ASSESSMENT ON POSTHARVEST LOSSES OF TOMATO (*Lycopersicon esculentem* MILL.) IN SELECTED DISTRICTS OF EAST SHEWA ZONE OF ETHIOPIA USING A COMMODITY SYSTEM ANALYSIS METHODOLOGY

M.Sc. Thesis

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JIMMA University

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M.Sc. Thesis

Submitted to the Department of Postharvest Management,
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The DEGREE OF MASTER OF SCIENCE IN POSTHARVEST MANAGEMENT (Specialization: Perishable Produces)

BY
GEZAI ABERA WOLDEGIORGIS

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DEDICATION

This Piece of work is dedicated to:

- my beloved brother and Sister Abraham Abera and Silas Abera.
- my passed parents whom I don’t exactly identify what their look is; may God rest their souls in peace!

STATEMENT OF THE AUTHOR

I, the undersigned, hereby declare that the thesis, Assessment on Post-harvest Losses of Tomato (*Lycopersicon esculentem* Mill.) in Selected Districts of East Shewa Zone of Ethiopia Using a Commodity System Analysis Methodology, is my original and genuine work and I do seriously claim that, it doesn't contain any material previously published or written by any person (s) nor submitted anywhere for the award of any academic Degree, Diploma or Certificate with this work. Thus, I carried out the study independently under strict guidance of research advisors: Ali Mohammed (PhD) and Sirawdink Fikreyesus (MSc). All the references used in this thesis are respectively acknowledged.

Hence, brief quotation from the thesis is allowable without special permission if accurate acknowledgment of the source is made. In all other instances, however, permission must be obtained from the author.

Name: Gezai Abera Woldegiorgis Signature _____

Place: Jimma University, Jimma

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BIBLIOGRAPHICAL SKETCH

The author, Gezai Abera was born from his father Mr. Abera W/Giorgis and mother Mrs. Etiye Hadera on 6th November, 1984 in special place called Mayinebri, Tigray Region, Ethiopia. As he got a chance to learn, he joined the "Dejazmach Geneme" Primary School in Addis Ababa. Subsequently he continued his secondary education at Addis Ketema Comprehensive Secondary School in Addis Ababa. After passing the formerly known as ESCLE, now Ethiopian Higher Education Entrance Qualification Certificate (EHEEQC) successfully, he joined College of Agriculture and Veterinary Medicine, Jimma University, in October 2005 and completed his study with Bachelor of Science (B.Sc.) Degree level with very great distinction in Horticulture in June 2008. Afterwards, he was recruited at Desa Plants PLC until the Ministry of Education in Ethiopia assigned him to Samara University, Afar, Ethiopia in December 2008 where he served as a Graduate Assistant in Horticulture Department till he joined the School of Graduate Studies of Jimma University, College of Agriculture and Veterinary Medicine, in September 2011 to pursue his Master of Science (M.Sc.) in Post-harvest Management.

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ACRONYMS AND ABBREVIATIONS

AVRDC	Asian Vegetable Research Development Center (The World Vegetable Center)
CSA	Central statistical agency
CSAM	Commodity System Assessment Methodology
CTA	Technical Centre for Agricultural and Rural Cooperation
DA	Development Agent
EC	Emulsifying concentration
Et al.	Et alii (and others)
etc.	Et cetera (and other unspecified things/so forth)
EU & EUR	European Union and Euro respectively
FAO	Food and Agricultural Organization
FAOSTAT	Food and Agriculture Organization, Statistical Division
FGD	Focus Group Discussion
Ha	Hectare
IFAD	International Fund for Agricultural Development
MARC	Melkassa Agricultural Research Center
NEPAD	New Partnership for Africa's Development
NGO	Non-Governmental Organization
OBFED	Oromia Bureau of Finance and Economic Development
PH	Post-harvest
Qt	Quintal
Qt/ha	Quintal per hectare
SPSS	Statistical Package for Social Sciences
SSA	Sub-Saharan Africa
SWOT	Strength, Weakness, Opportunity and Threat
UNECA	United Nations Economic Commission for Africa
UNFPA	United Nations Population Fund
WFP	World Food Program
WHO	World Health Organization
WP	Wettable powder

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ABSTRACT

In meeting a country's economic development in general and fulfilling the need of consumers in particular, boosting the production by itself is not enough unless what has been produced is properly managed. In Ethiopia, significant amount of food is lost along the post-harvest handling chain, though not found recorded and there has not been much emphasis given to understand the real causes of these losses. In view of this, a detailed assessment of post-harvest losses of tomato along the supply chain and the associated factors were evaluated in four purposively selected districts of East Shewa Zone of Ethiopia using Commodity System Assessment Methodology from "farm-to-fork". The objectives were assessing the status of postharvest losses of tomato along the supply chain and the associated factors in the pursuit of recommending appropriate mitigation strategies. Basic information was gathered from a total of 408 sampled chain actors (producers to consumers) and related institutions. The assessment was accompanied by focus group discussion (FGD) with key informants to extract realistic information. The collected data were subjected to computer software programs; SPSS 16.0. The results revealed that a loss of 20.45%, 8.63%, 2.93%, and 7.30% at producer, wholesalers, retailers, and hotel and café level was recorded respectively resulting in a total loss of 39.31% from harvesting to consumer. The loss in the districts ranged from 17.20-33.30%, significant losses being from Lume district ($p<0.01$) which might attributed to the absence of stacking of plants in the field together with the market problem. Field, transportation and market display were major points of losses of tomato; significant losses being observed right from field ($p<0.01$). There was no proper care and handling of the commodity regardless of its high production in the study area. Market fluctuation, climatic problems, perishable nature of the crop, no/poor sorting and mixed handling of the crop found to be major causes. Lack of awareness and technology, carelessness on the loss and its impact, involvement of so many intermediaries in the market chain, and others are major factors, which need improvement. This piece of work recommends that farmers in these districts require proper and extensive training on how to reduce tomato losses especially through introduction of pre-and post-harvest best practices like cultural practices, harvesting, sorting & grading, using proper packaging, transporting and cooling. Awareness creation on the effect of every single cause of loss and minimizing the economic loss is advisable. Market settlement through creating suitable marketing environment so that producers can harvest and supply to market with tomatoes of optimum maturity so that exaggerated price fluctuation and selling offhand are avoided and losses are reduced. The findings clearly showed the existence of high post-harvest loss of tomato in the study districts and hence it is an urgent agenda to device appropriate strategies including provision of tailored training for the different actors in the production and supply chain and creating access to affordable and appropriate technologies.

1. INTRODUCTION

1.1. Background

Population of the world is increasing and according to official Medias, it has reached seven billion as of October 30th 2011 (UNFPA, 2011) and increase to an estimated 9.2 billion people in 2050. While agricultural productivity has been slowing down over the last decades (Freibauer *et al*, 2011) and so, economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition (FAO, WFP and IFAD, 2012). Achieving food security in Africa remains a challenge and the root causes of food insecurity in Africa are still not well addressed, low production, induced by low productivity and the inability of people to gain adequate access to food due to poverty are the core challenges (UNECA. 2012). Country and producers based their needs on increasing the food production more efficiently, especially African producers (Webber and Labaste, 2010).

Despite its importance, agriculture continues to face a number of problems and challenges. This includes adverse climatic conditions; limited use of improved agricultural technologies; the predominance of subsistence agriculture and lack and/or absence of business oriented agricultural production system; limited or no access to market facilities and information communication all resulting in low participation of the smallholder farmers in value chain or value addition of their produces (Bezabih, 2010). Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (UNECA, 2012).

Agricultural practices determine the level of food production and, largely, the state of the global environment (Tilman *et al.*, 2002). Agriculture as the main branch of Ethiopian economy accounts for 50 % of the GDP and 85% of employment. From the total area of fruit plantation, individual peasant farmers cultivate about 70% while the area cultivated under vegetable crops is not well known (Tsegay, 2010).

The issue of food losses is of high importance in the efforts to combat hunger, raise income and improve food security in the world's poorest countries. Food losses have an impact on food security for poor people, on food quality and safety, on economic development and on the environment. Roughly, one-third of food produced for human consumption is lost or wasted globally, which amounts to about 1.3 billion tons per year (Gustavsson *et al*., 2011).

In developing countries, there is lack of standard packaging material in the farmers' field. Even the intermediaries use paper carton with no ventilation and un-cleaned & improper wooden boxes while transporting to long distance, which, therefore, will damage and/or decay the commodity when reaching the market (Assam Agricultural University, 2005).

The bulk of fresh market tomatoes are produced by small-scale farmers. Farmers are interested in tomato production more than any other vegetables for its multiple harvests, which result in high profit per unit area. Shortage of recommended package of information, poor quality seeds, poor irrigation systems, lack of information on soil fertility, disease and insect pest, high postharvest loss, lack of awareness of existing improved technology and poor marketing systems are the major production constraints of tomato production in Ethiopia (Lemma, 2002). Production varies in visible tomato characteristics important for fresh market and processing values, which differ in acceptability in the local market, quality, and storability (Lemma, 2002; Allen, 2008). However, tomatoes are especially vulnerable to postharvest loss due to their highly perishable nature and to a combination of factors such as pre-harvest diseases and inefficient post-harvest handling procedures (Bombelli and Wright, 2006).

Many technologies has been developed to reduce these losses, though they all have not been implemented in all places due to many factors, (Kader, 2005) and these technologies were developed after thorough understanding of the causes of losses at the different stakeholders (La Gra, 1990). A method, known as Commodity system assessment methodology, has developed to come up with information on problems/causes of loss and use local & low cost technologies/techniques to solve or minimize the problem. It helps the operation within the context of the local, regional or national commodity system to determine whether any of the practices which are now in use to produce, handle or market the horticultural crops are the cause

or are the source of postharvest losses, quality problems or loss of economic value or nutritional quality (La Gra, 1990).

1.2. Statement of the Problem

Vegetable production in East Shewa Zone is high and is the major source for the wider markets share in the country, tomato being one. The bulk of tomato production is concentrated in river valleys and lakes especially in the Awash Valley and around Lake Ziway for their favorable growing conditions, good access to market outlets and better infrastructure and other facilities. The productivity of tomato farms was 105 quintals per hectare. However, it is 250 and 400 quintals per hectare at the demonstration and research plots, respectively. In 2001/02, approximately 3,300.55 hectares of private holdings were under tomato cultivation and the total volume of fresh tomato harvested was 347,277.48 quintals (Ethiopian Investment Agency, 2008). Lemma *et al*. (2006) reported a 361500 qt tomato production 2919 ha of land with 4.04% volume contribution of Ethiopian vegetable.

The perishable nature of produces, poor technology and lack of awareness among producers as well as market actors resulted on poor handling of the tomato. Farmers are encouraged to produce vegetables in East Shewa Zone owing to the location advantages defined in terms of proximity to urban centers and developed infrastructures that are good opportunities. However, losses are high due to improper handling (Lemma, 2002).

Although fruits and vegetables, tomato being one of the top, are economically important commodities there was less study made on them to identify the key constraints and potentials on the system. There are some papers published on tomato. For example, Melkamu *et al*. (2008) studied on evaluating the combined effect of pre and post harvest disinfection and evaporatively cooled storage on the changes in sugar content of tomato. Meaza *et al*. (2007) studied on effects of pre-harvest treatments on yield and chemical composition of tomato in semi-arid climate in eastern part of Ethiopia, Temesgen *et al*. (2011) studied on effect of tomato cultivars, honey finisher and processing methods on quality of tomato ketchup and Meseret (2010) studied on evaluation of tomato varieties for fruit yield, quality and shelf life. However, most research

conducted in Ethiopia focused on market assessment of fruit and vegetables (Abay, 2007; Adugna, 2009; Alemnew, 2010; Birhanu, 2011). Post-harvest losses in tomato are, among others, the prime factor affecting the quantity and quality of tomato fruits in the market. Options to reduce or prevent post-harvest losses are limited, and thus the need to design research studies that are geared to developing such strategies (Meaza *et al*., 2007).

There is no adequate information on the postharvest loss and causes of tomato. The produce is mishandled from farm gate to the point of consumption due to improper harvesting, post-harvest handling, transportation, intermediaries' malpractices, storage and other reasons. Options to reduce/control post-harvest losses are limited, and thus the need to design research studies that are geared to developing such strategies. Identifying and understanding the constraints of pre-and post-harvest loss factors is very important in order to achieve maximum harvest and post harvest quality for any crop. Assessing and determining the specific causes of problem at which point and by what reasons will be helpful in devising appropriate technology. If the threats are not addressed and corrected, poverty reduction and other economic development will not go as planned. Thus, inclusive data collection along the value/market chain is a must to see the direction of in and out flows of tomato and set strategic plan for constraints creating loss of the crop.

Therefore, this research assessed postharvest loss and major constraint in the value chain of tomato in the Eastern Shewa districts provides a starting point on the loss reduction recommended methods for the future. It will also indicate the points where loss occurs and basic information on producers' practice to either be improved or modify for the future.

1.3. Objective

General objectives

- To assess the status, type and factors of post-harvest loss of tomato together with the existing knowledge, attitude and practice of actors in the loss and mitigating strategies.

Specific objectives

- To determine the extent , type and causes of postharvest losses along the tomato product chain
- To assess the knowledge, attitude and practices of different actors along the product chain with respect to postharvest losses and their mitigation strategies

1.4. Scope of the Study

Pertinent data were collected to determine the perception and expertise of participants/actors, causes of loss occurring during the main segments of the product chain and other related information. Hence, information on cultivating, producing, harvesting, grading/sorting, transporting; buying and selling techniques/systems; and linkages among value chain actors were looked at to make the most of long-term benefit along the chain. Hence, the analysis covered from field to marketing. Owing to the constraints of time, logistics and budget held back the investigator to collect reasonable information from all actors of the chain including market. Similarly, lack of record keeping by chain actors was one of the limiting challenges to collect relevant information in the channel. Thus, key informants like Zone/Districts agricultural officers, DAs, elders of the study area and secondary sources were extensively used to complement preliminary information and to understand rationality behind the status of value chains. In addition, a focus group discussion was used to have unbiased information. Generally, this study covered the producers, wholesalers, retailers, consumers and other beneficiaries of the produce that are involved in its flow chain.

1.5. Significance of the Study

The overall result in the status, factors, and knowledge of actors in the post-harvest loss can be used as a baseline information for a further and detailed study of post-harvest loss of vegetables in general and tomato in particular.

2. LITERATURE REVIEW

2.1. The Tomato Plant

The tomato (*Lycopersicon esculentum*Mill.) is an herbaceous fruiting plant (Ssekyewa, 2006). It was originated in the southern regions of the Andes Mountains, the coastal deserts of Peru, and Ecuador and parts of central Mexico (Parnell *et al*., 2004). It has become one of the most widely grown vegetables with ability to survive in diverse environmental conditions (Ssekyewa, 2006). Tomato is termed as "the most popular vegetable fruit" (International Cyber Business Services, 2000). Tomato is an important fruit vegetable and second most important vegetable crop after potato that is widely grown and consumed worldwide (Suarez *et al*., 2008; Izge & Garba, 2012)

Tomato is an annual crop, which can reach a height of over two meters. The first harvest is possible 45-55 days after flowering, or 90-120 days after sowing. Fruit shape differs per cultivar and the color ranges from yellow to red. Tomatoes contribute to a healthy, well-balanced diet (Naika *et al*., 2005).

It is believed that there are two type of tomato plant habit, determinate (bush or short type) and indeterminate (tall), but beside the two, there is semi-bush or semi-indeterminate type in between them as intermediate. The stem of indeterminate cultivars grows indefinitely, reaching to more than 10 m within one year, making it ideal for long season continuous cropping in greenhouses as they flower and fruit regularly and evenly. They are the best for long harvest period and they need staking. Since they, usually cover themselves, sun does not damage the fruit and ripe more slowly. The short type are popular for commercial cultivation/field condition and they have relatively concentrated fruit set which only lasts two or three weeks and the fruit ripen much faster. Since they support themselves there is no need of staking (Burrows and Graper, 2003; Kirimi *et al*., 2011; Naika *et al*., 2005).

