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A case study of Et-fruit distribution company In Addis Ababa, Ethiopia

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Tesfaye Sebeko

Abstract

This thesis underlines an assessment of the Postharvest loss conditions of selected fresh produces of Etfruit wholesalers and its impact on chain players in Addis Ababa, Ethiopia. Reducing Postharvest loss instead of increasing the volume of production can save scarce resources, ecofriendly and improve food security (Kader, 2004). The approach for conducting the study consists of semi-structured interview and observation techniques with detailed interviews of Etfruit-wholesalers and their close trade partners. Volume losses were estimated for each supply chain channel and fresh produce. Total food loss along supply chain channels for selected fresh produces is about 28% whereas 1% in consumers' channel. Postharvest loss largely occurs in supply channels than consumer for fresh produces in developing countries (Fao, 2014). Lack of incentives against food loss given the initial supply curve (amount) resulted in a lower quantity, higher price, producer's surplus, welfare disadvantage for consumers in fresh produces market. Moreover, failing to reduce food waste from consumption resulted in a higher quantity, welfare advantage for produces and higher price in the market. Therefore, lack of responsive action to reduce postharvest loss caused producers to be greatly affected players' in the supply chain.

There were hindrances which promote food loss in the supply chains; lack of cold chain system, inadequate packaging and heavy dependence on manual Labor. These problems can largely be reduced by implementing cold chain, refrigerated transport, plastic crates, locally viable technologies and persistent policies. In Ethiopia where traditional postharvest handling is the only choice, poorly harvested and packaged fresh produces loaded onto inadequate transport by means of manual labor. Valuation of postharvest losses of fresh produces at various phases of supply channels would benefit in pinpointing the causes for food losses. This also enables to develop proper measures required to reduce losses and to increase the accessibility of fresh produces. With postharvest concerns having been mostly overlooked, a firm indication starts from lack of common assessment method. Moreover, there have not been many researches on the impacts of food loss in developing countries. Therefore, there is an urgent need for further quantitative researches that provide accurate loss estimates. Unless deliberations on the potentials for reducing worldwide food loss will remains mostly rhetorical.

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1 Introduction

1.1 Problem background

Currently world is facing serious concern over the equitable, rational and sustainable use of the natural resources that support fair food supply, labour, land, clean water, environment friendly and agricultural inputs because failure in these endeavours leads to starvation and civil war (Stuart, 2009a). The management and synchronization of the supply chain for fresh produces has become increasingly fundamental concern. As business sectors need to reduce postharvest losses and wastes in the supply chain by taking advantage of market opportunities which perceived from fundamental shifts in customer preferences and tastes (Wilson, 1996). World population is expected to reach 10 billion by 2050 which will require a 70% increase in food production (FAO, 2009, Tilman et al., 2001). According to Fao (2014) study, 870 million people were food insecure and chronically undernourished during the year 2010-2012. Unfortunately, largest proportion of them lives in developing countries. The percentage of people in the world living as malnourished has declined from 18.6% to 12.5% since 1990. However, an increase in malnutrition has taken place in different parts of world like North Africa, sub Saharan Africa and Western Asia during the recent years. In sub Saharan Africa, about 27% or 234 million people have no sufficient food available (Fao, 2014). Therefore, Ethiopia is one of the Sub Saharan African nations that are poised at the brink of a severe food insecurity and poverty (www, faostat, 2015).

In order to fight poverty and ensure food security there has to be huge demand for investment and development in the agricultural sector particularly in developing countries (Fao, 2014). Production of agricultural products such as fruits and vegetables can contribute to increased food security as well as better nutrition intake which could leads to economic development (Weinberger and Lumpkin, 2007). The increased population size and shifting dietary lifestyles in Ethiopia has intensified the need for local fruits and vegetables (Woldewahid et al., 2012). However, the fruit and vegetable production has been small scale in Ethiopia related to other crops; however, it has plentiful potential for production of several horticulture products due to the climate is favourable (Emana and Hadera, 2007). For some local fresh produces production has been increased by 60% such as Avocado, Banana and Mango during the last decade in Ethiopia (www, faostat, 2015). Despite progress in horticultural production, failure to reduce postharvest loss can decline food availability due to increase in physical loss and decrease in income from the diminished market opportunities. Reducing postharvest loss

instead of increasing food production can save scarce resources and lesser environmental pollution. This is because increased production can lead to more intensive farming (Zorya et al., 2011). Therefore, reducing PHL is one of indispensable approaches to make more foods available without increasing the pressure on the natural resources (Hodges et al., 2011).

The production of fruits and vegetables in Ethiopia is normally scattered and carryout by a great number of small farm holders and transported long distance to reach central markets. To spread more to central outlet there are usually a lot of intermediaries between producers and consumers (Shukla and Jharkharia, 2013). Hindrances in the supply chain for fresh produces in Ethiopia mainly emanates from limited knowledge about postharvest handling and lack of infrastructure (Wakjira, 2010). Food loss often occurs in all phases of postharvest handling such as, storage, packaging, transportation, processing and marketing. Lack of information access, application of better technology and credit services are obstacles along supply chains and the infrastructure are mostly fragile in developing countries (Trienekens, 2011).

Ethiopia harbours an extraordinarily rich agro-biodiversity resulting from its geography, climatic variances, ethnic diversity and strong food culture. Uniqueness is the great variation in climates, due to the great variation in altitude ranging from sea level up to 4,500m. Together with ample possibilities for irrigation it is reasonable that a great variety of fruits and vegetables can be harvested in Ethiopia (Wiersinga and de Jager, 2009). However, the total area under fresh produce cultivation in Ethiopia accounts for about 5% of the total land suitable for cultivation. There are several small producers harvesting a small range of fruits and vegetables for the local market. The sector also comprises big state owned farms delivering fresh produces for local and export market (Emana and Gebremedhin, 2007).

1.2 Problem statement

As stated in the earlier section that dependable access to adequate food is limited in Ethiopia. Therefore has a need to grant food security by increasing food production while reducing losses along supply chain channels. Production of fresh produces can be one of the solutions to enhance food availability and relieve undernourishment (Parfitt et al., 2010). Many research findings showed that food loss is immensely increasing in developing countries. Latest research reports by Gustavsson et al. (2011) estimated annual quantitative food loss in the supply chain globally approximates 40-50% fresh produces; 30% for cereals; 20% for oilseeds, meat and dairy. Regardless of different drivers and incentives, one of the most

important reasons attributing to lower availability of fresh produce is its huge quantity loss that occur at different phases of supply channel (Prusky, 2011). Pariser (1982) argued that factors for food loss in developing countries are an outcome of comprehensive, administrative and technical constraints in harvesting methods, storage, transport, process, cold chain, road infrastructures, package and market integration system. (Rutten, 2013b) also demonstrated that a 40% decrease in food loss along supply chain in the EU would lead to, small, but positive, a decrease in food prices (0,2%) while an increase in food consumption (0,04%) in Sub Saharan Africa.

Few systematic approaches have been used to estimate the losses at each stage of handling in developing countries. Many of the them were based on small-scale experiments which do not reflect the actual holistic situations on postharvest losses of fresh produces (Ratnam and Nema, 1967, Biswas, 1969, FAO, 1981). Little information is available regarding postharvest loss of perishable produces in Ethiopia mainly at different phases and their impact on supply chain players. In Ethiopia, supply chain can be described as rudimentary system resulted from inadequate infrastructure, disintegrated market and lack of information. Moreover, harvesting of fresh produces dependant on natural rainfall and practically challenging (Wiersinga and de Jager, 2009). This study assesses supply channels for selected fresh produces, role of players, impacts of food loss on producers and consumers and estimation of food loss, Addis Ababa, Ethiopia.

According to FAO (2012), in the developing countries, absence of basic infrastructure and knowhow in post-harvest handling have been identified as significant drivers in the formation of food loss, both currently and foreseeable future. Kader (2005) also supported the notion where global markets, domestic strategies and capital investment are lacking, prime investments in basic infrastructure in developing world often unsuccessful. Postharvest losses are very much dependent on specific conditions and local situations in a given country. In broad terms, as per World Bank (2010), food losses are influenced by production and processing choices, patterns and technologies, internal infrastructure and capacity, supply chains and channels for distribution and consumer food use practices.

1.3 Aim and delimitations

The aim of this study was to assess postharvest losses along the supply chains of fresh produces in Addis Ababa, Ethiopia. In order to achieve the aim the supply and value chain for

selected fresh produces needed to be identified in Addis Ababa, Ethiopia. The research questions addressed were:

1. What are supply chain channels for fresh produces and their main players?
2. What are hindrances and volume of postharvest losses in the supply chains?
3. What are impacts of postharvest losses on supply chain players?

1.3.1 Delimitations

This study was conducted in Addis Ababa, Ethiopia as part of a project program between Addis Ababa University and Swedish University of Agricultural Science; particularly Department of Energy and Technology. The research area was delimitated to Addis Ababa, Ethiopia. This location represents mostly country's prevailing situations of postharvest loss and handlings for fresh produces. Trade industry office was instrumental for the selection of the main wholesalers of fruits and vegetables in Addis Ababa, Ethiopia. Fresh produces categories were determined through discussion of marketing experts of Etfruit wholesale firm on the bases of high loss prevalence and economic contribution. The study was delimitated to only PHLs, thus losses that can occur before harvest was not taken into account. There are several ways to estimate postharvest loss but interview technique was chosen as the method for this study. At large, information on postharvest losses were limited in developing countries and those existing were acquired either on the basis of the judgment of experts or estimation of questionnaires. These biases could affect study result for instance asking housewives to weight all food wasted at plate from total consumption through a given period of time. However, participation and consideration of players own perception on postharvest losses and handlings can only be achieved by this approach. Accurate results might be estimated with other methods, but valuable information from the players' perspective could be overlooked. In exploring the supply chain channels for fresh produces mainly downstream approach was used. Therefore, producer channel was not directly considered because using producers to consumers would entail the danger of interviewing several numbers of producers who may not produces fresh produces for commercial objectives in lager cities. Exploring further the produces supply and value chain situation can provide prospects to find improvement options that can be applied in both domestic and export chain.

2. Literature review

2.1 Fruits and vegetables supply chains in Ethiopia

Ethiopia has a comparative advantage in a number of fruits and vegetables productions because of its favourable weather, cheap labour, proximity to export market such as Europe and Middle East (Ruel et al., 2005). However, the production of fruit and vegetable is much less advanced than the production of staple grains. Normally, more than 2,399,566tons of fresh produces are harvested by private and public commercial farm which is estimated to be less than 2% of the total staple production. Total area under fresh produce is about 12,576 hectares in 2011 which is less than 1% (0.11%) of the total land area under cultivation (www, CSA, 2014).

Table 1. Fruit and vegetable cultivation in Ethiopia for private peasant holdings (2010/11) Statistical Abstract from (CSA, 2014)

Crop Type	Area (ha)	%	Production (Quintals)	%	Productivity Qt/Ha
Cereals	9,233,025.14	79.05	155,342,279.88	69.63	16.83
Oil seeds	780,915.89	6.69	6,436,143.98	2.89	8.24
Pulses	1,489,308.45	12.75	18,980,472.57	8.51	12.74
Cash Crops	159,287.98	12.75	39,226,177.5	17.58	246.26
Vegetable	7,309.16	1.36	1,403,234.19	0.63	192
Root Crops	4,419.64	0.06	996,331.80	0.45	225.4
Fruit Crops	5,266.91	0.04	706,119.18	0.32	134.07
TOTAL	**11,679,533.17**	**0.05**	**223,090,759**		

2.2 Agro-climate benefit for harvesting fruits and vegetables

Ethiopia has highly diverse climate and altitude that are favourable for various agricultural harvestings. It is also gifted by several rivers and lakes with massive irrigation possibilities. Ethiopia has an estimated 10 million hectares of land with the potential of irrigation of which merely about 1% is presently under irrigation system. Fruits and vegetables are crops of great economic importance with a prospect for local consumption, export markets and processing includes Bananas, Avocados, Mangoes, Mandarin, Papayas, Tomato, Onion, Carrot, and Cabbages.

Table 2. Estimated Potential Area for Fruit and Vegetable Investment (CSA, 2014)

No.	Regions	Area	Remark
1	SNNP	346,300	Rain fed and irrigation (Gibe, Omo, Sawla, Woito Rivers are source of irrigation).
2	Oromia	150,000	Rain fed and irrigation (Awash, Wabe. Dabus, Guder, Didessa)
3	Amhara	270,000	Grater than 200,000 ha based on out growers. Lake Tana and Abay river are source of irrigation.
4	Dire Dawa	1,000	Based on Ground Water
	Total	**767,300**	

2.3 Supply chain channels for fruits and vegetables in Ethiopia

As shown in *Figure 1* there exist at least three supply chain channels for fresh produces on the bases of product type and market destination. Ethiopian fresh produces marketing firm (Etfruit) is one of largest state owned enterprise that dominated domestic distribution channels. Etfruit supply and distribute fresh products of the horticultural state farms and other that harvest horticultural crops on a contractual basis. Private exporters are also involved in the export of fresh produces.

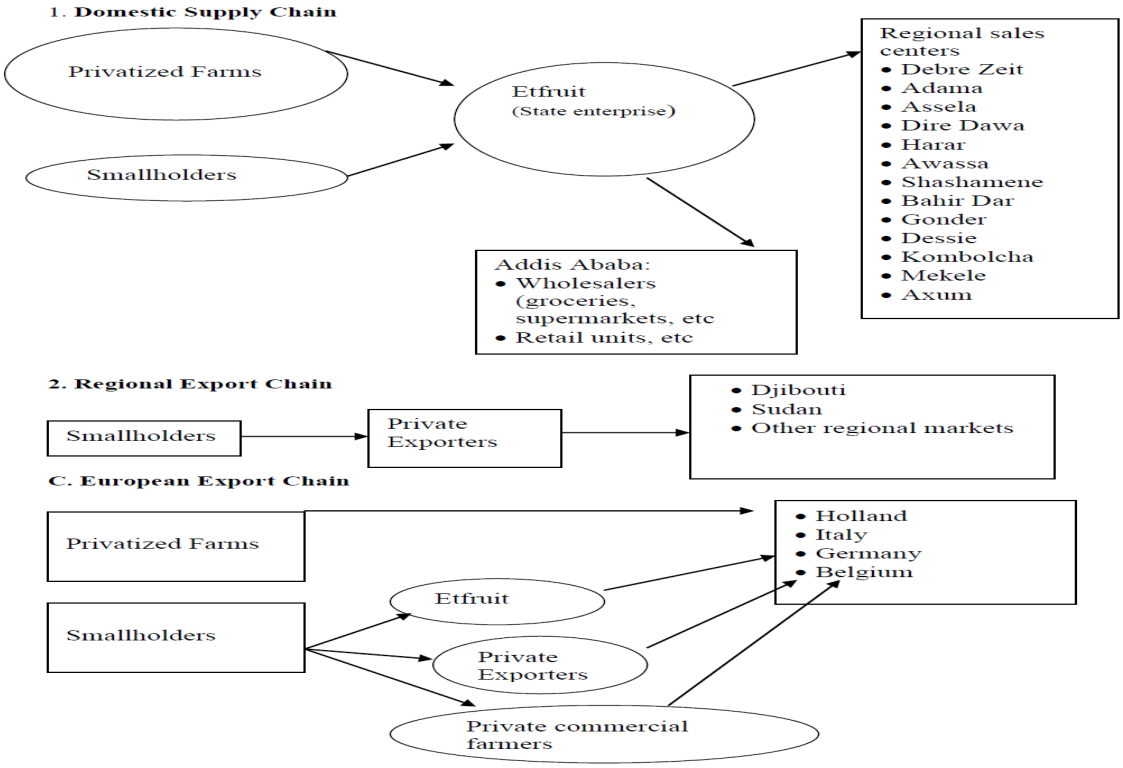

Figure 1. Three types of supply chain channels for fresh produces in Ethiopia (ETHEMB, 2014, p.8)

2.4 Worldwide Trends Influencing Post-harvest food Loss

There are global tendencies that influence postharvest losses of food according to (Parfitt et al., 2010). Firstly, it is apparent that there is continuous rapid developments of urban cities and reduction of the agrarian sector in many countries. Due to this fact, the last couple of decades have witnessed a substantial shift towards from the rural areas to the urban areas. Farm cultivators are departing their farm fields and heading to the urban cities in pursuit of improved livelihoods. Largest share of the world's population currently resides in urban cities. It is estimated that by year 2050, two-thirds of population or 6 billion societies will be residing in urban areas when compared with the estimation of only 32% in 1960. This developing phenomenon has initiated the need for protracted food supply chain channels to feed urban area population. More food shall have to be moved over longer distances to get urban cities, necessitating developments in transportation, roads, storage, distribution and marketing infrastructure to evade additional losses. How these protracted food supply channels adhere to pace with urban development has apparent effects for food loss globally.

The second development starts with the shift in food use practice patterns. Increased urbanization in association with income increment, principally in transitional countries such as China, India, Russia and, Brazil has caused in hasten of the diets diversification into fresh fruits and vegetables and a decrease in consumption of staples food (Parfitt et al., 2010). This change towards more fruits and vegetables, shorter shelf life produces is related with greater food loss combined with greater demands placed on farming in terms of inputs and lands to production system (Lundqvist et al., 2008a).

