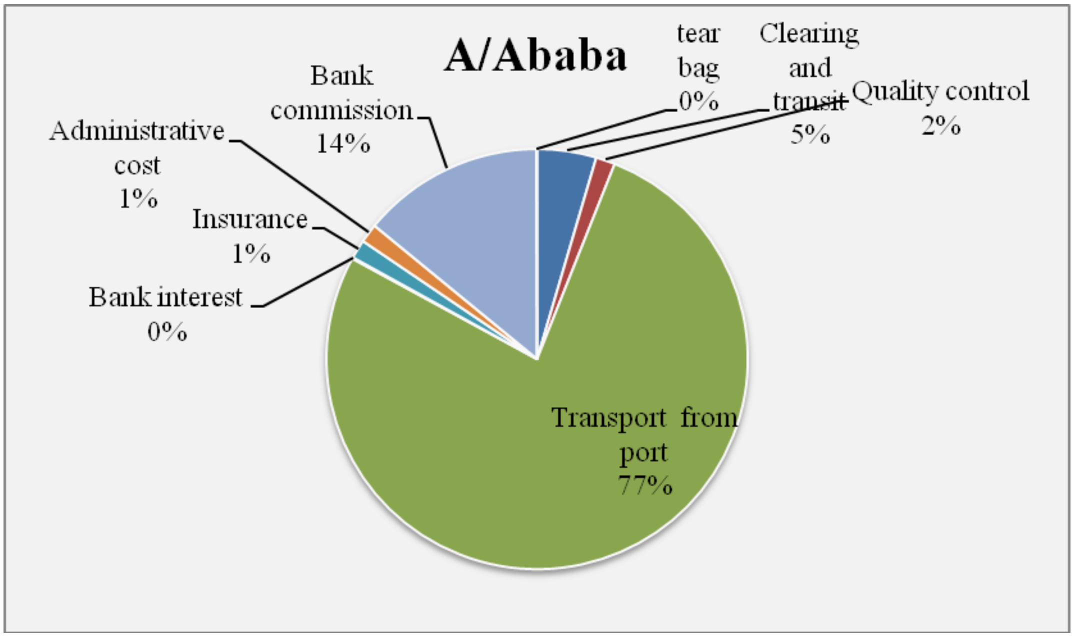


Figure 4.13. UREA logistics cost to Addis Ababa central warehouse from Djibouti port

Costs were also added on importer delivery price starting at the unloading charges at central warehouses. This cost included loading and unloading from central warehouses, warehouse rent, spillage and wear of bags, bank service charge, and administrative costs. In addition, the price of fertilizer in unions' warehouses included the transport costs and bank interest of 13.5% per month of the final price received at the warehouses. Tables 4.1 below indicated the additional costs of fertilizer incurred on farmers in Amhara regional state that was obtained from Merkeb union agreed for all unions in the region. Transport costs varied based on the distance travelled from origin. Bank interest also added based on the storage durations in the warehouses which amounted 13.5% per month. Figure 4.14 indicated below showed the percentage contribution of additional cost components of fertilizer from central warehouses to the end users.

Table 4.1. Additional costs of farmers unions for final delivery to service cooperatives

Cost component	Loading and unloading cost	Warehouse rent	Spillage and tear bag	Bank service charge	Administrative cost
Cost(Birr/qt)	6.00	3.50	1	1	6.25

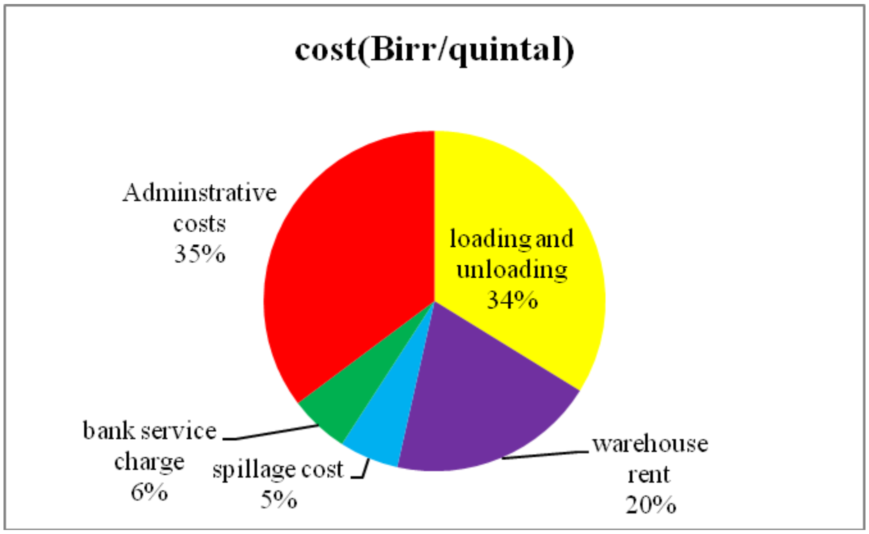


Figure 4.14. Amhara region unions' fertilizer cost build up from central warehouse to retailers

Transport and bank interest costs were not included as the costs vary in distance and duration of stay in warehouse, respectively. The bank charges were 13.5% of the unit quintal delivery price of fertilizer.

4.6 Result of seasonal variations of fertilizer flow

A Six year annual import of fertilizer were aggregated to four quarters and results of the mean difference between quarter means was obtained from SPSS 15.0 as shown in Table 4.2 below. The annual import of fertilizer from port to the country can be referred in Appendix-III.

One–way ANOVA Post Hoc test using SPSS 15.0 was used to determine whether there were the mean differences between the imports of fertilizer in each quarter of the year. Post hoc range tests and pairwise multiple comparisons can help to determine which means differ. Range tests identify homogeneous subsets of means that are not different from each other. Pairwise multiple comparisons test the difference between each pair of means, and yield a matrix where asterisks indicate significantly different group means at an alpha level of 0.05. The pair wise multiple comparisons between each quarter as shown in Table 4.2 were determined to see the mean difference between the quarters fertilizer flow.

Table 4.2. Multiple mean comparison result of quarterly fertilizer import from port of Djibouti

Dependent Variable: Fertilizer

Tukey HSD (Tukey Honestly significant difference test)

(A) Quarter	(B) Quarter	Std. Error	Sig. (A-B)
September, October, November (Quarter1)	December, January, February	13062.56801	.002(*)
	March, April, May	13062.56801	.000(*)
	June, July, August	13062.56801	.604
December, January, February (Quarter2)	September, October, November	13062.56801	.002(*)
	March, April, May	13062.56801	.977
	June, July, August	13062.56801	.062
March, April, May (Quarter 3)	September, October, November	13062.56801	.000(*)
	December, January, February	13062.56801	.977
	June, July, August	13062.56801	.022(*)
June, July, August (quarter 4)	September, October, November	13062.56801	.604
	December, January, February	13062.56801	.062
	March, April, May	13062.56801	.022**(*)**

* The mean difference is significant at the .05 level.

The result of SPSS 15.0 indicated that the mean flow of fertilizer in quarter 1 has a significant different with quarter 2 and quarter 3 at 0.05 level of significance. In addition, quarter 2 has a significant different mean flow of fertilizer with quarter 1 at significance level of 0.05 level of significance. Quarter 3 has a significance mean difference of fertilizer with quarter 1 and quarter 4. Quarter 4 showed a significance different mean flow of fertilizer with quarter 3 which can be concluded that all significance level were less than the 0.05.

Table 4.3 Homogeneous subset result

Tukey HSD

Quarter	N	Subset for alpha = .05		
		1	2	3
September. October. November	18	6647.3928		
June. July. August	18	22836.2356	22836.2356	
December. January. February	18		56101.1556	56101.1556
March. April. May	18			61398.5983
Sig.		.604	.062	.977

Means for groups in homogeneous subsets are displayed.

Harmonic Mean Sample Size (N) = 18.000.

Homogenous subset listed the sets of means which do not differ significantly from each other. Table 4.3 indicated the homogenous subsets comparing between the quarterly mean fertilizer flow which has no significant different from each other. So taking the rows for Tukey HSD on Table 4.3, there are three subsets of quarterly means. Subset 1 indicates that the quarter 1(September, October, and November) and quarter 4(June, July, August) means of fertilizer import of 6647.3928 and 22836.2356 do not differ significantly which has 0.604 significance level which is higher than the Alpha level of 0.05. Similarly, subset 2 contains quarter 4 (June, July, August) and quarter 2 (December, January, February) and the mean of fertilizer import in quarter 4 do not differs significantly from means of quarter 2. In addition, in subset 3, the means of quarter 2 and quarter 3 do not differ significantly.

4.7 Results of demand forecasting

In analyzing demand forecasting using time series, plotting the observation against the time was the first step followed. This showed us important features as trend, seasonality, discontuities and outliers. Hence, the monthly fertilizer flow from port of Djibouti to Ethiopia from year 2004/05 to 2009/2010 was plotted against the months in the X-axis as in Figure 4.15. The plot indicated monthly seasonal fluctuations for the six years. Hence, to estimate the demand of fertilizer imported for each forecasting years, seasonal index of each month was developed based on the six year demand and multiplied based on the yearly based trend line forecasting values for each month forecasted value determination.

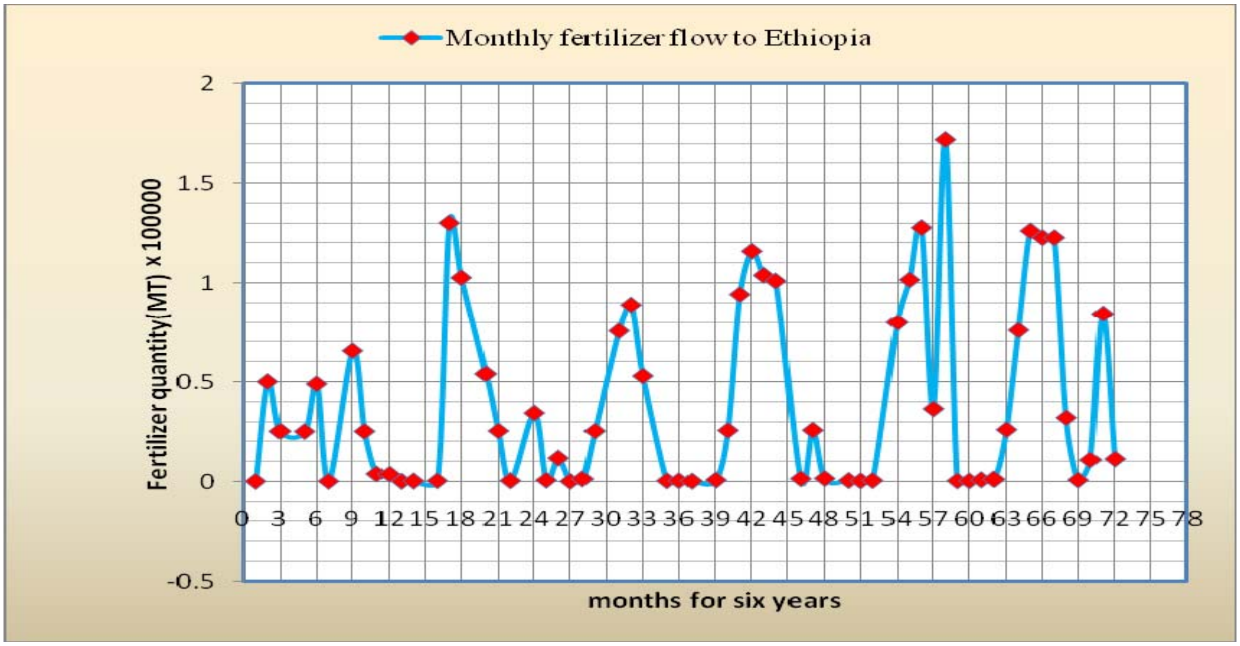


Figure 4.15. Monthly fertilizer flow to Ethiopia from 2004/05-2009/2010

Note the starting month for plotting Figure 4.15 is september of 2004/05 year.

Forecasting of imported fertilizer for the subsquent years should then be adjusted the the monthly data by considering seasonal index factors determined using the formula in chapter two (Methodology part). The analysis of the seasonal index of twelve months was presented as in Table 4.4 below.