Tomato requires a relatively cool, dry climate for high yield and premium quality. However, it is adaptable to a wide range of climatic conditions from temperate to hot and humid tropical. The optimum temperature for most varieties lies between 21 and 24 °C (Naika *et al*., 2005).The plant

can survive a range of temperatures but growing stops below 10^0C. It is good to wait until the winter is definitely over before sowing to avoid frost because it kills the plant. The optimum, minimum and maximum temperature are 20 to 27^0C, 10^0C, and 30^0C, respectively (Amati *et al*., 2002). Others describe the optimum temperature for most varieties lies between 21 and 24 °C. The plants can survive a range of temperatures, but the plant tissues are damaged below 10 °C and above 38 °C (Naika *et al*., 2005).

At least three months of rain must be counted on for better tomato production. Inadequate rainfall will cause buds and flowers to drop off. However, if rains are too heavy and humidity is too high, growing of mould and the rotting of fruit will increase. Tomato is especially sensitive to moisture and cloudiness slows down the ripening of tomatoes. Loamy type is best soils and gives highest yields with a pH of 5.5 – 6.8 (Amati *et al*., 2002; Naika *et al*., 2005). It is the most frequently consumed vegetable in many countries, becoming the main supplier of several plant nutrients and providing an important nutritional value to human diet (Meseret, 2010).

The cultivated tomato is the most important and widely grown vegetable in the world (Lemma, 2002; Allen, 2008), and is one of the most economically important vegetable crops and is widely cultivated in the world. Nowadays, its importance is increasing in Ethiopia. It is widely accepted and commonly used in a variety of dishes as raw, cooked or processed products more than any other vegetables (Lemma, 2002). Though some sources indicate it was being cultivated in Ethiopia by the beginning of the 1600s (http://www.eu-sol.net), there is absence of definite time recorded regarding the introduction of cultivated tomato, however, cherry type has been growing for long time around big cities and in small gardens (Lemma, 2002).

2.1.1. Importance of Tomato

a) Nutritional and health benefits

Many epidemiological studies have described that consumption of large quantities of vegetables and fruits reduce the risk of many types of human disease. It is well known that the antioxidant activity of fruits and vegetables differs with varieties and agronomic conditions (Maršić *et al*.,

2011). The increased awareness on the health protecting properties of non-nutrient bioactive compounds found in fruits and vegetables, has directed immense attention to vegetables as vital components of daily diets (Smith and Eyzaguirre, 2007).

Among the vegetables, tomatoes represent the predominant source of antioxidants, and besides the carotenoids (lycopene, β-carotene, and lutein), the flavonoids have been confirmed as a group of polyphenols important in conferring antioxidant benefits. Tomato is a widespread species commonly grown either in the field or under greenhouse conditions. It has the highest average consumption because it is frequently consumed both fresh and in tomato-based products (Maršić *et al*., 2011).

Tomato is a nutritive and versatile fruit with health benefits. The reason for its popularity and importance is that it is a good source of vitamins, C & A, and certain minerals such as Fe and Cu (Rupasinghe *et al*., 1991) including phosphorus and potassium (International Cyber Business Services, 2000), essential amino acids, sugars and dietary fibers much vitamin B and C, iron and phosphorus (Rao, 2007; Ayandiji and Omidiji, 2011).

It may be used as a fresh vegetable and as a processed product (Rupasinghe *et al*., 1991). It can be cooked as vegetable alone or in combination with potato besides eaten raw when ripe (International Cyber Business Services, 2000; Willcox, 2003; McDevitt *et al*., 2005; George Mateljan Foundation, 2010; and Singh, 2010). It can be consumed as fresh in salads or cooked in sauces, soup and meat or fish dishes. It can be processed into purées, juices and ketchup. Canned and dried tomatoes are economically important processed Products (Naika *et al*., 2005).

Tomato contributes to a healthy well balanced diet. Aside from being tasty, are very healthy as they are a good source of vitamins A and C (Rao, 2007; Ayandiji and Omidiji, 2011). Lycopene is a very powerful antioxidant, which can help prevent the development of many forms of cancer, and lycopene is a very powerful antioxidant, which can help prevent the development of many forms of cancer, and is a carotenoid that gives tomatoes their red color (Vasse, 2006). Cooked tomatoes and tomato products are the best sources since it is released when cooked. Lycopene may also reduce the risk of heart disease. Research has shown that lycopene reduces

oxidized low-density lipoprotein (LDL) which is known as the bad cholesterol (Vasse, 2006).Beside its nutritional use, tomato has a high demand both in local and foreign markets and brings countable foreign exchanges as fresh (Rupasinghe *et al*., 1991).

2.1.2. Production of Tomato

Tomato is one of the most widely cultivated crops in the world being recognized as a reach source of vitamins and minerals. It is an important cash crop for smallholders and medium-scale commercial farmers. As it is a relatively short duration crop and gives a high yield, it is economically attractive and the area under cultivation is increasing daily (Naika *et al*., 2005; Balemi, 2008).

Tomato is the second most important vegetable crop next to potato. In 2009, FAOSTAT reported the top tomato producing countries worldwide and China with 45,365,543 tons from 920,803 ha of harvested areas was a leader (492.7 qt/ha productivity). FAO estimation also showed Egypt from Africa was the leading tomato producing country with ten million tons of tomato from 250,000 ha of harvested areas. Ethiopia, from 4593 ha of land, produced 40,426 tons with yield of 8.8 tons/ha (FAOSTAT, 2012).

Ethiopian Investment Agency (2008) reported that there was 200 quintal per hectare tomato yield in 2003/04 to 2005/06 and an increased yield (212.44 qt per hectare) was shown in the year 2007/08. The first data recorded in FAO database is in 1993, 129.337qt/ha and since then there was a good yield of tomato per hectare in Ethiopia. However, after getting the highest yield in 2003 (145.89qt/ha), it started declining and even become worsen in 2005 with 73.949 qt/ha.

FAO has organized database on tomato production, productivity and harvested land for the period from 2000 to 2010. The tomato land harvested in 2000 was 4,344 ha with 123.623 qt/ha yield. Showing fluctuated figure in between for harvested land and yield, the 2010-recorded data revealed that yield was 89.70 qt/ha from 4593 ha of land which shows lower yield from relatively wider harvested land (FAOSTAT, 2012).

2.2. Postharvest physiology of tomato

Tomato is highly perishable and cannot be stored for longer duration. Due to its perishable, farmers are losing a bulk of the produce each year (Bhattarai and Gautam, 2006). Tomatoes are delicate fruits and need to be sent to the market quickly. If they are not handled carefully they decay easily, which affects their taste, flavor and nutritional value. The high water content of tomatoes makes them vulnerable to post-harvest losses. Over-mature fruit gets easily damaged or starts rotting (Naika *et al*., 2005).

Color, firmness, flavor, nutritive value, and safety of tomatoes are related to their composition at harvest and compositional changes during postharvest handling. Example, firmness affects susceptibility of tomatoes to physical damage and consequently their shipping ability (Kader, 1986).

The color and firmness are significantly influenced by the typology of the cultivars and by the maturity stage associated with the climatic conditions (Maršić *et al*., 2011). Tomatoes are harvested at various stages of ripeness and the storage conditions employed differ with each stage. In general, pre-cooling is required only if the fruit temperature is higher than 26-27°C and ripening is to be delayed (Passam *et al*., 2007).

There are many factors, such as cultivar, cultivation method and location of cultivation, that influence the chemical composition of tomatoes (Suarez *et al*., 2008). Ripening stage could decisively influence chemical parameters that means a series of quantitative and qualitative changes of the chemical composition take place during tomato fruit ripening (Suarez *et al*., 2008; Izge & Garba, 2012). The ripening of tomatoes is characterized by the softening of the fruit, the degradation of chlorophylls and an increase in the respiration rate, ethylene production, as well as the synthesis of acids, sugars and lycopene (Izge & Garba, 2012)

Although fully ripe tomatoes may be stored for a short time at low temperatures, nevertheless adverse effects on fruit quality may occur. For example, ripe fruits that had been stored at 5°C for 4 days were significantly less aromatic, less sweet and more acidic than corresponding fruit

stored for the same length of time at 20°C. Fruits stored at high temperatures are susceptible to increased oxidative activity, leading to membrane damage and a loss of fruit integrity (Passam *et al*., 2007).

When tomato fruits are roughly handled during early ripening stages, symptoms of internal bruising may occur that are noticeable during later ripening stages. Exposing tomato fruits to such mechanical injury may enhance fruit respiration and C_2H_4 production, this diminishing 2 days later. Although fruit ripening was enhanced under such conditions, fruit gel tissue failed to ripen normally and developed abnormal color, as indicative of internal bruising (Atta-Aly *et al*., 2000).

2.3. Post-harvest loss and loss causing factors

Postharvest loss is a "measurable quantitative and qualitative loss of a given product at any moment along the postharvest chain" and includes the change in the availability, edibility and wholesomeness of the food that prevents it from being consumed (Gustavsson *et al*., 2011). Both quantitative and qualitative losses take place in horticultural crops between harvest and consumption. Estimates of postharvest losses in developing countries are two to three times higher than those of the developed countries (Yahia, 2008).

Postharvest losses vary greatly among commodities, production areas and seasons and estimated that approximately one third of all fresh fruit and vegetable produced worldwide is lost before it reaches consumers (Kader, 2005).In developing countries, losses of fruits and vegetables during post-harvest fluctuate between 20 and 50% (Bombelli and Wright, 2006). According to CIRDAP (2010), postharvest losses of perishable products are seriously affected by different post-harvest operations. Of the total loss (35-50%), harvesting, stacking and packing, storage and transport contributed to 5-8, 15-20, 5-10, and 10-12% losses of perishables.

Fruits, vegetables and root crops are much less hardy, quickly perishable except under intensive care during harvesting, handling and transportation and the quality of produce starts deteriorating

right after their harvest. Postharvest loss is much more painful and costlier than pre-harvest loss both in terms of money and man-hours (work one person can produce/do in an hour) (Rehman *et al*., 2007; Adeoye *et al*., 2009).The total loss due to poor post-harvest handling of agricultural products when valued in monetary terms reflects a tremendous loss in the economy. Tomato is also one of the perishable crops, which is mostly affected after harvest easily by many causes, besides its nature of perishable. Loss is huge during the delivery to the consumer starting from field to the market (Baqui, 2002).

The extent of causes of food losses vary throughout the world and are very much dependent on the specific conditions and local situation in a given country (Guastavsson *et al*., 2011). Large portions of fresh fruits are lost worldwide after harvest. Primary causes of loss are like biological, mechanical, chemical, biochemical, mechanical, physical, physiological & psychological and secondary causes of loss are those usually the result of inadequate capital expenditures, technology and quality control (Atanda *et al*., 2011).

The main causes are physiological (wilting, shriveling and chilling injury, etc), pathological (decay due to fungi and bacteria) and physical (mechanical injury) (Mashau *et al*., 2012). Postharvest losses in quality and quantity are also related to immaturity at harvest, inadequate initial quality control, incidence and severity of physical damage, exposure to improper temperatures, and delays between harvest and consumption. Exposure to chilling temperatures adversely affects tomato flavor before other symptoms of chilling become apparent. Temperature also influences color uniformity and softening rate of tomatoes (Kader, 1986). These causes, in most instances can be interrelated, as for example, mechanical injury can lead to postharvest decay in many cases (Mashau *et al*., 2012).

The causes of food losses and wastage in low-income countries are mainly connected to financial, managerial and technical limitations in harvesting techniques, storage and cooling facilities in difficult climatic conditions, infrastructure, packaging and marketing systems. In medium/high income countries, such losses and wastages are related to consumer behavior as well as to a lack of coordination between different actors in the supply chain. Food can be wasted

due to quality standards, which reject food items that are not perfect in shape or appearance (Gustavsson *et al*., 2011).

Due to absence of proper storage and marketing facilities, farmers are forced to sell their produces at "throw away" prices. Losses are caused by mechanical injuries, inadequate storage, unsuitable handling, and faulty system of transportation and delayed transportation in the retail market (Adeoye *et al*., 2009). Tomatoes are especially vulnerable to postharvest losses due to their highly perishable nature and to a combination of factors such as pre-harvest diseases and inefficient postharvest handling procedures (Rupasinghe *et al*., 1991).

Waste/loss in can be reduced by raising awareness among food industries, retailers and consumers. There is a need to find good and beneficial use for safe food that is presently thrown away (Gustavsson *et al*., 2011). These causes of loss also touch tomato.

Generally, loss occurs during pre and/or postharvest activities. The farming system or operations practiced by farmers vis-à-vis watering, weeding, fertilizing, pesticide application, and other follow up activities really matter for next stage of the season in having the product at hand whether to loss or to profit with it. Most farmers prefer to grow cultivars available around them. They have no knowledge about the selection of the cultivar in relation to postharvest losses. Most may reply because they need high yield (Rupasinghe *et al*., 1991).

Post-harvest loss of tomato

Post-harvest losses are highest with horticultural produce like tomatoes whose postharvest quality is much dependent on climatic conditions, nature of the crop, different pre- and post-harvest practices (Asare-Kyei, 2009; Gustavsson *et al*., 2011). Appearance (color, size, shape, defects, and decay) of tomatoes are influenced by both genetic and environmental factors, such as temperature, light, nutrients and water supply, and the presence of diseases and insects. Most pathological disorders found during postharvest handling of tomatoes originate in the field before harvest. Incidence and severity of decay are increased by physical damage and chilling injury, which make the fruits more susceptible to decay (Kader, 1986).

Polygalacturonase is the major enzyme involved in fruit softening tomato during storage where its activity found to be increased in storage of for 4 weeks. Fruit stored at high temperatures are susceptible to increased oxidative activity, leading to membrane damage and a loss of fruit integrity (Passam *et al*., 2007).

The keeping quality of tomato fruits was found to be significantly affected by harvesting method and calcium treatment. Tomato fruits harvested with stalk had higher shelf life (15 days) as compared to those harvested without stalk (12.93 days) (Bhattarai and Gautam, 2006).A study conducted in Cameroon, Benin and Ghana to assess quantitative loss of vegetables that includes tomato, along the value chain using the CSAM showed loss can occur in different actors of the chain. The extent of post harvest loss at collectors, wholesalers and retailers level was reported to be 12, 8, and 12% in Benin and 2, 45.62 and 39.75% in Ghana, respectively (Guy *et al*., 2010).

Another study on economic analysis of tomato conducted in Nigeria showed that the high level of postharvest damage to tomato was mostly due to physiological, pathological and mechanical causes (Adeoye *et al*., 2009). As per the report of the authors, the loss was also variety/cultivar and chain dependent. Local varieties had high loss than the research-developed varieties. The mechanical damage for all varieties, recorded the highest economic losses followed by pathological damage while physiological damage recorded the least loss. Olayemi *et al.* (2010) also found 20% and 28% tomato loss during harvesting and during transportation respectively in Nigeria.

2.4. Post-harvest handling of tomato

Postharvest handling is the final stage in the process of producing high quality fresh produce. Being able to maintain a level of freshness from the field to the dinner table presents many challenges. A grower, who can meet these challenges, will be able to expand his or her marketing opportunities and be better able to compete in the marketplace (Bachmann and Earles, 2000).

Due to the crop maturity nature and the difference in activities during operating the cultural practice, harvested tomatoes must be handled properly during the postharvest period. Tomatoes are delicate fruits and need to be sent to the market quickly. If they are not handled carefully they decay easily, which affects their taste, flavor and nutritional value (Naika *et al*., 2005). Appropriate production practices, careful harvesting, and proper packaging, storage, and transport all contribute to good produce quality (Bachmann and Earles, 2000).

The best measure to help limit the extent of postharvest damage is harvesting on right time and applying proper post-harvest treatment of the fruit (Naika *et al*., 2005). Therefore, shortening the time between harvest and consumption can minimize loss of the characteristic tomato aroma and development of off-flavors (Kader, 1986). Over-mature fruit is easily damaged or starts rotting. It will be necessary to harvest several times, as the fruit of tomato plants do not all ripen at the same time (Naika *et al*., 2005).

Tomato can be harvested at different stages, depending upon distance and time needed to market the fruit. For long distance transport, fruit can be harvested at the breaker stage (not more than 10% of the surface is tannish-yellow, pink, or red). Tomatoes subjected to bruising usually have less "tomato-like" flavor and more off-flavors than those without physical damage (Kader, 1986). Therefore, reducing any means of causing mechanical damage or bruise is crucial in every point of handling the fruit.

Using nylon net bags or plastic buckets during picking and transported immediately to the sorting areas and the container (weigh not more than 25 kg) needs to hold only tomatoes that are mature, ripe and free from damage. Then, it should be washed and sorted (Naika *et al*., 2005).