The third trend is associated with the globalization of trade system. Related to trade globalization and liberalization, there are rapid increase in supermarkets – frequently multinational firms are operating throughout several countries. Supermarkets are appearing the central marketing intermediary among producers and consumers. They are displacing old-fashioned retailers in several countries such as in Africa, Latin America and Asia. Also it appears as the main rout line for delivering varied fruits and vegetables for the middle classes as well as the urban poor. Related with supermarket domination, there are obvious requirement to conform safety and quality standards of customers, along with volume and appropriateness of demands for export and local markets, hence all contributes for food loss in the supply chain.

To demonstrate these significant global drivers, (Parfitt et al., 2010) considered PHLs with technological and economical gradient from developing countries to transitional and developed countries. Equally as developing economies climbs the economic ladder, the stage of their postharvest infrastructures and supply-chain technologies advances and the pattern of their food losses changes. With rudimentary postharvest infrastructures, the bulk of food losses happen near the farm-gate while in economies with more innovative infrastructure, more of the food loss happens at the consumer and retail-outlets. Therefore, as the country becomes richer, the natures of food losses become more of deliberate.

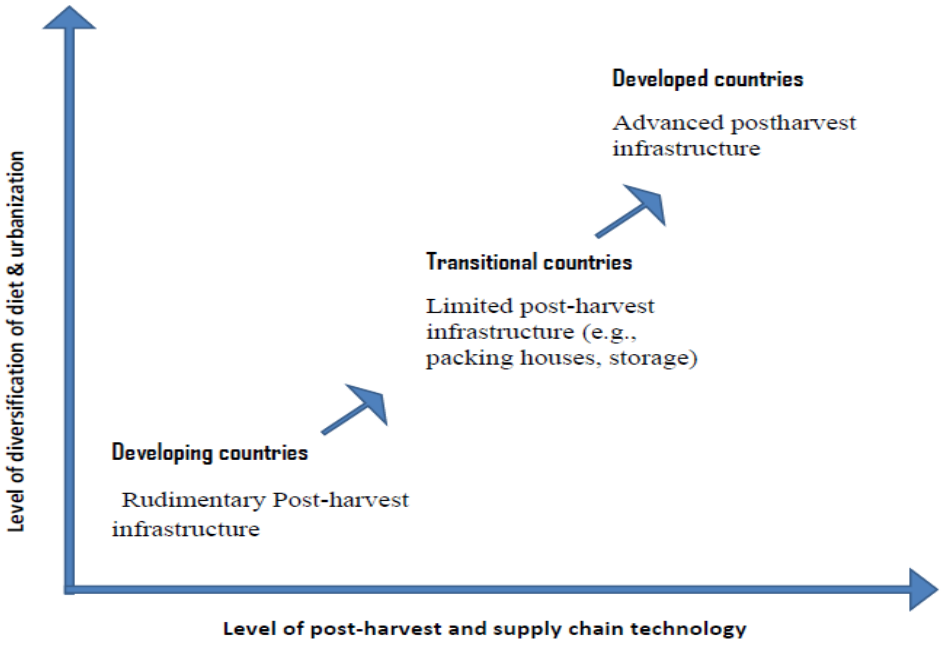

Figure 2. Development of postharvest infrastructure in relation to levels of economic development adapted from Parfitt et al. (2010)

2.5 Postharvest food loss in developing countries

The major postharvest losses often occur on or immediate the farm-gate in the developing countries, where the primary choice of commodity type and variety and the success of harvesting methods are central in retaining losses lower. Traditionally, most efforts to reduce postharvest losses have focused on-farm, predominantly crop storage, for motives of food security (World Bank, 2010). Extensive use of automation and cold chain know-how in developed countries retain on-farm PHLs lower than those in developing countries, even though they might still happen, such as when automated harvesters harm portions of the crop. Possibly in other developed nations, most food losses seem to be food waste than the farm-

gate, with superior bulks at the consumer channel than from the activities of retailers (Hodges et al., 2011).

The postharvest schemes of developing countries need substantial investment to form more formal markets and advance their performance to a place where PHLs can be considerably reduced. Particular of these developments have to take the form of public 'goods' comprising infrastructure for instance the expansion of all-weather feeder road and rail network so that commodities can reach right place at right time for right customer, a problem particularly severe in Africa where transportation expenses can be five times those in Asia (Rigg et al., 2009). Davis (1980), provided an illustration of the significance of the transport situations, stating an article available in the Wall Street Journal (26 June, 1980). It was described that production circumstances in Zaire changed from good to ideal, with the nation having the possibility to feed much of the inhabitants on the continent of Africa. Still, it lost competence to feed its own population due to a basic reason: Zaire has traditional transportation structure, a crumbling railroad system and practically no modem roads. The article voiced of farmers who are losing hope, since they easily cannot bring their crops to marketing places. Indeed, this is not unique to Zaire, but common trend to a great number of countries in Africa.

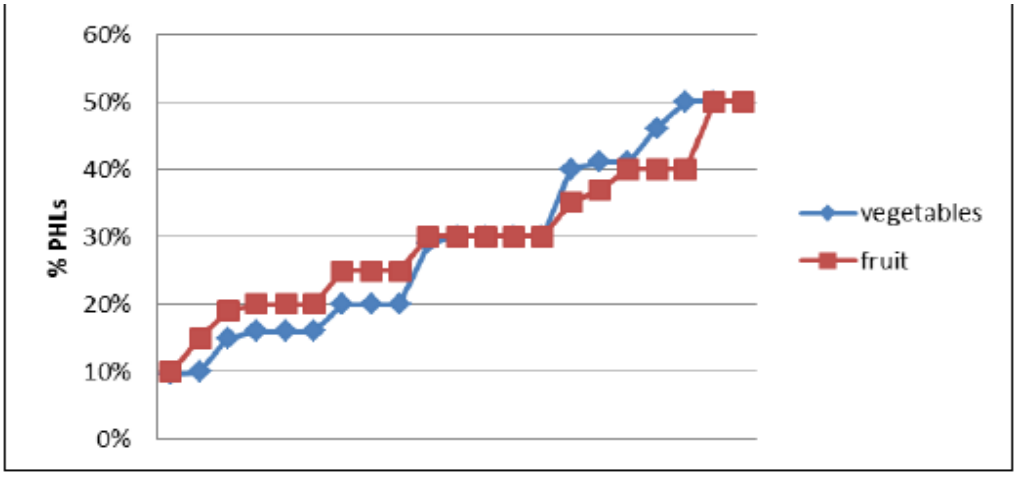

Figure 3. Percentage postharvest losses in developing markets from UR and Wageningen (2014)

PHLs facts that are normally used are obtained from the 2011 FAO report representing a loss of 25-40% happening from farm to fork. The underlying notion is that decreasing food loss in the supply chain will improve the set of conditions to enhance food security in developing counties, thus leading to sustainable livelihood (van Gogh and Aramyan, 2014). Adopting

improved methods and automation can free the time to devote on more profitable off-farm activities(World Bank, 2010).

Appropriate market organizations may need to be developed and stimulated to allow marketing community and individuals to best react to market demand. Cooperative marketing can take numerous forms and for grains might comprise inventory credit arrangements and Warehouse Receipt Schemes to hasten the efficient elimination of the commodity from the farmer into safe central storage system (Coulter and Shepherd, 1995). Effective marketing system relies on a dependable supply of better-quality produce and this can be attained by adopting value-added technologies that also lesser postharvest losses. In developing nations, the incentives to minimize postharvest losses are much greater as loss reductions can straightforward improve the life and food safety of the poor, and, possibly, food security and quality with related health related benefits.

The current attention for postharvest exploration in perishable products may be related with increasing concern for food safety (Pariser, 1982, Greeley, 1991). Food quality and safety aspects are receiving increased attention in food market (Henson and Loader, 2001). According to (Bourne, 1977), most of studies that conduct actions in the extent of PHLs reduction dedicate their efforts entirely to diminishing losses in grains and dry legumes. This approach is perhaps based upon the element that the cereals and dry legumes are principal foods and contribute foremost part of the calorie consumption of people in developing nations. However, as (Bourne, 1977) recaps, some of the main nutritional insufficiencies in developing nations, particularly of vitamins and minerals, can only be relieved through better intake of fruits and vegetables. Shortages of these trivial nutrients entail an extensive period of time to produce apparent clinical indications than do deficits in calories and proteins. But shortages in trivial nutrients can surge mortality rates as certainly as calorific and protein insufficiencies.

2.6 Strategies for reducing postharvest losses

Mrema and Rolle (2002), discussed an advancement of priorities inside the postharvest handling situation of developing nations from a predominantly technical emphasis geared towards the diminishing of losses, to a more all-inclusive method intended to tie on-farm activities to processing, marketing, and distribution. The major problems which contributes for high postharvest losses relates with poor marketing systems, poor research and

improvement capability, and insufficiencies in guidelines, infrastructure, and information sharing. Consistent analysis of every commodity's production and handling practices would be focal point in creating effective management strategies for reducing postharvest loss and also a cost-benefit examinations to understand the return on investment in the suggested postharvest technologies is indispensable (Kitinoja and Gorny, 1999).

Goletti (2002) also mentioned the most appropriate concerns for developing countries: the necessity for a regulatory basis that stimulates growth while safe-guarding well-being; for sufficient market information to be given to all members participated; for additional investments in postharvest exploration; and for involvement in international bargains which endorse trade and food security. Evidently reducing postharvest losses of previously produced food is more sustainable than boosting production to pay off for these losses, however, less than 5% of the subsidy for agricultural exploration is assigned to postharvest research extents (Kader, 2003).

The drivers for change up to 2030 differ from developed nations to developing nations. In the developed world, they include consumer education campaigns, carefully targeted taxation, and private and public sector partnerships sharing the responsibility for loss reduction. The developing countries drivers include more widespread education of farmers in the causes of PHLs, better infrastructure to connect smallholders to markets, more effective value chains that provide sufficient, financial incentives at the producer level, opportunities to adopt collective marketing and better technologies supported by access to microcredit, and the public and private sectors sharing the investment costs and risks in market-orientated interventions (Hodges et al., 2011). (Stuart, 2009b) offered an extended list of notions about in what manner consumers, retailers, governments and other groups can reduce food losses, while financial costs, logistic difficulties and consumer tastes might stance in the way. For numerous commodities in developed nations, food loss has dropped in current times (Buzby et al., 2009) and new loss-reducing expertise are under expansion. However, developing countries need exploration and dependable loss estimates for various foods types in the postharvest chain to pinpoint where food loss can be diminished efficiently.

3. Theoretical frame work

According to Lazzarini et al. (2001) during past few years there were all embracing theory formulation in the area of value chains, reflected in several explanations and methodical approaches. Scientific studies that contributed to the advancement of value chain theory can be categorized into four clusters with different stances on intercompany relationships, as explained in *Figure 4*.

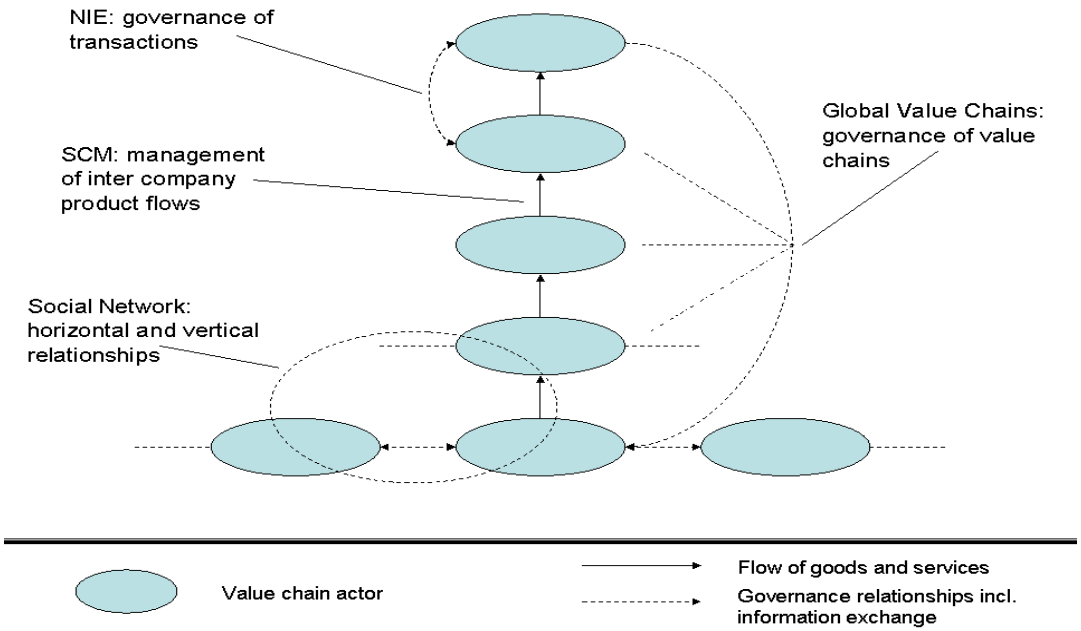

Figure 4. Perspectives of theoretical approaches on intercompany relationships from Trienekens (2011)

- Global value chain theory (GVC) emphases on the situation of the 'lead firm' in the value chains and power relationships between multinational companies (MNCs) and developing country producers.
- Social network theory (SNT) emphases on the interrelationships between social and economic interactions in production networks consist of many vertical and horizontal connections between value chain players.
- Supply management theory (SCM) focuses on management and control of intercompany operations such as flow of product and service.
- New institutional economics theory (NIE) analysis the governance of transactions between companies

3.1 Value chain analysis framework for developing country

The basis for choice of framework was discussed in the method chapter. Values chain analysis framework for this thesis considered as production function in which supply chain players exploit competitive advantage and works within an integrated environment.

Porter pioneered the theory of the value chain analysis in the framework of competitive advantage to evaluate particular activities so that businesses can create value by breaking down activities into value added. Porter selected two vital value adding activities of a business; primary activities such as inbound logistics, outbound logistics, operations, marketing, and sales and support activities such as human resource management, strategic planning, procurement and technology development (Porter and Millar, 1985).

The value chain can be termed as "a value chain describes the full range of activities which are required to bring a product or service from conception, through the intermediary phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumers, and final disposal after use" (Kaplinsky, 2000)

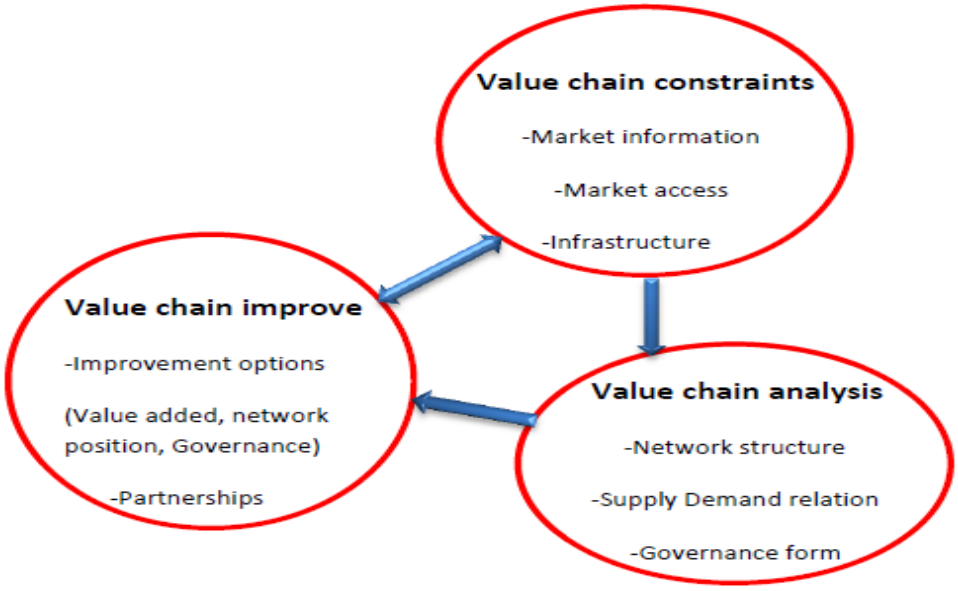

Figure 5. Value chain analysis framework, adapted from Trienekens (2011)

3.2 Value chain constraints

3.2.1 Market access

The food market in developing economies can be classified as A- B- and C-systems with different market channels and a variation in quality demand and safety (Ruben et al., 2007). The **A** system commonly occurs of small scale harvesters that distributes to a limited market (local) and a low income chain (Ruben et al., 2007). Despite the fact that this market intents at a local level but it can also be part of other market system through middlemen. This usually builds to be part of extended chain while the added value is shared by a large number of players. The locations from production to consumption are lengthy and the producers have limited market information. In developing countries despite the fact the A systems usually supply a large quantity of agricultural produces, however the significance is fairly low.

The B- market system is local supply chain which mostly aims supermarkets ranging from middle to high income (Ruben et al., 2007). The farmers in these supply chains are usually operates in a small or medium level and are connected to each other in associations, cooperatives and contracts. The amounts supplied by the B- market systems are at large lesser than what has delivered by the A market system, however produces larger value yet. They also accomplish quality standard to domestic and in certain cases international safety standards for retailers to a greater extend when related to the A market system (Ruben et al., 2007). The C market system is mostly focused on export market; however the products those are inappropriate for export market is aimed to the domestic market (Ruben et al., 2007). The C market systems are coordinated to a higher degree than the other market systems. In this system fewer players exist and delivers a fewer quantity products with greater added value (Ruben et al., 2007)

3.2.2 Infrastructure and resources

The lack of affordable, reliable and adequate infrastructure facilities touches the life of developing country's family (Lebo and Schelling, 2001). In developing markets, there are four significant constraints concerning infrastructure and resources. Firstly, there is limited access to input resources. Secondly, geographic location of many producers that constrained by long distance for the accessibility of market location and end consumers. Thirdly, lack of skilled human resource and technology is a limit factors for markets to develop for production and dissemination drives. Moreover, there is inadequate infrastructure concerning information and distribution. Efficient

distribution of products and information dissemination are basic conditions for a supply chain to advance.