Table 4.4 The seasonal index analysis of fertilizer flow in Ethiopia from 2004/05-2009/10

Period	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	**Mean monthly import**	**seasonal Index**
SEP.	140.78	148.06	717.23	220.81	545.96	897.57	445.07	**0.012**
OCT	50133.96	254.88	11720.02	416.25	547.08	1156.2	10704.73	**0.291**
NOV	25223	226.87	130.11	801.79	368.97	26003.53	8792.38	**0.239**
Dec	25068	415.05	1337.63	25639.19	544.42	76135.47	21523.29	**0.586**
JAN	25113.7	130357.66	25355.91	94375.59	7492.81	126348.11	68173.96	**1.855**
FEB	49036.6	102887.38	511.19	116132.02	80088.54	122981.53	78606.21	**2.139**

MAR	179.9	28169.62	75831.57	104104.5	101792.21	122949.49	72171.22	**1.964**
APR	78817	54025.55	89057.52	101203.02	127936.46	31994.38	80505.66	**2.191**
MAY	65644	25409.53	53002.14	7830.4	36457.86	769.62	31518.93	**0.858**
JUN	25179	452.5	14283.82	1445.41	172174.28	10878.01	37402.17	**1.018**
JULY	3830.34	20097.53	411.77	25751.2	357.73	84467.78	22486.06	**0.612**
AUG	3698.32	34350.14	443.93	1565.76	329.07	11335.65	8620.48	**0.235**
							36745.85	**12.000**

A seasonal index of 1.00 for a particular month indicated that the expected value of that month is 1/12 of the overall average. A seasonal index of 1.5 indicated that the expected value for that month was 50% greater than 1/12 of the overall average. Similarly, the seasonal index of 0.621 indicated that the seasonal value for that month was about 38% less than 1/12 of the overall average. Seasonal index calculated in Table 4.4 can be explained in similar way. Hence, seasonal index for the months of January, February, March and April showed that the fertilizer flow in these months have higher contribution for seasonal variations.

After analyzing the seasonal index, trend line was fitted for 15 years historical annual fertilizer flow for forecasting subsequent years demand and the best fit trend line was selected from the scatter plot based on coefficient of determination or coefficient of correlation values obtained from EXCEL model. The result of the trend was indicated as in Figure 4.16 below and the values could be referred in Appendix –IV.

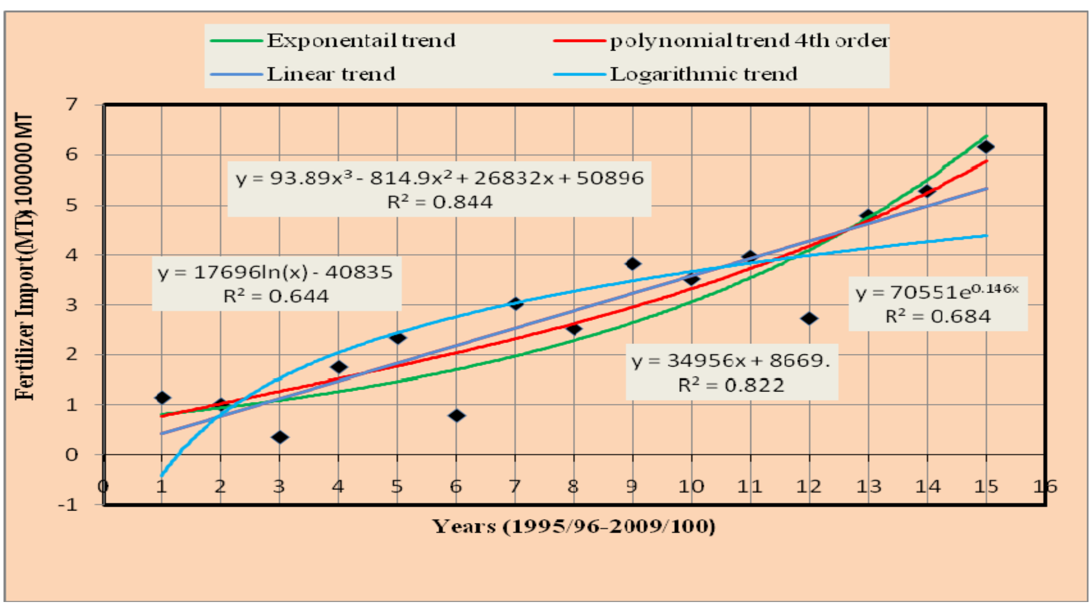


Figure 4.16. Fifteen year annual fertilizer import trend line fit from scatter plot

To compare the different trend option models of time series forecasting, construction of the scatter plot and fitting different trend options and observing the $\mathbf{R^2}$ values provide an important clue for selection of the right trend line for the data. Hence, by constructing the scatter diagram and plotting of trend lines, it was observed that polynomial trend of 3rd order provide a better fit which provided a higher $\mathbf{R^2}$ value **(=0.844)** than the other trend option models as summarized in Table 4.5 below.

Table 4.5 Summary of predicting models of time series data using Excel-2007

Trend model options	Equations	R^2	R
Linear Trend	Y=34,956.03x +8669.48	0.82	0.906
Polynomial Trend	y=93.89x3-814.9x2+26832x+50896	0.844	0.919
Logarithmic trend	Y=17696ln(x)-40835	0.644	0.802
Exponential trend	$Y=70551e^{0.146x}$	0.684	0.827

Where Y= the annual predicted fertilizer import volume (MT)

X= the target year (period 1, 2, 3-----15)

Subsequently, the estimated forecasted fertilizer import was determined based on the polynomial trend line equations of Table 4.5. The monthly import volumes of fertilizer from port of Djibouti were then determined using the seasonal index of each month using Table 4.4.

Results of the forecasted volumes of fertilizer import for five years were provided in Table 4.6 below based on the polynomial model.

Table 4.6. Forecasted volumes (MT) of fertilizer from 2011/12-2014/15

Year	2010/2011	2011/2012	2012/2013	2013/2014	2014/2015
Period	16	17	18	19	20
Forecasted	656167	732815	817410	910516	1012696

Note: periods for X-value (16, 17, 18, 19, and 20) were used in polynomial trend formula of Table 4.6. Monthly estimate of the yearly forecasted fertilizer volumes in Table 4.6 can be adjusted using the seasonal adjustment factor or index in Appendix-IV calculated. If the quarterly demand forecasting was required, quarterly adjustment factor was applied based on similar index in Appendix-IV.

The estimated monthly forecasted volume of fertilizer for a target year could also be determined by multiplying yearly forecasted value by a seasonal index of Table 4.5 and divide by number of months of the year.

4.8 Location analysis result

Locations of proposed central warehouse

Proposed locations were identified using Center of gravity method of location analysis as in Appendix-VI. Center of gravity method was analysed using the fertilizer consumptions of zones for the year of 2008/2009. The X-Y coordinates of zones were selected based on the mean center of zones which were the mean of weredas population within the zone. Hence, center of gravity for each region was calculated using Excel-2007 as in Appedix-VI and the coordinates of center of gravity result was plotted on GIS 9.3 software and results were shown in Figure 4.17 below. However, the proposed warehouses using center of gravity technique not concided with the town locations, relocating to the nearby towns were made for better accessability of the warehouses interms of labour, electricity and better road conditions. Zones were grouped according to their proximity as in Appedix-VI and the grouped center of gravity were determined. Accordingly, The results of location of the proposed warehouses were layed on Gonder, Indesselassie, Woreta, Dogolo, shewarobit, Debremarkos, Debresina and Gedo.

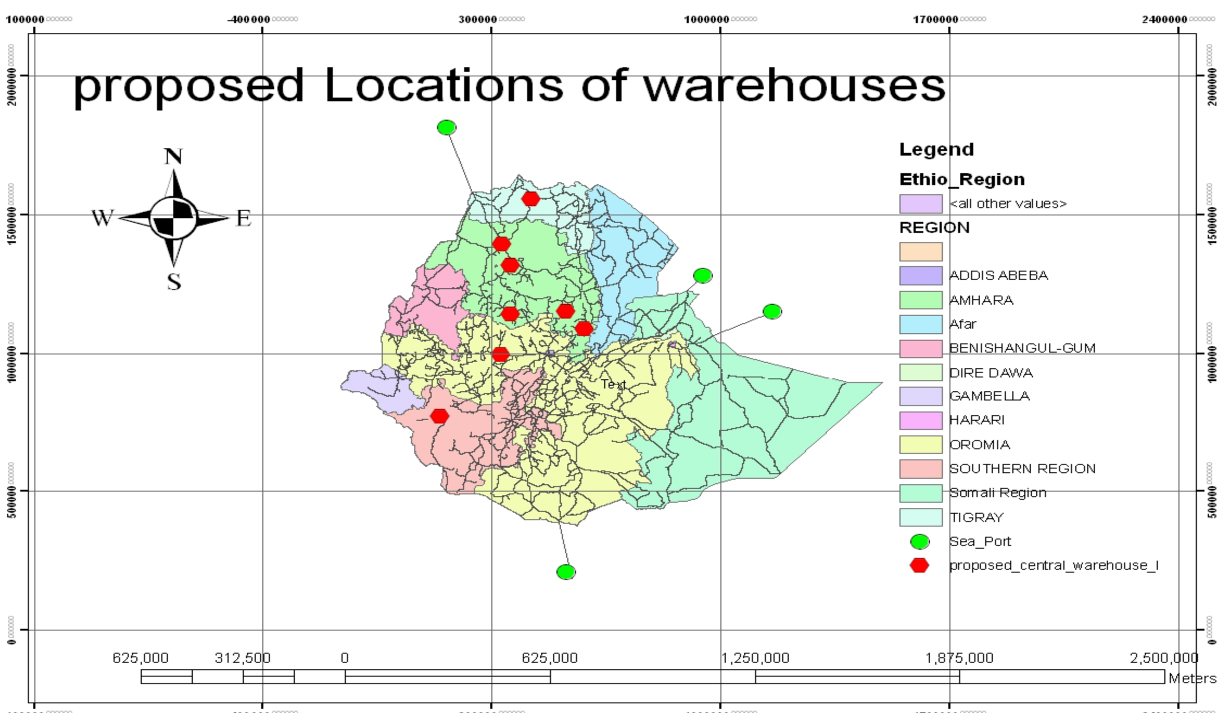


Figure 4.17. Proposed locations of additional central warehouses

Most of the existing central warehouses were located near the central part of the country as observed in Figure 4.18. These locations could provide better accessibility for warehouses as they were around capital cities of the country. The new proposed facilities may provide better distribution system of fertilizer throughout the country and may reduce frequent loading and unloading when direct shipment could be applied.

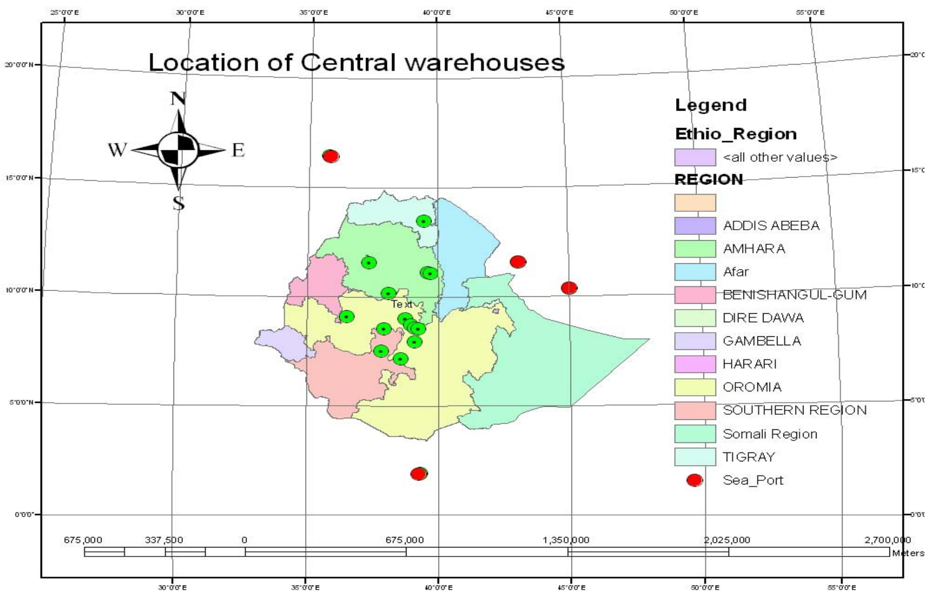


Figure 4.18. Locations of Existing central warehouse in the country

Cluster Mapping

Figure 4.19 below indicated that astring of outliers separate clusters of ahigh number of fertilizer consumption was observed around the central part of the country. These included west Gojam, Awi, East Gojam, East Welega,West shoa and Arsi. These zones Cotype field from result of GIS9.3 indicated HH for astatistically (0.05 level) cluster of high values. The results of cluster analysis was based on the Z score values. The Z score is the measure of standard devaition away from the mean. The Z score of +2.58 in the following figures were interpreted as +2.58 standard devaition away from the mean fertilizer consumption of zones. The critical Z score values when using a 95% confidence level are -1.96 and+1.96 standard devaitions. The p-value for the 95% confidence level is 0.05. Similarly, the hotspot analysis identified clusters with highvalues, hot spots, and clusters with low values,cold spots, based on annual fertilizer consumption as in Figure 4.20 below. Zones as Debub Gondar, West Gojam, Awi,East Gojam, East Welega and West Shoa contributes for high spot areas with Z score value of +2.58 for Figure 4.20. The Zones with high Z value and lower P-value indicates aspatial clustering of high values. Alow negative Z score value and a small P-value indicates aspatial clustering of low values.