Washing can be done with ‘sorting canals’, long water containers in the reception areas, where the tomatoes are gently poured into the water. The water prevents from hitting a hard surface; so fewer will be damaged. Water cleans the dirt off the fruit. Chlorine solution for disinfection can be added to the water. Fresh tomatoes can be stored after they have been harvested and sorted or they can first be packaged before storing. Cooling before and during storage is important (Naika *et al*., 2005).

Grading simply consists of arranging the tomatoes into a number of uniform categories according to the economically important physical and quality characteristics. The process involves identification, classification and separation (Naika *et al*., 2005). During grading of fruits, damaged, rotten and cracked fruits should be removed. According to Tan (2005), tomatoes should be intact, fresh and sound. They should be clean, free from foreign matter, off-smell or taste. Tomatoes should be firm, without spots, cracks, bruises or chilling injury (which could result in a glassy appearance). They should be regular in shape and color typical of the variety.

Badly packed tomatoes will not only ruin the tomato crop for sale, but will also mean lower prices. How tomatoes are packed depends on the end use to which they will be put. Fresh tomatoes are often packed without stems. Mature green mature tomatoes can be stacked on top of one another in a package, since they are firm, but remember that not too many must be packed all at once, or the tomatoes at the bottom of the package will be deformed or bruised due to excessive weight on top of them. In all cases, it is a good idea to use padding material at the bottom of packages and in between layers of tomatoes. Packaging material is expensive, in terms of total costs, and must not be wasted (Naika *et al*., 2005).

Harvest should be completed during the coolest time of the day (at about 20^0 C) which is usually in the early morning or evening and should be kept shaded in the field to remove field heat (Olayemi *et al*., 2010).

Most researches are mostly pointing or circulating on the method of trying to reduce the loss by devising different methods/technologies; trying on different methods effectiveness and so on. Most of these may or may not be effective on reducing the loss and additionally, they need huge amount of facility and money, not mentioning the time spent on trying the technologies in every point of the operations, which may or may not be appropriate, but waste of money and time.

Pre- and post-harvest treatments also help reducing loss. Bhattarai and Gautam (2006) explained Calcium has desirable effects; particularly it can delay ripening and senescence, reduce respiration, extend shelf life and reduce the physiological disorders. Stalk of fruits showed less

infection than without stalk fruit upon ripening. Longer shelf life and better marketability of tomatoes is better with tomato fruit having a small pedicel along with calyx.

Storing tomatoes in tropical and subtropical climates can be difficult without cold storage. Sometimes fast marketing is the only solution. Tomatoes that are to be sold fresh for table consumption must not be stored for long. Storage facilities will vary according to marketing demands. Fresh table tomatoes will need to be stored somewhere where they can ripen or be stored for a short amount of time. At other times cold storage rooms are required. Tomatoes often need to be stored at different points while they are in transit to a final destination (Naika *et al*., 2005).

The different point of the crop chain system, which includes from field production to final consumption, has its own influence on the loss of the crop, but differently. Loss at one point of the chain is not the same as the other operation throughout the supply chain of the crop. Therefore, there needs to be assessing the respective causes of losses in the different operations so that appropriate measurement is devised.

2.5. Concepts of Commodity System Analysis in terms of Perishable Crops

The main objectives of applying postharvest technology to harvested fruits and vegetables are: to maintain quality (appearance, texture, flavor and nutritive value), protect food safety, and reduce losses (Kitinoja and Kader, 2003) and enhance value-addition between harvest and consumption (Hsu, 2010). Postharvest loss occurs in every operations and every point of the chain of the system during delivering the crop to final users. Different actors behave differently involved within the supply chain of the crop. The phrases supply chain, value chain and other related one seems creating ambiguity when used in such issue. Nevertheless, one way or the other, they reflect the same idea.

Supply chains is a set of interdependent companies/bodies that work closely together to manage the flow of goods and services along the value-added chain of agricultural and food products, in

order to realize superior customer value at the lowest possible costs (Genova *et al*., 2006). Value chain is a sequence of related functions from initial raw material production to ultimate consumption through physical transformation (Birhanu, 2011; Webber and Labaste, 2010). Both definitions reflect the flow of goods from one corner to another with a mediation of different actors involved for its continual flow and for its sake of final destination.

In any attempt to solve problems in developing work, there are three basic steps: identification and description of the problem, identification and formulation of the solution, and execution of the solution (the first two being interdependent) otherwise effective solutions cannot be prepared without a clear understanding of the problem(s) (La Gra, 1990).

So, to have clear and manageable loss reduction method or technology, it is better to see each problem separately. For that, Jerry La Gra (1990) tried to clearly put a method to assess causes of postharvest loss of a given crop with a method called commodity system analysis methodology (CSAM). The CSAM is a systematic method for identifying and measuring factors affecting postharvest losses and identifying bottlenecks leading to quality problems for a specific commodity in a specific location. The information for CSAM comes from written reports, government documents, extension publications, farm and field visits, interviews, observations, and measurements (Kitinoja, 2011) and it uses questionnaires for commodity system components and for collecting information (Fidafrique, 2007).

La Gra (1990) suggested it is needed to divide each of the difficulties into as many parts as possible. Descartes (2010) pointed out that reality can only be understood by breaking it down into smaller and smaller parts and suggested the need to divide each of the difficulties under examination into as many parts as possible. They can be examined into as many parts as possible and as might be necessary to resolve them better and then to conduct the existing experience and practices in an orderly way. Kader and Rolle (2004) indicated that in most cases, solutions to existing problems in the post-harvest handling system require the use of existing information rather than new research.

This method is a tool for a rapid appraisal/assessment/evaluation or an in-depth case study that provides user a description of the commodity system. It also helps in identifying the major components of the system and the major participants and their roles. In addition, it helps in identification of the priority problems within each component of the commodity system and their causal relationships; and identification of possible solutions to the problems and their order of priority and an adequate data base to identify project ideas and repair project profiles (Fidafrique, 2007).

In analyzing a particular commodity system, it is very important to obtain a clear understanding of the diverse participants in the chain and their respective roles and motivation to ensure as complete understanding as possible, which produce better result that benefit the nation and all those involved (La Gra, 1990). Kader and Rolle (2004) mentioned that solving the post-harvest technology problems in a given country necessitates cooperation and effective communication among research and extension personnel. This method has 26 components (Figure 2) each with potential importance in the system though not all may necessarily be relevant for all commodities. It permits analysis of whole commodity systems, which requires multidisciplinary team with different professions. It helps to differently see and solve them to have final solution by respective specialized professions, determine the extent, types and core causes of postharvest losses and identify ways to cost effectively reduce losses (La Gra, 1990).

This title, CSAM, does not intend to differentiate supply chain and value chain and their final goal. It follows the basic methods devised under this title so as to have crosschecked method of getting result applied other places. Besides seeing each component of the system and try to study them one by one and have basic information to devise methods of reducing the causes of losses, the major points can be raised by value chain otherwise.

2.6. Review of Empirical Evidences on Postharvest Losses and Related Issues

With the agreement CSAM doesn't differ from value chain analysis, this study has reviewed Value Chain Assessments, postharvest loss and handling indicatives conducted elsewhere in the

world on commodities such as: tomato, avocado, vegetables, and others(La Gra, 1990). The paper further argues other social and farming system related aspects of value chain by analyzing data covering 1990-2011. Some of those reviewed papers include the following.

Tomato is one of the most commonly cultivated and consumed vegetable fruit in Ethiopia. However, higher percentage of this product is lost prior to utilization during harvesting, transportation and short time ambient storage (Temesgen *et al*., 2011). Hence, there is an urgent need for further study to develop proper procedure to prolong its shelf life and uplift food insecurity. Based on those reviewed works, on the subject of this work parts of the findings are shown here below.

Adeoye *et al*. (2009) examined economic analysis of tomato losses in Nigeria and information on traders' characteristics, types of post-harvest loss, intensity of damages and marketing margin accrued from the losses. They showed in their result that more men were involved in wholesaling of tomato while more women were involved in retailing tomato. Further, they indicated the major causes of economic losses to tomatoes were physiological, pathological and mechanical damages. Based on their result, they recommended provision of improved mode of transportation and storage to minimize losses in tomatoes.

A study conducted by Rehman *et al*. (2007) on post-harvest losses in tomato in Pakistan tried to estimate the post-harvest losses in tomato; and they reported the post-harvest losses of tomato was estimated 20% of the total production. There losses mainly occurred during picking of the crop, during handling and transportation to the markets, etc.

In Iran Mohammadi-Aylar*et al*. (2010) conducted an impact test (using 0.18 to 2.88J force) to investigate the effect of stage of ripening on mechanical damage in tomato fruit considering stage of ripening and two varieties. They found some injuries were caused after degradation of the fruit later as latent damage due to small impact like when fruits fall from a shorter height (59 cm) while falling from higher (118 cm) level caused different ruptures to the fruit depending on the stage of the ripeness-occurred in 30% of the samples. Impact energy and stage of ripeness

had significant effect on all types of mechanical damage and severity & rate of latent damage increased progressively, through 24 to 72 hours of storage of fruits in natural conditions.

Kader (2005) estimated a loss from production to retail sites to be at 12% (2-23) in developed and 22% (5-50) in developing countries. The author further expound that losses at retail, food services, and consumer site as 20% (5-30), 10% (2-20) and 32% (7-53), respectively with a cumulative total loss of 32% (7-70). The post-harvest loss of tomato in Egypt has been reported as 43% (Guerra *et al.,* 1998 cited in Kader, 2005).

Abay (2007) has diagnosed the value chain of tomato in South Gonder; and he reported rural local collectors-retailers-wholesalers channel was significant where upper say of wholesalers is evident to determine price in market. Similarly, betterment to infrastructure and institutional factors are reported to affect positively.

3. METHODOLOGY

3.1. Description of the study area

The study was conducted in four districts of East Shewa Zone of the Oromia Region, Ethiopia. The Zone is located east of Addis Ababa, capital city of Ethiopia. It extends from $7^0$33'50''N to $9^0$08'56''N and from $38^0$24'10'' to $40^0$05'34''E it indicates that it is located in sub-tropical and tropical climatic zones. The dominant soil type is clay-loam and sandy-loam by texture.

Table 1: List of East Shewa zone districts, areas and town s

No	Districts	Capital town	Area (km^2)
1	Fentale	Methehara	1545
2	LibanChukala	Adulala	1197
3	Ade'a	Bishoftu	694
4	Adami Tulu-JidoKombolcha	Ziway	881
5	Gimbichu	Chefedonsa	1271
6	Lume	Modjo	870
7	Dugda	Meki	751
8	Boset	Welenchiti	1085
9	Bora	Bote/Alemtena	1506
10	Adama	Adama	441
East Shewa zone			10,241

Source: OBFED (2009)

This zone is boarded to the North by Amhara National Regional State, on the North East by Afar National Regional State, to the South East by Arsi Zone of Oromia, on the West by South West Shewa zone and, West Arsi Zone in the South. East Shewa zone covers approximately 10,241 km^2 and Adama is the capital town. There altitude ranges from 1600 to 2000 m.a.s.l and the temperature varies from less than 10^oC along high altitudes to above 30^oC in tropical lowlands. Large portion of the zone is located along the Rift Valley. Rainfall varies from 600mm to 1000mm. Rift Valley consists of valley type lakes (Ziway, Abijata, Shala, Beseka and Langano),

creator type lakes (Chukkala, Bushoftu, Hora, HoraOda, Kuriftu, Green, and Cheleleka) and manmade lake (Koka) found in the Zone that are used as a source of water for many purposes. Major potentials and utilizations of these lakes mainly focused on fishery, recreation, irrigation, hydroelectric power and others (OBFED, 2009; Heyradin *et al*., 2012).

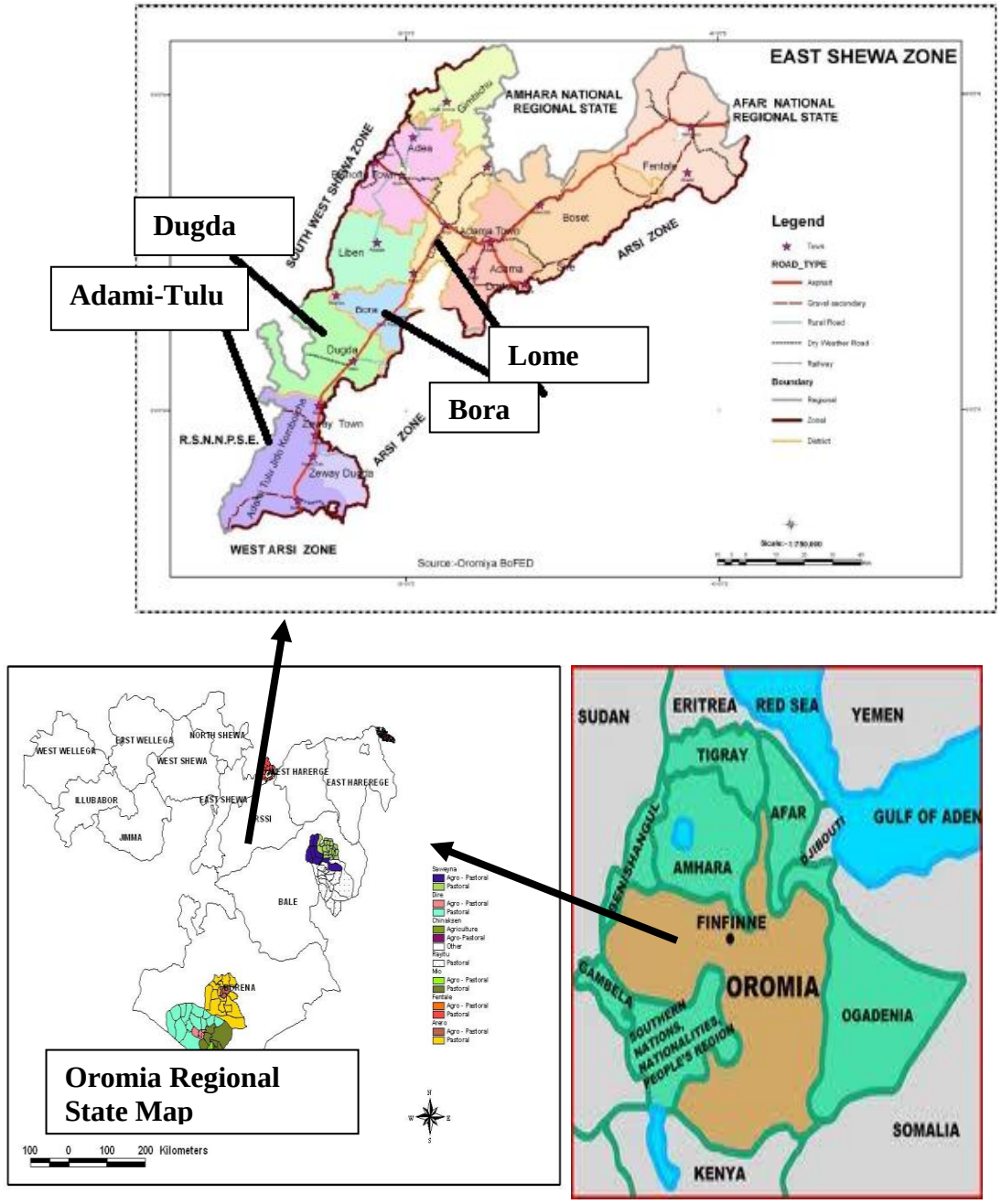

Figure 1: Map of the Study area, East Shewa Zone

Source: OBFED (2009)

East Shewa is believed to be the major source of many vegetables and fruits for many major market centers of the country as a whole. Suitability of the land for production of tropical and subtropical crops and its vicinity for nearby major roads of the country, including the Djibouti line makes it special, in addition to its suitable agro-ecology irrigation potential, for production of many horticultural crops including tomatoes.

The four study districts were purposively selected for their high vegetable production in general and tomato in particular. The area lies in the Great Rift Valley system of the Horn crossing Ethiopia and ecologically characterized by dry and arid climatic conditions of the low land area of the Rift Valley regions. With ample water source, vicinity to center market, relatively suitable road and environment for production of vegetable relatively than the other areas of the country are main reason for selecting the study districts. They are selected for this study since the tomato production and marketing flow is high.