There are several scholars who argue that infrastructure is certain constrain for supply chains in developing countries (Viswanadham, 2006, Shukla and Jharkharia, 2013, Barrett and Mutambatsere, 2008). Lack of proper infrastructure and resources for load, transport, process and cold storage are some of the ultimate drives for food loss in the fresh supply chains in developing economies ((Viswanadham, 2006, Shukla and Jharkharia, 2013). Beyond these infrastructural problems absence of information infrastructure is a main hindrance for the option of improvement in the value chains (Shukla and Jharkharia, 2013). This problem is enormously related with information gap between producers and consumers which in turn results in difficulties to estimate balance in supply and demand.

In developing countries, there are a large number of intermediaries along supply chains, which can match the immature infrastructure, however it remains as huge cost for the chain (Boer and Pandey, 1997). Local food chain systems which denotes various food systems usually has disorganized dissemination infrastructure in developing countries (Gebresenbet and Bosona, 2012) This is usually exhibited through distribution system which is decentralized and huge transport cost for each unit. Several producers residing in the rural locations are inhibited by insufficient transportation infrastructure thus it is important in these locations to emphasis on developing the collection centre, packaging, storage and distribution infrastructure of agricultural products (Gebresenbet and Bosona, 2012).

3.3 Value chain analysis

3.3.1 The network structure

The network perspective offers trust and openness amid the players as a condition for achievement of the best possible outcomes from cooperation. The network theory is characterized by three principal variables: players, activities and resources (Snehota and Hakansson, 1995). The network approach (structure) in a value chain is greatly reliant on what market channels players have chosen (Trienekens, 2011). In supply chain networks, players are those who perform goal oriented activities or control resources. They can be an individual or group of firms that embedded in economic relationships. The chain players perform activities by creating, using, consuming heterogeneous bundles of commodities which can be controlled directly or indirectly. These two forms of controls are of typical interest as the former is based on ownership and the latter is attained through relationships. Significance of indirect control

arises when supply players forms exchange relations with other players hence connections of dependence are formed and therefore their resources controlled by the central player. In this perspective, players incline to be mutually independent to effectively coordinate their capabilities and activities (Snehota, 2004).

Lazzarini et al. (2001) developed a theory called "netchain analysis" to achieve a network analysis on condition where horizontal and vertical relationships in a value chain exist. In this model both supply chain and network approaches are used to explore inter organizational relationships focusing on value creation and harmonized sources within players in a network. Supply chain analysis emphases on vertical transactions among the players in the supply chain for instance contractual arrangement and logistics management (Lazzarini et al., 2001). Network analysis underlines the horizontal relations between players in a network and assesses social attachments and knowledge transfer. The netchain analysis highlights on mapping out players on each phase of the value chains and their relationships to players on the same phase. Relation development is intensely affected by the players' opinions, expectations and interests in addition to their mutual efforts in the collaboration process. As (Mattsson and Johanson, 1992) shows, uniqueness could rise with the enhancement of the specialization process. From a network viewpoint, positioning and network approach are interrelated notions that influence players' behavior. Network theories disclose the players' visions and intents in the network. To declare effective controlling of their connections with suppliers firms must have ample knowledge about the linkages they are embedded (Möller and Halinen, 1999)

3.3.2 Supply and Demand relationship

This section examines the economic impacts of food losses in a low-dimension partial equilibrium analysis theory.

Reducing food loss in supply chain and its Impact on price, quantity and welfare

Economic perspective of value chain aims at the incorporation of business harmonization and act of balance between supply and demand along the supply chain. It attempts to combine both suppliers and customers in one concurrent business operation. It extents the whole chain from original source to the final consumer (Halldorsson et al., 2007). *Figure 6* shows the market for a food commodity chain, d with a standard downward sloping demand curve and a standard upward sloping supply curve (Salvatore, 2008). Pricing mechanism is a system in the

market which determines that demand equals supply. The balance in the market chain for a food commodity is reached at point A, where the original price (P^0) and quantity (Q^0) is traded. When supply and demand are in balance, the market economy is said to be in equilibrium between price (P^0) and quantity (Q^0). Hence, optimal supply curve is the combination of P^0Q^0 (Rutten and Kavallari, 2013). *Figure 6* described as capturing the full supply chain from farm to fork in the market.

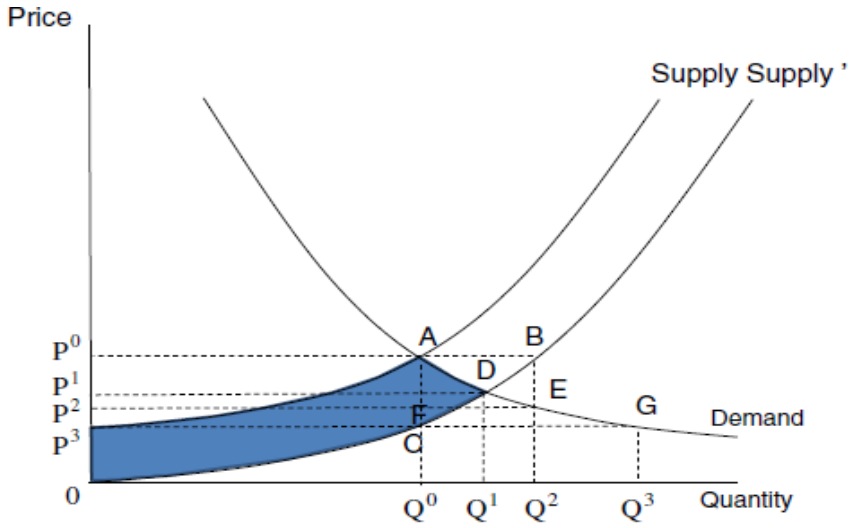

Figure 6. Impacts of reducing food losses in supply chain. Blue shaded area: overall welfare gain, from Rutten (2013a)

Assume that there were food losses along supply chain. In this case, the supply curve along food chain that would not have these losses, lies below the original supply curve denoted as Supply' in *Figure 6.* Given the original price (P^0), more food commodity can actually be produced and supplied to the market as shown (Q^2 at point B). Equally given that the original quantity (Q^0) food commodity can actually be produced at a much lesser cost (P^3 at point C) if food losses were to be absent in the supply chain (Rutten, 2013a).

Assume the prospect that losses could be tackled in supply chain for food commodity. This can be done by inducing various approaches. For example Suppliers may be induced to tackle the food losses as a result of the introduction of a new technology, or new policies such as taxes, regulations, and subsidies that penalize and encourage reductions in food loss. The measures of reducing food loss provided the initial demand curve and main motivation to do so, would result in a higher equilibrium quantity (Q^1) and a lower price (P^1) in the market as indicated by point D. At this new market equilibrium, consumers can buy more food commodities at a lower price. This creates a welfare advantage to consumers as measured by

the change in the consumer's surplus of P^0ADP^1 (Rutten, 2013a). Similarly, producers can sell more food commodities at a lower price. This causes a change in the producers' surplus of $P^1D0 - P^0AP^3$, which is also positive outcome. The overall welfare advantage equals the sum of the changes in the producers and the consumers' surplus, which amount to the area of P^3AD0, the blue shaded region under the demand curve and between the two supply curves (Lipinski et al., 2013b)

Reducing food waste in demand and its Impacts on price, quantity and welfare

Figure 7 describes the market for a food commodity along the supply chain from farm to fork designed into a standard downward sloping demand curve and a standard upward sloping supply curve. As illustrated in the *Figure 7* the market equilibrium takes place at point A, where the equilibrium price is P^0 and the equilibrium quantity traded is Q^0(Salvatore, 2008). Assume that there are food losses in the consumption of this commodity, in that buyers (consumers) waste portion of what they demand. In that case, the socially optimal demand curve that would not have these losses lies to the left of the original demand curve is shown by Demand' in *Figure 7* (Nicholson and Snyder, 2011). Provided that the original price, P^0, less food commodity needs to be consumed (Q^2 at point B) in order to attain some level of utility if waste portion was to be absent. On the other hand, the original equilibrium quantity (Q^0) entails a much lesser value to the consumers (P^3 at point C) (Rutten, 2013a).

Consumers could be convinced to tackle food waste as a result of a growing morale against waste. There could be introduction of new policies, regulations and taxes that penalizes and encourage reductions in food waste. Avoidance of waste in food consumption, provided the original supply curve and underlying incentive of reduction in food waste would result in a lower equilibrium quantity, Q^1, and in lower price, P^1, in the market as represented by point D. At this equilibrium, producers are capable to sell less commodity at a lower price, as a result their benefit (welfare) is negatively affected as indicated by a change in the producers surplus of $P^1DE - P^0AE = -DAP^0$. Taking the subtraction between the area under the two demand curves (old and new) and above the two prices (old and new) respectively, $P^1DF - P^0AG$, creates a change in the consumers' surplus of P^1DBP^0 –BAGF which is negative value (Rutten, 2013a).

The variance in the consumers surplus if food waste is eliminated equals to $P^1DF - P^0BF = P^1DPB^0$ which is positive value. The over-all variation in society welfare equals $P^1DBP^0 - P^1DAP^0 = -BDA$, the red shaded part in Figure 2 (Rutten and Kavallari, 2013). While the

equilibrium quantity move down from Q^0 to Q^1 which is the distance between Q^2Q^0 or BA denoted food waste and was not eaten by consumers in the first place, thus actual food intake is going up from Q^2 to Q^1 (Rutten, 2013a).

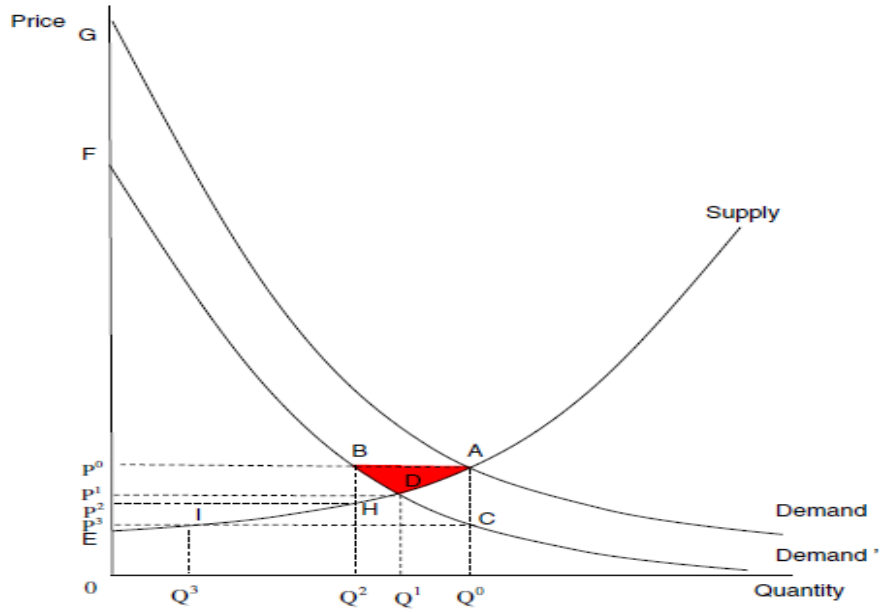

Figure 7. Impacts of reducing food waste in demand. Red shaded area: overall welfare loss from Rutten (2013a)

3.4 Value chain enhancement

3.4.1 Value added

Value chain enhancement can be done through different methods such as product upgrading, functional upgrading, inter sectorial upgrading and process upgrading. Upgrading of processes and products are often used upgrading option for value added in emerging economies. Functional improvements indicate to the practices of insourcing production and inter sectorial improvement to differentiating the business line. Product upgrading can classified as internal and external (Trienekens, 2011). Internal improvement on supply chain focuses to characteristics such as product value, packaging, and composition. External development is more associated to the features of the processes such as fair trade or green production. Developments concerning handling, transport, packaging and storage facilities are significant aspects to nurture quality and reduce loss of fresh produce along supply chain (Kader, 2004). With the intent of improving quality and safety of production along with production processes some standard quality assurance and certification systems can be applied (Trienekens and Zuurbier, 2008).

Process improvement links to the optimization of products and distribution in the production system (Trienekens, 2011). Developments of new technologies are often required in order to optimize the productions. Distribution system can be upgraded by better interaction between the players,' use of new transport technology, cold chain and practice of GPS systems, internet access and mobile phones. In developing countries functional upgrading continued to remain at low level as they deliver services for developed countries, therefore value adding occurs in the final parts of the chain. Certain value adding activities have increased in the supply chain of developing countries for instance juice processing, yet activities in form of branding and marketing needs big measure (Humphrey and Memedovic, 2006).

4. Method

4.1 Choice of theoretical framework and literature review

In this thesis, the literature reviews were collected with the purpose of creating awareness on production of fruits and vegetables in developing countries. Furthermore information about postharvest losses and handlings of the fruits and vegetables were acquired from the literature. The collected relevant literatures were then used for the purpose of the interview and as a tool during discussing and analysing the empirical evidences. The theoretical framework for this study was selected on the bases of Trienekens (2011) value chain analysis for developing countries. It consists of three theoretical approaches within the value chain framework such as value chain constraints, value chain analysis and value chain improvements. Value chain constraint approach was used to identity what constraints exist in the supply chain concerning market access, infrastructure and resources. Value chain analysis approach was used in the framework to examine the network structures, governance structure and value adding activities in the supply chain. The last approach deals with options for improvement within the value chains. The theoretical framework was used to analyse the supply chain channels for selected 11 fruits and vegetables in Ethiopia. The selection of framework was based on the appropriateness of value chains for the developing country. Trienekens (2011) framework comprises global value chains, which was not included in this exploration as it mostly focuses the domestic market in Addis Ababa, Ethiopia. Moreover, other research papers (Rutten, 2013a, Kader, 2004, 2009) have been used in the theoretical framework so as to elaborate which were not covered by (Trienekens, 2011).

4.1 Sample selection

Trade industry office was instrumental for the selection of the major wholesalers of fruits and vegetables in Addis Ababa, Ethiopia. After purposive selection of the wholesalers, the other supply chain actors were randomly picked from the list of names provided by the wholesalers interviewed as per the survey questionnaire was demanded wholesalers to provide their close trade partner. Thus, other actors were then chosen based on the list of names supplied by wholesalers interviewed. Afterwards, fresh produce types were determined through discussion of marketing experts of Etfruit firm on the bases of high prevalence of losses and economic contribution. After all, Etfruit wholesale distribution company was selected purposively as unit of analysis for this study; which is the major domestic distributor and exporter of fresh

fruits in Ethiopia. In exploring the supply channels for fresh produces mainly downstream (wholesaler-to-consumer) interview approach was used.

4.2 Sample size

The total sample size for consumers channel were 120 households and 47 respondents of supply chain players were interviewed in Addis Ababa, Ethiopia. The sample incorporated 3 Etfruit-wholesalers, 11 retailers, 3 exporters, 9 processors, 11 street vendors, 6 Etfruit container seller and 3 other wholesalers on the basis of Etfruit wholesale information. Downstream interview method commenced with wholesalers. Major Etfruit Distribution Company has been selected as initial phases for the interview with three sample Etfruit wholesalers. At the end of the interview, the wholesalers were solicited to disclose names of retailers, processors, street vendor and other wholesalers with whom they most often interacted. Based on the revealed information, three other wholesalers, six container sellers, nine processors, eleven retailers, eleven street vendors and four exporters were selected in Addis Ababa, where most of its marketing activities were held. Names of fresh produces suppliers (producers) with whom Etfruit-wholesalers' trade partner were then included for needed information. In general, the total sample was sought to be equally distributed along supply chain players given that trade partnership with Etfruit wholesale. Eleven fruits and vegetables (oranges, mandarin, banana, avocado, mango, papaya, tomato, onion, potato, cabbage and carrots) were selected on the basis of high loss occurrences. The aim of sample was to validate equal representation of supply chain players associated with the fruits and vegetables that this study was mainly intended in.

4.3 Mapping out supply chain players

Quantities purchased from producers were provided by the Etfruit wholesalers and amounts sold to other actors have been calculated using the estimate provided on the share of produce sold to the actors with whom Etfruit wholesalers partnered. This has been the foundation in developing derivation of the actual shares of fruits and vegetables for which Etfruit wholesalers supplied at various channels and sold to their main actors with respect to total volume sold. This was elucidated with *flow-map* in association with volume supplied by Etfruit wholesalers and food lost through downstream supply chain (Etfruit wholesalers-consumers) in *Figure 8.* Furthermore, it incorporated the upstream associations (Etfruit wholesalers-producers) looking into major supplies of fruits and vegetables.