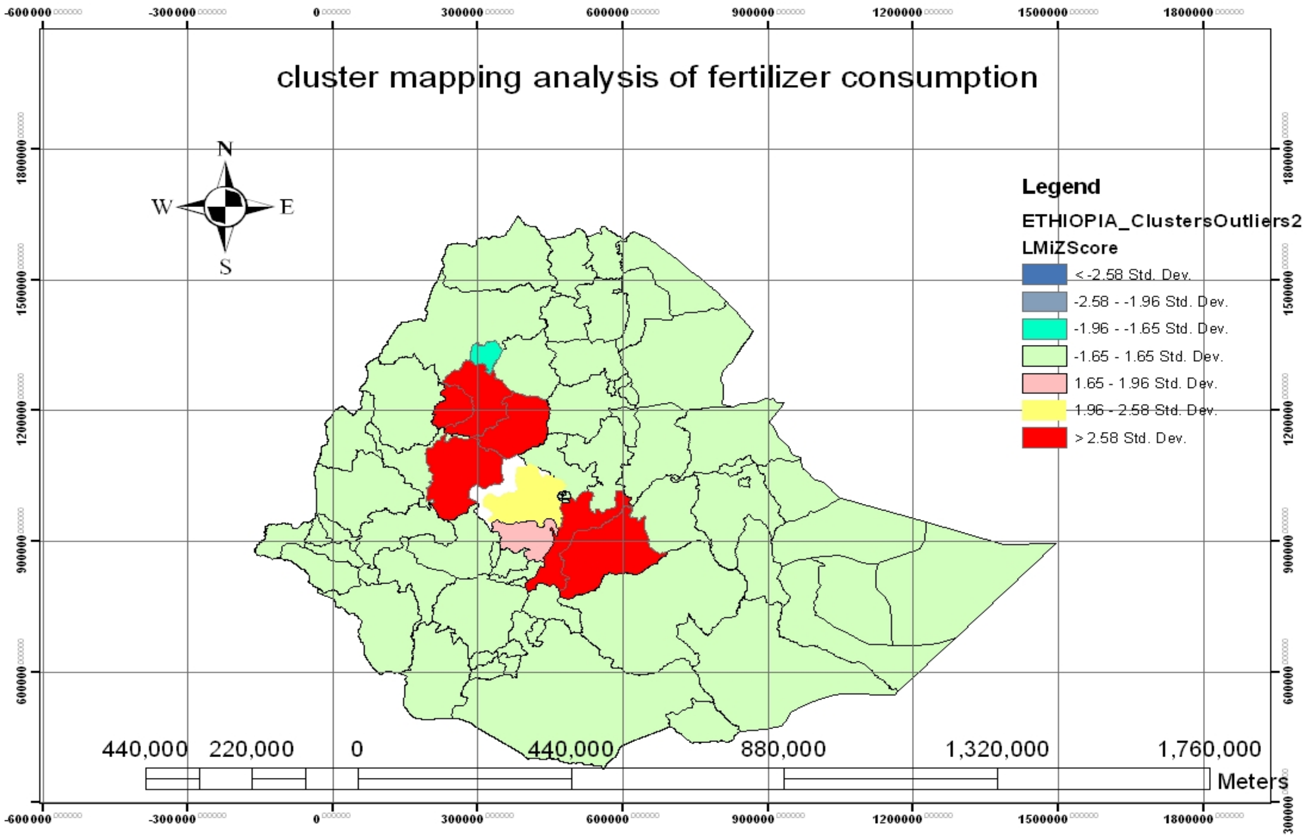


Figure 4.19. Cluster Mapping results of fertilizer consumption zones of Ethiopia

The cluster outlier between +1.96 to +2.58 on Figure 4.19 showed for west shoa zone and between +1.65 to +1.96 was for Gurage zone. Most of the country indicated was between-1.65 to+1.65.

4.9 Route optimization

The optimum route selected using GIS 9.3 from the port of Djibouti to the existing central warehouses are obtained from Figure 4.21. The result of optimum routes using GIS 9.3 software from port of Djibouti to existing central warehouse locations were idetified using the towns they passed from origin to destination. The towns that the selected routes passed were shown in Table 4.8 below. The optimum route distance from Djibouti port to the main central warehouses were obtained from GIS 9.3 out put taking the port as origin and cental warehouses as destination. The distances from port to central warehouse destinations were determined from the optimum route analysed using Network Analysis tools.

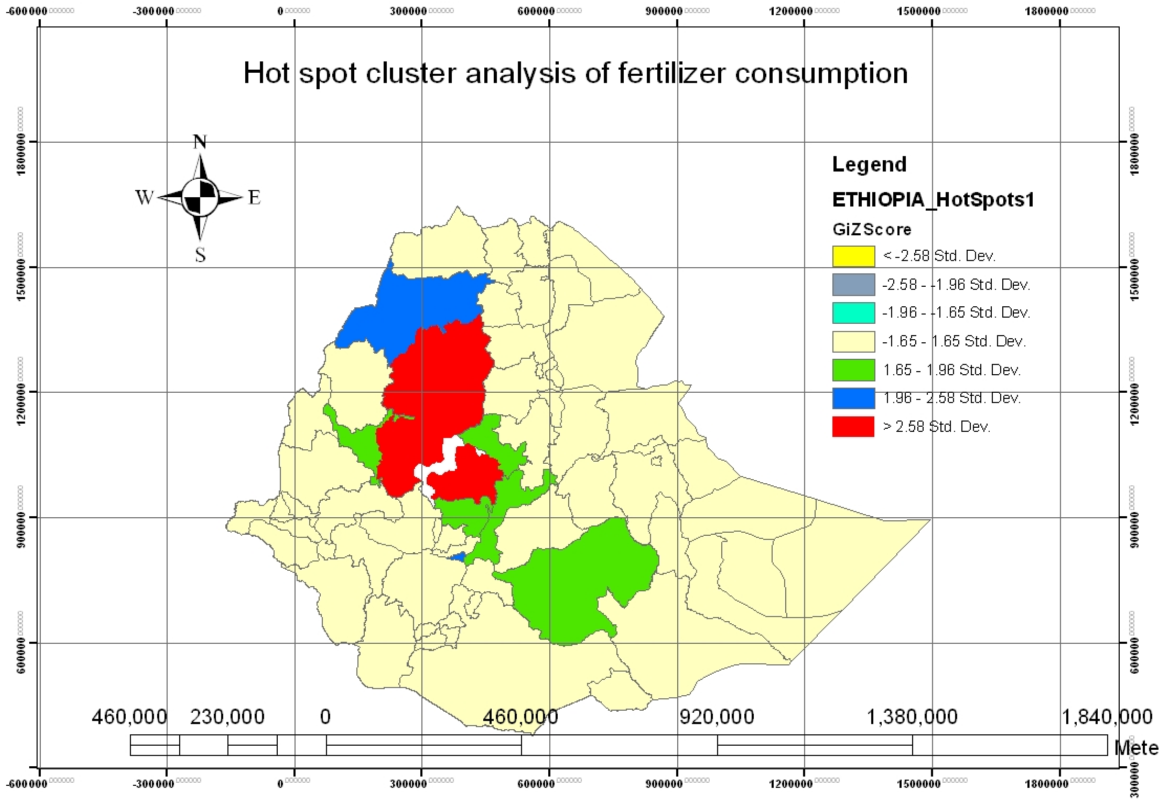


Figure 4.20. Hot spot cluster mapping results of fertilizer consumption

The distance were obtained after the network analysis tool solve between the stops (Origin-Destinations) on separate way and observing the attribute table for the out put of network analysis tool. The attribute table result provided the distance between the origin and destination as atotal distance and distances by segment based on the road types as dry weather, motarable, all weather road conditions and between left and right turns along the route. The fourteen optimum routes were then obtained separately with the respective distances and the overall distance were summerized as in Table 4.7 below. hence, the optimum route distances obtained from GIS 9.3 compared with the existing road network using ERA network Analysis were tabulated as in Table 4.7.

In Table 4.7, the actual distance that obtained from the network analysis of Ethiopian Roads Authority indicated a shorter distance when compared with the optimum routes that obtained from GIS 9.3 result using digital network. However, the road networks in actual distance case have two major routes from Port Djibouti to the central warehouses. The first route directed to the northern part of the country which passes through Kombolcha and the second route to the central and other parts of the country which passes through Addis Ababa. As it was observed in Table 4.7 below, the alternative routes indicated the longest distance that may the transporter used, as for example most of the time the importer of fertilizer explained that due to the unavailability of unions to receive the direct delivery in Tigray region, the importer was forced to stock in Addis Ababa warehouse for final distribution to the region. This indicated that almost the distance to the region doubled when compared to going through Djibouti-Kombolcha route. The bracket used in the Table was to show that the distance used passes through either Djibouti- Kombolcha or Djibouti-Addis Ababa route. The alternative actual routes were mostly applied for Bahirdar, Mekelle, Kombolcha and Dessie as in Table 4.7.

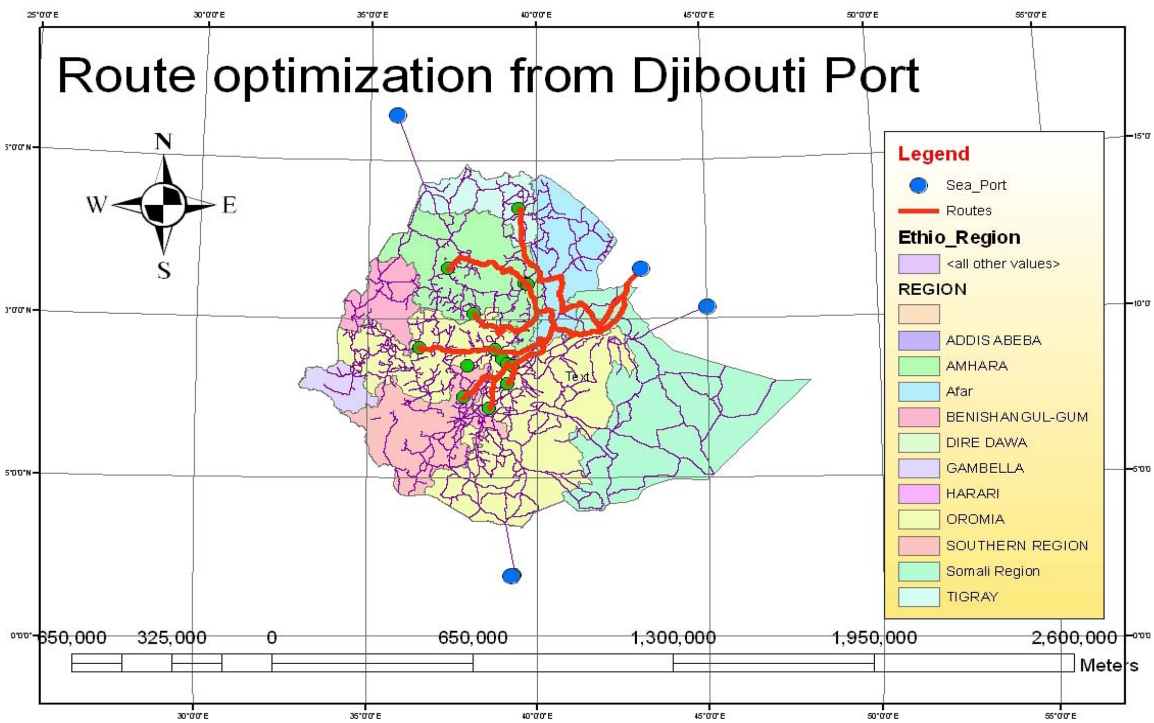


Figure 4.21. GIS based route optimization from Djibouti port to existing Central warehouse

Table 4.7. Optimum route from GIS 9.3 and existing route from ERA network

Code of warehouses	Optimum route distance (Km)		Existing Distance from Djibouti port	Alternative route lengths through A.A(km)	Unit Transport cost (Birr/tkm)
	Warehouses location (Dest.)	GIS 9.3 output	Shorter distance		
		Djibouti(origin)	Djibouti(Origin)	Djibouti(origin)	
7	Addis Ababa	916	910	910	0.087