3.2. Data required

Both Primary and secondary type of data have been used for this study. The data from the farmers were obtained according to demographic status of the famers/producers; by interviewing and discussing on their practice of handling the tomato from production until they take it to their buyer; data regarding their interaction with the respective actors and government and physical flows of produce was collected through interviewing schedules. Most of data focusing on factors related to loss and their causes were gathered. Case studies, discussions with key informants, and FGDs were also part of the source of data to fulfill the stated objective.

Information was gathered from traders on issues pertaining to the smoothness of the flow of the commodity along market and to the consumer. Their know-how and application of their best towards the safety and accessibility, information, their services provision to customer and their source, farmers/producers; their coordination and communication system with whom they work; and others was also gathered. The data collection from the wholesalers focused mainly on know-how and application of national and international rules and regulations regarding safety and

quality issues during buying/distribution- selling. Data were also collected pertaining to their effort in trying to reduce the loss of the commodity taking into consideration their advance know-how about the cause and the respective loss as related to those who are less aware.

The data from consumers, including from hotel and cafés, mainly focused on their daily experience towards the quality and handling of fresh tomato together with their marketing practice. A social aspect on consumption and perception towards the production and postharvest loss of the tomato was evaluated to come up with concrete data on attitude of the consumers. The discussion points raised by the participant/respondents of the FGD and key informants are discussed with descriptive analysis below on the result and discussion part. Points are listed as per their importance and forwarded ideas were given emphasis to have a background and forward a recommendation in order to have some solutions in the future.

3.3. Method of data collection

A wide set of methods may be combined in a flexible way to describe the post-harvest chains of the commodity as well as the actors and their interests and roles. These methods include: collection of secondary data (including Internet search and printed papers), focus group discussion with stakeholders/ agricultural officers other farmers on gender and age base and also key informants & other actors were used at different stages of the analysis. In the present study, survey methods using modified questionnaires adopted from La Gra (1990) were used with semi-structured interviews, formal questionnaires, direct observations, and retrospective method (organizational diagrams and other techniques), as source of secondary data.

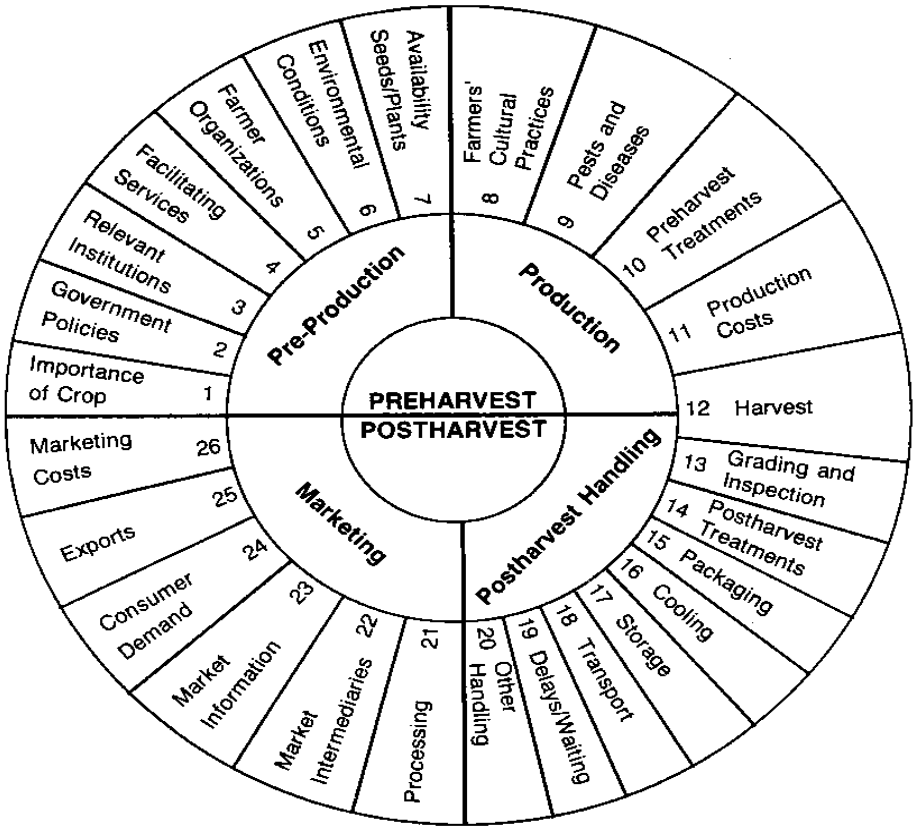

Figure 2: A Commodity System Assessment Methodology chart

Source: La Gra (1990)

First, the correct number of districts and potential areas with their respective tomato-producing farmers were known. Then the exact sample size of each study area and respondents was clearly defined. Accordingly, the study employed purposive sampling of tomato producing districts. It was hypothesized on the proposal that if the tomato producing districts were less in number, purposive sampling could be used (i.e. only those districts to be considered during the study), since the others are not within the target of this study to satisfy the purpose of the study. From the existing districts in the target zone, potential tomato producing areas were identified and four districts (Lume, Bora, Dugda and Adami-Tulu) were purposively selected and used for the study. Within each district, potential areas were purposively selected in the same manner as above taking in to account the existing total tomato production status and potential. Data were then collected with the aid of structured questionnaires prepared according to La Gra (1990).The questionnaire was prepared, pre-tested with sample respondents, rechecked for its appropriateness for clear understanding and responding, and distributed to the respective selected

representative respondents. Focus group discussion (FGD) and interviews with key informants were conducted and data were collected and analyzed. Assessing/observing the real situation was also used as a crosscheck method to have real data.

Sampling

Based on the selected districts and tomato producing areas/kebeles, population proportional to size (PPS) technique was applied to select respondent households based on Slovin's formula which is used for sampling respondents from a total of farmers/producers (Birhanu, 2011).

$$n = \frac{N}{1 + N(e)^2} \quad \text{..... (Formula 1)}$$

Where:

n=sample size for research uses

N=total number of tomato producing household in the target area

e=margin of error at 10%

As the selected respondents may not be available during the interview time due to several unforeseen reasons, in such sampling technique, it is difficult to control such error occurrence so it is better to have a correction point, margin of error (e). This works mostly in social sciences, which allows working with a 10% margin of error while determining our sample size with 90% percent confidence level,99 tomato producers were used. There was also a focus group discussion with key informants.

Table 2: Sample distribution of respondents

Chain actors	Lume		Bora		Dugda		Adami-Tulu		A.A./ Adama		Total	
	Popn.	Sample	Popn.	Sample	Popn.	Sampl	Popn.	Sample	Popn.	Sample	Popn.	Sample
Farmer	1892	**15**	8,518	**20**	17,158	**31**	26,190	**33**	-	-	-	**99**
Wholesalers	-	-	-	-	-	3	-	3	-	8	-	14
*Retailers	-	10	-	15	-	10	-	15	-	20	-	70
Sub-total for Traders												**84**
Hotels/Cafes	-	20	-	6	-	15	-	35	-	20	-	**96**
Consumers		15		20		31		33		30		**129**
Total for the study												**408**

Source: - District Agricultural Offices, December-January (2011/12)

**Retailers: include roadside, shops and town traders*

- *Sample for size of each district was randomly taken*

Efforts were made to account for gender representations, and the actual random sampling resulted in 30 female-headed households from the 99 sample producers. In addition, attempts were made to interview the household head in the presence of his spouse so that the responses account for the view of the women.

As the exact number of wholesalers in the districts was not known, enough and reachable representative respondents were supposed to be used using purposive sampling during the study. Therefore, 14 (8 from Addis, 3 from Meki and 3 from Ziway) wholesalers were interviewed from the four districts markets including those found in Addis Ababa, most often found in "Atikilt tera". Based on the current availability and number of traders found in the selected districts, especially selected areas of each district, a representative sample of 70 retailers/traders were interviewed as participants in the chain of the crop. Samples were taken from the four districts of the East Shewa zone, from Addis Ababa and Adama town. These retailers included roadside sellers, town market displayers and other small-scale traders.

Considering the nearby market and consumers' vicinity to the study area, enough representative consumer respondents were interviewed. Randomly selected consumers of 129 were interviewed from the study districts and nearby town and city. Under this group, 96 hotel/café owners were also purposively selected and interviewed. The criteria for selecting the Hotels and cafés was just the service they provide related to food using tomato more often.

In this method, purposive sampling was applied. FGD was conducted to get the different perceptions from different users in the commodity chain system and crosscheck the reliability of the information. Available and reachable tomato producer sample of focus group discussions (FGDs) were taken. Due to its behavior, the FGD was undertaken when conditions were convenient for availability of all actors together. Accordingly, eight group discussions of producers divided in two sub groups (men and women), each having 32 men and 14 women were participated for the FGD. Additional and basic information was also obtained from key informants, like development agents, agricultural officers, and research professionals. One group discussion was held in MARC (the national fruit and vegetable research-coordinating center) by involving 5 participants. This was purposely done to gather

information from knowledgeable researchers who have been involved not only in the development of tomato varieties but also tomato seed multiplication and distribution for all tomato growers in the country.

3.4. Data Analysis

The raw data from survey questionnaire were re-coded, organized and subjected to a computer software program called SPSS (version 16.0) and Microsoft Excel 2007 database system and relevant mathematical computations and inferences were made accordingly. Results of the SPSS analysis were used as tabulated reports and descriptive statistics. Independent sample t-test, pair wise ranking and chi-square was used to generate a result.

Strength, weakness, opportunity and Threat (SWOT) analysis was duly considered in the interview schedule for producers to complement data and realize the objectives of the study. Focus group discussions (FGDs) were conducted with major target groups to get the different perceptions of different stakeholders along the commodity chain system and to crosscheck the reliability of the information obtained from professionals and field and major chain point observation. Based on tomato production experience, available and reachable sample of FGDs were conducted. However, the numbers of participants were not as planned due to unforeseen inconvenience of time for some stakeholders. Additional and basic information was obtained from key informants, like development agents, agricultural officials and research professionals at MARC.

4. RESULTS AND DISCUSSION

This section deals with the results of the data analysis in light of the objectives set forth at the beginning of the study. Sufficient and appropriate discussions of the results have also been made referring back to the method used for this work, the CSAM, with its 26 components. The pre-production, production, post-harvest handling and marketing parts are discussed here below.

4.1. Profile of the respondents

a. Age and sex of respondents

Age and sex compositions are the major demographic features used to characterize the working capabilities of the respondents. In the study area, men were found to be often responsible for farm work and the women have the major responsibility in the reproductive roles, marketing of smaller quantities of farm products and purchase of food and non-food items for consumption. Table 3 shows that there was no significant difference of age of respondents between districts.

Sex distribution among the respondents was 69.7% men and 30.3% women. The proportion of females in the present study was observed to be better than Adugna (2009) and Alemnew (2010) who took 97.5% male headed. Better sampling was possible due to the presence of sufficient number of women producers in the study area. This shows that there is a favorable condition to encourage women participation in vegetable production in the study area.

The result of the study has depicted that mean age respondents was 34.7 years, with a range of 26 and 50 years, i.e. 26 to 44 for men and 26 to 50 for women. The mean age of respondents in the study area is higher than what was reported by Adugna (2009); Alemnew (2010)and Ayelech (2011) who found 42.7, 42 and 41.33 years respectively in their works. The result clearly showed that the age range of the household remained within productive age (15 and 64 years) (Birhanu, 2011).

Table3**:** Mean of ages, family size and price of tomato in the East Shewa Zone districts

Indicators	**Lume (N=15)**	**Bora (N=20)**	**Dugda (N=31)**	**A/Tulu (N=33)**	**Overall (N=99)**	**p-value**
	Means ±SD	Means ±SD	Means ±SD	Means ±SD	Means ±SD	
Age of HHH	35.3±5.8	35.0±5.2	34.8±4.9	34.0±3.2	34.7±4.6	0.785^{ns}
Family size	5.6±1.8	5.9±1.9	5.2±2.7	5.40±2.2	5.5±2.2	0.796^{ns}
Price, birr/box	166.7±24.4	177.5±25.5	177.4±25.3	175.8±25.4	175.3±25.1	0.547^{ns}

***=significance difference p<0.0; ns=no significant difference at p<0.05;HHH=head of house hold*

b. Family size

As depicted in Table 3, family size ranged from 1 to 10 with a mean of 5.5 (~6) family members per house hold. The incidence is in line with Adugna (2009). Ayelech (2011) and Birhanu (2011) who articulated household size have had significant positive effect on quantity of marketed fruit & vegetables and avocado respectively. In addition, Bezabih and Hadera (2007) have witnessed different labor sources are employed in horticultural production of eastern Ethiopia where family labor takes the majority share of labor.

Larger family size could be considered as an advantage in small-scale horticulture business. For instance, Birhanu (2011) mentioned that increase in family size was directly proportional to give productive labor force for avocado production, which might result in lower dependency ratio, affects the supply of avocado positively and thereby leading to better participation in markets.

c. Marital status of the respondents

Among the total number of sampled respondents (99) of the study districts 39.4, 30.3 and 30.3 % were married, unmarried and widowed, respectively. Most of the widowed respondents were women who are responsible for caring for their children and their farming activities. Adugna (2009) gave a picture of almost the same harmony of respondents' marital status in Tigray. However, it was much lower than what Alemnew (2010) reported that 97.5% of red pepper producers in West Gojjam Zone are married.

d. Education Level

Literacy is one of the important characteristics that influence farmers' decisions on adoption of new technologies (Rehman *et al*., 2007). Data with respect to the literacy status of sample farmers were collected on the basis of their schooling years categorized into preparatory/technique and above, secondary school (7-12), primary school (1-6) read and write (can be through experience, informal or other) and illiterate (Birhanu, 2011) in order to know the composition of the literate population of the respondents. Educational level of the respondent was better (3% illiterate) than Alemnew (2010) and Ayelech (2011) who reported 18% and 11.7% illiterate respondent producers in their work.

It was observed that, out of the total respondent farmers, 97% literate 50.5% attended primary school, 35.4% attended secondary school, 7.1% with ability to read and write, and 4% with certificate and above and the rest 3% were found to be illiterate. These producers are not necessarily living in that area but involved by renting, sharing and other means, technically called tenants. Especially in areas going to the rural area, literacy rate is much lower. The 3% illiteracy rate of the farmers could be due to involvement of farmers in livelihood activities, prevailing poverty in the area and less opportunities for education as explained by Rehman *et al*. (2007) for tomato farmers in Pakistan.

Though the data is confined to tomato producing areas, closer to urban, the literacy is encouraging. Same author, referring Ethiopian Media on 2010, stated that the national average literacy rate as 35.5%. Education is instrumental to influence farmers' decisions and attitudinal changes and it has an implication to enhance volume of production and sales of tomato in the study areas.

e. Major means of income

In the study districts, there are diversified sources of income to the household but the major one was found to be mixed type farming. Growers produce vegetables, maize & other crops as well as rear animals. Of course, they also participate in small scale trading of what they produced. Tomato, onion, head cabbage, melon, papaya, and others represent the major

vegetables and fruits grown in the study districts (Table 4). The best income source among vegetables was rated to be tomato followed by onion, cabbage and green pepper. The proportion of growers in respect of the crop type they grow showed that 65.65% were noted to be involved in growing tomato and onion; 19.2% in tomato, onion and maize and 15.15% in tomato only (Table 4).

This result indicates that tomato can be grown together with onion, maize and other vegetables or it can be rotated with onion. As reported by Adugna (2009) most growers in Amhara region practice cultivation of sole tomato (9.3%) or together with onion (16.4%) and papaya (1.4%).Most producers of the study districts of East Shewa zone were observed practicing growing different crops at once, especially those with smaller lands and partitioning for different crop cultivation.