4.4 Estimation of postharvest loss

Data was collected through using semi-structured questionnaires and personal observation approaches. Mean and percentage were used to calculate the PHLs of fruits and vegetables at different phases of supply chain. For supply chain actors such as Etfruit-wholesalers, retailers, processors, street vendor, Etfruit-container seller and other wholesalers, loss estimate was quantified and calculated as the difference between volume purchased and volume sold in relation to total volume sourced. Loss route line was calculated by administering questionnaires for marketing research experts of Etfruit-wholesale. Accordingly, the experts were consulted to estimate loss value percent for eleven fresh produces along supply chain channels on the bases of total food loss. At the end, average estimated loss percent was determined for every fresh produce. The mean value was identical for three different Etfruit-wholesale market experts. Therefore, it was extracted from supply chain actors' data bases. This was executed by multiplying total food losses experienced along each channel with corresponding loss percent of each fresh produce within channel to obtain estimated food loss amount. To estimate monetary value of losses occurred, actual food losses in kilograms (kg) was multiplied by average selling prices of each fruit and vegetable.

4.5 Sample selection for Households

A three-stage sampling scheme was used. The first stage involved purposive selection of Local administration areas (sub-city) in connection with Etfruit wholesales information; the second, selection of districts within this areas; and the third, selection of sample population from each district. There are 10 local administration sub-cities in Addis Ababa city consisting of 116 districts. Kirkos sub-city was selected as household survey unit because Etfruit wholesalers disclosed good account of household members as their customers from this district. Moreover, use practices of fruits and vegetables declines as one move from population center to sparsely-populated city areas. Thus, it is densely populated sub city.

There are eleven districts in Kirkos sub-city from which four districts were selected randomly given that these woredas are selected based on residents density as it increases representation of population and concentration of fresh produces stallholders. Thus, four districts with a total of 120 households were identified as unit of analysis for this study. These households are located at four sample districts namely district 01, district 04, district 06 and district 08. The sample was intended to be as representative of the household population of Addis Ababa city

as much as possible, except that for operational reasons households in the sparsely-populated areas since this study conducted relatively in populated areas.

4.6 Sample size for households

Household information along with their corresponding addresses was obtained from particular districts (woredas) for fair representation of population diversity and resource management. Three categories of socio-economic status (SES) respondents are picked systematically from each district having 10 traders, 10 employees and 10 other households by using interval sampling. The same development has been applied for remaining three categories of districts. Hence, the total sample size amounts to 120 householders consist of equal number of traders, employees and other households for each district. Socio-Economic Status (SES) indicators were mainly categorized on the bases of the income, occupation, and education. The purpose of this assessment is to estimate the food loss happening after food serving at plate in the household and to find whether there were significant differences among households with high, Middle and those with low SES in contribution for food loss. The person in charge for food serving (cooking) at home was consulted for data collection.

4.7 Estimation of food loss at household level

Data analyses was carried out with the support of descriptive statistics. Food loss estimates at plate of household has been quantified and calculated as percentage of consumed amount for over one week and amount that has been left from provided cuisine on plate in unit of grams for each household. This has been accomplished by asking a person to estimate loss amount from household members who held responsible in serving the ready meal for diners by the support of food frequency questionnaires (FFQ). A food frequency questionnaire contains structured lists of individual fresh produce or food groups. Subsequently, Household members are asked to estimate the frequency of consumption and wastage of those foods at plate, indicating the amount of food consumed as well as wasted over a given period of time (day, week, and month) (Cade et al., 2004). Therefore, a total of 120 households are arranged according to their Socio-Economic Status group based on parameters such as income earrings, occupational status, and educational backgrounds. Thus, three categories of household groups were formed; each category has 40 households with high socio-economic status, middle socio-economic status and low socio-economic status.

5. The empirical study

5.1 Overview of Et-fruit

The Ethiopian fruit and vegetable marketing share company (Et-Fruit) was pioneered since 1980, as the Horticultural Development Corporation (HDC) with the intention of functioning as a marketing body for entirely state held horticulture farms. Through liberalization and decentralization of the state's economic strategy, Et-fruit was restructured again in 1993 in harmony with provision of the public enterprise. The range of its service provision has since then expanded to comprise private-horticultural farmers striving to move into export market. Et-Fruit can be labeled as a leading and major national distributor and exporters of fresh fruits and vegetables, and processed horticultural produces. Thus, it played a significant character in the advancement of the horticultural sub-sector of Ethiopia at large (www, Etfruit, 2015).

Et-Fruit is the main domestic wholesalers and exporters of fresh fruits and vegetables, processed and flower products in Ethiopia. The varieties of fruits distributed to domestic markets are avocado, banana, grapefruit, mandarin, mango, lemon, lime, orange, processed fresh produces such as orange marmalade, tomato juice, orange squash, strawberry jam and guava nectar are similarly supplied to the domestic markets like fresh vegetables such as tomato, onion and potato…*etc*. Marketing chain facilities of Et-Fruit have progressed to better status of development since last three decades through to its better market network and associated facilities compared with other wholesalers (www, Etfruit, 2015). Nowadays, Etfruit has 500 permanent workers as well as hires-up to 400-700 laborers annually on the bases of volumes delivered. Et-Fruit has established its dissemination center and outlets in 16 main cities of the country. In Addis Ababa, Et-fruit have four main wholesale places, 60 retail outlets and 30 mobile-shops. The key suppliers of fresh produces are the Upper-awash Agro-industry Enterprise, Metehara sugar factory and Horticultural development enterprise followed small private horticulture growers such as North Omo agricultural development enterprise and Elfora Agro-Industry. Furthermore, it provides other services as market information, refrigerated semi-trucks for rent and import quality seed (www, CSA, 2014*)*.

On the other hand, household information was obtained from particular districts known as Kirkos sub-city covered an estimated area of 14.72square kilometers. According to population census of Ethiopia (2007), residents of the sub-city accounts for about 220,991 from total 5 million populations in the capital, Addis Ababa. 103,314 populations are male residents

while the remaining 117,677 populations are female residents. However, the total share of population accounts for only 8% of Addis Ababa's total population. Accordingly, the population density of the sub-city amounts 15,012.97 people within a kilometer square (www, CSA, 2014). Apparently, this shows that this area is overpopulated area in the capital city of Ethiopia, Addis Ababa.

5.2 Etfruit supply chain channels

Channel valuation was made mainly based on volume parameters that the channel has accommodated from total supply. Supply chain channels as recapped in the *Figure 8* was developed from supply chain players' assessment. There were seven main supply chain channels for perishable produces which incorporates one international outlet and the rest operates with in national level. The total quantity of fruits and vegetables obtained from farm gate was 35673700 kg (100 percent) of eleven types of fruits and vegetables on annual bases. As a result of food loss along the producers' store until wholesales store, the total amount has declined to 96 percent. From wholesale store, the fresh produces often be supplied and distributed to other supply chain players. There was high chance of food loss until it got consumer destination due to mode of transportation, storage facility and load facility. About 80 percent of fresh produces from Etfruit wholesale store distributed to other chain players. However, 72% of fresh produces has finally reached consumers. As can be seen from *Figure 8* the main suppliers from producers were Etfruit wholesalers with an estimated 96 percent volume.

***Channel one**: Producers→Et-fruit Wholesalers →other wholesalers →Consumers*

Channel one (see *Figure 8*) distributed the highest volume of fruits and vegetables to final consumers. It accounted for 37% of the total fresh produces supplied and distributed to final customers and was found to be the most important distribution channel in terms of volumes passed through to final consumers. There were several producers where Etfruit wholesalers outsource to different market players in the supply chain. Players such as producers are most important element of markets that harvests fresh produces for different intermediaries. Major sources of fruit and vegetables for Etfruit Company were; small farm holders, state farm (upper awash agro-industry enterprise), various Cooperatives (farmers' association), Methehara sugar factory, Hurso Military camp, Erergota Enterprise and private investors.

***Channel two**: Producer→Etfruit Wholesaler →Etfruit container seller →Consumer channel*

This channel accommodated 13.8% of volumes of fresh produces distributed in the supply chain to final consumers. The channel was found to be the second vital marketing channel in terms of volume supply and distribute. There were two main approaches that the Etfruit Wholesale can reach final customer; direct purchase from wholesalers' outlet and or direct selling fresh produces through retail outlet to final customers. Each approach has different selling strategies to accomplish the objective. The objective is to stimulate fair distribution of fruits and vegetables to all customers. Therefore, customers have the opportunity to obtain the fresh produces either by minimum purchase of 5kg directly from Etfruit wholesalers and or maximum purchase of 2kg from Etfruit container retail-outlets.

***Channel three**: Producers →Etfruit Wholesalers →Processors →Consumers channels*

This supply channel accounts for 9% volume flows from total fruits and vegetables marketed and distributed to final consumers. It is the third principal marketing channel in Addis Ababa. Fresh produces are highly in demand and apparently witnessed enormously in juice making plants where *Africa juice processing plant* and *Yami juice processing plant* takes the leads in cuisine preparation. Despite the fact it is source of raw material for cosmetic industries; still there were few maturing agro-processing plants in Addis for instance *Kaliti food complex* that underpin its endeavor of blending avocado to produce *macaroni* and *pasta*. There were also other local processing plants like Cosmetic Industry *´Zenit Gebse Eshet`* has instigated processing of hair pomade by means of avocado as raw material.

***Channel four**: Producers→Etfruit Wholesalers →Export Market →international customers*

This distribution channel accounts for 5% volume flows of entire fresh produces distributed along Etfuit supply chain and an important distribution channel in terms of volume delivered to an international outlet.

***Channel five:** Producer→ Etfruit Wholesaler→Retailers→ Consumer*

This channel distributed about 3.6% volumes of fruits and vegetables to the final consumers. This supply channel was regarded as the fifth essential outlet with respect to volume delivered for final customers. In this channel retailers supply fresh produces and provide roles such as door to door service for several cafés, restaurants, supermarkets and juice making houses.

***Channel six:** Producer→Etfruit Wholesaler →Consumer*

This channel accounts for 2.5% of total fresh produces supplied to final consumers. From the consumers' perspective, the shorter the supply chain channel, retail price would be more likely affordable. At a retail store, the value final consumers pay for produce usually includes the expenses of producing, packing produces, transporting produces, wholesaling produces,

and retailing produces. This all mostly affects the final consumers as they are supposed to cover middlemen's cost.

Channel seven: *Producers → Etfruit Wholesalers →Street Vendors →Consumers*

Vendors channel accounts for least 1.1% volume flow of fruits and vegetables. Street vendors deliver fresh produces in slight volumes to customers who were interested on his fruits and vegetables along main streets of Addis Ababa. Fresh produce distribution in vendor channel carryout by means of wheelbarrow where street vendors circulate with the help of carriage wheels alongside main roads.

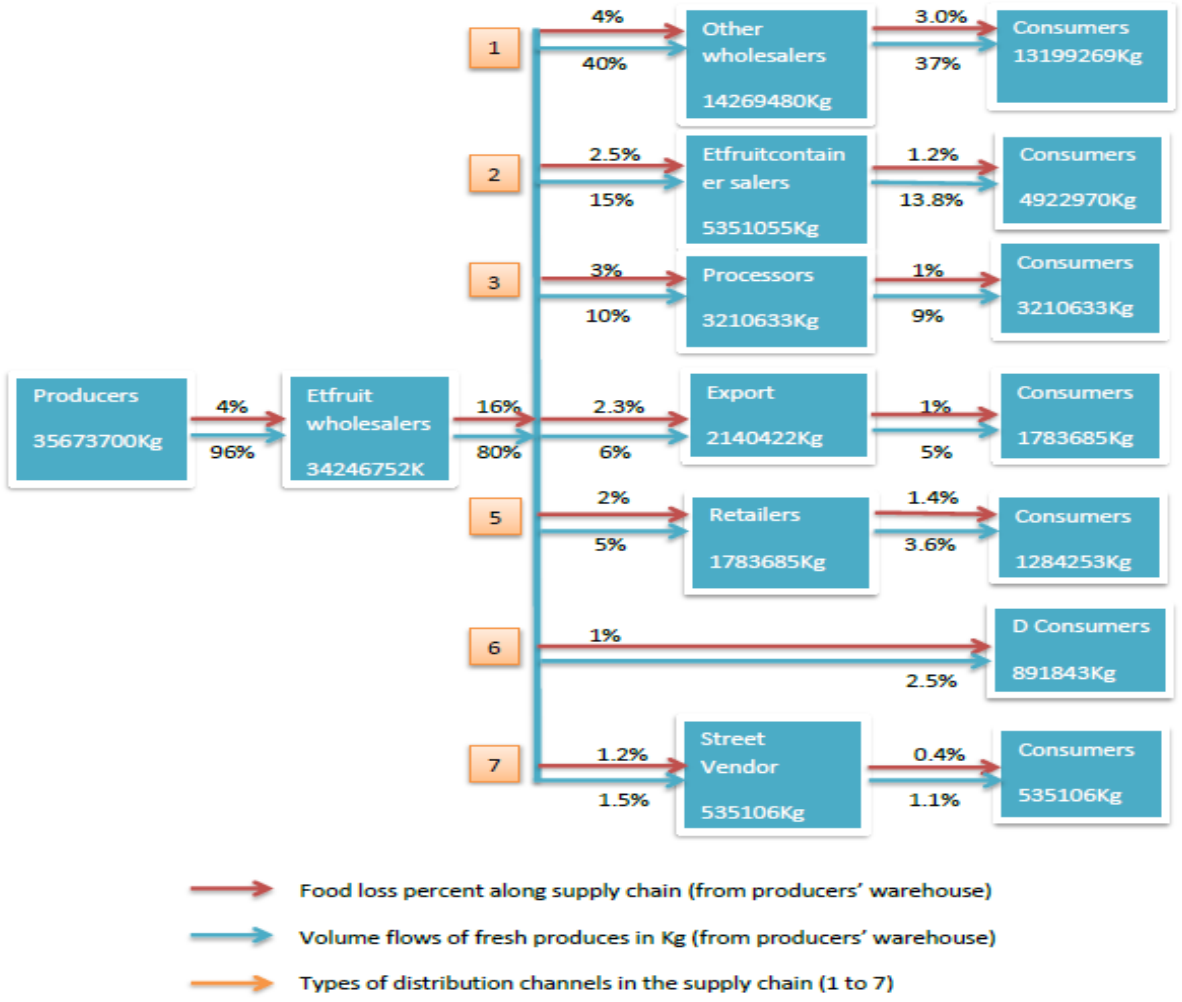

Figure 8. Distribution channels for each player along supply chain with their corresponding volume flows and losses occurred

5.3 Food loss in the supply chain

As presented in *Figure 8* seven supply channels were identified as distribution channels of fresh produces from producers' storage to final consumers' destination. On the bases of these

channels, food loss was estimated for each supply chain players. In general, as presented in *flow charts* of *Figure 8* and *Figure 9;* the total of 28% of fruits and vegetables were food loss along seven supply chain channels. Therefore, 72% of fruits and vegetables were delivered to final customers. Volume flows of fresh produces and their respective loss amount from producers' store to final consumers described with the help of *flow chart* in *Figure 9*.

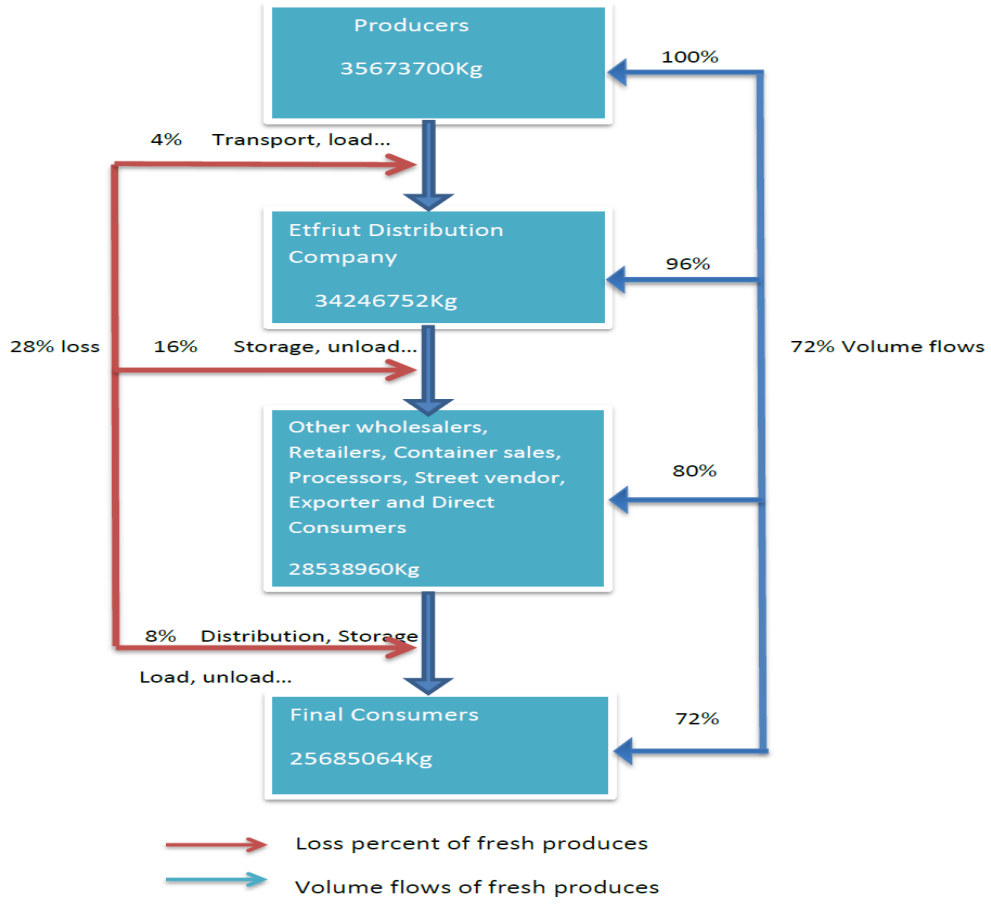

Figure 9. Mapping the volume flow of fresh produces from producers to final consumers and their loss percentage for supply chain channels

It was also estimated food loss for eleven selected fruits and vegetables as shown in Table 29 of the *appendix*. Major share of food loss accounted to about 24.6% of Banana, 22% of Mandarin, 20% of Orange and 17% of Tomatoes. While remaining fruits and vegetables demonstrated lowest food loss along supply chain channels. Lowest food loss did not mean there were special treatments and handlings for those fresh produces, however, the supplied amount were limited in volume and permitted the players to market before deterioration. Each supply chain player experienced food loss until it gets final consumers. Therefore, at producers' store comprising load and transport, 4% of fresh produces loss occurred from total

supply. Etfruit wholesales accounts for an estimated 16% loss from total fresh produces, which was the highest loss occurred.