6	Debrezeit	896	878	878	0.087
5	Modjo	851	853	853	0.087
2	Nazret	833	828	828	0.087
1	Kombolcha	525	533(Kombolcha)	1298(A.A)	0.112
13	Dessie	535	558(Kombolcha)	1311(A.A)	0.112
10	Dejen	1041	1139	1139	0.087
3	Asela	902	902	902	0.087
4	Shashemene	1025	1030	1030	0.087
8	Hosaina	1062	1087	1087	0.087
9	Woliso	1007	1026	1026	0.087
12	Nekemte	1174	1237	1237	0.087
11	Bahirdar	1197	1039(Kombolcha)	1454(A.A)	0.112
14	Mekele	1101	828(Kombolcha)	1654(A.A)	0.112

Note:(Kombolcha) indicated through Djibouti-Kombolcha route

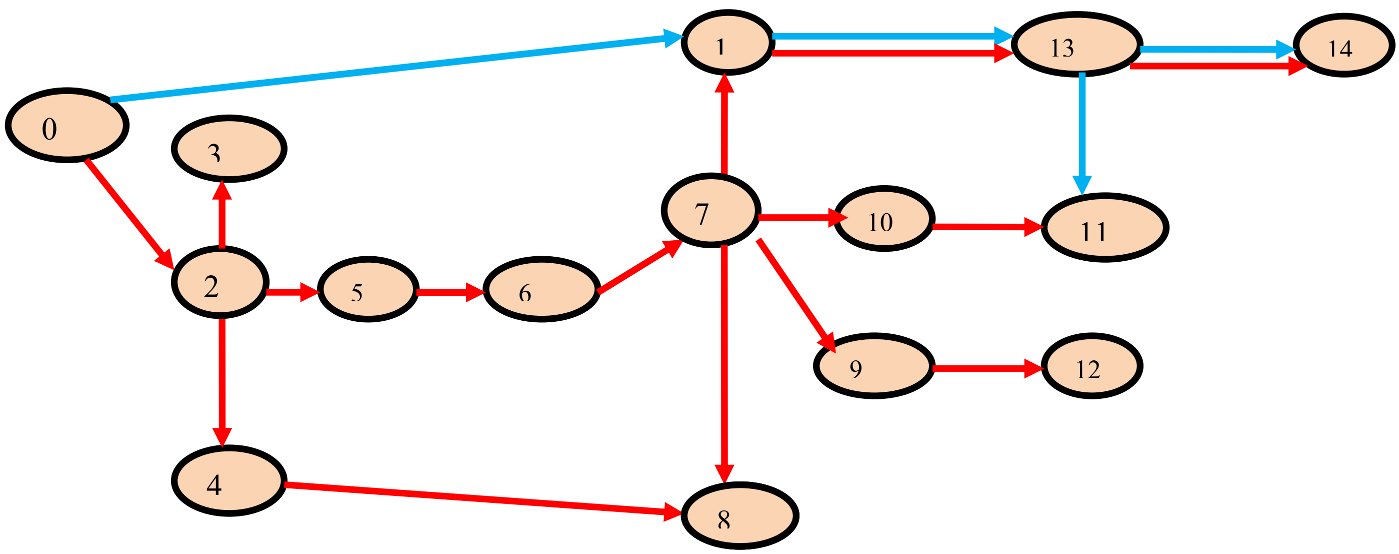


Figure 4.22. The existing route distribution to the fourteen existing central warehouses

The numbers from 1-14 in Figure 4.22 above indicated the central warehouse locations and the numbered codes were given for central warehouse and port of origin. The number 0 indicated for the port of origin or Djibouti port. The red arrows indicate routes through Djibouti –Addis Ababa and blue arrows indicated the Djibouti-Kombolcha route. The figure was only to indicate how the network distributed from port of Djibouti(0) to final destination warehouses numbered from (1-14). The code numbers were given for each central warehouses named as in Table 4.7 above.

The optimum routes length obtained from GIS 9.3 software was to some extent comparable with the network length developed from Ethiopian Road Network Analysis (ERA,2003). Although the optimum routes minimizes the transport cost on the distance base, in most cases transport of fertilizer to the northern part of the country especailly to Tigray region was through Addis Ababa. This doubled the transport distance from the Djibouti-Kombolcha route.The unit transport cost through the Djibouti –Kombolcha route exceeded that of Djibouti-Addis Ababa route by about 23%. The unit transport costs through Addis Ababa route for the year of 2010/11 was 0.087 Birr/tkm and 0.112 Birr/tkm through Kombolcha route.

Table 4.8. Results of optimum route from GIS 9.3

Origin	Destination	Towns that passes
Djibouti	Mekelle	Dewelle-Adigala-Shinelle-Asbuli-Dehabo-Werenso-Bati-Robit-Ambalage-Mekelle
	Bahir-dar	Dewelle-Ayisha-Hurso-Gota-Bike-Debele-Kemissie-Kombolcha-Dessie-Wereta
	Dejen	Dewelle-Ayisha-Diredawa-Hurso-Bike-Debele-shewarobit-Debrebrehan-Weberi-Fiche-Dejen
	Nekempte	Dewelle-Afden-Melka werer-Arerti-Chefe Donsa-Addis Ababa-Holota-Ginch-Ambo-Ejaji-Bako-Nekempte
	Hosaina	Dewelle-Hurso-Bike-Melkasede-Awash-Metehara-Welenchiti-Mojo-Alemtena-Meki-Keber-Hoisana
	Shashemene	Dewelle-Ayisha-Diredawa-Afdem-Awash-Metehara-Nazereth-Mojo-Koka-Meki-Abosa-Bulbula-Shashemene
	Nazereth	Dewelle-Ayisha-Diredawa-Hurso-Bike-Afdem-Awash-Metehara-Welenchiti-Nazereth
	Mojo	Dewelle-Ayisha-Diredawa-Hurso-Bike-Afdem-Awash-Metehara-Welenchiti-Nazereth-Mojo
	Debreziet	Dewelle-Ayisha-Diredawa-Hurso-Bike-Afdem-Awash-Metehara-Welenchiti-Nazereth-Mojo-Debreziet
	Assela	Dewelle-Ayisha-Diredawa-Hurso-Bike-Afdem-Awash-Metehara-Welenchiti-Nazereth-Dera-Iteya-Assela
	Addis Ababa	Dewelle-Afden-Melka werer-Arerti-Chefe Donsa-Addis Ababa
	Dessie	Dewelle-Ayisha-Hurso-Gota-Bike-Debele-Kemissie-Kombolcha-Dessie

	Kombolcha	Dewelle-Ayisha-Hurso-Gota-Bike-Debele-Kemissie-Kombolcha
	weliso	Dewelle-Afden-Melka werer-Arerti-Chefe Donsa-Addis Ababa-Alemgena-Sebeta-Tefki-Tulubolo-Weliso

The proposed warehouse routes were also determined from GIS 9.3 in similar manner of routes for central warehouses from port Djibouti. The proposed warehouse locations obtained in Figure 4.17 was used as a destination and the optimum route was analyzed using Djibouti port as destination. It was then shown as in Figure 4.23 below.

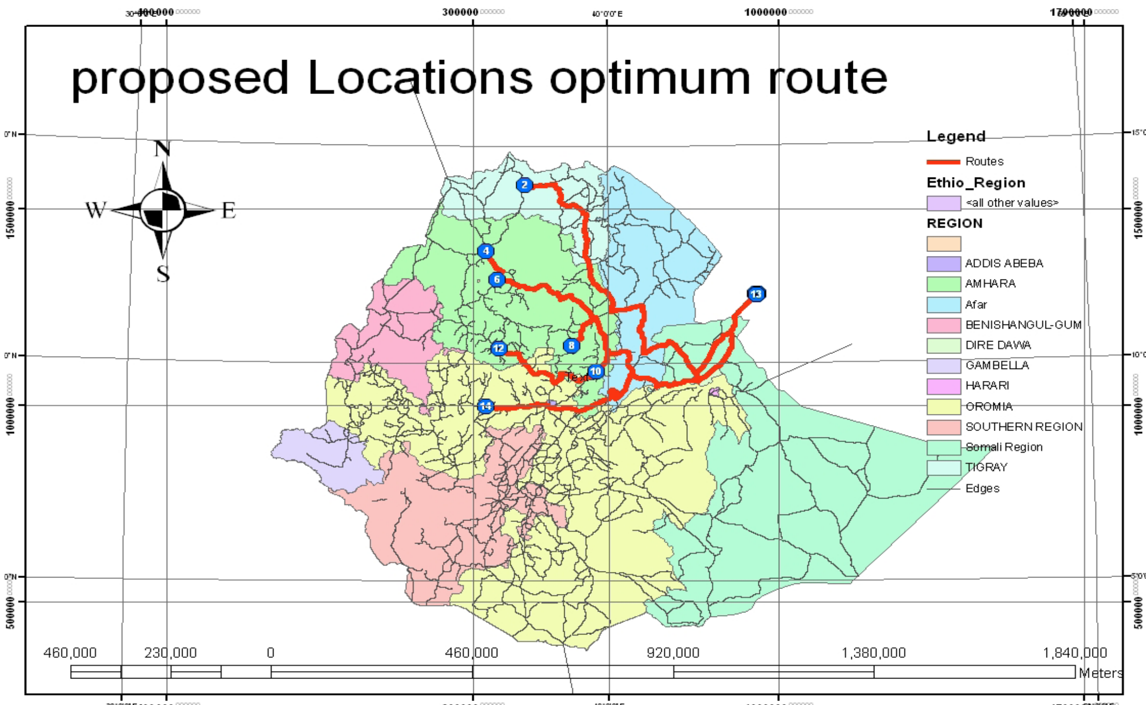


Figure 4.23. Optimum route result from Djibouti port to proposed warehouse locations using GIS 9.3.

The distance from Djibouti port to proposed warehouses were also obtained from the GIS 9.3 software as in Table 4.9. These proposed warehouses can improve the distribution system of fertilizer by reducing the traffic congestion ,loading and unloading charge in most existing warehouses which are in central part of the country.

Table 4.9 Results of optimum routes from port Djibouti to proposed warehouses

Origin	Proposed warehouses(Destination)	Distance(km)	Towns that the route passes
Djibouti	Indasilase	1318	Dewelle-Asbuli-Weranso-Kobo-Mekelle-Adi Abun-Wukro-Indasilase
	Gonder	1251	Dewelle-Ayisha-Bike-Ataye-Kutaber-Nefasmewcha-wereta-Gonder
	Dogolo	953	Dewelle-Ayisha-Bike-Ataye-kabe-Dogolo
	Tarmaber	795	Dewelle-Ayisha-Bike-Debel-Tarmaber
	Debremarkos	1127	Dewelle-Ayisha-Bike-Debel-Tarmaber-Weberi-Gebreguracha-Debremarkos
	Gedo	1082	Dewelle-Ayisha-Bike-Chefe donsa-Gedo
	Woreta	1156	Dewelle-Ayisha-Bike-Ataye-Kutaber-Nefasmewcha-wereta

5. DISCUSSION

5.1 Seasonality of demand

Fertilizer consumption was observed highly seasonal in Ethiopia. The main consumption season of fertilizer in Ethiopia was observed from May to September which was the main agricultural season of the country. Farmers' survey in Amhara region revealed that the fertilizer was purchased at the time of agricultural season. The results of pair wise multiple comparison tests indicated that there were a significant difference of fertilizer flow between some quarters of the year from six year quarter data of fertilizer. The Tukey HSD pair wise comparison between quarters mean flow of fertilizer indicated that there were a significance difference of fertilizer flow in quarter 1 with quarter 2 and quarter 3 but not with quarter 4. This indicates that seasonal variations of fertilizer flows were existent between quarters. On the other hand, the homogenous subset of post hoc test indicated the quarters mean flow of fertilizer have not significant difference.

This study indicated that a changing seasonal pattern of fertilizer flow in Ethiopia based on the quarterly flow of fertilizer. As the analysis of the long-term trend was based on the quarterly data, only simple descriptive methods were used, as pooling the data into quarters or longer time periods might mask individual months with exceptional fertilizer flow rates. First possible reason in the real change in the seasonality pattern might be produced by the farming season of the country are mainly in the months of May-August (*Meher* season). Secondly, changing fertilizer import seasonality could have hypothetically been induced by the market structure of the country in that in most cases procurement contract are held in the months of August to November and distribution starts in December. This might produce a highly concentration to the available infrastructure consumption with in short duration and subsequently induced scarcity of resources.