Table 4: Ranking matrix of major means of income of the respondents

	Prime income sources						
	Components	**1**	**2**	**3**	**4**	**Value**	**Rank**
1	Vegetables production only	X	1	3	1	2	2nd
2	Livestock production		X	3	2	1	3rd
3	Mixed type farming			X	3	3	1st
4	Other sources				X	0	4th
	Superlative income sources among vegetables						
1	Tomato	X	1	1	1	3	1st
2	Onion		X	2	2	2	2nd
3	Cabbage			X	3	1	3rd
4	Pepper				X	0	4th

This indicates, there is a know how or experience of using crop rotation which is one best way of improving production and protecting disease/insect-pest attack, reducing nutrient depletion from the soil and improve soil fertility. Baldwin (2006) strengthens the idea that no one disputes the fact that rotations are beneficial. Farmers agree that yields are generally higher when crops are grown sequentially in rotations. The more they grow different crops once, the better income they get in terms of production, nutritionally rich crops and timely available crop at once.

f. Relationship between demographic characteristics and loss of tomato

The social, economic, cultural and other demographic characteristics of producers may lead to different role in practicing good management required by the agricultural produces. Independent samples t-test was computed for the means. From the observed field and other points of the chain in tomato, the result (Table 5)showed that gender play significant role ($p<0.01$) in the loss, that higher losses were recorded for men (21.70%) than for women (17.60%). This result is in contrast with the idea of Mequanent (2009) who explained males are better than female farmers regarding farming experience and access to technologies. Females are more of attached with giving care/management and mostly settle than males. Due to their experience, they try to handle their produce and reduce loss. With the fact that agricultural activities are seen as labor intensive, and therefore male dominated, females hire labor, even paying extra cost.

Table 5: Relationship of demographic characteristics &loss of tomato in the study districts

Variables		**Mean (±SD) percentage loss**	**t-test**
Sex of respondents	Male	21.70 (±5.84)	2.886**
	Female	17.60 (±7.86)	
Marital status	Married	20.60 (±4.84)	0.177^{ns}
	Unmarried	21.36 (±7.78)	
Education	Literate	20.59 (±6.74)	1.572^{ns}
	Illiterate	13.58 (±1.20)	

***significant difference; ns=non-significant difference*

Marital status could have an implication on post-harvest losses in tomato production since; married farmers are likely to have access to more family labor especially for harvesting. The time taken to do the harvesting may be longer and in an attempt to rush the works fruits are badly handled due to poor skill in handling as compared with hired laborers (Ayandiji and Omidiji, 2011). With this fact, there was high loss recorded even though it is not significantly different with the unmarried producers.

There was no statistically significant difference between the literate and illiterate. However, numerically education showed negative relationship with extent of loss of tomatoes that relatively higher loss was recorded (20.59%) from those literate than the illiterate ones. The reason could be due to presence of other option as source of income for those educated farmers/producers. Basavaraja *et al.* (2007) revealed education level of farmers influences the post-harvest losses significantly at farm level. Literacy is a contributory factor to high post-harvest losses in tomato production because only farmers with knowledge to read and write can appreciate and use most of the post-harvest technologies available (Ayandiji and Omidiji, 2011). However, it was observed, in the contradictory, that those producers with higher education do not care much after they pick the amount they want it to cover their cost with enough profit. However, those with least education seemed to give relatively good care and fighting problems to pick as frequent as possible. The difference seems it is the matter of having other source of income or not.

Table 6: Correlation of tomato loss versus age of respondents and family size

		Total Loss	**Age of Respondents**
Pearson Correlation	Total Loss	1.000	0.248
	Age of Respondents	0.248	1.000
Sig. (1-tailed)	Total Loss	.	0.007
	Age of Respondents	0.007	.
		Total Loss	**Family size**
Pearson Correlation	Total Loss	1.000	-0.052
	Family size	-0.052	1.000
Sig. (1-tailed)	Total Loss	-	0.304
	Family size	0.304	-

There was a positive relation of age of producers and significant loss of tomato. As age of producers increase, the loss recorded at different points of the chain is relatively higher. The reason could be due to less management provided at field and less handling after harvest. The involvement of the older ones in another business, social interaction and related issues can also play role to the less care given to the tomato which in turn result on loss. Negative relation but non-significant loss was observed between loss of tomato and family size.

Logically, size of HH does not matter but active power does who play role on post-harvest loss reduction through different activities.

4.2. Pre-harvest section

Here under, cultural practices of the producers in the study districts and as related to loss are discussed.

4.2.1. Pre-production component

In this part, importance of the tomato, governmental policies, and facilitating services, relevant institutions or organizations, availability of planting materials, and environmental conditions' suitability are covered. Data were taken from direct and indirect interview of the respondents.

I. Importance of the crop

Tomato farm size held by the respondents

Inputs like land and labor have a major influence on output in horticultural production (Ira´izoz *et al*., 2003). The mean farm size for tomato was recorded as 0.24ha in the districts with range of 0.06 to 0.50 ha. This is closer to what is reported by Adugna (2009) land size allocated for tomato production in Amhara region was 0.19 ha. Rehman *et al.* (2007) reported regarding the operational area held by respondents of tomato producer in Pakistan that, majority of them hold up to 1.012 ha. This shows land size for vegetable production is less, considering horticultural crops are grown intensively and require less area as compared with cereals.

Productivity of tomato in the study districts

Results presented in Table 6 show that there was a significant difference between districts in respect of tomato productivity; Lume district being the least productive (179.40 qt/ha). The average total productivity of the four study districts was registered to be 227.30 qt/ha. This is

much better than the national average of 70.49 qt/ha (CSA, 2008) and the FAOSTAT data (89.702 qt/ha) for the year 2010 (FAOSTAT, 2012).

Table 7: Mean family size, distance and productivity of tomato in East Shewa Zone districts

Indicators	**Lume (N=15)**	**Bora (N=20)**	**Dugda (N=31)**	**A/Tulu (N=33)**	**Overall (N=99)**	**p-value**
	Means ±SD	Means ±SD	Means ±SD	Means ±SD	Means ±SD	
Farm size, ha	0.36±0.12	0.23±0.11	0.21±0.11	0.24±0.09	0.24±0.11	0.000**
Distance, km#	14.50±5.5	6.60±2.3	6.50±2.1	7.40±3.1	8.00±4.2	0.000**
Productivity, qt/ha	179.40±17.4	233.40±19.4	240.90±21.5	232.70±7.9	227.30±26.6	0.000**

***significant difference; # distance covers from field to local market*

Similar findings were also reported by Ethiopian Investment Agency for the year 2003/04 to 2007/08 that 200 to 212 qt/ha was recorded (Ethiopian Investment Agency, 2008). The lowest result from Lume district could be due to poor handling and management before and after harvest. For example, there is no adoption of staking on the field for tomato while there is in the other three districts. Some of the producers grow nearby the Modjo River, which is often prone to flooding.

Distance of farm from market

Result of the assessment (Table 7) showed that there was a highly significant difference between one district, "Lume" and the other three.

Production system

According to the respondents of the sampled producers, production system of tomato in the study districts is as plantation (65.7%), as sole crop (20.2%) and backyard (14.1%) farming (Table 8). There was a significant difference ($P<0.01$) on the production systems of the producers for growing tomato as plantation is major growing system in all the four districts.

Those producing as plantation are with wider farming system and they rotate crops seasonally while those producing as sole mostly produce only tomato.

Table 8: Production system and best time of tomato demand in East Shewa Zone, Ethiopia

Characteristics	**Responses**	**Percents**	X^2
Production system	Sole	20.2	47.09**
	Backyard	14.1	
	Plantation	65.7	
Best Time of demand	Fasting	27.3	20.46**
	All time	72.7	

** *Significant at p<0.01*

Best time for selling of tomato was significantly different (P<0.01) between the study districts (Table 8). Majority of the respondents (72.7%) replied the crop is demanded all the time reasoning that tomato is used almost every day in different forms in everyone's dish while others (27.3%) responded the major demand/sell of the crop is during fasting implying using tomato for salad besides being as sauce preparation.

There was a significant difference on where and how the produce is sold immediately after arrival from farm to districts. Majority of the tomato passes through deal or no deal of brokers (76.8%) who do not allow both producers and wholesalers to come face to face and deal on how much to sell and to buy(Figure 3). There are farmers who are members of union, like that of Meki-Batu Farmers' Union (14.1%) who provide farmers with service of training and other additional facilities and sets a pre-production dealing. While harvesting, though price goes up or down, farmers will get what they have been promised initially. In this case, the union bears the risk and takes whatever benefits come from price changes. The rest (9.1%) of respondents declared that they just take and sell it to the local market. There is a kind of fight/argument with the brokers if they try to sell to wholesalers on the market.

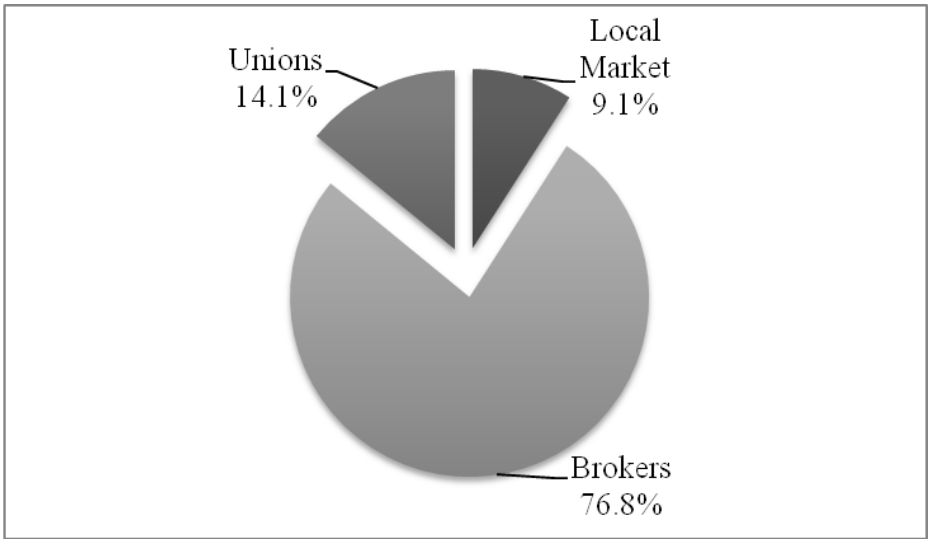

Figure 3: Decision of farmers to sell their produce after harvesting of tomato

Most of the producers do not want such argument. They have fear for the future and just let brokers deal with the wholesalers, come, and check on their farm early in the morning and deal on price including the decision as to when to harvest and how many boxes of tomatoes to collect. They all agreed that price determination is better through brokers/dealers otherwise; they may face a huge loss because they will not be able to contact the wholesalers. Price satisfaction by the producer is better in recent years compared with the past due to, may be, the awareness of the producer and consumer demand towards the use of vegetables, especially tomato.

This shows the market is not on a healthy condition and requires follow up from governmental and other concerned bodies. Together with the governmental legal required activity, producers/farmers need to work in coordination to deliver their produce to the intended market with full benefit from it.

II. Government policies and relevant institutions

All the respondents agreed that recent government policy is encouraging for vegetable production. It is playing a key role in providing land, training and seed, which all together helps the farming practice. However, there is doubt on market settlement that 68.7% of the respondents said the government is not involved or not giving due attention in settling the

marketing system and price inequality (Table 8). However, prices varied depending on quality of produce and seasonal glut.

They mentioned that there is a wide problem of market information, price determination and continuous involvement of informal brokers who are not direct players of value chain the production. The rest of the respondents (31.3%) replied that there is an indirect involvement of government by allowing roadside market. All agreed on the importance of the market settlement structure by government and related information. Birhanu (2011) reviewed that the absence of research and market information in some Ethiopian commodities' value chain have wasted the nation's incalculable benefits and lack of government support have increased knowledge gap among Ethiopian small scale farmers.

The government encourages farmers to produce tomato. Nevertheless, the policy practicality on existing conditions throughout the producers and among the districts is not equal. Almost half of the respondents (51.5%) responded that the policy is practical and helpful and 48.5% said there is no visible activity (Table 9). This showed that there is location and practical difference between producers in four of the districts. Some are closer to the urban setting with access to training or latest information. On the other hand, some farms are far away from urban settings and the farthest the farm, the lesser information dissemination or to the lesser the farmers' appetite to such exposure.

There are NGOs and farmers' union organizations providing services. Some respondents (18.2%) received inputs like motor pump, while some others (37.4%) obtained credit services and the rest (44.4%) get training and technical advices (Table 9). Alemu *et al*. (1998) pointed out that strength and efficiency of support services such as extension, credit, and input supply can condition the effectiveness of research results emanating from experiment stations. This can be true in the condition that farmers with these accesses could have opportunity in improving the farming practice, producing quality product and delivering with good handling and same role can be played with the rest of the actors of the chain with the same access on serving the produce from field to the consumer.

Table 9: Governmental and other organizations involvement in tomato production

Characteristics	Responses	Percent	X^2
Government's involvement in market settlement	Yes	31.3	13.83**
	No	68.7	
Policy Practicality on existing conditions	Yes	51.5	0.091^{ns}
	No	48.5	
Any organization you involved in related to the crop	Yes	36.4	7.364**
	No	63.6	
Participation in the organization service	Yes	45.5	0.818^{ns}
	No	54.5	
Organizations' provision	Inputs	18.2	10.97**
	Credit	37.4	
	Training & technical advices	44.4	

***Significant difference and ns=non-significant*

Regarding the availability of facilitating services to support the producers, all respondents replied they receive credit, inputs (like fertilizers, seeds etc) and trainings and technical advice on farming and marketing of their produce. There is an organization in which some producers are involved in crop production and marketing including training and provision of other facilities (36.4%) while the rest 63.6% are not involved in yet (Table 9). Farmers at Dugda and Adami-Tulu districts are more beneficiaries due to the Meki-Batu Farmers Union Cooperative ($P<0.01$). In those two districts, 45.5% tomato producers are participating as members of the Union. Though not as strong as Meki-Batu Farmers' Union Cooperative, Lume-Adama Farmers' Union Cooperative is also working in the same manner with farmers around Modjo and Adama areas.

Those who are members of the union get a benefit of on time collection of their produce and reduced cost of transportation, information on market cost, and reduced waiting time of their produce after harvest. The union determines the price of the tomato before planting which is also with the agreement of the producers. Accordingly, whether there will be high or low price, the farmers will get the price which has been initially agreed upon. This shows being involved in unions helps producers get plenty of benefit including safe harvest and selling of their tomato.

III. Environmental conditions of the study areas

The assessment was conducted during the months of December to February 2011/12. Joosten *et al*. (2011) reported a mean maximum temperature of 28.5^{o}C and mean minimum of 12.6^{o}C, rainfall range of 500-850 mm per annum with a relative humidity of as low as 50% is characteristics of the study area, recommending it is favorable for plant health and disease prevention. It is believed to reach a maximum of 38^{o}C. There is favorable environmental condition especially for irrigation production system in the study zone. The water source, the market dissemination infrastructures, the vicinity to the major cities and towns of the country and other facilities makes this zone a good alternative for producing vegetables together with the climate.

All producers agreed that the local climate, soils and other related conditions ease the production quantitatively and qualitatively compare to other areas. However, there are environmental conditions that affect the produce. According to the zone agricultural office and vulnerable producers, 2010/11 season was a year that hosts a huge problem of losing almost all their tomato crop due to the failure to bear good fruit in the field and the excess tomato producers and other reasons. Most producers shifted to tomato without market assessment in that area. Due to the loss they faced, some farmers were lead to a condition of paying their psychological, health and moral, properties and even to deep condition, their life. Few producers forced to sell their motor and other properties they owned to reset their life and to come back to their former position while some swore not to produce again.

Rainfall is a major problem of the tomato production and flood to some areas from Modjo River during heavy rain. Temperature was not considered regarding cause of the fruit perish. According to the respondents, there are significant difference ($P<0.01$) in specific problems like improper market condition, inadequate road, transport cost while some said those above mentioned as major problems and other additional problems exist though they did not want to mention them(Table 10). There was a no significant difference among districts regarding the environmental problems to their farming.

There were varieties introduced to the production by MARC but did not sustain for they could not be adapted to the environment. The existing cultivars under production are appropriate for the location and they are profitable.

Table 10: Environmental conditions of the study districts

Characteristics	**Responses**	**Percent**	X^2
kind of problems	Improper market condition	48.5	15.697**
	Inadequate road, Transport cost	35.4	
	All of the above	17.2	
	Others	1.0	
Appropriateness of farm location	Yes	60.6	4.455*
	No	39.4	
Major problem	Distance from market and transport. facility	51.5	20.788**
	Distance, transport and shortage of water	34.3	
	Others	14.1	

*** Significant at P<0.01, *significance at P<0.05; others=e.g. involvement of informal brokers*

Producers' farm is differently located and suitable. Almost all the farms are appropriate for production and marketing of tomato. However, majority of them said their farm is appropriate for production as well as marketing while some of the farms are not suitable for marketing due to transportation/road problem (Table 10). Some are furthest and unsuitable road even to donkey cart.