5.4 Loss Impact on price, quantity and welfare of consumers

Lack of measures to reduce food loss given the original quantity demanded and deterrence to do so would result in a lower equilibrium quantity (Q^1) and a higher price (P^1) in the market for fresh produce as indicated by point B. At this new market equilibrium, consumers buy less fruits and vegetables at a higher price. This creates a welfare disadvantage to consumers as measured by the change in the consumer's surplus of P^0ABP^1. Shift in the supply curve to the left of original supply curve as shown by *supply'* would result in decline of fruits and vegetables supply volume. Therefore, market price for fresh produces increases whereas the volume supply in the market decreases. An increase in market price decreases consumers' surplus yet increases producers' surplus. However, producers cannot sell more fruits and vegetables at a higher price. The overall welfare disadvantage equals the sum of the changes in the producers and the consumers' surplus, which equals to the area of $0ABP^2$, *the red shaded region* under the demand curve and between the two supply curves.

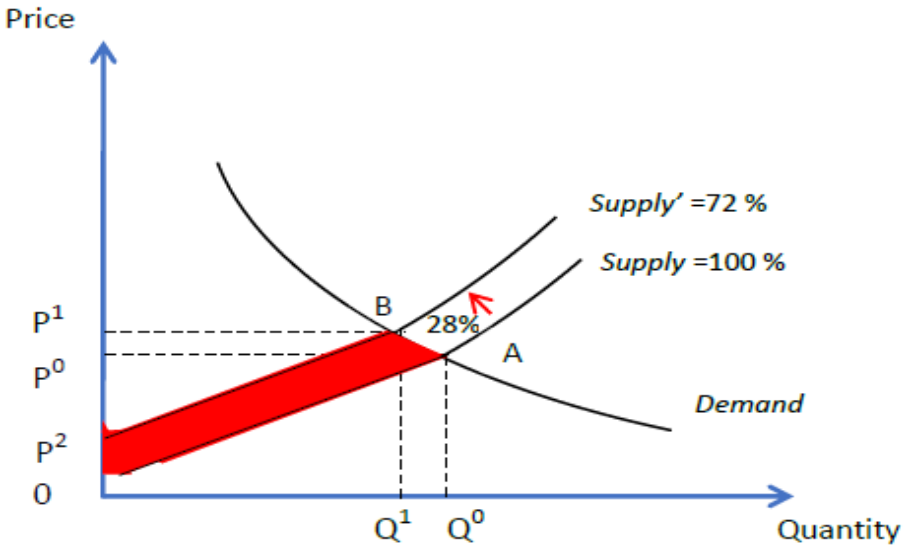

Figure 10. Impacts of failing to reduce food losses in supply chain. Red shaded area: overall welfare loss

5.5 Losses at consumers channel

Food loss at household was estimated to demonstrate fresh produces usage and wastage level in main socio-economic status (SES) household groups such as high SES, middle SES and low SES households. Fresh produce consumption pattern between each socio-economic group highlights substantial differences among each socio-economic group. As shown in Table 3, on average, high, middle and low socio-economic household consumes 684 grams, 429 grams and 261grams of fruits and vegetables per person per week respectively. In view of that, high socio-economic household consume two fold times as much as the low socio-economic household consume. Average consumption of fruits and vegetables for each household category was estimated on weekly bases in terms of kg. Estimated fruits and vegetables consumption for each SES household was depicted in *Figure 11.*

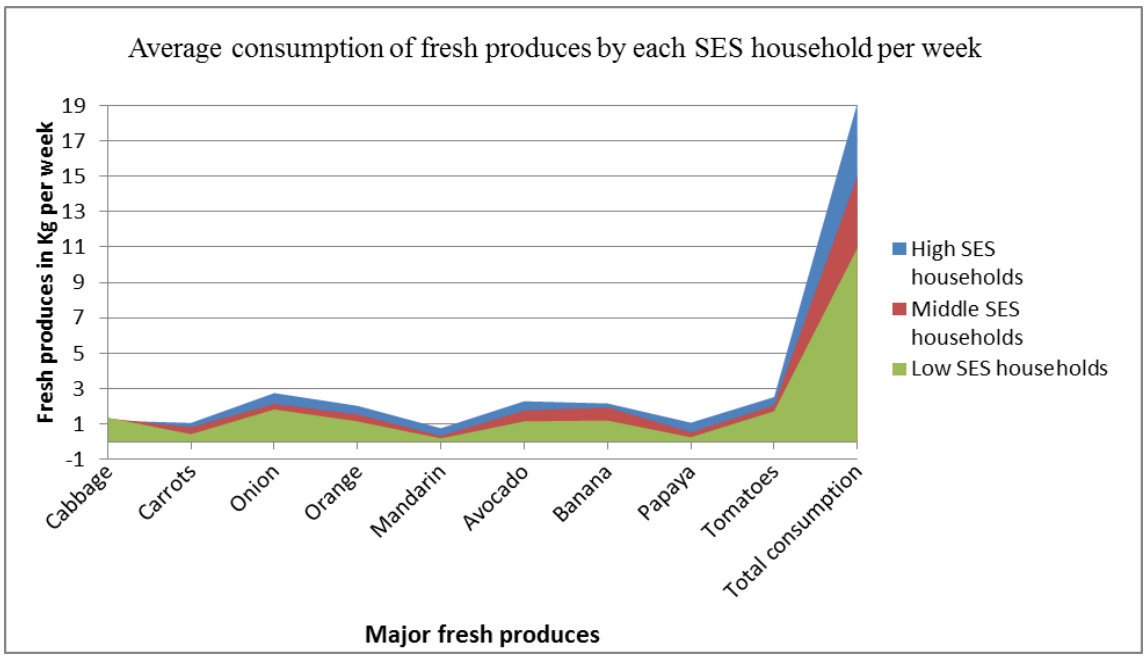

Figure 11. Estimated consumption of fresh produces for each SES households in kg per week

From aggregate consumption, averagely, High SES diners waste 155grams per week per household whereas middle SES diners waste about 117grams per week per household. Likewise, low SES diners' food waste estimated to 80grams per week per household. Composition of the family size determines food waste considerably. Number of family members within socio-economic household ranges from 4 to 6 and can basically affect consumption and food wastage pattern. Averagely, high, middle and low SES diners waste 38.6grams, 23.4 grams, and 13.3grams of fruits and vegetables per person per week. Food wastage in percent for each SES household and fresh produce is presented in *Figure 12*.

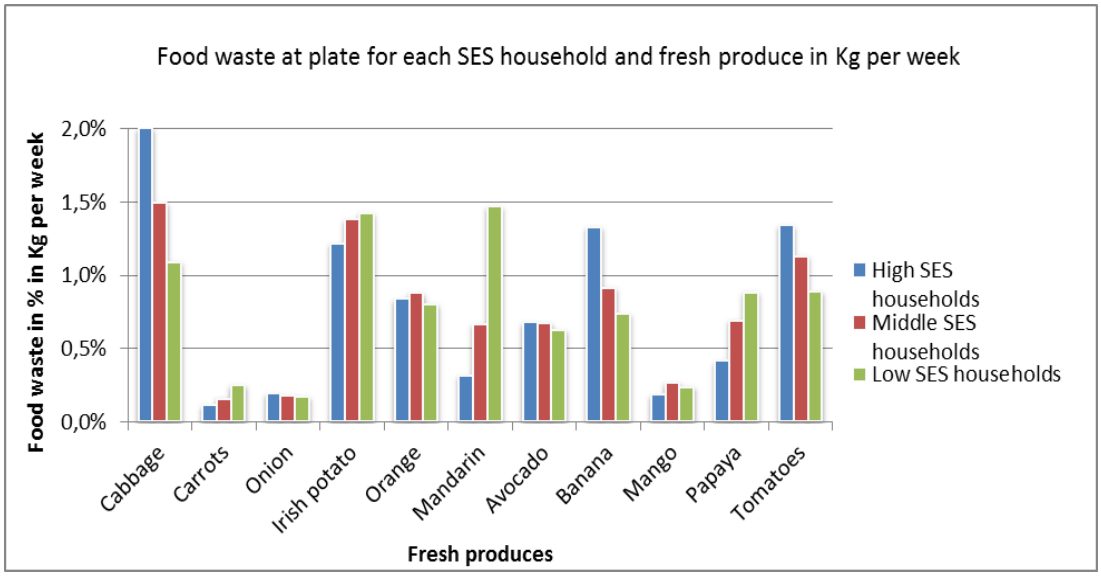

Figure 12. Estimation of food wastes for each SES household

5.6 Food waste in consumers channel and its Impacts on price, quantity and welfare

Failing to reduce food waste from consumption, given the original supply curve (quantity supplied) and lack of incentives to reduce in food waste would result in a higher equilibrium quantity which is denoted by Q^1, and higher price which is denoted by P^1, in the market as indicated by point A. At this equilibrium, producers are capable to sell more fruits and vegetables at a higher price, as a result their welfare is positively affected as indicated by a change in the producers surplus of P^1AE-P^0DE=DAP^1. When demand increases (demand curve shifts right), it means that consumers have to purchase higher quantity of fruit and vegetable for higher price. Looking at it differently, consumers paid a higher price for the same quantity of fruits and vegetables. New equilibrium at point A demonstrates that higher price and a higher quantity of fruits and vegetables than the old equilibrium at point D. The over-all difference in society welfare equals P^0DAP^1-P^0DBP^1= BDA, the *red shaded* part denoted food waste and was not eaten by consumers in the first place.

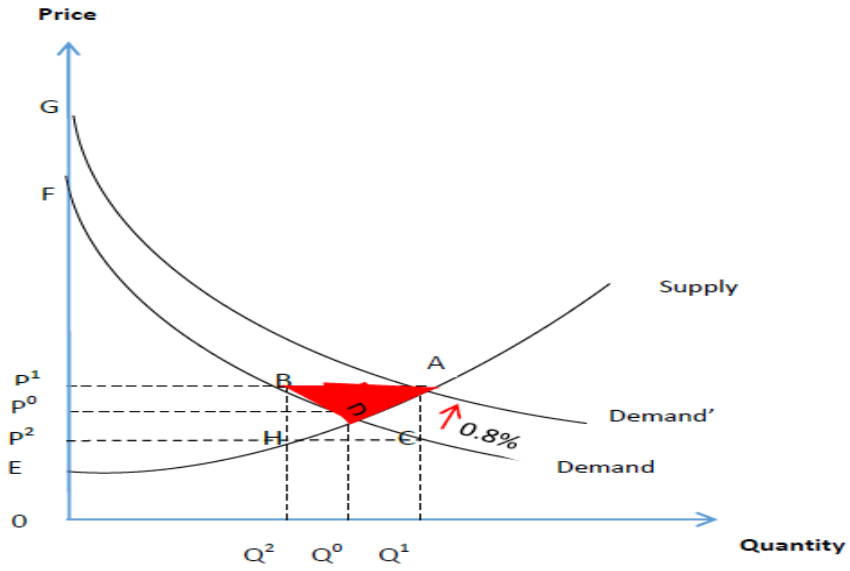

Figure 13. Impacts of not reducing food waste in demand. Red shaded: overall welfare loss

5.7 Hindrances that promote food loss in the chain

5.7.1 Packing systems

Lack of cold chain refrigeration is one of several setbacks that affect fruits and vegetables held at Addis Ababa Etfruit storage. Further fresh produces deterioration has happened from lacking necessary package materials. Despite the fact that all export deliveries are packed by cardboard box as per the standard requirements for fresh fruits and vegetables and precautions are taken. In the entire supply chain and handling system, packaging system has constrained to maintain storage value and life. Almost all fresh produces reaches at Addis Ababa Etfruit wholesale storage in exposed manner with poorly protected containers where plastic crates covered with papers. The plastic crates are central packaging method along Etfruit-channels for transporting fresh produces from producers' storage to Etfruit-wholesale destination. During moving fruits and vegetables by Etfruit-wholesalers, it tends to be exposed for further severe damage mainly when plastic crates stacked on the top of each other. Therefore, consumers in Addis Ababa such as small shops, supermarkets, container sellers and retailers often have concern of receiving fresh produces. As presented in *Figure 14* Etfuit wholesale uses only plastic crates for packaging fruits and vegetables whereas export market players often package by means of cardboard box. Certain chain players like container sellers, processors, retailers and producers uses combination of packing materials such as plastic crates, cartons, baskets and sacks. However, Players like Street vendors often lack packaging material for fruits and vegetables.

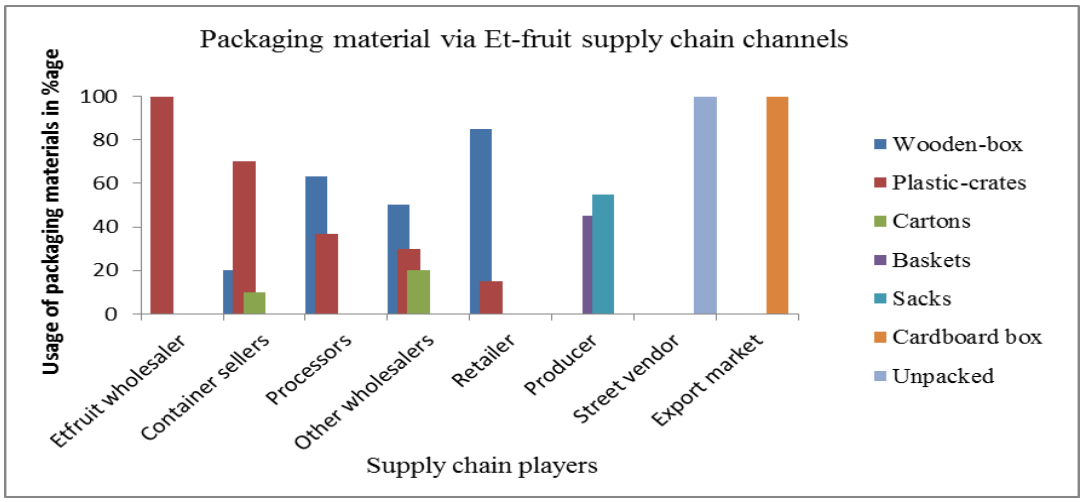

Figure 14. Packaging materials used along supply chain channels

Fresh produces packed for easiness of handling and protection, however, packing materials such as baskets or sacks deliver no safety to the fruits and vegetables when stacked each other. Besides protection, allows fast handlings during marketing activities and can reduce effects of rough organization. As depicted in the *Figure 15* wooden box is too bulky to protect and keep fresh produces and the tomatoes were compressed in the bottom of container

Figure 15. Wooden box as packaging material for fruits and vegetables

5.7.2 Mode of transportation

Eefficient transportation of fruits and vegetables requires organized facilities to be accessible on the farm-gate to load produces as quickly as possible with little damage. However, in Ethiopia where traditional postharvest handling is the only choice, collected fresh produces from production loaded onto inadequate transport by means of manual labor. As presented in the *Figure 16,* producers often use combination of transport mode such as baskets on their

shoulder which accounts for 32 percent, handcart accounts for 25 percent and pickup vehicles accounts for 43 percent. As transport continuous on poor roads, combination of carriage mode was used, 35 percent of refrigerated trucks as well as 65 percent of non-refrigerated trucks were used for transporting fruits and vegetables. Moreover, the bumping increases additional bruising and contributed for further food loss. At the Etfruit wholesale store fresh produces are unloaded and often piled for additional heaps, exposing for additional damage. All the combinations within store of Etfruit wholesales generate high food loss of 16 percent when compared with other players.

Food loss between point of production and destination through supply chain could also be exacerbated due to inadequate road situations. Each player in the supply chain has their own transportation system, packaging system and waste disposal mechanism. The most common transport system includes non-refrigerated trucks, refrigerated trucks, hand cart, hand drawn gharry and basket in the supply chain. All of export fruits and vegetables transportation carry-out by refrigerated trucks and enhanced post-harvest techniques are applied on farm as well. To some extent, modern cooling facilities have been installed to ensure the freshness and quality of the products specially at receiving stores.