The seasonality of fertilizer flow may also be influenced due to the movement of relief food that would affect the availability of transportation facilities and other logistics infrastructure facilities to accommodate the commodities at the same time. Hence, fertilizer importers have to develop their logistics system based on seasonality of demand and develop transportation, warehousing plans and also inventory management based on seasonality. This may reduce the seasonality problems for effective logistics system of fertilizer distribution.

5.2 Demand Forecasting

Fertilizer has to be conveniently available to farmers in rural areas in sufficient quantities to meet needs at farming times. The time lapse between making a decision to procure fertilizer from the international market and availability in rural areas might range from 5 to 6 months in Ethiopia. Prior to an import decision, a determination should be made of the market demand by product. The importance of market information systems to assist in the determination of procurement amounts and types is important when there is a lack of integration. Forecasting the future demand may improve the effective planning and controlling logistics systems. The capacity of warehouses required, the amount of trucks required may be planned from the forecasted result. A seasonal monthly and quarterly index factors may be used for determination of future demand of monthly and quarterly, respectively. These factors might improve planning of logistics activities for the respective months and quarters. Fertilizer demand forecasting may improve the requirements of transport and warehouse for each month or quarter using seasonal index factors. These factors for this thesis were adopted from the six year historical data obtained from National Bank of Ethiopia. In general, demand forecasting may induce an efficient logistics chain system by minimizing the inventory level, transportation requirement and warehousing problem.

5.3 Major cost components of fertilizer

Different components of fertilizer costs have a significant effect on overall farm gate price of fertilizer. Among the different cost components the transport costs was observed the most significant components of distribution costs from Djibouti port. The rise of transport cost may be due to the distance of customers from port, road type and conditions which have a significant effect on fuel consumption. Next to transport cost, bank charges were observed the second most components of fertilizer distribution cost to the central warehouses. This may be for the higher requirements of foreign currencies for the letter of credit requested by the importer for two months.

The transport cost varied per ton-km along the two major routes of the country from Djibouti port due to the road condition and terrain type. Transport costs are also increasing from time to time as the fuel price increases and it is the main challenges to avoid its influence on economical growth of the country. Transport cost increases as fertilizer travels off the main arteries extending from port in to outlying areas throughout the country as it may be due to the poor road conditions. Costs also increased during the rainy season or during periods of peak demand for trucks. The availability of high levels of road density may reduce the transport costs due to the savings from being able to haul fertilizer to its destination by trucks. The transport costs increased for import commodities as it may be difficult to obtain back load due to the imbalance of import and export of the country. The rising of export commodities may induce some balancing of import and export commodities so that the efficiency of freight transport can be improved.

The most significant factors that may result the increase of transport costs includes Geography, economies of scale, energy, trade imbalance, infrastructure , modes of transport and lack of educated personnel. Trade imbalance is the main contributing factors as import exceeds the export which results for empty loading of return trips to port and makes the import fertilizer price higher than the export goods to same destination. Energy is one of the single most factors which have a direct cost on fertilizer import cost. Oil prices have increased in recent years driven by a strong global demand. The prices have also affected by the political situation in the countries exporting oil. Measures for any efficiency savings in fuel may impact overall transport costs. This may be obtained by using alternative fuel than the diesel oil as biofuels and electricity, compressed gas fuel. Biofuels which are produced either from plant material or organic waste oils and fats may be easily accessible alternative fuels. More importantly, training and motivating drivers in fuel-efficient driving techniques may be one of the most cost-effective approaches to fuel saving.

An overall increase of fertilizer transport costs may arise due to confined distribution system of fertilizer which is concentrated mostly during the farming season. The inefficiency of the country's transport system may result for unnecessary charges in addition to actual fertilizer costs.

The Lacks of backload from inland to the port is the major constraints for efficiency of transporters. This might result environmental pollution in terms of air pollution, congestion, and health and safety issues. The main causes that might result empty running of trucks from central warehouses to Djibouti port were lack of co-operation between shippers and carriers with in the country, lack of co-ordination in planning and scheduling and imbalance of import and export of the country. Demand fluctuations throughout the year results lesser utilization of trucks. Transport companies may subject to seasonal fluctuations that can hire additional vehicles or outsource their transport during the assignments of vessel shipment at one time.

The four transport provider companies claimed that the poor utilization of trucks during the peak periods of fertilizer distribution was mainly due to poor warehouse configuration and interface interactions. The unloading operations in most warehouses may affect the turn round times of trucks from warehouse to port.

Over all transport charges of the country that may be occurred due to empty trucking can be improved by applying significant coordination of the freight industry. Potential efficiency measures that might improve the utilization of freight industry inside the country can be finding of back loading. This may result improved operational efficiency and reducing emissions. This may be improved using internet based transport exchange which enables shippers and carriers to be matched, resulting in potentially more back loading arrangement. However, some transporters commented that coffee is the most dominant exporting commodities through Djibouti but difficult to match both import and export activities. Inspection of coffee before exporting results under utilization of trucks as the trucks are loaded and waiting for inspection for a number of days. Single coordination unit representing the country's import and export of commodities may improve the inefficiency of truck loadings.

Information technology based route and load planning might maximize vehicle utilization and reduce the incidence of empty–running. GPS based tracking might improve greater transparency of the operations activities throughout the route, increase load factors, decrease in average transport distance and planning and rescheduling of transport operations during the day.

Storage and financing costs also had considerable effects for the final costs of fertilizer. Storage charges may be occurring at different level of distribution system that was at import, wholesale and retail points. Closely related were costs of financing of stocks, which cover the interest during the period between the purchase and sales of fertilizer. Storage and interest charges may be minimized by applying the direct delivery of fertilizer to farmers when it arrived at the retail warehouses. However, it was informed that due to the late announcement of fertilizer price for the retailers, the fertilizer was stocked for about 3-4 months in the warehouses. These long storage periods implied a significant interest charge, which unfortunately failed to account in many stakeholders.

5.4 Fertilizer Distribution System

The distribution system of fertilizer to farmers in Ethiopia is not as ideal distribution system that enables the right product to be available at the right time, sufficient quantities and at most economical costs at consumption center. Main central warehouses were located mainly in central part of the country that may be for logistics service purpose. However, the areas of consumption are spread over a wide area. Transport facilities may be inadequate as they are shared with other commodities which arrive at time in the port.

In general, Distribution costs in general handles terminal costs, cost of packaging, handling at the port, inland freight cost, warehousing cost(inventory holding, storage rental, handling, documentation) cost of re-bagging, standardization at the warehouse, loss due to handling, pilferage. Inventory carrying costs is a major component of distribution costs, every effort should be made to reduce this cost items. A careful balance between demand and supply by means of effective demand forecasting may result in an efficient system.

Hence, for effective distribution systems, all aspects of distribution must be integrated to achieve cost effective deliveries. This may be between inter and intra organizational, inter and intra regional transporters, unions and consumers. In addition to the integrated distribution systems, distribution planning and management can help minimize the total costs incurred on fertilizer farm gate price.

Market policy

The existing organizational structure of fertilizer distribution chain from port of Djibouti to final destination required passing through sequence of activities and stakeholders. The activities were performed in most cases independently of the stakeholders. Most of fertilizer retailing in Ethiopia was not vertically integrated with the wholesalers, importers and retailers. The importer delivers fertilizer to wholesalers at the central warehouse; the wholesaler in turn delivers to the retailers at their warehouses. Finally, the retailer delivers to farmers. If the cooperative unions are not ready to receive the imported fertilizer at their warehouses, the importer places at its warehouse mainly in Addis Ababa. This may result additional loading and unloading charges at the intermediate places although it could help as a buffer for transporters.

In addition, instead of transporting fertilizer to the northern part of the country along the Djibouti-Kombolcha route, it was observed in transporting along Djibouti-Addis Ababa route which may incur additional transport charges based on the longest distance. This may happen due to less coordination of the importer and the respective regions. Hence, in some instance the chain of fertilizer distribution was observed fragmented and was not vertically integrated. The coordination of these stakeholders was handled with regional governments' agricultural bureau. The price of fertilizer was set with the farmers' cooperative union for unnecessary cost increment neutralization. Efforts to provide timely delivery of fertilizer were often constrained by the late announcement of fertilizer price to the retailers.

Distribution network

Road is the sole distribution type of transport mode of fertilizer connecting to the respective retailers. In addition, most of the central warehouses are concentrated in central part of the country and along the major roads of the country. This might result inefficiency of the distribution system of fertilizer throughout the country even though it can provide greater access in terms of labour, road and other facilities. The condition of road networks may affect the significant level of fertilizer distribution systems. The improving level of road networks in terms of density and condition may improve the efficiency of distribution systems.

5.5 Location analysis and Route optimization

The existing warehouse locations are mostly located around the central part of the country and along the main arterial road of the country. The proposed warehouse locations may improve the efficiency of distribution systems. Since the demand of fertilizer increases from year to year, the proposed warehouses may give substantial benefit to handle the imported fertilizer with the existing central warehouses.

The GIS 9.3 result of route optimization may not necessarily based on the travel time rather using the distance. The result may not purely indicate the actual shortest path to the central warehouses as it may not evaluate the travel time that may occur due to poor road condition and terrain type. Hence, the result may give a direction for improvement of the existing road conditions which minimizes travel time.

6. CONCLUSIONS

The following conclusions can be stated from the current study:

- From the different components of fertilizer cost, transport cost was found the leading contributor of fertilizer farm get price.
- Interest cost, clearance cost and quality control costs increased with the increase of fertilizer procurement costs(C&F) as they are determined from percentage of the procurement cost.
- Stakeholders of fertilizer distribution were not well integrated and collaborated to establish an effective system of distribution.
- Transporters selections for fertilizer transport from port were not transparent in that only four transporters were selected for the total shipment of fertilizer.
- There was no clear logistics concept observed between organizations for fertilizer distributions. Most stakeholders perform their own activities independently which resulted inefficiency of the whole logistics chain of fertilizer.

- The flow of fertilizer from port varied seasonally. The quarterly flow in quarter 1 was significant different with quarter 2 and quarter3 but not differ with quarter 4.
- Forecasted Demand insured the planning of the future logistics service for warehouses and transport demand. The seasonality index of fertilizer consumption for the months of January, February, March and April was higher than other months which contributed for seasonal variations.
- The optimum route obtained from GIS 9.3 could improve the logistics chain and traffic assignment to the existing and proposed warehouse locations.
- New proposed warehouse obtained from location analysis using center of gravity technique which has additional contributions for better distribution of fertilizer from port.
- Fertilizer distributions to farmers were not at the right times which were during farmers farming periods which indicated the delivery was not at the right time.
- Warehouse and transport interfaces were the major challenges of fertilizer distribution. There were no sufficient capacities of warehouses to accommodate the stocked and new coming fertilizer at a time. In addition, the warehouses in retailers were poor in conditions which could affect the moisture on fertilizer. The warehouse keepers were not available when trucks arrived to unload due to seasonality of fertilizer store and distribution.
- Longer turn round times of trucks resulted delay of vessel discharge in the port.
- The cluster analysis of fertilizer consumption indicated that most of fertilizer consumer zones in the country were west Gojam, Awi, East Gojam, East Wellega, West shoa, East Shoa and Arsi.
- There was no central information data sharing sources for easily communications of stakeholders so that the information flow was from point to point.
- Most trucks were moving empty from central warehouses to the port which contributed for lesser load factors. Most truck owners applied phone calling techniques to track vehicles along the routes between Djibouti and central warehouses.

7. RECOMMENDATIONS

On the basis of results and conclusions the following recommendations were made:

- It is very important to have a fertilizer industry in the country, which may reduce the foreign freight cost and port charges and procurement charges although it needs higher investment at an initial stage.

- The Government should cut the bank charges on total fertilizer cost which was observed the second highest cost from port to the central warehouses.
- Improve the road network nationwide to access distant farmers from primary roads to sell their products and buy farming input commodities from market.
- The government should promote the development of logistics supply chain concept to the industries. Lack of attention and development of supply chain leads to inefficiencies, higher costs and spoilage. Promote cooperation and organization between the importer, service providers to identify and implement actions to reduce key bottlenecks and cost points within fertilizer subsector.
- The government needs to develop a stakeholder group to study the transportation industry problems and develop long term solutions. It also needs to develop policies and incentives that encourage growth and investment in the trucking industry sector as entering of new trucks.
- The contractual basis of transporters should be based on the form of joint venture to the capacity of discharging single vessel within the specified time frame to avoid demurrage costs.
- Ministry of Transport (MoT) should enhance communication and cooperation between Ethiopian and Djiboutian Customs Authorities. It is also required to encourage the implementation of harmonization of transit documentation and procedures along Ethiopia's transport corridors. Strengthening of Ethiopian customs in use of the same document processing like "ASYCUDA++ "with Djibouti customs procedure is essential to coordinate and for easy transfer of data.
- Developing of automated truck tracking system like GPS with online access to shippers and other transit professionals is required to control the fuel consumption by reducing total distance travel and the condition of trucks along Djibouti to central warehouse.
- Road transport costs can be minimized by using alternative modes of transport like rail. Rail system can be used for longer distance as from port to central warehouses and road transport from central warehouses.
- Integrated information technology applications using webpage is required to improve the point to point information flow using E-mail, EDI and internet.
- National coordination units of import and export are essential to optimize the transport demand and minimize empty trucking.