Out of those saying farm location is not suitable, there was a significant difference (P<0.01) regarding their reason. all most half of the respondents mentioned that a distance of market and transportation problem as a reason, some of them reason out distance from market & transportation and shortage of water or motor pump while the remaining respondents said there are also other additional reasons though not mentioned (Table 10).

IV. Availability of seed/planting materials

Previously, major source of planting materials were from government organization or from market. However, recently, most of the producers start preparing their own seed by selecting the best fruit from their own field and following basic principles of seed extraction. Some of

the respondents are almost new to the production and they use seed from market while other respondents buy from market and prepare their own seed (Table 11). From those preparing their own seed some said they took seed, produces, and use best fruits from their farm to prepare seed to next round instead of buying. However, the rest of those preparing seed reasoned because of unavailability and insufficiency (if available) of the certified seed.

There is an increasing trend of tomato production and cropping pattern during the past five years. There is a problem of using improved seed materials due to its less availability and high price. According to the MARC horticulture division office, there were about 12 varieties released and adopted to the farm but recently only nine of them are grown by farmers. Those varieties like Roma VF and Marglobe are out of the farmers' field production due to less adaptability problems. "*Melkasalsa*", "*Melkashola*", "*Chali*", "*Cochoro*", "*Fetan*" and others are on production in different location of the country.

There are two generally known varieties by the producers/farmers of the study districts, "*Sembersana*" and "*Cochoro*" as locally called. The farmers name pear shaped tomato varieties on production as "*Sembersana*". This variety is with the characteristics bearing high number of fruits per plant, though smaller in size but sensitive to damage and deteriorates shortly. "*Cochoro*" is given to those varieties with firm fruit. However, this dominantly growing tomato and displayed widely on the market is "*Chali*" (personal communication with Dr Lemma Dessalegn and Selamawit Ketema). This group is characterized by bearing lower fruit numbers per plant with larger fruit size but good in resisting damage and stays longer relative to "*Sembersana*". For that reason, "*Cochoro"* is used for distant markets including export purpose and majority of the producers are involved in producing "*Cochoro*" variety while "*Sembersana*" is used for short distance market and for home consumption.

More than half of the respondents had grown "*Cochoro*" variety on their fields while the remaining cultivated "*Sembersana*" variety. There are also other varieties like Shanti, Israeli hybrids which are recently on production by commercial producers and few private growers in these districts. It is high yielding variety and mostly grown by producers that are more aware and with better management.

Table 11: Availability of planting materials in the studied districts

Characteristics	Response	Percent	X^2
Sources of planting material	Buy from market	11.1	25.27**
	Preparing own seed	57.6	
	Buying & prepare	31.3	
Obtaining adequate supplies when you need	Yes	80.7	3.06^{ns}
	No	19.3	
If no adequate supplies, reason for not getting	Ignorance	56.2	2.46^{ns}
	High cost	43.8	

*** Significant at p<0.01; ns=non-significant*

When farmers were asked if they obtain adequate supplies when in need, majority of the respondents mentioned that they do get supplies on time regardless of its continuity while the rest said they do not (Table 11). There was non-significant difference among the study districts with regard to supplies. Growers did not obtain adequate supply on time might be related with lack of awareness/neglect of the producer to get the supplies though it is available and while some replied it is due to the high cost of supplies.

4.2.2. Production components

This component part includes farmers' cultural practices; pest & diseases, pre-harvest treatments and production cost are discussed here under. The inappropriate production system and causes for loss can be seen as a direct relationship.

I. Management practices of farmers

Many cultural practices such as spacing, fertilization (rate and frequency), irrigation etc are adopted from other countries and recommended for large and small-scale producers (Seifu *et al*., 2006). These practices are still hard to be adopted properly by the farmers. The major practices are fertilization and irrigation, which can help in increasing nutritional quality, keeping quality and disease resistance of the fruits if applied properly.

Tomato is produced two to three times per year by those who own pump in East Shewa districts due to the availability of plenty of water source, namely Awash River, Ziway Lake, Koka Lake, Modjo River, and shallow well (10-15m deep). The major watering system is irrigation, furrow type rainfall being the least preferred for such purpose. More than 85% of the respondents used irrigation from the lake and river naturally available while the rest (~15%) used bore-hole and from the lakes when getting help of motor-pump and plastic tube to run the water longer distance.

The land is ploughed moderately using oxen if the land size is about half a hectare and above and finished using hired labor. If the size is small enough, it is prepared by digging manually using hoe. Mostly it is ploughed once and finished during preparing the furrow to transplant. Seed is sown on separate field and transplanted to the prepared land. Tomato reaches for first picking after three month (~3.5 month).

Furrow system is prepared where seedling is planted in relatively raised bed and water is released in between the rows. The spacing used for tomato in the studied districts is not specific but ranges from 20 to 30 cm between plants and more than 70 cm between rows (technically between the planting beds). According to the experts from the district agricultural office, it is dependent on the soil type. For example, if the soil is Vertisol/black soil, it is better to use wider spacing (up to 30 cm) between plants to prevent water logging but if it is clay loam to sandy loam, like in the case of Koka, advisable to use narrow (15-20 cm) spacing.

Watering frequency is dependent on season. During dry season, it is watered three times in a week but during rainy season, it is watered twice. Watering is not one time activity but frequent. After the first pick of the fruit, there is twice watering before the next pick and twice watering and again picking.

Most producers apply fertilizer during transplanting after one week of transplanting by mixing 50 kg DAP and 50 kg Urea per ha. Some respondents mentioned that they sometimes practice splitting system of the fertilizer, half during transplanting and half after one to two weeks.

There is a huge amount of chemical applied for the sake of controlling and preventing of diseases and pests while it is in the field. Fungicides like Mancozeb, Ridomil gold and pesticides like Selectron, Carbarile85% WP (effective broad spectrum insecticide) or Siven as dust or solution form, Diazinone60% EC, Malathion EC (broad spectrum) Malathion WP (for storage pests) and Endolufan (in 35%, 50% and 39% EC form).Almost all chemicals are applied in the field however, there is no any chemical applied to the fruit after harvest.

Figure 4: Tomatoes in the market with visible residue of unidentified chemical (a) and quality tomato fruits without any visible chemical residue (b)

Though the presence and amount of residue of the chemicals on the fruit and their effect on public health is open for study, there was clearly visible whitish powder-like substance observed on the surface of fruits (Figure 4a).Physically quality tomatoes without visible chemical residues can be observed in some cases from farm gate and from market (Figure 4b). The indication of such powder could be due to the time of application of chemicals. The timing of chemical application did not consider picking/harvesting time.

The furrow irrigation system and lack of draining of logged water could also result in high field loss of tomato due to hanging down of the fruit on the ground in the absence of stacking, as observed in Lume districts. The amount, time, and frequency fertilizer application and balance of nutrients might have also resulted in different yield and quality of tomatoes among producers.

Constraints of production of the respondents in the study districts are unaffordable fertilizer, disease problem and insect problem, lack/poor training and shortage of improved seeds and finally predators (animals and others). These problems of production played role in the mishandling and poor quality production of tomato one way or the other.

Intercropping is practiced in order to minimize the risk of pests and diseases occurrence in the preceding crop (Rehman *et al*., 2007). In this assessment, only about 5% of the total respondents were just practicing intercropping of tomato with maize. This result is much less than what Rehman *et al.* (2007) found (54%) in their survey of tomato growing farmers who practiced intercropping of tomato with other short season crops.

A survey result by Adugna (2009) showed that 57% of tomato producers in Amhara area undertake crop rotation practice. Depending on the crop type and nature of production, crop rotation could be important in increasing soil fertility, preserving the environment, optimizing use of nutrients, weeds, diseases and pests, efficient utilization of water and ultimately boosting production and productivity which boosts economic return and add to crop and market diversity (Adugna, 2009; Baldwin, 2006).

Adugna (2009) described that planting tomato after Chickpea-Maize-Cotton as first practice and growing after Onion is more or less important practice. Because some crops fix nitrogen (leguminous plant) others use nitrogen like maize and most of them are from different family with different root system, some shallow and some are relatively deep, and this therefore, protects diseases, pest, and optimal utilization of nutrients at different level of the soil.

Rotating tomato with Onion and head cabbage was observed in the study districts by most producers and Baldwin's (2006) result support this idea that tomato and onion are popularly used in crop rotation. Mostly tomato, onion, cabbage and maize are popular in the cropping system of the Zone. Adugna (2009) also found that tomato can be cropped after onion or cotton or sesame as experienced in Amhara region. Based on the above-mentioned ideas, crop rotation helps in reduced post-harvest loss of any crop as long as factors leading to damage are reduced. From the sampled respondents in the study districts (Table 12), majority of them

grow tomato and onion based on the crop they produce. This shows there is crop rotation practice in the districts, but to a limited extent.

Table 12: Sample growers by crop type

Grower by type	Respondents	
	Number	Percentage
Only Tomato	15	15.15
Tomato and Onion	65	65.65
Tomato, Onion and Maize	19	19.2

There was an observation on the way in which the chemical was being applied and the care given about the chemical handling regarding the way it should be. Missing personal safety protection (Figure 5a) from chemical spray may lead to guessing the awareness about the safety care given to the product by the same person. This shows there is an exposure of human health to danger.

Figure 5: Chemical and fertilizer application on field tomatoes and impact of watering on soil condition and fruit quality in the studied districts

Fertilizer is applied insecurely on the furrow part of the field (Figure 5b) and water is heavily applied (Figure 5c) which may reduce its availability to the plant. The poor staking system and excess

watering at once can lead to fruit quality reduction (Figure 5d) and in turn loss of the produce. Observations on the common cultural practices major producers of tomato showed that there is need to increase awareness on how to apply proper cultural practices and reduce their negative impact.

II. Diseases and Pests

There is no research finding to the scope of this researcher's access browsed which showed scientifically on the status of the pest and diseases except Beneberu *et al* (2006) who indicated late blight caused by a pathogen called *Phytophtora infestans* is one tomato disease incident in North Shewa. The data from districts' Agricultural office - protection division indicated late and early blight are the major disease problems of tomato. Of course, literate producers with enough know-how on the science found-out that there is occurrence of powdery, canker, black spot disease beside blight. From the response of the respondents and observation, late blight creates ring spot on the leaves and it is physiologically obvious that it reduces photosynthesis activity and weakens the plant. Late blight on tomato can lead to 100% loss within short period.

All respondents responded they all face the same problem related to pests-diseases that there is a disease and pest problems. From the field pest problem, the major ones were birds, bollworm, white flies, aphids (locally called "wag" or "keshkesh"), tuber moth and others. Birds consume and damage the left fruits. As explained by the producers, "wag/keshkesh" occurs sometimes during warm season and mostly when there is a high temperature due to sun light for about 3 to 4 days after a rain and a warm air comes out of the soil and burns the leaf of the tomato. Both aphids and whiteflies result on color change of the fruit and reduce demand of the fruit, of-course result on economic loss. Bollworm first lays its egg on the fruit and the egg hatches-out. The newly hatched one then pierce, inter to the fruit, feed, and finishes its life cycle there (Figure 6). This results on fruit damage and reduce its acceptability, though not given due attention in these case.

Figure 6: Tomato fruit showing a hole due to bollworm on field (a) & later on market (b) and other field pest attacked fruit (c)

The attack results in reduction of the quantity and quality of the produce. The damage and loss was hard to quantify. There was an observation that producers applying chemicals at two Liter/ha for insect-pest. Agricultural office - protection division of Adami-Tulu mentioned that **i**nsecticides should not be applied before the insect-pest appears on the plant.

III. Pre-harvest Treatments

There are physical and chemical pre-harvest treatments that might affect post-harvest quality of tomato, like use of pesticides, pruning and thinning depending on the appropriateness of the practice to the specific crop. Fruit quality can be affected by genetic factors, pre-harvest factors (like climatic and cultural practices), maturity at harvest and postharvest handling and the poor practice of these factors increase produce losses. Climatic condition, cultural practices, maturity at harvest in relation to quality, method of harvesting in relation to physical damage and uniformity of maturity are related to pre-harvest activity of certain crops.

According to the results of the present assessment, pre-harvest treatments and their effect on postharvest quality of tomatoes in the studied districts include limited or no plant protection, over/under watering which leads to water logging or drying, mechanical damage by human or animal in the field or during harvesting, rate and time of fertilizer application played significant role on the final loss of tomato. The environmental factors that affect the fruit quality and increase loss include very high or low temperature, relative humidity, wind, frost and rain though no exact properly set ranges practically exist for these factors in Ethiopia.

IV. Production Costs

This sub-section estimates the total cost of production (inputs, labor, rent, etc) and touches the major costs of any proposed alternative methods. Costs associated input supplies and other means of delivering the produce like transportation and container together with labor cost are factors faced by producers forcing them less from what they produce. There was a significant difference among districts ($P<0.01$) on cost and net income of tomato production. Highest cost and income was from Dugda followed by Bora and Adami-Tulu districts (Table 14). The observed high cost could be due to the use of inputs with higher price (fertilizer and chemicals) and labor-intensive nature of tomato production (Fischer *et al*., 1990; Alwang, 2008).

Relatively the lowest net income was from Lume districts (15800±3384.8birr) which could be due to the relatively poor cultural practice and other natural conditions including the less adoption of practices like that of using staking. This can be one factor that producers with less source of money resulted in less production and with less managed farming which in turn results in losing crop and monetary value. However, it does not mean that all illiterate producers are the reason for this. They produced tomatoes using what they have at hand and what was not in field is not considered as loss. Those producers with other options also could be the reason for less return because they do not pick as frequently and as much as those with less/no other income source options.

Table 13: Mean cost of production and net income (birr/ha) of small scale tomato producers in the studied districts

Indicators	**Lume**	**Bora**	**Dugda**	**A/Tulu**	**Overall**	**p**
	Means ±SD	Means ±SD	Means ±SD	Means ±SD	Means ±SD	
Cost	16720.0±4398.6	18575.0±1695.8	20645.2±1205.5	19227.3±1159.8	19159.6±2426.1	0.000***
Income	33600.0±2693..9	37400.0±4706.1	46677.4±5350..3	40090.9±4752.4	40626.3±6544.3	
Net	15800.0±3384.8	18825.0±3781.1	26032.3±4492.5	20863.6±3841.1	21303.0±5332.2	

4.2.3. Relationship between pre-harvest components and loss of tomato

The indirect involvement of government in recent practice of widening the roadside market, existence of unions as a guarantee of selling produce is positive aspects to the farmer/producer in the study districts. However, there are points to raise where losses occur and which needs to be improved. The distance and relative inappropriateness of the road together with other facilities can result on production and loss problem.

Table 14shows the contribution of some pre-harvest components to tomato post-harvest loss. The study shows that producers who sell their produce to local market and brokers face more loss than those selling to Unions. In addition, those participating in organizational or non-organizational services are with less tomato loss due to the awareness created and application of the training on practice. However, needs thorough study, producers who use their prepared seed found to bear less loss than those who buy from market and those buying and preparing. It could be the time they spend on their field and following the routine activity than those going here and there to get the seed. Moreover, freshly prepared seed they have at hand is with more confidence to produce because they select the best fruit for seed preparation. There was non-significant difference in respect of loss due to the types of services the producers obtain from the organization.

There was no significant difference ($P<0.01$) with regard to loss among components of production system, government involvement on market settlement, policy practicality, kinds of problems of environmental condition, appropriateness of location for tomato, major problem, obtaining adequate supplies when you need, and reasons for no adequate supplies. However, there was a significant difference ($P<0.01$) loss between those growers with and without involvement in organization and there was higher loss reported from producers that were involved with organization (Table 14).