About 80 percent (see *Figure 16*) of distribution was carried out by other wholesalers via non-refrigerated trucks to corporate customers like hospitals, universities, big hotels and big restaurants. Trolley trucks are frequently used transport apparatus by street vendors for marketing activities from place to place in the major roads of Addis Ababa which accounts for about 68 percent of transport system within street vendor channels**.** Main roads in Ethiopia seem mostly intended to shoulder heavy passengers in the larger cities irrespective of efficient traffic flow from rural locations to central. In the course of shipping via Etfruit-wholesalers, the fresh produces tend to be exposed for further severe damage especially when plastic crates, alone used, stacked on the top of each other. Furthermore, countryside roads serving as main channel to production locations usually suffered from severe cracks. Most of produces at farm location carries baskets on their shoulder, handcart and pickup vehicles while transporting fresh produces. Moreover, main rural roads were relatively impassible by vehicle and other labor workers during moving fruits and vegetables to pick up station.

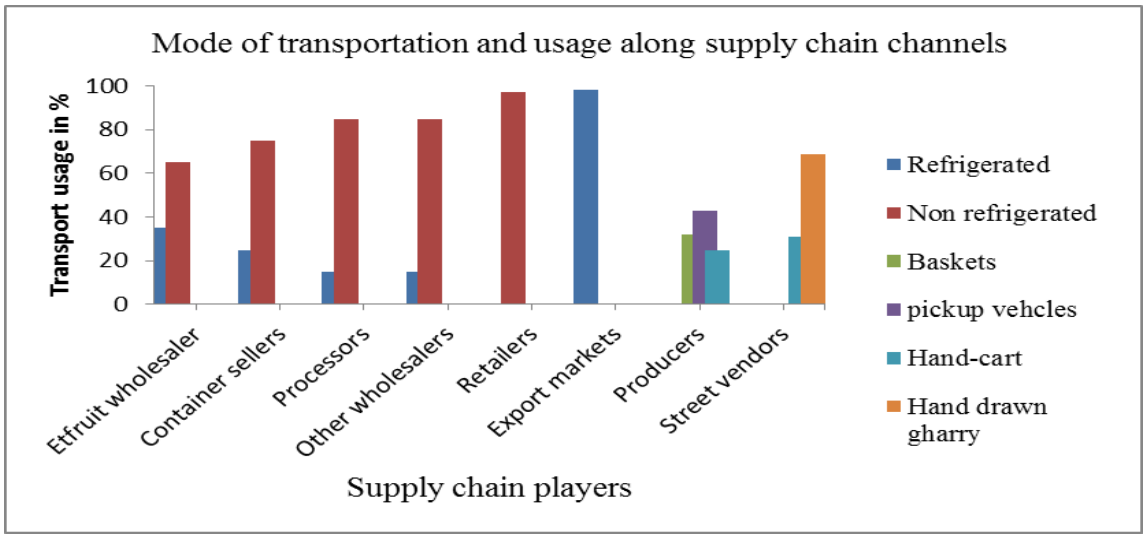

Figure 16. Mode of transportation system and their usage along supply chain channels of fresh produces

6. Analysis and discussion

6.1 Value chain constraints

6.1.1 Market access

For this study the supply channels for fresh produces can mostly be categorized as B-system (Ruben et al., 2007). The B-system functions well for medium level players in the chain. The fruits and vegetables in this study were often disseminated from wholesalers to market players such as retailers, supermarkets and hotels in Addis Ababa, Ethiopia. This market system matches well with the B-system as it aims at a local market but can mostly be part of different market system, often via middlemen. A good numbers of the producers were members of cooperatives as B-system was mostly connected in associations, cooperatives or other kinds of contracts. The B-system largely aims supermarkets (Ruben et al., 2007), this was often the case for this study as they mostly aim supermarkets, retail shops, and juice houses in local markets. Production of fruits and vegetables for the internal market were often in scattered manner and small scale in Ethiopia. The number of supply chain affiliated marketing outlets are increasing quickly in Addis Ababa, however, many retail shops and supply chain stores do not plant adequate number of storage facilities to validate operating with their own exclusive distribution hubs. Producers were independently unable to achieve the volume, place and quality standard of chains players and supermarkets in the city, Addis Ababa. The B-system often focuses at values shared between numbers of players ranging from middle to high income. Moreover, the C-system focused often on export market as there was only one global channel in this study (Ruben et al., 2007). Thus, the supply channels for fruits and vegetables in this study were best considered in B-systems.

Emana and Hadera (2007) stated that fresh products moving closer to the consumers' destination from producers have little added value. Also stated that the producers have a little information as the producers and sellers mostly have no any straight communication with each other. Similarly Demissie (2011) claimed that producers have little bargaining power in the supply chains of Ethiopia. Et-fruit wholesales' bargaining powers generates from the sourcing strategy. Etfruit wholesalers were often known for their purchase of bulky perishable produces with better financial and information capabilities. They were most dominant players in the supply channels and supplies fruits and vegetables directly from producers. Price was determined on farm by the producers when its produces demanded by numerous consumers.

Therefore, producers were the purchase price-setter in advance via open tender invitation and at least better price provision accepted and the winning award letter recognized. When the producers were many and the wholesalers were few in numbers, the wholesalers have more bargaining power and the price was determined through negotiation. This can place producers on the loser side of supply chains.

6.1.2 Infrastructure and resources

The persistent reliance of Addis Ababa's middlemen on the central Etfruit wholesale can be mainly attributed to the lack of a well-organized infrastructure and market integration in several Ethiopian fruit and vegetable production locations. Absence of infrastructure and poor harvesting techniques in several developing countries are major elements in the formation of food loss (Kader, 2005). This research has shown that lack of dependable transportation, finance, transparent information, packaging sheds and quality standards. The central issue for developing nations is its inefficient and unorganized postharvest supply chain systems that lead to the losses of food (Hodges et al., 2011). These have obliged close trade partners or middlemen to depend heavily on wholesalers which reasonably meet their demands for sizes, maturity, value, location and appearances.

Expansion of adequate and efficient infrastructural networking is necessary for better transportation, easy packaging, vehicles load and unload. Easy, cost-effective and improve packaging system is required to keep food fresher for extended time. For instance, if fresh produces picked directly into plastic crates in the production area, thus the food losses in such perishable fresh produces in fact can be minimized significantly, even when more advanced mechanical apparatuses were not on-hand for handling. This simple approach can easily reduce the level of food losses, but they were not implemented so far. Moreover, now days, it is common to witness prominence of pallet-trucks in developed world. But it requires comfortable floor and usually require loading bay to have access for other distribution vehicle. However, those engineered infrastructure is not available in Addis Ababa, Ethiopia.

6.1.3 Inadequate use of cold chain system

Lack of refrigeration capacity is mostly accountable for the big postharvest losses experienced in developing countries (Parpia, 1976). Trade partners admitted that the Etfruit-wholesalers lacked to realize the significance of cold chain preservation for fresh produces. It was well observed in the capital, Addis Ababa, no market players interested to invest in cold chain

because it demands huge capital. When fresh produces move out from main distributor (Etfruit), commodities were already in risk of shrinkage and spoilage because it was not passed through cold chain system. This has direct-effect on quantity and quality of purchases made by households. Many of households in Addis Ababa had inadequate access to refrigeration facility at home, therefore, likely to buy only slight quantities of fresh produce at occasion of store visit (Reardon et al., 2003).

6.1.4 Lack of adequate packaging sheds

To some degree only fruits and vegetables for export market often sort and classify at Etfruit wholesale packing shed since these commodities are intended for export market. However, packing materials for internal marketing of fresh produces was often just plastic crates. Packing has so many functions for the product itself, seller and user. Packaging is so significant in protecting a product from damage, keeping the product together; identify the product, ease of transport, stacking and printed information (Ragaert et al., 2004). Trade partners indicated all-embracing views as to why most fresh produces handled by Addis Ababa Etfruit wholesale facilities were provided in plastic crates instead of more protective card-board containers. Etfruit wholesalers at large replied that they use plastic-crates since price sensitive trade-partners in Addis Ababa are reluctant to cover extra cost for insulated and robust packaging. This was aggravated by Addis Ababa's current experiences of inflation, which elevated uncertainty to those consumers with low purchasing power of income unable to afford fresh produces which were packed in more expensive packages. Instead, Etfruit wholesalers described their packaging style as an alternative means to reduce financial outlays by using reusable plastic packages.

6.1.5 Heavy dependence on manual Labor

The practice of employing automated forklifts to transfer pallet loads from cold stores was nonexistence at Addis Ababa. Automated forklifts have become a crucial piece of equipment in supply chain operations which offers greater safety during product load and unload (Manikas and Terry, 2010). There were no refrigerated warehouses and insulated packaging facilities possessed by Etfruit-wholesale companies. Therefore, forms of packing materials in the supply chain would make it impossible to use machine-driven forklifts for load and collection docks. Furthermore, the manual labor cost is easily affordable in Ethiopia, which created alternative approach. The apparent limitation of labor-intensive loading system could

greatly delays time that the produces would have been at right location and leads to more exposure of high temperature and contributes for further severe product damage and substantial shelf life reduction.

6.2 Value chain analysis

6.2.1 Network structure

There were seven main supply chain channels for perishable produces which incorporates one international outlet and the rest operates with in national level. These supply channels consists of eight various market players such as producers, Etfruit wholesalers, other wholesalers, processors, export, retailers, street vendors and consumers. However, the findings related with types of players were not similar with the study which was undertaken in eastern part of Ethiopia by Emana and Hadera (2007). The network structure in a value chain is greatly reliant on what market channels players have chosen (Trienekens, 2011). Existing market networks for chain players to market their fruits and vegetables influenced by the market access hindrances.

Network structure underlines the horizontal relations between players in a network and assesses social connections and knowledge transfer (Lazzarini et al., 2001). There were weak horizontal connections among chain players in the value chain for fruits and vegetables marketing. Almost all players were well understood for their dependency on Etfruit wholesalers with limited competence of supplying and handling perishable produces from far rural production location combined with low financial and information capacity. Robust collaboration in a horizontal connection can inspire and facilitate market access and information (Trienekens, 2011). In contrast, wholesalers are the dominant players in the supply network structure which possess necessary marketing services as they renders market information, rent of refrigerated semi-trailer truck for transportation and supply value added seeds. There were some form of farmers associations and cooperatives with fragmented cooperation with other chain players. Efficient flow of information and resources between supply chain players are the most important component for horizontal cooperation to become the strongest (Trienekens and Willems, 2007).

6.2.2 Supply and Demand relationships

As highlight in various qualitative literatures (Gustavsson et al., 2011, Lipinski et al., 2013a, Lundqvist et al., 2008b) which support impacts of food loss on supply chain players. A long the supply-side of market chain; lack of measures against food loss given the original supply curve resulted in a lower equilibrium quantity, higher price, producer's surplus, welfare disadvantage for consumers in the market for fresh produces. This is compatible with the impacts from the viewpoint of developing countries, where food loss on the supply channel side dominates. Food loss largely occurs in supply channel in developing countries according to World Bank (2010) research on PHLs of fruits and vegetables. The aggregate loss in the supply chain appears to be much bigger in consumers' channels in developing countries. Kantor et al. (1997) recapped loss estimates for the USA that from 222mill tons of food supply for the year of 2008, 9% (19.5 mill tones) were lost at the retail level and 17% (37.7 mill tones) at the consumer level. the result of this study reveals different results with the Kantor et al. Estimated food loss for Ethiopian Et-Fruit company that from 36 thousand tons of fresh food supply for the year of 2012, 28% (10 thousand tones) were lost at the supply chain channels and less than 1% (0.732 tones) at the consumer level. Market price for fresh produces increases while the quantity delivered in the market decreases. Therefore, an increase in market price decreases consumers' surplus, but increases producers' surplus. When look at it differently, producers cannot sell more fruits and vegetables at a higher price.

There were food losses in the consumption side of fresh produces, in that consumers waste portion of what they demand. In that case, the socially optimal demand curve lies to the right of the original demand curve is shown by Demand' in *Figure 13* (Nicholson and Snyder, 2011). Along the demand-side of market chain, failing to reduce food waste from consumption, given the original supply curve and lack of incentives to reduce in food waste resulted in a higher equilibrium quantity, and higher price in the market. Producers are capable to sell more fruits and vegetables at a higher price; as a result their welfare is positively affected. When demand increases (demand curve shifts right), it means that consumers will be forced to purchase more quantity of fresh produce for higher price. Looking at it differently, consumers paid a higher price for the same quantity of fruits and vegetables.

In this study, food waste from demand side mainly related to households' usage and wastage practices of fresh produces. Higher SES household related with relatively higher usage and waste of fresh produces when compared with low SES groups. The results supported the evidence that people belonging to a higher SES have both a higher usage and wastage of fruits

and vegetables (Marmot et al., 1991, Holcomb, 1995, Hupkens et al., 1997, Osler and Schroll, 1995, Prättälä et al., 1992, Roos et al., 2001, Johansson et al., 1999). The estimate of difference in the waste of fruit and vegetable between higher SES and low SES households was 25g/person / week. The study of Estevez *et al* (2000) recaps us that the estimate of the difference in the waste of fruit and vegetable was 24g/person/day between higher and low socioeconomic households in developed countries. This showed the differences in wastage level of fruits and vegetables at household and thus, the food wastage level is insignificant at consumer channel in developing countries. This study found out households with high persons would waste lower fruits and vegetables. Several studies support the same notion (Wenlock and Buss, 1977, Osner, 1982, WRAP, 2006) they also demonstrated that food loss was significantly affected by the composition of the family member and size. Family with larger household size would waste less food per person than smaller household composition. This study has indicated an average person in each SES household accounts four, five and six from High to Low respectively.

6.2.3 Governance structure

The selection of governance mechanism is influenced by how dependent the players in the supply chain with each other and the differences in market power (Trienekens, 2011). A chain player with ample market power can regulate the governance structure (Ruben et al., 2007). In this study it was the Efruit wholesalers that appear to have utmost power in the value chains by possessing better facility, pricing strategy and information. Et-fruit wholesales' bargaining powers generates from the product sourcing strategy. Etfruit wholesalers were known for their purchase of bulky perishable produces with better financial and information capabilities. They were most dominant players in the supply channels and supplies fruits and vegetables directly from producers. Similarly Demissie (2011) stated that producers have little bargaining power in the supply chains of Ethiopia. According to Etfruit-firm general manager, price determination has its own strategy on farm-gate. Price was determined on production site by the producers when its produces demanded by many purchasers. Therefore, producers were the purchase price-setter in advance via open tender invitation and at least better price provision accepted and the winning award letter recognized. When the producers were many and the wholesalers were few in numbers, the wholesalers have more bargaining power and the price was determined by negotiation. However, Et-Fruit often undertakes price-negotiation procedures on farm-gates as they were dominant player in the supply chain with high possibility of forming bargaining power. This can place producers on the loser and affected side of chain.

The incompetence of several Ethiopian perishable producers to provide market oriented fresh produces directly to final markets combined with failure of other supply chain players to play better role in market stabilization has created domination and significant advantage for Etfruit-wholesalers. Etfruit-wholesale was capable to receive fresh products by refrigerated and non-refrigerated mode of transport, and unloads commodities that possibly devalued in transit to retail customers. They also overprice their close trade partners as all burden mounts to producers and final consumers to compensate their outlay. Moreover, lack of adequate quality control which has provided possibilities for the Et-fruit wholesale to take an advantage of selling their blow par fruits and vegetables to other chain players and consumers.

6.3 Improving

6.3.1 Market access

If big middleman such as wholesalers market dependably can deliver and provide standard fresh products at favourable prices and also can be part of improved supply chains' new desires (Humphrey, 2007). Improved market access has to be implemented. Creating conducive marketing environments is necessary for reduction of PHLs. This was evidently exhibited by Mutangadura (2004), the purchase for progress (P4P) program in the World Food Program. It delivers the most vulnerable supply chain participants with access to markets and enables them to make durable investments, by contributing them various ways of investment incentives and approaches of selling their fresh produces.

Market improvement is vastly associated with creation of awareness among chain players such as consumer education, campaign, fair trade or green production (Trienekens and Zuurbier, 2008). It is a worthwhile to ensure that farming skills, postharvest handling and home economics have been taught in universities, colleges, schools and communities. For example conducting gender based consumers' education and campaign would be paramount. Almost all the food handlings and cooking process are undertaken by females in developing countries. Therefore, offering guidance for consumers on how to access product information, market, store, prepare, and handle would be required. Therefore, invaluable campaigns, common principles, educations and standards may inspire implementation of good practices. Also considering local framework into account and involvement of supply chain participants within a participative approach would be critical success factor for reducing PHLs.

6.3.2 Value added

Upgrading of processes is often used upgrading option for value added in developing countries. Certain value adding activities have increased in the supply chain of developing countries for instance juice processing, yet activities in form of branding and marketing strategy needs big measure (Humphrey and Memedovic, 2006). There were some improvements especially in processing wise but still there were huge gaps on branding and selling strategy; however, it was mostly related with development level of country. There were also high need to ensure internal improvement on supply chain such as product value, packaging, and composition. Developments concerning handling, transport, packaging and storage facilities are significant aspects to nurture quality and reduce loss of fresh produce along supply chain (Kader, 2004). Developments of new technologies are often required in order to optimize the productions. Distribution system can be upgraded by better interaction between the players,' use of new transport technology, cold chain and practice of GPS systems, internet access and mobile phones. In developing countries functional upgrading continued to remain at low level as they deliver services for developed countries, therefore value adding occurs in the final parts of the chain Process improvement links to the optimization of products and distribution in the production system (Trienekens, 2011)

6.3.3 Infrastructure and resources

There is greater need for improved access to low cost handling and storage technologies such as storage bags, evaporative coolers, crates and metal silos. For instance, supply chain players especially producers have to construct evaporative cooler storage system. It delivers better cooling environment by providing lower temperature and better humidity. As demonstrated by Nenguwo (2002) study, this approach has successfully implemented for fresh produce handling in Rwanda.