- Standard warehouses are required nationwide for effective fertilizer distribution and the existing warehouses should be inspected in terms of quality and capacity before new procured fertilizer arrived.
- Regulations should be set for the delay of trucks during unloading and loading at the warehouses.
- Delivery of fertilizer to farmers should be made before the start of farming and rainy season.
- The axle load control system should be placed at the freight station in the port so that overloaded trucks must go back to be unloaded in the port.
- In order to minimize the control delay, tracking system should be implemented by the customs authority.

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APPENDIX

APPENDIX-I Distribution cost components of fertilizer to central warehouses

		Destination of central warehouse													
S.No.	Cost types	A/Ab aba	Nazar eth	Mojo	D/Ziet	Shash emene	Komb olcha	Mekel e	Asela	Wolis so	Bahir dar	Dejen	Dessi e	Neke mpte	Hosin a
		910km	828km	853km	878km	1030km	533km	828km	902k m	1026k m	1039km	1139km	558km	1237km	1087km
1	(C&F)	1008.33	1008.33	1008.33	1008.33	1008.33	1008.33	1008.33	1008. 33	1008. 33	1008.33	1008.33	1008.33	1008.33	1008.33
2	Clearing and transit	4.68	4.68	4.68	4.68	4.68	4.68	4.68	4.68	4.68	4.68	4.68	4.68	4.68	4.68
3	Quality control	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02
4	Transport from port	79.17	72.04	74.21	76.39	89.61	58.63	91.08	78.47	89.26	114.29	99.09	61.38	107.62	94.57
5	Bank interest	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
6	Insurance	2	2	2	2	2	2	2	2	2	2	2	2	2	2
7	Administrati ve cost	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
8	Bank commision	21.03	21.03	21.03	21.03	21.03	21.03	21.03	21.03	21.03	21.03	21.03	21.03	21.03	21.03
9	teared bag	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
10	spillage	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
	1Quintal cost	1119.21	1112.08	1114.25	1116.43	1129.65	1098.67	1131.12	1118. 51	1129. 3	1154.33	1139.13	1101.12	1147.66	1134.61

2010/2011 Central Warehouse DAP delivery cost

		Destination of central warehouse													
S.No.	Cost types	A/Ababa	Nazareth	Mojo	D/Ziet	Shashemene	Kombolcha	Mekele	Asela	Wolisso	bahir dar	Dejen	Dessie	Nekempte	Hosina
		910Km	828Km	853Km	878Km	1030Km	533Km	828Km	902Km	1026Km	1039Km	1139Km	558Km	1237Km	1087Km
1	(C&F)	758.55	758.55	758.55	758.55	758.55	758.55	758.55	758.55	758.55	758.55	758.55	758.55	758.55	758.55
2	Clearing and transit	4.68	4.68	4.68	4.68	4.68	4.68	4.68	4.68	4.68	4.68	4.68	4.68	4.68	4.68
3	Quality control	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52
4	Transport from port	79.17	72.04	74.21	76.39	89.61	58.63	91.08	78.47	89.26	114.29	99.09	61.38	107.62	94.57
5	interest	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
6	Insurance	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
7	Administrative cost	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
8	Bank commission	14.43	14.43	14.43	14.43	14.43	14.43	14.43	14.43	14.43	14.43	14.43	14.43	14.43	14.43
9	teared bag	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
10	spillage	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
	1Quintal cost	861.8	854.67	856.84	859.02	872.24	841.26	896.92	881.72	844.01	1154.33	1139.13	1101.12	1147.66	1134.61

2010/2011 Central Warehouse UREA delivery cost

APPENDIX-II: The importer calculations cost components of fertilizer to central warehouses

The cost components of the logistics from port to inland central warehouses are calculated from the services

Bank service costs:

Bank service cost is 1.25% of the procurement cost(C&F). Hence, based on this calculation DAP bank service cost is 21.04birr/quintal and for UREA is 14.43 birr per quintal. The cost also includes for the time extension payment of letter of credit.

Quality control cost:

Quality control test cost for Ethiopian quality control authority in the country is based on the procurement cost of fertilizer (C&F). The cost is 0.20% of the procurement cost(C&F). Hence, based on this assumption for DAP 2.02 birr per quintal and for UREA 1.52 birr per quintal are required for quality control test.

Administrative cost:

Admistrative costs for procurement and transporting is estimated to be 2 birr per quintal by Agricultural Input Supply Enterprise (AISE). However, the cost is agreed to 1.50 birr per quintal since AISE main task is from procurement to delivery to central warehouses.

Bank interest cost:

Interest charged for the opening of letter of credit by Agricultural Input Supply Enterprise for two months. Hence, interest charges for DAP and UREA are 0.13 birr per quintal and 0.1 birr per quintal respectively. Additional interest payments are incurred on final farm gate price while the fertilizer is stored in central warehouses and retail warehouses till the distribution of fertilizer to the farmers and payment is finished from retailers. Long storage periods imply significant interest charges, which are the current situations of Ethiopian fertilizer storage stays for longer period since the start of December to May until delivery to the farmers is started.

Other costs:

Other costs include cost of rebagging teared bags is 0.05 birr per quintal and loss due to handling of spillage costs 0.13 birr per quintal.

In addition to the logistics costs of AISE from port to central warehouses, storage cost is incurred up to the delivery of the consumer. There is a need to store fertilizer at warehouses of port, wholesaler, and retailers. Hence, storage costs which are associated the renting of warehouses, loading and unloading laborers and the losts within the stocks and pilferages are a significant element in total marketing costs.

APPENDIX-III Monthly imported Quantities of fertilizer

Period	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10
SEP.	140.78	148.06	717.23	220.81	545.96	897.57
OCT	50133.96	254.88	11720.02	416.25	547.08	1156.2
Nov	25223	226.87	130.11	801.79	368.97	26003.53
Quarter1	75497.74	629.81	12567.36	1438.85	1462.01	28057.3
Dec	25068	415.05	1337.63	25639.19	544.42	76135.47
JAN	25113.7	130357.66	25355.91	94375.59	7492.81	126348.11
FEB	49036.6	102887.38	511.19	116132.02	80088.54	122981.53
Quarter2	99218.3	233660.09	27204.73	236146.8	88125.77	325465.11
MAR	179.9	28169.62	75831.57	104104.5	101792.21	122949.49
APR	78817	54025.55	89057.52	101203.02	127936.46	31994.38
MAY	65644	25409.53	53002.14	7830.4	36457.86	769.62
Quarter 3	144640.9	107604.7	217891.23	213137.92	266186.53	155713.49
JUN	25179	452.5	14283.82	1445.41	172174.28	10878.01
JULY	3830.34	20097.53	411.77	25751.2	357.73	84467.78
AUG	3698.32	34350.14	443.93	1565.76	329.07	11335.65
Quarter 4	32707.66	54900.17	15139.52	28762.37	172861.08	106681.44
Total	663892.88	684241.7	529610.46	902892.55	883722.9	1029349.81

APPENDIX-IV Seasonal index results of monthly and quarterly flow of fertilizer

Period	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	Mean monthly import	**seasonal Index**
SEP.	140.78	148.06	717.23	220.81	545.96	897.57	445.07	**0.012**
OCT	50133.96	254.88	11720.02	416.25	547.08	1156.2	10704.73	**0.291**
NOV	25223	226.87	130.11	801.79	368.97	26003.53	8792.38	**0.239**
Dec	25068	415.05	1337.63	25639.19	544.42	76135.47	21523.29	**0.586**

JAN	25113.7	130357.66	25355.91	94375.59	7492.81	126348.11	68173.96	**1.855**
FEB	49036.6	102887.38	511.19	116132.02	80088.54	122981.53	78606.21	**2.139**
MAR	179.9	28169.62	75831.57	104104.5	101792.21	122949.49	72171.22	**1.964**
APR	78817	54025.55	89057.52	101203.02	127936.46	31994.38	80505.66	**2.191**
MAY	65644	25409.53	53002.14	7830.4	36457.86	769.62	31518.93	**0.858**
JUN	25179	452.5	14283.82	1445.41	172174.28	10878.01	37402.17	**1.018**
JULY	3830.34	20097.53	411.77	25751.2	357.73	84467.78	22486.06	**0.612**
AUG	3698.32	34350.14	443.93	1565.76	329.07	11335.65	8620.48	**0.235**
							36745.85	**12.000**

Quarter	period						Mean of quarters	**Seasonal index**
	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10		
Quarter1	75497.74	629.81	12567.36	1438.85	1462.01	28057.3	19942.18	**0.181**
Quarter 2	99218.3	233660.09	27204.73	236146.8	88125.77	325465.11	168303.5	**1.527**
Quarter 3	144640.9	107604.7	217891.23	213137.92	266186.53	155713.49	184195.8	**1.671**
Quarter 4	32707.66	54900.17	15139.52	28762.37	172861.08	106681.44	68508.71	**0.621**
Total	352064.6	396794.77	272802.84	479485.94	528635.4	615917.34	440950.15	**4**

APPENDIX –V Annual fertilizer consumptions of zones in Ethiopia

		2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	Average consumption(qt)
		qt	qt	qt	qt	qt	qt	
Ethiopia		2581775	2914701	3927813	4045834	4506715	4204601	
Tigray		135358	117020	133660	147847	166280	153573	
1	Central Tigray	45527	35932	38051	43472	64098	56161	47207
2	East Tigray	18847	21417	20897	31422	28785	16080	22908
3	South Tigray	30847	31290	35986	39259	34535	43551	35911
4	Western Tigray	40137	28381	38727	33695	38861	37781	36264
Amhara Region		770162	884267	1282389	1323949	1640177	1574033	

1	North Gondar	42556	61658	86736	71633	93343	55521	68575
2	South Gondar	33975	60068	85133	90865	114190	93964	79699
3	North Wolo	2782	7055	8806	7390	17836	13392	9544
4	South Wolo	38775	60890	68834	78197	98880	109660	75873
5	North Shewa	125681	110396	167021	203750	160869	135960	150613
6	East Gojjam	204423	231957	345071	374014	513162	455279	353984
7	West Gojjam	268875	282500	405775	380410	500872	545808	397373
8	Waghamera	0	0	0	0	0	0	0
9	Awi	53071	69,679	114,496	117635	140438	164077	109899
10	Oromia Zone	0	0	0	0	0	0	0
Oromia Region		1342713	1591475	2109854	2162643	2186399	1,992,804	
1	West Welega	42943	49108	70559	38338	38364	41,321	46772
2	East Welega	135444	140734	226608	88913	108395	85,973	131011
3	Illubabor	17254	15605	36006	21437	24464	19,198	22327
4	Jimma	138864	103273	129205	136596	125288	129,318	127091
5	West Shewa	207878	217092	298317	270932	332131	300,178	271088
6	North Shewa	80973	100061	120452	107344	149227	126,146	114034
7	East Shewa	222666	262507	373761	350726	330173	343,026	313810
8	Arsi	185608	239437	270418	264258	243595	196,922	233373
9	West Harerge	11922	19734	45658	27620	15633	21,714	23714
10	East Harerge	117577	152321	199532	187375	113172	71,748	140288
11	Bale	37639	109840	72547	105503	80478	65,408	78569
12	Borena	0	610	2628	1012	0	0	708
13	South West Shewa	139858	175564	253115	250810	278805	253,793	225324
14	Guji	3569	5588	11049	3589	9602	0	5566
15	Kelem	0	0	0	8129	8095	9,424	4275
16	Horogudur	0	0	0	141275	174944	175,536	81959
17	West Arsi	0	0	0	158786	153175	145,826	76298
Benishan		9330	7020	17407	13780	18611	13099	13208

gul-Gumuz								
1	Metekel	7067	6166	15464	13113	17176	11506	11749
2	Asosa	366	268	163	77	431	220	254
3	Kemashi	1898	586	1780	590	410	657	987
4	Pawe Special				0	586	672	419
S.N.N.P. Region		266687	287803	353071	361476	479686	455381	
1	Gurage	42576	55675	67755	62646	73242	68729	61771
2	Hadiya	72277	70024	87348	94415	120163	106903	91855
3	Kembata-Tembaro	20760	23896	23119	30287	36325	28137	27087
4	Sidama	56139	38816	70996	70628	133318	111614	80252
5	Gedio	0	4229	6565	0	0	0	1799
6	Wolayita	33025	27255	21556	23248	21155	20838	24513
7	South Omo	0	0	1301	725	0	273	383
8	Sheka	0	0	485	0	0	0	81
9	Keffa	0	1352	4480	1274	837	2116	1677
10	Gamo Gofa	0	0	2046	613	0	0	443
11	Benchi - Maji	130	999	1637	577	0	753	683
12	Yem Special Wereda	4122	4646	6991	6163	9354	5852	6188
13	Amaro Special Wereda	242	53	80	0	0	0	63
14	Burji Special Wereda	42	3	0	0	0	0	8
15	Konso Special Wereda	0	0	0	0	0	0	0
16	Derashe Special Wereda	0	0	0	0	0	0	0
17	Dawro	0	348	0	0	0	0	58
18	Basketo Special Wereda	257	234	815	186	139	41	279
19	Konta Special Wereda	0	20	152	397	0	0	95
20	Silitie	31291	50078	50755	55779	61480	72583	53661
21	Alaba Special	4083	8244	6972	10101	18517	33342	13543