Table 14: Loss of tomatoes (%) as influenced by pre-harvest components

Characteristics	Response	Means ±SD
Production system of the crop	Sole	19.42±7.01[a]
	Backyard/garden	23.37±7.08[a]
	Plantation	20.14±6.53[a]
Government involvement on market settlement	Yes	21.63±6.98[a]
	No	19.92±5.62[a]
Policy Practicality on existing conditions	Yes	21.63±6.90[a]
	No	19.21±6.75[a]
Any organization you involved in related to the crop	Yes	16.67±3.68[b]
	No	22.62±7.16 [a]
Kind of environmental problems	-Improper market condition	20.16±6.63[a]
	-Inadequate road & transportation cost	20.99±7.41[a]
	-Both of the above	20.15±6.75[a]
Appropriateness of location for tomato	Yes	20.81±6.26[a]
	No	19.90±7.48[a]
If not appropriate, major problem of the location	-Distance from market and transportation facility	18.92±6.21[a]
	-Distance, transport and shortage of water	21.80±5.89[a]
	-Others	22.75±9.33[a]
Sources of planting material	-Buy from market	26.33±6.70[a]
	-Preparing own seed	18.43±5.40[b]
	-Both buying and preparing	22.10±7.48[b]
Obtaining adequate supplies of planting material when you need	Yes	19.49±6.15[a]
	No	21.40±8.21[a]
If there is no adequate supplies, reason	-Lack of awareness	23.34±8.99[a]
	-High cost	18.91±6.93[a]
Participate in the organization	Yes	17.50±3.19[b]
	No	22.92±7.88[a]
What organizations provide you	-Inputs	19.45±5.69[a]
	-Credit	20.92±7.21[a]
	-Training & technical advice	20.47±6.84[a]

Means with the same letter(s) are not significantly different

There was a positive relationship between loss of tomato and farm size and distance of the farm from the market. As farm size increased, the extent of tomato loss increased. This could be attributed due inefficiency of growers to properly apply appropriate handling management as the size of their farm increased.

Table 15: Correlation of tomato loss versus production, farm size and distance the fruit travel

		Total Loss	**Production of Tomato**
Pearson Correlation	Total Loss	1.000	-0.828
	Production of Tomato	-0.828	1.000
Sig. (1-tailed)	Total Loss	.	0.000
	Production of Tomato	0.000	.
		Total Loss	**Farm size for tomato**
Pearson Correlation	Total Loss	1.000	0.589
	Farm size for tomato	0.589	1.000
Sig. (1-tailed)	Total Loss	.	0.000
	Farm size for tomato	0.000	.
		Total Loss	**Distance produce travel sold**
Pearson Correlation	Total Loss	1.000	0.434
	Distance produce travel sold	0.434	1.000
Sig. (1-tailed)	Total Loss	.	0.000
	Distance produce travel sold	0.000	.
		Total Loss	**Cost of production**
Pearson Correlation	Total Loss	1.000	-0.396
	Cost of production	-0.396	1.000
Sig. (1-tailed)	Total Loss	.	0.000
	Cost of production	0.000	.

Distance played significant positive role on loss of tomato due to the longer time it takes on the road to get to the market and the extent of exposure to different handlings together with the perishable nature of the crop (Ayandiji and Omidiji, 2011). As distance of the farm from market increased, the greater is the exposure of the fruit to sun light/temperature and damage, and hence the higher is the loss. There was a negative relationship between losses of tomato versus volume of tomato and cost of production. It seemed as a volume of production of tomato and cost of production increased the amount of tomato loss decreased. However, tomato loss is high in bulky production as handling management is less. The more products the producer has, the more attention and time given to market dealing and market flow through wholesalers and others. The more money spent on production of tomato, the more management is applied and less is the loss.

4.3. Post-harvest section

This part deals with those components related to postharvest handling and loss of tomato in relation with the major causes of losses.

4.3.1. Postharvest handling components

Harvesting, postharvest treatments, type and related issues of packaging, availability of cooling practice, availability of standard storage practice of tomato, mode and related issues of transporting tomato and other loss related points are discussed in this section.

I. Harvesting of tomatoes

The time of harvesting is determined by the degree of maturity. Standard tomato quality is primarily based on uniform shape and freedom from growth or handling defects. Size is not a factor of grade quality but may strongly influence commercial quality expectations. Distinction among grades is based predominantly on external appearances, bruising and firmness (Suslow and Cantwell, 2012).

The time of picking is considered as the most important factor in postharvest losses. In the research area, picking time is determined by the commitments of farmers with the transporters, for long distance transportation. Result of this study showed that, all respondents do not have specific time of harvesting but do it in any time of the day as long as they get market demand. Just to finish the amount of the boxes required by the dealer on time, harvesting is done anytime of the day (mostly after 10 AM). This result, one way or the other, is in contrast with results from Sherma *et al* (2007) in Pakistan that showed farmers who bring their produce to the local and nearby markets, pick tomato crop early in the morning (79%) while the farmers who transport their produce to distant markets, pick their produce in afternoon (5%) and evening time (16%).

All the respondents from the study districts agreed and reasoned that harvesting at any time of the day is just for the sake of making the produce ready for transportation/delivery and be

available for sale in the available markets, this aim being in line with Sherma *et al* (2007). With regard to maturity index used to decide time of harvest, almost half of the respondents bench marked market demand while the rest said both color of the fruit & market demand being their reference to harvest their produce. Other researches indicated standard tomato quality is primarily based on uniform shape and freedom from growth or handling defects (Suslow and Cantwell, 2012). For most growers, the maturity index to decide harvesting of tomato fruits in the studied areas was found to be color of the fruits.

For home consumption, majority of the respondents used fully red tomatoes while the rest mentioned that they have used tomatoes at any ripening stage as long as it is mature. Those who preferred fully red tomatoes reasoned out that such kinds of fruits are not meant to be marketed due to their perishable nature rather better used for home consumption than earlier stages of maturity. Those who said any stage of the fruit is used reasoned out that, they use fruit from the stage of turning to red ripe and after this stage because they did not recognize what they use for home consumption is not significant amount. It was not considered as that much influencing in reducing the amount of tomato to be marketed.

In assessing the knowledge of the respondents in terms of identifying the right stages of harvesting tomatoes for home consumption and market, a significant difference ($P<0.01$) was noted among the four districts. Majority of the respondents confirmed that red ripe stage is used for home consumption and processing while mature half red stage is used mainly for market. The remaining respondents replied that there is no difference based on their perception and what they practice.

In most cases, hired labor was used to harvest the produce while some of them harvested their produce by themselves including family members. Growers said there is mishandling of their produce by hired labor while harvesting due to carelessness, which leads to loss in the field and subsequently in the market owing to the mechanical injury inflicted due to careless handling by hired laborers. They mix over-ripe and damaged tomato fruits with healthy ones. Majority of the labor were illiterate.

The type of harvesting container used by growers in all studied areas was wooden box. The wooden boxes are set on the front side of the farm where loading and unloading is possible and two or three laborers take one box and fill it and then one carries it from the field to the collecting area. During picking, each laborer has his/her own sack in case the place is not appropriate to put the box in between and fill it on the ready box to be taken to the collection site. Sack was not usual but rarely used in some farms during picking and filling the box only.

From the total respondents 73.73% of them gave response to the question whether they harvested at the proper maturity stage for the intended market and said that they do not mostly practice the proper maturity stage but mixed picking while the rest of them did not respond. While assessing this work, most of the respondents were not exactly responsive to what they were asked. Some respondents had fear and gave extremely to positive answer. Those non-responsive respondents were considered as uncomfortable with the particular question and their condition was considered. Moreover, their condition was checked indirectly regarding what their situation is whenever they do not react towards the question.

All respondents stated that tomato for local market is sold at any stage but mature (breaking stage and above). They added that they first give priority for long distance market due to its benefit of getting higher price from it. All respondents used mixture of breaker, turning, pink and light red stages for longer distance market.

There was tomato loss during harvesting due to mismanagement of the time, criteria and other related issues. Though non-significant difference exist between the points, higher loss was recorded (Table 16). The result shows that loss exists whether the producers use their own criteria to harvest and whoever harvests.

Table 16: Loss of tomatoes (%) as influenced by harvesting components

Characteristics	Response	Means ±SD	p
Point of criteria to harvest	Market demand	20.42±6.46	0.962^{ns}
	Color of the fruit and market demand	20.49±7.10	
Maturity for home consumption	Fully red	20.55±6.90	0.753^{ns}
	Any stage as long as it is mature	19.95±6.06	
Who harvests the tomato	Family of the householder	20.21±5.25	0.883^{ns}
	Hired labor	20.49±7.00	
Difference of maturity for home and market	Red-ripe for home and mature half red for market	21.63±6.87	0.011^{ns}
	No difference for all	17.99±.84	

ns=non-significance

II. Grading and sorting

Grading in tomato is referred to as categorizing of the fruits based on color, size and stage of maturity/degree of ripening, etc. Grading is very important during marketing of vegetables. Untrained laborers can damage the skin of the tomato during grading and that invites fungal contamination (Saeed and Khan, 2010). However, there was no clear distinction of graded and non-graded tomato on the market as well as on the field. During the assessment respondents replied that they do practice sorting. Mostly they sort out damaged and diseased from healthy as well as ripe from unripe & mature from immature. This might have similarity with the practice depicted by Suslow and Cantwell (2012) who mentioned distinction among grades is based predominantly on external appearances, bruising and firmness. The produce is sorted right in the field.

Practically it was observed that there was also an attempt of sorting out those unfit and with externally visible damage and diseased fruits in the boxes in the market during the merchandizing process. The final cult is often sold at lower price and otherwise just used for animal feed right in the field.

They actual seem to have graded products while selling their tomatoes based on the presence of damage and related defects and determine price differences. Though respondents were

found to try to grade their produces, they however do not want to lose much because of the amount of tomato to be left unsold would be greater that they do not want to happen. Tomatoes with Mediocre quality are sold mostly to the nearby café/small restaurant owners and to be used immediately for sauce making for daily use in "Wet".

Most respondents replied that any size but mixed color and healthy, to be their first grade for local market while bigger and half red to be for distant market as first grade. They often faced price change due to the change in the quality of their produce. They suggest that there should be voluntary or mandatory body for inspection of their produce and training provision. They further mentioned that they do not grade because they do not want to reduce the amount of their produce to be sold. They did not realize what loss they were facing due to mishandling or grade/sorting of their produce and selling at good price.

III. Post-harvest Treatment

All producers responded that they apply postharvest treatment before marketing their produce, which is cleaning from debris and perished one. Their practice is important to the produce which otherwise lead to additional cause of damage, disease, or other defect of the harvested produce, which might also lead to the reduction of the price due to poor appearance. However, there are no other standard technological treatments like washing and coatings because of lack of know how or due to expenses associated with such types of treatments.

Regarding trainings concerning post-harvest treatments of the produce, 62.6% of them have attended training provided by agricultural office of the districts while the rest 37.4% did not for unknown reasons. Those trained producers found the training helpful that they start to follow their produce while still in the field and also recognize the value of having good produce to the market in order to get good price.

IV. Packaging of Tomato

Packaging systems play an essential part in the logistic chain for protecting, labeling and stacking of valuable or fragile contents (Department Life Cycle Engineering and Febe-

Ecologic. 2007). Methods of packing can affect the stability of products in the container during shipping, and influence how much the container protects their quality. Prepackaging or consumer packaging generally provides additional protection for the products (Rehman *et al*., 2007).

Wooden boxes are the packaging materials being used in the four districts. Rehman *et al*. (2007) reported similar practices from Pakistan. The type and size of boxes used for harvesting and transporting tomatoes to the nearby market and those used for longer distance transportation are somewhat different. When filling in the field, boxes are relatively bigger and overfilled. On the other hand, to bring it to the market there is a relatively different box used which is to be filled with less quantity of tomatoes than the previous one.

The surface of the wood is rough such that it results in mechanical damage and other deterioration. There is a practice of using previously used box due to cost and of course limited awareness about possible cross contamination. Those boxes are mostly placed in home yard regardless of how they are piled one over the other and not shaded from rain and sun. The cost is one major factor for not to using new boxes or managing the bulk amount of the box, though the second can be related with carelessness.

Producers also predict the size and other criteria of the wooden box. They mostly know the effect of size and roughness of surface of the box, but do not have alternative option because of financial problem. The absence or poor packaging material in the major marketing systems of Ethiopia can be one huge problem for the horticulture industry. Birhanu (2011) pointed out that unavailability of standardized packing material has forced exporters in Ethiopia to import packing material from Netherlands and Israel.

Boxes alone have different weight, but on average, a box was found to weigh 7.1 kg (~7 kg). New ones can weigh up to 10 kg or more while those used for longer period of time might weigh as low as ~5 kg due to continued drying and damage considering the thickness of the wood used in general (Table 17).

Table 17: Mean weight of packaging materials for tomato in the study districts

Weight (Kg)	Lume	Bora	Dugda	A/Tulu	Overall	p
	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	
Weight of box alone	6.2±0.8	6.7±1.2	7.6±0.8	7.2±1.3	7.1±1.2	0.000**
Weight of Tomato	58.8±1.9	59.5±1.8	60.9±1.3	60.2±1.6	60.1±1.7	0.000**
Total weight	63.8±1.9	64.5±1.8	65.9±1.3	65.2±1.6	65.1±1.7	0.000**

***significant difference*

There was also an argument in having the approximate weight of one box of tomato alone. Regardless of the information from most of the producers and traders, based on sample of measurements, the average box of tomato weight was found to be 60.1 Kg (60 Kg). The gross weight of boxes (fruits plus box) was found to be 70 Kg (with mean total weight of 65.1±1.7 Kg) or more (Table 17). In calculating the production and amount of loss, only 60 Kg was used as an average weight of tomato per box in the study areas.

The results of the present study indicated that packing is the most important factor damaging the tomatoes at quite early phase of postharvest handling. Lose of tomatoes due to packaging problem in Pakistan reaches up to 27% (23 to 27%) in different market places of main business point where tomatoes are brought from all over producing areas (Saeed and Khan, 2010).

Case Study 1: Variation in terms of weight of individual boxes between producers and traders

The benefit of producer is not only affected due to loss and price fluctuation, but also due to the variation in terms of the weight of individual boxes between producers and/or the local retailers and the final market points or near consumer traders.

Approximately, on average, the weight of a boxful tomato is recorded to be 60 kg (ranging up to more than 70 kg) at producers and nearby market, but there was an obvious difference of approximately 10 kg less on the final market. This difference was not fortunate for one specific location and time but repetitive regarding time and location. There was an indirect check-up in cities and towns, like Jimma, Hawassa and others every time there was a chance to do so.

Reasons could be, (1) optimistically thinking, the weight loss due to water loss on the long journey of the crop, and (2) on suspect, due to mistreating of both the producer and the final user/consumer by the middlemen. One way or the other, the one who suffers by price are the producers and consumers of course the later being affected not only by price but also not getting quality produce due to the time spent in between and the poor handling together with the perishable nature the crop.

Figure 7: Tomato boxes differ in their fill, which proves weight of tomato is different among producers and final market holders

There was a significant box weight difference (P<0.01) between districts (Table 18) largest mean being found in Dugda owing to the presence of high production and trading activity that might lead to giving attention to have new boxes, which are often relatively heavier than the frequently used ones that dried and worn out due to frequent use.

V. Cooling and storage of tomato fruit

Cooling produces to remove field heat is scientifically recommended by many researchers. Nevertheless, almost no practice of cooling tomatoes is done at any stage of the chain in the studied districts. There is no management of temperature. It was observed that tomatoes were put in box right in the field without any protection from the scorching sun while waiting for the trucks to come and pick them up.

Figure 8: Tomato covered with available materials for protection from sun-exposure

There was an observation though that some producers who transport their produce to the local market with their donkey cart cover the produce with the available materials, net like covers (Figure 8a and 8d) and fresh and dried leaves (Figure 8b and 8c) to reduce exposure to sun. This practice is one of the best practices observed at the producers' level.

Case Study 2: Loss of Tomato due to damage from overfilling and staking of boxes

A sample of six farms were taken as examples for this case study to know the damage of tomato due to over filling of the box and rough nature of the wooden box together with the mishandling of the labor. There was a huge damage of tomato. Assuming that 10 fruits weigh one kg and taking three average pile of boxes, fruits damaged by the box during filling and marketing both in the field and local market were counted. There were different ranges of damaged fruits with a range of 15 to 17 fruits per one box from the bottom box and 9 to 11 fruits per box from the middle box.

There was mean loss of 3.44 kg (5.7%) and 2.18 kg (3.6%) tomato from the bottom and middle piled boxes respectively. From the result, it is clear that the pile size affects the amount of fruit loss. There was high loss in all the six farms. Using LSD mean separation test for loss, there was a significant difference ($p<0.05$) between the bottom and the middle piled box and even among the farms due to the apparent difference in their handling practice.