Installation of cold chain system incorporated both refrigerated warehouse and transportation system is required. To transport temperature sensitive fresh produces with full freshness, cold-chain system should have well automated processes from production to final users. Additionally, modern technologies have to be introduced which are intended to improve the efficiency along supply chain with which fresh produces transported, stored, displayed and delivered to consumers. This was validated by Houghton and Portougal (1997) as *Just-In-Time (JIT)* production and application of online stock control system. This application has

radically reduced the amount of stock inventory in the food supply chain, taking down cost drivers and waste accumulation despite transportation congestion and environmental issues.

Despite supply chain's complexity, well-known by resilient interaction of important number of chain actors, comprehensive approach is significant mechanism in policy-making for loss reduction. Reducing food loss deserves urgent reaction from the private sectors, policy-makers and non-governmental players. It also demands thinking out of box, '*farm-gate approach'*, the usual motto of '*increasing production'*, but increasing funds for studies of post-harvest losses is vital (Marsden et al., 2000). Thus, all phases throughout supply chain have to be managed entirely so as to prevent impact transmission from one phase to another.

7. Conclusions

This chapter of thesis addressed the aim and research questions. The aim of this study was to assess postharvest loss in the supply chains of fresh produces in Addis Ababa, Ethiopia. Identified main players in the supply chain were Et-fruit wholesalers, Et-fruit retailers, other wholesalers, processors, retailers, producers, vendor sellers and consumers. *Channel one* distributed the highest volume of 37% fresh produces to final consumers. Et-Fruit wholesalers were the main domestic distributors of fresh produces in Addis Ababa. The total food loss along supply chain channels for selected fresh produces was about 28% whereas 1% in consumers' channel. Postharvest loss largely occurs in supply channels than consumers for fresh produces in developing countries (Fao, 2014). Outcome of this study showed the similar result; lack of responsive actions against food loss like players might be induced to tackle the food losses as a result of a new technology, or new policies such as taxes, regulations, and subsidies that penalize and encourage reductions. In the supply-side of market chain; lack of such a measures resulted in a lower quantity, higher price, producer's surplus, welfare disadvantage for consumers in the market for fresh produces. In addition to this, failing to reduce food waste from consumption resulted in a higher price in the market. Therefore, failing to reduce food loss caused producers and consumers to be more affected players.

There were hindrances which promote loss in the supply chain; lack of cold chain system, lack of adequate packaging sheds and heavy dependence on manual Labor. In Ethiopia where traditional postharvest handling is the only choice, poorly harvested and packaged fresh produces loaded onto inadequate transport by means of manual labor. Valuation of postharvest losses enables to develop proper measures which are required to reduce losses and to increase the accessibility of fresh produces for domestic consumption as well as export purposes. The major losses in the supply chain occur in the process of storage, transport and packaging. These losses can largely be reduced by implementing cold chain system, refrigerated trucks, plastic crates with safety cover, use of locally viable technologies and persistent policies are desired. With postharvest concerns having been mostly overlooked, a firm indication starts from lack of common valuation method. Furthermore, there have not been many researches undertaken on the impacts of food loss in developing countries. Thus, there is an urgent need for further quantitative researches that provide accurate loss estimates. Unless deliberations on the potentials for reducing world-wide food loss will remains mostly rhetorical.

Bibliography

Literature and publications

BARRETT, C. B. & MUTAMBATSERE, E. 2008. Agricultural markets in developing countries.

BISWAS, M. 1969. Wastage of Orange in Transit to Varanasi. *Agricultural Marketing,* 12**,** 11-16.

BOER, K. D. & PANDEY, A. 1997. India's Sleeping Giant: Food. *The McKinsey Quarterly***,** 82.

BOURNE, M. 1977. Post harvest food losses–the neglected dimension in increasing the world food supply.

BUZBY, J. C., WELLS, H. F., AXTMAN, B. & MICKEY, J. 2009. Supermarket loss estimates for fresh fruit, vegetables, meat, poultry, and seafood and their use in the ERS loss-adjusted food availability data. United States Department of Agriculture, Economic Research Service.

CADE, J., BURLEY, V., WARM, D., THOMPSON, R. & MARGETTS, B. 2004. Food-frequency questionnaires: a review of their design, validation and utilisation. *Nutrition Research Reviews,* 17**,** 5-22.

COULTER, J. & SHEPHERD, A. 1995. *Inventory credit: an approach to developing agricultural markets*, Fao.

DAVIS, J. C. 1980. Agriculture and transportation: a positive impact, in: increasing understanding of public problems and policies. 51-58.

DEMISSIE, M. 2011. Marketing of Kabuli and Desi chickpeas by smallholder farmers in Eastern Shewa Zone.

EMANA, B. & GEBREMEDHIN, H. 2007. Constraints and opportunities of horticulture production and marketing in Eastern Ethiopia. *Dry land coordination group (DCG) report,* 46.

EMANA, B. & HADERA, G. 2007. Constraints and opportunities of horticulture production and marketing in eastern Ethiopia. *Dry land coordination group (DCG) report,* 46.

FAO 1981. Food loss prevention in perishable crops. *agricultural service Bulletin,* 43.

FAO 2012. Global initiative on food loss and waste reduction.

FAO, U. How to Feed the World in 2050. Rome: High-Level Expert Forum, 2009.

FAO, W. 2014. IFAD (2012) The State of Food Insecurity in the World 2012: Economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition. *FAO, Rome*.

GEBRESENBET, G. & BOSONA, T. 2012. *Logistics and supply chains in agriculture and food*, INTECH Open Access Publisher.

GOLETTI, F. Current status and future challenges for the postharvest sector in developing countries. XXVI International Horticultural Congress: Issues and Advances in Postharvest Horticulture 628, 2002. 41-48.

GREELEY, M. 1991. *Postharvest technologies: Implications for food policy analysis*, World Bank.

GUSTAVSSON, J., CEDERBERG, C., SONESSON, U., VAN OTTERDIJK, R. & MEYBECK, A. 2011. Global food losses and food waste. *Food and Agriculture Organization of the United Nations, Rom*.

HALLDORSSON, A., KOTZAB, H., MIKKOLA, J. H. & SKJØTT-LARSEN, T. 2007. Complementary theories to supply chain management. *Supply Chain Management: An International Journal,* 12**,** 284-296.

HENSON, S. & LOADER, R. 2001. Barriers to agricultural exports from developing countries: the role of sanitary and phytosanitary requirements. *World Development,* 29**,** 85-102.
HODGES, R. J., BUZBY, J. C. & BENNETT, B. 2011. Postharvest losses and waste in developed and less developed countries: opportunities to improve resource use. *The Journal of Agricultural Science,* 149**,** 37-45.
HOLCOMB, C. A. 1995. Positive influence of age and education on food consumption and nutrient intakes of older women living alone. *Journal of the American Dietetic Association,* 95**,** 1381-1386.
HOUGHTON, E. & PORTOUGAL, V. 1997. Reengineering the production planning process in the food industry. *International Journal of Production Economics,* 50**,** 105-116.
HUMPHREY, J. & MEMEDOVIC, O. 2006. Global value chains in the agrifood sector.
HUPKENS, C. L., KNIBBE, R. A. & DROP, M. J. 1997. Social class differences in women's fat and fibre consumption: a cross-national study. *Appetite,* 28**,** 131-149.
JOHANSSON, L., THELLE, D. S., SOLVOLL, K., BJØRNEBOE, G.-E. A. & DREVON, C. A. 1999. Healthy dietary habits in relation to social determinants and lifestyle factors. *British Journal of Nutrition,* 81**,** 211-220.
KADER, A. A. 2003 A perspective on postharvest horticulture (1978-2003). *HortScience,* 38**,** 1004-1008.
KADER, A. A. Increasing food availability by reducing postharvest losses of fresh produce. V International Postharvest Symposium 682, 2004. 2169-2176.
KADER, A. A. 2005. INCREASING FOOD AVAILABILITY BY REDUCING POSTHARVEST LOSSES OF FRESH PRODUCE. *Acta Hort,* 682**,** 2169-2176.
KADER, A. A. Handling of horticultural perishables in developing vs. developed countries. VI International Postharvest Symposium 877, 2009. 121-126.
KANTOR, L. S., LIPTON, K., MANCHESTER, A. & OLIVEIRA, V. 1997. Estimating and addressing America's food losses. *Food Review,* 20**,** 2-12.
KAPLINSKY, R. 2000. Globalisation and unequalisation: What can be learned from value chain analysis? *Journal of development studies,* 37**,** 117-146.
KITINOJA, L. & GORNY, J. R. 1999. Postharvest technology for small-scale produce marketers: economic opportunities, quality and food safety. *Postharvest Horticulture Series-Department of Pomology, University of California*.
LAZZARINI, S. G., CHADDAD, F. R. & COOK, M. L. 2001. Integrating supply chain and network analyses: the study of netchains. *Journal on chain and network science,* 1**,** 7-22.
LEBO, J. & SCHELLING, D. 2001. *Design and appraisal of rural transport infrastructure: ensuring basic access for rural communities*, World Bank Publications.
LIPINSKI, B., HANSON, C., LOMAX, J., KITINOJA, L., WAITE, R. & SEARCHINGER, T. 2013a. Reducing food loss and waste. *World Resources Institute Working Paper, June*.
LIPINSKI, B., HANSON, C., LOMAX, J., KITINOJA, L., WAITE, R. & SEARCHINGER, T. 2013b. Reducing Food Loss and Waste." Working Paper, Installment 2 of Creating a Sustainable Food Future. *World Resources Institute, Washington, DC*.
LUNDQVIST, J., DE FRAITURE, C. & MOLDEN, D. 2008a. Saving water: from field to fork. Curbing losses and wastage in the food chain.
LUNDQVIST, J., DE FRAITURE, C. & MOLDEN, D. 2008b. Saving water: from field to fork: curbing losses and wastage in the food chain.
MANIKAS, I. & TERRY, L. A. 2010. A case study assessment of the operational performance of a multiple fresh produce distribution centre in the UK. *British Food Journal,* 112**,** 653-667.

MARMOT, M. G., STANSFELD, S., PATEL, C., NORTH, F., HEAD, J., WHITE, I., BRUNNER, E., FEENEY, A. & SMITH, G. D. 1991. Health inequalities among British civil servants: the Whitehall II study. *The Lancet,* 337**,** 1387-1393.
MARSDEN, T., BANKS, J. & BRISTOW, G. 2000. Food supply chain approaches: exploring their role in rural development. *Sociologia ruralis,* 40**,** 424-438.
MATTSSON, L.-G. & JOHANSON, J. 1992. *Network positions and strategic action: an analytical framework*, Univ.
MÖLLER, K. K. & HALINEN, A. 1999. Business Relationships and Networks:: Managerial Challenge of Network Era. *Industrial marketing management,* 28**,** 413-427.
MREMA, G. C. & ROLLE, R. S. Status of the postharvest sector and its contribution to agricultural development and economic growth. 9th JIRCAS International Symposium, 2002. 13-20.
MUTANGADURA, G. B. 2004. World Health Report 2002: Reducing Risks, Promoting Healthy Life: World Health Organization, Geneva, 2002, 250 pages, US $13.50, ISBN 9-2415-6207-2. No longer published by Elsevier.
NENGUWO, N. 2002. Appropriate technology cold store construction and review of post-harvest transport and handling practices for export of fresh produce from Rwanda. *Fresh Produce,* 1.
NICHOLSON, W. & SNYDER, C. 2011. *Microeconomic theory: basic principles and extensions*, Cengage Learning.
OSLER, M. & SCHROLL, M. 1995. Lifestyle and prevention of ischaemic heart disease in Denmark Changes in knowledge and behaviour 1982–1992. *The European Journal of Public Health,* 5**,** 109-112.
OSNER, R. 1982. Food wastage. *Nutrition & Food Science,* 82**,** 13-16.
PARFITT, J., BARTHEL, M. & MACNAUGHTON, S. 2010. Food waste within food supply chains: quantification and potential for change to 2050. *Philosophical Transactions of the Royal Society B: Biological Sciences,* 365**,** 3065-3081.
PARISER, E. 1982. Post-harvest food losses in developing countries. *Nutrition Policy Implementation.* Springer.
PARPIA, H. 1976. Postharvest Losses—Impact of Their Prevention on Food Supplies, Nutrition, and Development. *Nutrition and Agricultural Development.* Springer.
PORTER, M. E. & MILLAR, V. E. 1985. How information gives you competitive advantage. Harvard Business Review, Reprint Service.
PRÄTTÄLÄ, R., BERG, M.-A. & PUSKA, P. 1992. Diminishing or increasing contrasts? social class variation in Finnish food consumption patterns, 1979-1990. *European journal of clinical nutrition,* 46**,** 279.
PRUSKY, D. 2011. Reduction of the incidence of postharvest quality losses, and future prospects. *Food Security,* 3**,** 463-474.
RAGAERT, P., VERBEKE, W., DEVLIEGHERE, F. & DEBEVERE, J. 2004. Consumer perception and choice of minimally processed vegetables and packaged fruits. *Food Quality and Preference,* 15**,** 259-270.
RATNAM, C. & NEMA, K. 1967. Studies on market diseases of fruits and vegetables. *Andhra Agricultural Journal,* 14**,** 60-65.
REARDON, T., TIMMER, C. P., BARRETT, C. B. & BERDEGUÉ, J. 2003. The rise of supermarkets in Africa, Asia, and Latin America. *American journal of agricultural economics,* 85**,** 1140-1146.
RIGG, J., BEBBINGTON, A., GOUGH, K. V., BRYCESON, D. F., AGERGAARD, J., FOLD, N. & TACOLI, C. 2009. The World Development Report 2009 'reshapes economic geography': geographical reflections. *Transactions of the Institute of British Geographers,* 34**,** 128-136.

ROOS, G., JOHANSSON, L., KASMEL, A., KLUMBIENÉ, J. & PRATTALA, R. 2001. Disparities in vegetable and fruit consumption: European cases from the north to the south. *Public health nutrition,* 4**,** 35-44.
RUBEN, R., VAN TILBURG, A., TRIENEKENS, J. & VAN BOEKEL, M. 2007. Linking market integration, supply chain governance, quality, and value added in tropical food chains. *Tropical food chains: governance regimes for quality management***,** 13-46.
RUEL, M. T., MINOT, N. & SMITH, L. 2005. *Patterns and determinants of fruit and vegetable consumption in sub-Saharan Africa: a multicountry comparison*, WHO Geneva.
RUTTEN, M. & KAVALLARI, A. 2013. Can reductions in agricultural food losses avoid some of the trade-offs involved when safeguarding domestic food security?
RUTTEN, M. M. 2013a. What economic theory tells us about the impacts of reducing food losses and/or waste: implications for research, policy and practice. *Agriculture & Food Security,* 2**,** 13.
RUTTEN, W. Y. 2013b. The socio-economic impacts of reducing food waste Presentation given by LEI Wageningen UR at Save Food Partnership Event
Rome
SALVATORE, D. 2008. Microeconomics: theory and applications. *OUP Catalogue*.
SHUKLA, M. & JHARKHARIA, S. 2013. Agri-fresh produce supply chain management: a state-of-the-art literature review. *International Journal of Operations & Production Management,* 33**,** 114-158.
SNEHOTA, I. 2004. Perspectives and theories of market. *Rethinking Marketing. Developing a new understanding of markets. Hokeboken, NJ: John Wiley & Sons***,** 15-32.
SNEHOTA, I. & HAKANSSON, H. 1995. *Developing relationships in business networks*, Routledge.
STUART, D. 2009a. Constrained choice and ethical dilemmas in land management: Environmental quality and food safety in California agriculture. *Journal of agricultural and environmental ethics,* 22**,** 53-71.
STUART, T. 2009b. *Waste: Uncovering the global food scandal*, WW Norton & Company.
TILMAN, D., FARGIONE, J., WOLFF, B., D'ANTONIO, C., DOBSON, A., HOWARTH, R., SCHINDLER, D., SCHLESINGER, W. H., SIMBERLOFF, D. & SWACKHAMER, D. 2001. Forecasting agriculturally driven global environmental change. *Science,* 292**,** 281-284.
TRIENEKENS, J. & WILLEMS, S. 2007. Innovation and governance in international food supply chains: The cases of Ghanaian pineapples and South African grapes. *International Food and Agribusiness Management Review,* 10**,** 42-63.
TRIENEKENS, J. & ZUURBIER, P. 2008. Quality and safety standards in the food industry, developments and challenges. *International Journal of Production Economics,* 113**,** 107-122.
TRIENEKENS, J. H. 2011. Agricultural value chains in developing countries a framework for analysis. *International Food and Agribusiness Management Review,* 14.
UR, O. W. U. W. & WAGENINGEN, C. W. 2014. Reducing postharvest food losses in developing economies by using a Network of Excellence as an intervention tool.
VAN GOGH, J. & ARAMYAN, L. Reducing postharves food losses in developing economies by using a Network of Excellence as an intervention tool. Proceedings of the IFAMA 2014 Symposium Proceedings' People Feed the World', 2014.
VISWANADHAM, N. 2006. 1 Can India be the Food Basket for the World? *Achieving Rural & Global Supply Chain Excellence***,** 1.
WAKJIRA, M. 2010. Solar drying of fruits and windows of opportunities in Ethiopia. *African Journal of Food Science,* 4**,** 790-802.