	Wereda							
Gambela Region		*	*		0	0	0	0
1	Agnuwak	_				0	0	0
2	Nuware	*				0	0	0
3	Mezhenger	10886				0	0	3629
4	Itang Special	44181				0	0	14727
Harari Region		27924	13319	12274	14686	14574	14739	16253
Addis Abeba		16257	12883	18011	19742	0	0	11149
Dire Dawa		*	73	*	456	415	0	236

APPENDIX-VI Center of Gravity Result

Tigray region center of gravity grouped based on proximity of zones

Zone name	Location Id	Xi	Yi	Wi (metricTones)	Xi*Wi (10^6)	Yi*Wi (10^6)
W.Tigray	1	365569	1547150	3,778	1,381.16	5,845.29
C.Tigray	2	482828	1550840	5,616	2,711.61	8,709.67
	Sum	**848397**	**3097990**	**9,394.20**	**4,092.77**	**14,554.96**
		Center of gravity coordinate Determination				
		X=Σ(Xi*Wi)/ΣWi	**435670**	is the x coordinate		
		Y=Σ(Yi*Wi)/ΣWi	**1549356**	is the y coordinate		

Zone name	Location Id	Xi	Yi	Wi(Metric Tones)	Xi*Wi (10^6)	Yi*Wi (10^6)
S.Tigray	3	550847	1438300	4,355	2,398.99	6,263.94
E.Tigray	4	556462	1556990	1,608	894.79	2,503.64
	Sum			**5,963.10**	**3,293.78**	**8,767.58**
	Center of gravity coordinate Determination					
		X=Σ(Xi*Wi)/ΣWi	**552361**		is the x coordinate	

		Y=Σ(Yi*Wi)/ΣWi	**1470306**	is the y coordinate

AMHARA region Center of Gravity result

Zone name	Group 1 Location Id	Xi	Yi	Wi(Metric Tones)	Xi*Wi (10^6)	Yi*Wi (10^6)
East Gojam	1	264182	1207110	16,408	4,334.62	19,805.90
Awi	2	308664	1225750	45,528	14,052.82	55,805.82
West Gojam	3	375038	1165500	54,581	20,469.87	63,613.92
	Sum			**116,516.40**	**38,857.32**	**139,225.64**
	Center of gravity coordinate Determination					
		X=Σ(Xi*Wi)/ΣWi		**333492**	is the x coordinate	
		Y=Σ(Yi*Wi)/ΣWi		**1194902**	is the y coordinate	

Zone name	Group 2 Location Id	Xi	Yi	Wi (Metric Tones)	Xi*Wi (10^6)	Yi*Wi (10^6)
South Wollo	4	528330	1203630	10,966	5,793.67	13,199.01
North shoa	5	557588	1089880	13,596	7,580.97	14,818.01
Oromia zone	6	600975	1165900	0	-	-
	Sum			**24,562.00**	**13,374.63**	**28,017.02**
	Center of gravity coordinate Determination					
		X=Σ(Xi*Wi)/ΣWi		**544525**	is the x coordinate	
		Y=Σ(Yi*Wi)/ΣWi		**1140665**	is the y coordinate	

Zone name	Group 3 Location Id	Xi	Yi	Wi (Metric Tones)	Xi*Wi (10^6)	Yi*Wi (10^6)
North Wollo	7	522203	1306760	1,339	699.33	1,750.01
South	8	382533	1302100	9,396		

Gonder					3,594.43	12,235.05
Waghamera	9	494472	1394590	0	-	-
North Gonder	10	322872	1395450	5,552	1,792.62	7,747.68
	Sum			**16,287.70**	**6,086.38**	**21,732.74**
	Center of gravity coordinate Determination					
		X=Σ(Xi*Wi)/ΣWi		**373680**	is the x coordinate	
		Y=Σ(Yi*Wi)/ΣWi		**1334304**	is the y coordinate	

OROMIA region center of Gravity result

	Group 1					
Zone name	Location Id	Xi	Yi	Wi (Metric Tones)	Xi*Wi (10^6)	Yi*Wi (10^6)
Borena	1	456052	609289	-	-	-
Bale	2	620366	784921	6,540.80	4,057.69	5,134.01
Arsi	3	549326	866446	34,274.80	18,828.04	29,697.26
East shoa	4	484665	904397	34,302.60	16,625.27	31,023.17
	Sum			**75,118.20**	**39,511.00**	**65,854.44**
	Center of gravity coordinate Determination					
		X=Σ(Xi*Wi)/ΣWi	**525984**	is the x coordinate		
		Y=Σ(Yi*Wi)/ΣWi	**876678**	is the y coordinate		

Zones	Group 2 Location Id	Xi	Yi	Wi (Metric Tones)	Xi*Wi (10^6)	Yi*Wi (10^6)
Jimma	5	264305	876680	12,931.80	3,417.94	11,337.05
Illubabor	6	160714	925973	1,919.80	308.54	1,777.68
East Hararge	7	807770	1028980	7,174.80	5,795.59	7,382.73
East wellega	8	256869	1039820	8,597.30	2,208.38	8,939.64
	Sum			**30,623.70**	**11,730.45**	**29,437.10**
	Center of gravity coordinate Determination					
		X=Σ(Xi*Wi)/ΣWi		**383051**	is the x coordinate	
		Y=Σ(Yi*Wi)/ΣWi		**961252**	is the y coordinate	

Zone name	Group 3 Location Id	Xi	Yi	Wi (Metric Tones)	Xi*Wi (10^6)	Yi*Wi (10^6)
west hararge	9	695281	992759	2,171.40	1,509.73	2,155.68
west welega	10	80882.398	1013600	22,628.10	1,830.21	22,935.84
west shoa	11	380159	1006880	30017.8	11,411.54	30,224.32
North shoa	12	467223	1063780	37,993.90	17,751.62	40,417.15
	Sum			**92,811.20**	**32,503.11**	**95,732.99**
	Center of gravity coordinate Determination					
		X=Σ(Xi*Wi)/ΣWi	**350206.7522**		is the x coordinate	
		Y=Σ(Yi*Wi)/ΣWi	**1031481.033**		is the y coordinate	

SNNPRS region center of gravity result

Zone name	Group 1 Location Id	Xi	Yi	Wi (Metric Tones)	Xi*Wi (10^6)	Yi*Wi (10^6)
Derashai	6	319635	629317	-	-	-
Debub omo	7	236138	635546	27.30	6.45	17.35
Semen omo	8	327095	740671	-	-	-
Burji	9	377864	614437	-	-	-
Konso	10	320917	596842	-	-	-
BenchiMaji	11	123849	760593	75.30	9.33	57.27
Amaro	12	381525	643447	-	-	-
Keficho	13	168206	809286	-	-	-
	Sum			**102.60**	**15.77**	**74.62**
	Center of gravity coordinate Determination					
		X=Σ(Xi*Wi)/ΣWi	153727		is the x coordinate	
		Y=Σ(Yi*Wi)/ΣWi	727320		is the y coordinate	

Zone name	Group 2 Location Id	Xi	Yi	Wi(Metric Tones)	Xi*Wi (10^6)	Yi*Wi (10^6)
Gedeo	14	417093	688129	-	-	-
Sidama	15	448546	761747	11,161.40	5,006.40	8,502.16
	Sum			**11,161.40**	**5,006.40**	**8,502.16**
	Center of gravity coordinate Determination					
		X=Σ(Xi*Wi)/ΣWi	**448546**		is the x coordinate	
		Y=Σ(Yi*Wi)/ΣWi	**761747**		is the y coordinate	

APPENDIX-VII Interview Questioner

I. INTERVIEW QUESTION FOR FRIEGHT TRANSPORT PROVIDER

Acknowledgment for the Interviewee

Hereby, I would like to express my gratitude for your dedicated cooperation as this questionnaire is conducted for the purpose of fundamental scientific research. Had it not been your genuine cooperation of filling this questionnaire, it would have not been possible to conduct this thesis.

Questioner No. --------- Date-------------------------

Company Name------------ Location--------------------

1. What are the main types of transport service carried out by the company?
2. How do you get your loading business?
3. Through freight agents, by telephone/fax from customer, by trucks waiting at lorry parks, by drivers finding their own load
4. What is your usual load rate when transporting fertilizer/improved seed?
5. How do you plan your route?
6. What are your main destinations when transporting fertilizer?
7. Have you faced seasonal variation in your transportation service? Yes/No
8. If your answer is yes, on which quarter of the year that your transportation service is the busiest?
9. September-November 2. December – February 3. March- May 4. June-August
10. What are the principal commodities moved on peak seasons?
11. Do you face problems when plan to transport fertilizer compared to other commodities? Yes/No
12. If your answer is yes, what are the main problems?
13. What capacity of truck does your company use in transporting fertilizer/improved seed from port to final destination?
14. Less than 30 tone 2. 30-35 tone 3. 35- 40 tone 4. More than 40 tone
15. Do you think all of your trucks carry at their full capacity? Yes/No
16. To how much time does your company face directional imbalance of loading when transporting fertilizer/improved seed?
17. Most of the time 2. Some times 3. Always 4. Not at all
18. To what extent does your transport operational cost is affected on road condition?
19. Slightly significant 2.less significant 3. More significant 4. Highly significant
20.
21. Do you have main problems related to enforcement procedures along the road and at the border posts? Yes/No
22. If your answer is yes, specify the problems?
23. Do you communicate the position and the condition with truck driver? Yes/No/some times
24. If your answer is sometimes/No, what is the reason of miscommunication?
25. What are the main constraints preventing more efficient transport operations in your company?
26. What strategies do you suggest to improve these constraints?
27. On your company transport logistics, how do the following barriers influence the overall effectiveness?

SR.no	Transport Service barriers	Does the barrier exists?		If the answer is yes, Extent of barriers impact on service efficiency (thick on corresponding item)				Influence on	
1	Customs Procedure and inspection	yes	no	No	Slightly	Moderate	High	Time	cost
1a	Time consuming documentation requirement								
1b	Burdensome inspection requirement								
1c	Arbitrary independent ruling								
1d	Lack of border crossing coordination								
1e	Improper penalties								
1f	Limited hour operation of customs office								
1g	Corrupt practices								
1h	Security related delays								
1i	No of check points through the country								
2	Road related barriers								
2a	Poor road condition								
2b	Terrain condition of the road								
2c	Directional imbalance								
2d	Axle load limit on weigh bridge stations								
3	Infrastructure barriers								
3a	Absence of adequate warehousing and specialized								
3b	Inefficient handling equipment at warehouse								
3c	Availability of communication means								

28. We would now like to get some cost details of transporting fertilizer/improved seed on your most recent fertilizer shipment in which you transported fertilizer/improved seed?

route	Origin	Destination	Road condition[1]	Terrain condition(mountainous, flat, rolling, escapement)	Total days to travel	Unit transport cost	Average truck capacity	Usual load rate
1								

[1] road condition

1. poor condition/earthen 2. good condition/earthen 3.poor condition/gravel 4.good condition/gravel

5. Poor condition/asphalt 6. Good condition/asphalt 7.other (specify

INTERVIEW QUESTION FOR TRUCK DRIVERS

1. What problems do face when transporting fertilizer from port to distribution centers?
2. Do you have any queue problem at the port, at the arrival terminal, at the departure terminal, at final district or provincial points? Yes/no
3. If your answer is yes, what are the major causes of these queues?
4. If your answer is yes, please provide the following information

Specified location name	Maximum and Minimum time spent(hour/day)											
	Port		Arrival terminal		Departure terminal		Storage areas		Weigh bridge stations		others	
	max	min	max	min	max	min	max	min	max	min	ma	min

5. Do you travel in night time when transporting fertilizer/improved seed? Yes/No
6. If your answer is yes, have you faced safety/security problem since start of transporting it? Yes/ No.
7. At what condition the available road stretches you observe when transporting fertilizer/improved seed?

8. Poor condition 2. Good condition 3. Better condition 4. Best condition
9. To what extent do restrictions on weight of fertilizer/improved seed on weigh bridge station influence your traveling time?
10. No impact 2. Slightly significant effect 3. Significant effect 4. Very significant effect
11. To what extent do time consuming documentation requirements of customs office influence your traveling time?
12. 1. No impact 2. Slightly significant effect 3. Significant effect 4. Very significant effect
13. To what extent do limited hours of operation at customs facilities influence the efficiency of your transportation of fertilizer /improved seed?
14. 1. No impact 2. Slightly significant effect 3. Significant effect 4. Very significant effect
15. To what extent do security related delays influence the total time of transporting fertilizer/improved seed?
16. 1. No impact 2. Slightly significant effect 3. Significant effect 4. Very significant effect
17. To what extent do lacks of border crossing coordination with regional neighbors influence the timing of transporting fertilizer/improved seed?
18. 1. No impact 2. Slightly significant effect 3. Significant effect 4. Very significant effect
19. To what extent do multiple uncoordinated offices influence the driving efficiency?
20. 1. No impact 2. Slightly significant effect 3. Significant effect 4. Very significant effect
21. Have you faced improper penalties when transporting fertilizer/improved seed? Yes/No
22. Do you face discriminatory licensing requirements at the port when transporting fertilizer/improved seed? Yes/No
23. Do you face limitations on fleet size and hours of operation regulation when you transport fertilizer/improved seed? Yes/No
24. Do you face regulation on prohibiting operation during certain days of a week or on certain highways when transporting fertilizer? Yes/No
25. Have you face fueling station problem over the stretch of the road? Yes/No
26. To what extent the geographical nature of the country influence your driving performance?
27. 1. No impact 2. Slightly significant effect 3. Significant effect 4. Very significant effect
28. Have you faced loading and unloading problem at warehouses and ports? Yes/No
29. To what extent your travel time of fertilizer/improved seed transportation influenced by loading and unloading?
30. 1. No impact 2. Slightly significant effect 3. Significant effect 4. Very significant effect
31. Have you faced problems at weigh bridge stations when transporting fertilizer/improved seed? Yes/No
32. Do the customs work over time for clearance of cargo when you transport Fertilizer/improved seed? Yes/No
33. If you do not reach on customs working hour, do you face problem on your cargo transport? Yes/No
34. Do you think customs clearance is quite lengthy? Yes/No
35. Do the customs inspect fertilizer/improved seed thoroughly? Yes/No
36. To what extent this problem influences your travel time of transporting fertilizer/improved?
37. 1. No impact 2. Slightly significant effect 3. Significant effect 4. Very significant effect
38. How many times per trip you are commonly asked to submit documents when transporting fertilizer/improved seed?

INTERVIEW QUESTIONS FOR CUSTOMS AUTHORITY

1. To how many points do you check throughout the country?
2. How many documents you apply for importing fertilizer? Name of documents
3. Do you have your own warehouse at the port? yes/no
4. Do you always take a physical inspection on the imported fertilizer or could you use x-ray scanning? yes/no
5. If your answer is yes, how much is the rates of the imported fertilizer inspection you take the inspection?
6. How many amount of fertilizer (in tone) that passes through the port in this year?
7. How long is the queue time (waiting time) before unloading at the port?
8. What is the cost of waiting time in USD per hour or per day?
9. What are the main factors causing delays or long waiting time at the port?
10. Do the customs work at the port sufficient time based on the available fertilizer cargo? Yes/No
11. Do the customs work over time for clearance of cargo? Yes/No
12. Who pay for these over time?
13. 1. Truck owner 2. Customs itself 3. Others
14. What are the working days of customs official?
15. Do you use electronic device to improve document processing? Yes/No
16. If your answer is yes, what are most applicable devices?
17. Do you have a standard format for imported goods checking? Yes/No
18. With what language do your format of documentation written?

Questioner for Agricultural Input Supply Enterprise (AISE)

1. Do you have a fertilizer distribution quantity for each region?
2. Who are the major wholesaler/retailers for each region?
3. How do you plan the number of vehicles for the required shipment size?
4. How much is the current international price of fertilizer?
5. Do you face currency problem when you buy fertilizer?
6. Where are your first fertilizers stocking places in each region?
7. Could we have the percentage demand of each region's storage?
8. Do you have the capacity of the proposed warehouse in the region?
9. How many vehicles do you plan to transport for each lot shipment?
10. Who are your major transport providers?
11. How do you assign vehicles on two routes of the country? Based on tariff differences
12. Do you have deadline for transport provider to deliver to the storage area?
13. Is stevedoring and bagging activity by cargo owners or by you?
14. Do you have bagging machine capacity to plan your vehicle to the port?
15. How do you think the costs related to port in efficiency?
16. Who is responsible for the demurrage costs at the port due to congestion?
17. Do you think port charges, bagging and transport charges affected mainly due to congestion of the port?
18. When is international contract signed for this years and delivery occurred?
19. Do you have a demurrage cost of a 25,000 MT ship per day?
20. Do you have coordination with other commodity importers as food aid?
21. How much you incurred from port charges?
22. What is your base for freight rate decision to contract with freight provider?
23. Could I have a three year freight rates?
24. How do you manage the seasonal market price difference?

25. Do you have estimated costs for every activity done for shipment up to final destination?
26. Could we have a three year twelve month imported fertilizer quantity?

QUESTIONER FOR ETHIOPIAN SEED ENTERPRISE

1. How do you determine the demand of improved seed throughout the country?
2. Do you have a demand for each region/zone?
3. Who are the major distributors of improved seed throughout the country?
4. What problem do you face from the transport company to transport improved seed to different areas?
5. Where are the major producers of improved seed from different regions?
6. Where is your central warehouse to distribute improved seed?
7. How many seed processing unit do you have throughout the country? Where are they located?
8. How do you plan to distribute improved seed to different regions, zones, and weredas?
9. What is the current price of improved seed?
10. What problem do you face when distribution improved seed?
11. Do you have quantity produced from each farm?

QUESTIONER FOR MARITIME AFFAIRS AUTHORITY

1. What is the role of maritime affairs authority on the available ports of the neighboring countries?
2. What is the level of current container and multimodal transportation system?
3. Do you make any coordination between different authorities in the port to facilitate the trade?
4. What agreements do you make with the port authority to improve the efficiency of the port?
5. What measure do you apply when there is a bulk of fertilizer stocked at the port?
6. How many controlling authorities are there at Djibouti port?
7. How many agents are there in the port of Djibouti?
8. What are the main constraints in using ports other than Djibouti port?
9. What is the constraint in applying effective containerization and multimodal transport?

Checklist for Mari time and transit service enterprise

Indicators of time

1. Total time for trade-related procedures (average and maximum)
2. Customs inspection clearance time (average and maximum)
3. Technical control clearance time (average and maximum)
4. Time for trade document procedures (average and maximum)
5. Vessel turnaround time (average)
6. Time to resolve customs appeals (average and maximum)
7. Vessel waiting time to obtain berth

Indicators of cost

1. Total cost for trade-related procedures
2. Port- and terminal-related charges
3. Total cost for trade document procedures
4. Border control costs

Indicators of complexity and risk factors

1. Total number of documents per trade transaction
2. Number of signatures per trade transaction
3. Criteria for customs inspection
4. Level of customs inspection
5. Shutdown of port due to natural disaster and labor dispute (days)
6. Frequency of vessel calls at port
7. Number of agencies that have the power to inspect fertilizer
8. Number of times consignments are typically inspected
9. Percentage of vehicles electronically scanned
10. Percentage of vehicles physically inspected
11. Waiting time at border crossings (average and maximum)
12. Harmonization of documents with transit country
13. Whether there is free transit access for vehicles across borders

CHECKLIST FOR ETHIOPIAN ROADS AUTHORITY

1. Length of classified road network(km)- for five years
    - Federal roads
    - Regional roads
    - Community roads
2. What is the road density/km2 or per 1000 population
3. length of all weather roads(in km) by region
4. Road network condition (percent) throughout the country?
    - For federal roads
    - Regional roads
5. Current road sector development program of the country
6. Axle load record of overloading

CHECKLIST FOR TRANSPORT AUTHORITY

1. Total available dry cargo trucks
2. Registered vehicles by type and size for a number of years
3. Commercial dry cargo freight transport vehicle fleet for the current year with operators?
    - Number of vehicles
    - Average pay load(tone)
    - Commercial operators-parastatal, affiliated association, association, share companies, individual
4. Commercial vehicle age distribution?
5. Capacity of dry cargo freight transport vehicle stock?
6. Dry cargo transport performance(ton-km)

INTERVIEW QUESTIONS FOR FARMERS ASSOCAITION /SERVICE COOPERATIVE/WHOLESALER

1. Do you participate in sale of fertilizer distribution? Yes/No

2. Is the (1) fertilizer supplies delivered to you or (2) do you have to collect the fertilizer supplies on behalf of the farmers?
3. Did you hire transport? (yes/no) ______
4. If you did not hire transport, how do you collect the fertilizer?
5. If transport is hired by you to collect fertilizer , could you give the details of different examples of collection

	origin	destination	KM	Total quantity	Transport cost(specify units)	Loading costs	Unloading costs	Month
1								

6. What were the biggest problems you encountered in getting your fertilizer supplies this year?
7. Is there anything that you can do differently next year to avoid these problems?
8. Is there anything that other actors in the fertilizer sector (importers, retailers, government, extension agents) can do to reduce these problems?
9. Was there ever a period when farmers wanted fertilizer and you had none in stock?
10. (Yes/no) ____________
11. If your answer is yes, what was the source of the problem?
12. Do you sale fertilizer/improved seed with cash or credit? Cash/ Credit
13. If your answer is on Cash, what has been your experience with cash sales? Do they pose different problems than credit sales? If yes, explain.
14. What was your timing of reporting fertilizer/improved seed needs to agricultural bureau? Month begin----------------------Month end----------------------
15. At what time arrival of fertilizer/improved seed reaches to your storage area? Month begin--------------------- Month end----------------------------
16. What were major problems that you encounter in your fertilizer/improved seed sales this year? (Unexpected costs, delays in delivery to clients, complaints about fertilizer quality, dissatisfied clients, delays in payments by clients, other.)

INTERVIEW QUESTIONS FOR WAREHOUSE AND STORAGE AREA PROVIDER

1. Is the storage rented or owned?
2. If storage space is rented, do you give us a report on total annual expenditure on rent during months in which fertilizer is stored?
3. If storage space is owned, how much income you could make by renting the storage space to others or how much it would cost you to rent a similar amount of space from others during the months that you store fertilizer?.
4. Do you have separate warehouse for fertilizer/improved seed? Yes/No
5. What problem do you face when storing fertilizer/improved seed?
6. Do you face damage of fertilizer/improved seed during loading and unloading? Yes/No
7. What is the unit price of storing fertilizer/improved seed per ton?

8. Do you have any extra cost you incur for fertilizer/improved seed?
9. Do you have equipment to unload/ reload fertilizer /improved seed? Yes/ No
10. If your answer is yes, do you have sufficient daily laborer to unload and reload? Yes/No
11. What is the maximum capacity of laborer or equipment to loading /unloading in tone per day?
12. How do you pay the employer working at storage houses? Per quintal/kg/tone/month/day
13. What is your storage capacity in M3?
14. Do you face traffic congestion in the storing area during fertilizer/improved seed loading and unloading? Yes/No
15. Is the warehouse Governmental or private owned?
16. Do you think warehouse handling is difficult? Yes/No
17. What is the storage cost?
18. How long the consignment remains in the warehouse?

INTERVIEW QUESTIONER FOR MINISTRY OF AGRICULTURE

1. How do you determine the demand of fertilizer throughout the country?
2. Who is the major distributor of fertilizer throughout the country?
3. Who is the major wholesaler of fertilizer in each region?
4. Do you set the pricing mechanism for each region?
5. Have you faced foreign currency problem?
6. What problem do you face from the transport company to transport fertilizer to regions?
7. Do you revise the price given by the retailers?
8. What mechanism do you apply to this revision?