WEINBERGER, K. & LUMPKIN, T. A. 2007. Diversification into horticulture and poverty reduction: a research agenda. *World Development,* 35**,** 1464-1480.
WENLOCK, R. & BUSS, D. 1977. Wastage of edible food in the home: a preliminary study. *Journal of human nutrition,* 31**,** 405.
WIERSINGA, R. C. & DE JAGER, A. 2009. *Business opportunities in the Ethiopian fruit and vegetable sector*, LEI Wageningen UR.
WILSON, N. 1996. The supply chains of perishable products in northern Europe. *British Food Journal,* 98**,** 9-15.
WOLDEWAHID, G., GEBREMEDHIN, B., HOEKSTRA, D., TEGEGNE, A., BERHE, K. & WELDEMARIAM, D. 2012. Market-oriented beekeeping development to improve smallholder income: Results of development experiences in Atsbi-Womberta District, northern Ethiopia.
WORLD BANK, W. 2010. Missing Food: The Case of Postharvest Grain Losses in Sub-Saharan Africa.
WRAP 2006. Understanding Consumer Food Management Behavior.
ZORYA, S., MORGAN, N., DIAZ RIOS, L., HODGES, R., BENNETT, B., STATHERS, T., MWEBAZE, P. & LAMB, J. 2011. Missing food: the case of postharvest grain losses in sub-Saharan Africa.

Internet sources

CSA, Central Statistical Ageny, www.csa.gov
Fruit and vegetable cultivation in Ethiopia, 2014-08-10,
http://www.countrystat.org/home.aspx?c=ETH&ta=238CLI010&tr=11

Etfruit, Ethiopian Fruit and vegitable marketing share company, www.etfruit.et
General information about Etfruit, 2015-03-26, http://etfruit.et

ETHEMB, Ethiopian Embasy, www.ethemb.se
Investment opportunities profile for the production of fruits and vegetables in Ethiopia, 2015-05-20, http://ethemb.se/business/investment/investment-opportunities/

FAOSTAT, Food and Agriculture Organization Stastistics, www.faostat.fao.org
Production-fruits and vegetables in Ethiopia, 2015-o3-22
http://faostat3.fao.org/search/fruits%20and%20vegetables/E

Personal Messages

Endalkachew, T., Member of House of Peoples' Representatives or parliament of Ethiopia, personal meeting

Fitamo, G., Expert of Ethiopian Revenues and Customs Authority (ERCA), personal meeting

Mengistu, K., General Manager of Ethiopian Fruit and vegitable marketing share company, personal meeting

Gebresenbet, G., Professor at Swedish University of Agricultural Sciences, department of Energy and Technology, personal meeting

Tsegaye, S., Marketing researcher of Ethiopian Fruit and vegitable marketing share company, personal meeting

Appendix (I)

Questionnaires for Household

1. Instructions to enumerators:
   - Please make brief introduction before starting, introduce yourself to the household, greet them in local ways and make clear the objective of the study.
   - Please fill the interview questionnaires according to the household reply.
   - Please ask each question clearly and patiently until they get your points.
2. Name of household head?
3. Marital status of household head.
4. Religion of the household
5. Total number of family members'
6. Education level of household head (respondent)
7. Main occupation of the respondent
8. Annual income of the respondent
9. Is fruit and vegetable consumed in your family?
10. Experience in fruit and vegetable products consumption?
11. What is the proportion of your income used for purchase of fresh products per month?
12. Do you purchase fruits and vegetables frequently?
13. If the answer is yes, what would be the reason?
14. If the answer is No, what would be the reason?
15. What type of fruit and vegetable products purchased for consumption?

Commodity type	Quantity purchased in Kg /week	No of market day/week	Low price paid	High price paid	From whom do you buy? **
Vegetables					
Cabbage					
Tomatoe					
Carrot					
Onion					
Irish potatoes					
Fruits					
Orange					

Mandarin					
Avocado					
Banana					
Mango					
Papaya					

16. What are the reasons for loss of fruit and vegetable goods during home consumptions?
17. How many Kg of fresh produce do you loss during leftover?
    1. While Cooking per kg per week
    2. While Preparing per kg per week
    3. While serving per kg per week
19. What do you do with leftover during home consumption?
    1. Dump at right garbage palace
    2. just throw at any place
    3. donate for street people/ others
    4. sell for reuse (animal husbandry)
20. What should be done to reduce food loss at house hold level?
21. What do you do about environmental pollution related with food waste disposal?
    1. I care about environment
    2. I don't care about environment
    3. I have no awareness about environmental pollution
    4. Others
22. Food Frequency Questionnaire (Will be asked for the last Week per households)

Commodities	produces purchased/week	Consumed amount/week/grams	Plate waste estimated/grams
Orange			
Mandarin			
Banana			
Avocado			
Mango			
Papaya			
Tomato			
Onion			
Potato			

Questionnaires for Intermediaries

Instructions to enumerators:

- Please make brief introduction before starting any question, introduce yourself to the traders, greet them in local ways and make clear the objective of the study.
- Please fill the interview schedule according to the traders reply (do not put your own feeling).
- Please ask each question clearly and patiently until they get your points.

1. Name of wholesale/retail outlet/ shops…
2. What is Main mode of transportation during the movement of fruits and vegetable?
   1. Hand carts
   2. Hand drawn gharry
   3. Baskets on shoulder
   4. Non-refrigerated trucks…
   5. Refigerated trucks
   6. Pick-up vehicles
3. From whom do you often buy fruits and vegetable?
4. What type of packaging material do you use for the movement of fruits and vegetables to wholesale market?
   1. Plastic crates
   2. Wooden-box
   3. Cartons
   4. Baskets…
   5. Unpacked
   6. Sacks
   7. Card-board box
5. Amount of fresh produce supplied to market and traders in 2004 through Et-Fruit Company?

Fresh produces	Places to buy 1.Farm gate 2.Local market 3. Other cities	Distance to marketing places (Km)	Mode of transport	To whom did you sell
Cabbage				
Tomatoe				
Carrot				
Onion				
Irish potatoes				
Ornage				
Mandarin				
Papaya				

Avocado				
Banana				
Mango				

6. How much did you pay for purchasing fruits and vegetables in kg/annam
7. How many quintals of fruits and vegetables do you loss during transportation time in kg/Annam
8. What are the causes for the losses during transport?
    1. Poor packing
    2. Poor transport service
    3. Poor road
    4. Poor temperature management
    5. Others…
9. What do you suggest to improve food loss during transportation time?
10. How many quintals of fruits and vegetables do you loss during packing in kg/annam?
11. What type of packaging system do you use during package of product per year?
    1. Loose-fill jumble pack
    2. Multilayer pattern pack
    3. Multilayer size graded pack
    4. Single layer packs
    5. Others…
12. What do you think the reasons for the loss during packaging fruits and vegetables?
    1. Inadequate packing
    2. Lack of special treatment during pre-packing (Fumigation, Initiation of fruit ripening)
    3. Lack of post-packaging treatments (fumigation, cooling, storage)
    4. Lack of adequet ventilation
    5. Others specify…
13. What do you think the barriers for direct shipment of produce directly from producer-to consumer?

Barriers to direct shipment	Prioritize from highest barrier (5) to lowers barrier (1). (1, 2, 3, 4 & 5)
Institutional barriers	
Infrastructural barriers	

Producer resistance	
Legal obstacles	
Wholesaler dominance	

14. What type of storage management system do you use for the fruits and vegetables while storing and dispatching?
    1. LIFO
    2. FIFO
    3. Others
15. How many kg of fruits and vegetables do you loss at storage per year?
16. What do you think the cause for the losses?
    1. Poor treatment (cleaning/washing, fungicide spraying, selection, size-grading)
    2. Poor storage facility
    3. Poor temperature management (too warm/too cold)
    4. Others…
17. What kind of treatment do you use for the storage?
    1. Fumigation (spraying for fruit fly)
    2. Initiation of fruit ripening (treatment of the packed fruit with ethylene gas in insulated)
    3. Degreening of citrus fruit (treatment to develop their normal natural color if artificially degreened by an ethylene treatment)
    4. Others…
18. How many kg of fruits and vegetables do you loss during storage time in kg/ year?
19. What are the causes behind the loss?
    1. Warm climate/Humid climate
    2. Lack of quality (Aesthetics defects such as not bright orange, blend, blemish /broken)
    3. Rodents
    4. Parasites
    5. Fungus
    6. Others specify…
20. Who determines the price for fruit and vegetable produce during purchase from farm?

    1. Growers 3. Wholesaler
    2. Local traders 5. Consumers
    4. Pre-contractors 6. Retailers
21. Do you think that grower (farmer) gets reasonable price for their produces?

1. Yes
2. No

22. If the answer is No, what could be the reason? Multiple answers are possible.
    1. Due to weak market organization
    2. Due to lacking access to right marketing place
    3. Due to fragile coordination among growers
    4. Due to bargaining power of other intermediaries
    5. Others?
23. Who has more power while negotiating price for more perishable fruit and vegetable produces?
    1. Farmer
    2. Wholesaler
    3. Retailer
    4. Local collector (merchants)
    5. Others specify
24. Who has more power while negotiating price for relatively durable fruit and vegetable produces?
    1. Farmer (grower)
    2. Wholesaler
    3. Retailer
    4. Local collector (merchants)
    5. Others specify
25. What do you think about environmental pollution related with scraps of fresh produces waste disposal?
    1. I care about environment (throw at right garbage)
    2. I don't care about environment (throw everywhere)
    3. I have no awareness about environmental pollution
    4. Others specify…
26. What kind of mechanism do you use for waste disposal?
25. Estimation of loss percent for each crop along each supply chain channels

22. Estimation of loss percent on the bases of total loss experienced for each crop along each supply chain channels												
Crops	Etfruit Wholesaler(1) Estimated loss for each crops via each channels				Etfruit Wholesaler(2) Estimated loss for each crops via each channels				Etfruit Wholesaler(3) Estimated loss for each crops via each channels			
	T	L & UL	S	D	T	L& UL	S	D	T	L &UL	S	D
Orange												
Mandarin												
Banana												
Avocado												
Mango												
Papaya												
Tomato												
Onion												
Potato												
Cabbage												
Carrots												

T = Transport L& UL = Loading and Unloading S = Storage D = Distribution

23. Which of the following Food waste disposal mechanisms do you use along your supply chain channel?

Supply chain actors	Waste disposal mechanisms					
	Public garbage	Private garbage	Donate for charity	Disposal at any places	Feed for animals	Feed street dwellers
Consumers						
Retailers						
Street vendors						
Other wholesaler						
Processors						
Container sellers						
Etfruit wholesaler						

Appendix (II)

Supplementary Information

Table 3. Estimated fresh produces consumption for each SES household in Kg /week

SES Group	Mean	SD
High		
Cabbage	1,2	0,677476
Carrots	1,0625	0,521186
Onion	2,75	0,46685
Irish potato	1,6125	0,582738
Orange	2,025	0,565572
Mandarin	0,7625	0,542873
Avocado	2,2875	0,5761
Banana	2,1625	0,754368
Mango	1,825	0,474342
Papaya	1,075	0,615505
Tomatoes	2,525	0,905468
Average consumption	19,1625	2,242902
Middle		
Cabbage	1,325	0,460629
Carrots	0,8125	0,502398
Onion	2,1375	0,480218
Irish potato	1,1375	0,530934
Orange	1,55	0,477708
Mandarin	0,325	0,349908
Avocado	1,7625	0,565997
Banana	1,9375	0,533343
Mango	1,45	0,405096
Papaya	0,5375	0,429482
Tomatoes	2,05	0,575125
Average consumption	15,025	1,06186
Low		
Cabbage	1,3625	0,408052
Carrots	0,425	0,40112
Onion	1,825	0,349908
Irish potato	0,925	0,513285
Orange	1,15	0,426675
Mandarin	0,1875	0,245145
Avocado	1,15	0,303822
Banana	1,2	0,335888
Mango	0,7625	0,438346
Papaya	0,25	0,320256
Tomatoes	1,725	0,298501
Average consumption	10,9625	0,585101

Table 4. Estmated food waste from total consumption for each SES household in kg/week

SES Group	Mean	SD	SEM
High SES			
Cabbage	0,024035	0,006162	0,0009742
Carrots	0,00116275	0,00132	0,0002087
Onion	0,00518675	0,004236	0,0006697
Irish potato	0,019596	0,005812	0,0009189
Orange	0,01691475	0,009197	0,0014542
Mandarin	0,002387875	0,003198	0,0005056
Avocado	0,0154355	0,008596	0,0013592
Banana	0,028713	0,0119	0,0018816
Mango	0,00330325	0,003928	0,0006211
Papaya	0,0044365	0,003936	0,0006223
Tomatoes	0,03376	0,013397	0,0021183
Average plate waste	0,154931375	0,022215	0,0035126
Middle SES			
Cabbage	0,0198525	0,005234	0,0008275
Carrots	0,001303	0,001288	0,0002036
Onion	0,00391125	0,003508	0,0005546
Irish potato	0,015745	0,004716	0,0007457
Orange	0,0136315	0,007322	0,0011576
Mandarin	0,0021718	0,003228	0,0005104
Avocado	0,011893	0,004218	0,0006669
Banana	0,0177875	0,005879	0,0009296
Mango	0,0038365	0,00838	0,001325
Papaya	0,00373375	0,003863	0,0006108
Tomatoes	0,023225	0,005787	0,0009151
Average plate waste	0,1170908	0,010253	0,0016212
Low SES			
Cabbage	0,0148915	0,004435	0,0007013
Carrots	0,0010625	0,001147	0,0001813
Onion	0,00310275	0,002649	0,0004189
Irish potato	0,0131965	0,004424	0,0006994
Orange	0,009249	0,004338	0,000686
Mandarin	0,0027602	0,003298	0,0005215
Avocado	0,0072135	0,003252	0,0005142
Banana	0,008863	0,004165	0,0006585
Mango	0,00182	0,00335	0,0005297
Papaya	0,0022165	0,003391	0,0005362
Tomatoes	0,0153325	0,004513	0,0007135
Average plate waste	0,07970795	0,006054	0,0009573

Table 5. Total fresh produces supply and purchase and selling price

Produces	Total supply for (2004) in Kg	purchased price in Birr/Kg	selling price in Birr/Kg	Place of supply with Km
Cabbages	1783685	3.75	4.50	Meki 90km from A.A
Carrots	142695	7.00	10.00	Holeta 42km from A.A
onions	356737	2.50	3.50	Merti 230km from A.A
Potatoes	535106	2.50	3.50	Shashemane 250km from A.A
Orange	7134740	6.40	7.70	Merti 230km from A.A
Mandarin	7848214	4.00	5.00	Merti 230km from A.A
Avocado	1426948	4.50	7.00	Yergalem 330km from A.A
Banana	8775730	4.00	7.50	ArbaMinch 505km from A.A
Mango	713474	300	5.00	Assosa Merti 760 km from A.A
Papaya	1070211	2.75	3.75	Merti 90km from A.A
Tomatoes	5886161	3.00	4.50	Wenji 110km from A.A

Table 6. Food loss in supply chain for major players and fresh produces in Kg ('000th)

Fresh produces	**Supply chain actors**										
	Total supply	Producer Store	Etfruit wholesal	Processors	Other wholesale	Export	Etfruit contain	Retail	Vendor	Total loss	Loss %
Cabbages	1784	71	285	18	54	18	21	25	7	499	5%
Carrots	143	6	23	1	4	1	2	2	1	40	4%
Onions	357	14	57	4	11	4	4	5	1	250	1%
Potatoes	535	21	86	5	16	5	6	7	2	150	2%
Orange	7135	285	1142	71	214	71	86	100	29	1998	20%
Mandarin	7848	314	1256	78	235	78	94	110	31	2198	22%
Avocado	1427	57	228	14	43	14	17	20	6	400	4%
Banana	8776	351	1404	88	263	88	105	123	35	2457	25%
Mango	713	29	114	7	21	7	9	10	3	200	2%
Papaya	1070	43	171	11	32	11	13	15	4	300	3%
Tomatoes	5886	235	942	59	177	59	71	82	24	1648	17%
Total	35674	1427	5708	357	1070	357	428	499	143	9989	100

Table 7. Monetary loss for major fresh produces in supply chain in Ethiopian Birr ('000th)

Produces	Supply chain actors									
	Producers store	Etfruit wholesale	Processors	Other Wholesale	Export	Etfruit containers	Retailers	Vendors	Total loss	Loss
Cabbages	321	1284	80	241	80	96	112	32	2247	4%
Carrots	57	228	14	43	14	17	20	6	400	1%
Onions	50	200	12	37	12	15	17	5	350	1%
Potatoes	75	300	19	56	19	22	26	7	524	1%
Orange	2198	8790	549	1648	549	659	769	220	15382	25%
Mandarin	1570	6279	392	1177	392	471	549	157	10988	18%
Avocado	400	1598	100	300	100	120	140	40	2797	5%
Banana	2633	10531	658	1975	658	790	921	263	18429	30%
Mango	143	571	36	107	36	43	50	14	999	2%
Papaya	161	642	40	120	40	48	56	16	1124	2%
Tomatoes	1060	4238	265	795	265	318	371	106	7417	12%
Total loss	8665	34661	2166	6499	2166	2600	3033	867	60656	100%