Figure 9: Tomato boxes piled right in the field and market places depicting damages that cause loss

The impact from mechanical damage, though its degree differs based on the stage of ripeness, later on results in deterioration of quality of the fruit. Impact energy and stage of ripeness had significant effect on all types of mechanical damage. Severity and rate of latent damage increase progressively in fruits through time in natural conditions. This opinion is in accordance with that of Mohammadi-Aylar *et al*. (2010) who stated the different ruptures caused to the tomato fruits depend on the stage of the ripeness-occurred in 30% of the samples through 24 to 72 hours storage.

There is no storing of tomato among the producers. Since there is immediate selling of the produce, there is no storing even by traders in the study districts except those town and roadside traders. There was a result described by Saeed and Khan (2010) that losses due to storage, grading and distribution up to the consumers in Pakistan does not show much differences in occurrence and remain 3%, 1% and 1% only respectively. The major reason why the producers do not store tomato are; due to less production, perishable nature of the produce, and there is no modern technology knowledge to store & finance problem. Even sometimes, in case there is misunderstanding with buyers, though happen rarely, they use wooden boxes placed pilled.

VI. Mode of Transportation of tomato

In this study, there are different modes of transportation used by the farmers for tomato marketing. There was significant difference ($P<0.05$) among the mode of transport used. Majority of the tomato growers (60.6%) bring their produce to the local market used cart with pack animals as a mode of transportation while the remaining farmers (39.4%) use truck (mainly the Isuzu truck) takes the produce from field based on their deal and road access to vehicle though not always (Table 18). Rehman *et al.* (2007) clarified that, during transportation the produce should be moved by proper packaging and stacking, to avoid excessive movement or vibration because vibration during transportation may cause severe bruising or other types of mechanical injury.

Rehman *et al*. (2007) reported that tomato producer of Pakistan (59%) who brought their produce to other than the local market used pickup truck as a mode of transportation, while the remaining 41% farmers used cart and other means to bring their produce to the local market for sale. Animals play, same as transporting of other goods, a major role in tomato production too. Regarding the use of transportation, donkeys attached with carts are used to transport tomatoes from farm gate to accessible roads and markets. This is in line with Birhanu (2011) who affirmed that donkeys and horses are principally used for transport of avocado, and their manure is used as organic fertilizer source in the study areas. Based on observations, there is an abuse of these pack animals which is agreeing with statement of

Birhanu (2011) who tried to point out their existence is remarkably constrained by critical shortage of grazing spot and feed though explained their mishandling indirectly.

Produce is loaded and unloaded with container, wooden boxes. There was no observed activity of dumping of the produce on truck during the assessment. Though container used, there was loss during loading and unloading of the produce while transferring from producers' box to trader/buyer box and loading to the truck. There was poor handling of tomato together with the rough wooden container. In addition, loading and unloading of the over-filled box of mixed mature tomato lead to mechanical damage. It needs proper care during loading and unloading plus sorting the over-ripe and damaged ones from properly matured tomato.

The produce passes through different transportation points as it is transported from the field until it reaches to consumer. There was significant difference ($p<0.01$) on frequency of transporting the produce from field to consumer. There was an observation from majority of the respondents that tomato is transported three times, field to retailer, and retailer to wholesaler, and wholesaler to major cities' market (Table 18)**.** In some cases, there was more than three times transportation of the produce when intermediary involvement is seeking additional profit, which is one of the major postharvest loss problems observed during the assessment. There is also transporting the produce twice, from field to wholesaler and then to major cities of the country.

Table 18: Means and frequency of transportation of tomato in the study districts

Characteristics	**Response**	**Percents**	X^2
Type of transportation used	Truck	39.4	4.455*
	Pack animals	60.6	
Frequency of transportation	Twice	7.1	31.273**
	3 times	49.5	
	> 3 times	43.4	

***significant difference at p<0.01; *significant at P<0.05*

There is also a loss between harvesting till sold in the market due to any reasons, mishandling, damping from producers' box to buyers', exposure to sun and others. There was an average

tomato loss of ~ 3.79 boxes/ha according to the total guess of the respondents. The causes mentioned include theft; drop in the way, eaten by human raw and so on.

Table 19: Mean result of transportations of tomato in the study districts of East Shewa Zone

Variables	**Lume**	**Bora**	**Dugda**	**A/Tulu**	**Overall**	
	Means ±SD	Means ±SD	Means ±SD	Means ±SD	Means ±SD	**p**
Distance from field to local market, km	14.5 ±5.5	6.6 ±2.3	6.5 ±2.1	7.4 ±3.1	8.0±4.2	0.000**
Transportation Loss , box/ha	1.9 ±0.4	3.1 ±0.6	2.7±0.5	3.1±0.6	2.8±0.7	0.000**

A study in Pakistan by Saeed and Khan (2010) indicated transport is one cause of post-harvest losses and found up to 12% loss of tomato from three selected market places. In contrast to what is normally expected, the results of this study showed that loss was relatively lower for produce transported along a longer distance, showing negative relationship between distance and loss (Table 19). As previously said, there was negative relation between volume of produce and loss. But considering market movement, it seems that the loss was high in areas where production and marketing activity are higher in the respective districts, where selling of tomato was tried at fresh and with higher price to the wholesalers. Loss of tomato was found in the three other districts. With the average of 8.02 km distance of farm to market (local market) of the study districts, there was a mean loss of 2.80 box/ha during transportation.

VII. Delays/waiting

Due to market problem there is delay of tomato shipping during handling in the study districts. Mostly the delay is when taking from field to market. According to the respondents, when it happened, the product waits to a maximum of half day (71.7%). In some cases, there is a delay of one whole day (28.3%). The reason for this delay in collecting from field is when truck does not come on time. On the other hand, there is also picking ahead of time. There is also a case when deal is broken between producer and the one who takes the produce due to misunderstanding or cheating by brokers/middlemen.

If in case delay of the produce occurred, it stays on open sun as a pilled bulk of the wooden boxes. Producers understand the side effect of exposing the produce to sun. They can tell quality and quantity reduction/loss, reduction in price, and reduction on their encouragement to produce will result. Their major reason for not doing a shading or other managements is financial problem they experience and lack of knowledge on small-scale postharvest practices on how to make shade using locally available materials with less cost.

Processing

Tomato can be processed into different final functional products such as ketchup, dried tomato, juice and puree. Thus, introduction and promotion of tomato processing aimed at value addition and shelf-life extension through the development shelf stable product could partly solve these problems (Temesgen *et al*., 2011).In order to know the farmers' knowledge of tomato processing, producers were interviewed whether they process and deliver tomato products to the best of their knowledge and experience. Though most of them have knowledge of processed products (like ketchup and sauce like that of Merti product), they do not exactly practice delivering the required type of tomato type. They only have an experience of selling what they have produced on time to the existing market air as fresh.

There is also an activity of using over-ripe and unsold (together with the damaged one) tomato for juice and using it as a sauce for "Wet" by the local and nearby small hotel service providers. Rehman *et al*. (2007) explained that for reducing the post-harvest losses and gluts supply to the markets, the surplus or over ripe produce is processed. This might have some public health consequences. Also regarding the loss concept, since most of the processed tomato was which is supposed to be wasted due to its damaged and behind the so quality criteria was being used in the small cafés for daily food services. In this case, the amount of loss recorded during the assessment resembled to the field and the extremely perished & thrown produce.

4.3.2. Tomato postharvest loss at producers' chain point

The responses indicated that loss exists and they directly or indirectly confirm it. The extent of tomato loss was found to be highly significant (P<0.01). Figure 10 shows the response on the extent of loss of tomato that 99% of the respondents put the loss from medium to high. Tomato loss <= 10% was considered as low, between 20%>x>10% as medium loss and >=20% as high loss was considered in computing the extent of tomato loss.

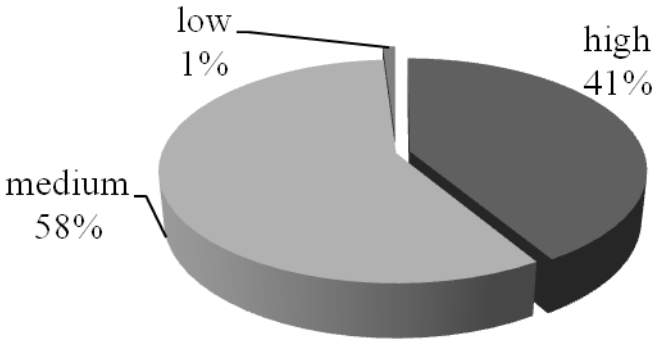

Figure 10: Extent of tomato loss in East Shewa Zone districts

Table 21 shows, the major points of the chain where losses occur are indicated. Based on the respondents' response together with observation of the existing practice and handling condition, assumed loss of tomato in the major areas of the study districts was recorded. From those, field loss (10.14% per ha) was the major contributor for the total loss recorded (20.45% per ha) in the study districts during this assessment(Table 20). This was because of market fluctuation & interference of many intermediaries, crop sensitivity to damage during handling on field and during harvesting, less knowledge on maturity indices of the crop and other reasons. Ayandiji and Omidiji (2011) reported that the more the days the tomato fruit spent on the farm after maturity, the more the loss.

Relatively huge loss was recorded from Lume district followed by Bora, Dugda and A/Tulu districts. There was significant difference (P<0.01) of loss within the different chain points and between districts (Table 20).

Table 20: Loss of tomato at different point of producers in the four districts of East Shewa Zone, Ethiopia (2011/12)

Variables	Lume	Bora	Dugda	A/Tulu	Overall	p-value
	Means ±SD	Means ±SD	Means ±SD	Means ±SD	Means ±SD	
Loss- mishandling (damping, sun exposure, etc)	1.46±0.4	1.07±0.4	0.98±0.3	0.72±0.3	0.99±0.4[a]	0.000**
Loss-field sorting	0.75±0.1	0.47±0.1	0.53±0.1	0.57±0.1	0.57±0.1[c]	
Loss- to transport	0.70±0.2	0.82±0.1	0.66±0.1	0.82±0.1	0.75±0.2[b]	
Loss-market delay	0.79±0.2	0.67±0.2	0.64±0.1	0.71±0.1	0.69±0.2[b]	
Loss- loading/ unload	0.85±0.2	0.51±0.1	0.49±0.1	0.50±0.1	0.55±0.2[b]	
Loss- left on field	17.25±2.8	10.10±2.0	8.68±2.2	8.30±1.5	10.14±3.7[a]	
Total Loss	**33.32±5.1**	**20.38±3.9**	**17.77±4.1**	**17.16±2.79**	**20.45±6.7**	

Means with the same letter vertically are not significantly different

The reason for high loss recorded in Lume districts could be the impractical of staking/support sticks for the crop by majority of the producer; less care to field due to proximity town doing other activities and others. It can lead to the weakening of the plant to carry the heavy load of the foliage and the fruit and fall on the ground that in turn lead to damage and spoilage of the fruit on ground finally left on the field. Other reasons like poor postharvest practice of the harvested fruit by the actors in the chain might be almost the same between districts, but still reasonably contributing to the loss.

The cumulative percent loss of producers at the study districts found during this assessment was 20.45% (± SD. of 6.7%) in the study districts during the assessment work period of 2011. The percent losses of tomato were calculated through estimating by averaging losses reported by the respondents during different processes of assessment, which is the same trend to what was reported by Rehman and colleagues (2007).

As mentioned before, higher contribution of loss from left on field in Lume district put top in higher significant percent loss followed by Bora, Dugda and Adami-Tulu districts. The causes may be almost the same as that of Rehman *et al*. (2007) who listed the causes as picking, grading, packaging, storage, transportation and poor marketing, though loss was higher on field in this case.

The major causes of loss pointed out by the sampled respondents showed that the major one was market delay (74.7%) followed by climatic fluctuations (25.3%) like heavy rain and flood in farms found next to Rivers, like that of Modjo River. There was no significant difference between districts on the agreement of those causes. Market delay being a huge problem, field loss after harvest precedes all points of the chain as a point where high loss is recorded. This response was a general one. The first cause was the base for the other consecutive causes of loss of tomato and result of other causes. Market delay was mostly related with price fluctuation created by the intermediaries specially the brokers who hinder the information flow & communication and blocking of producer and buyer/wholesaler contact and their free-open deal on price and other means vis-à-vis the perishable nature of the crop.

4.4. Marketing Components

Under this discussion point, marketing of tomato and market intermediaries including the information regarding the quality and marketing cost fairness of tomato delivered to consumers, the role of wholesalers and retailers is discussed.

Marketing is not simply the last step of handling fresh produce, but must be part of the overall plan to provide produce that best meets the needs of the consumer. Consumer preferences play a

large role in determining the economic value of the produce to be sold (La Gra, 1990). Madrid (2011) strengthen the need of assessing market related factors with postharvest loss that in the Europe Union an estimated 4 billion Euro was lost due to postharvest losses and reduced quality of fruit.

4.4.1. Market information

There is an agreement from the assessment result found that handlers and/or marketers have no access to current prices or volumes in order to plan their marketing strategies. They are just practicing what was on practice before. Whether the price goes down or up, the main way of knowing or getting information is through person-to-person communication. The tomato production and market information can be found in the agricultural office. The respondents doubt accuracy of the available information. On the contrary, none of the actors in the tomato value chain seems to practice record keeping. About 20% of the respondents were not willing to give response about the information dissemination.

4.4.2. Market intermediaries

There are many intermediaries who participate in the passage of the produce from field to consumers' plate. There was a significant difference ($P<0.01$) to whom tomato is sold. Accordingly, majority of the producers sell to collectors or brokers while the rest sell to Unions, especially those members of the Union from Dugda and Adami-Tulu (Table 21). There are producers who directly sell to the local market (4%). For instance, most of the producers from Meki and Ziway sell to Unions while brokers collect majority of produce from Lume and Bora.

Brokers are majorly involved in price determination while the rest of respondents responded that they are not sure (technically fooled by brokers) who really determine the price(Table 21). Sometimes they think the major market participant who ever starts it determines the market. Practically, these brokers/collectors are the major bodies who handle the crop between producers and consumers. These intermediaries are not supposed to buy the produce but who control the

buying-selling deal between the producers and the buyers. They hide information from both party and set their own invisible existence in between.

It is believed by the respondents and other part of the community in the chain that they can control the movement of the produce until price get high and price agreement is done. There is no special attention/care and with ignorance in handling the produce. There is no/less awareness on what would happen to the produce due to waiting/delaying with no special care. The method existed was pushing the producer to sell their produce in the determined price otherwise, it will be lost. The producers will have no other option. All the respondents agreed that all actors in the chain are responsible for losses. Producers and consumers are the two most affected parties. Producers are affected financially whereas consumers are affected both financially and in getting quality and enough quantity of safe produce.

There is a significant difference ($P<0.01$) in respect of the location where the produce is sold. Most of the produce is displayed on the farm gate including on farm site to be sold whoever takes it, be it wholesaler or retailer (Table 21). It is the place where dealing takes place. There are producers who sell their produce on the roadside for passerby.

Table 21: Market price determination and role of intermediaries at the study districts

Characteristics	**Responses**	**Percent**	X^2
To whom to sell the produce	Collectors/ Brokers	72.7[a]	74.606**
	To Local market	4.0[c]	
	To Unions	23.3[b]	
Price determiner	Brokers	77.8[a]	30.556**
	Others	22.2[b]	
Place to sell the produce	Farm gate	97.0[a]	87.364**
	Roadsides	3.0[b]	

***significance difference*

The major marketing problems of the producers are ranked based on the response priority given by the respondents (Table 22). Brokers who used to act like an intermediate body who serves both as buyer and as seller get benefit from both sides.

Table 22: Rank matrix of marketing problems of tomato in the study districts and vicinity markets

	Components	Rank
1	Brokers hinder fair sales	1
2	Perishable nature of the crop	2
3	Lack of market information	3
4	Lack of market place	4
5	Low price	5
6	Storage problem	6

4.4.3. Tomato Traders

As major source of tomato, Eastern Shewa hosts huge number of longer staying, in, and out traders of vegetables, mostly tomato and onion. The traders in selected markets of Eastern Shewa and Addis Ababa (Dawit and Hailemariam, 2006) handle the average concentration of vegetables and fruits crops. For this study, 84 traders (70 retailers and 14 wholesalers) were used randomly from the study district towns and vicinity cities including Addis Ababa.

a. Wholesalers

It was difficult to identify and find wholesalers due to the informal movement of the system; fortunately, 14 were found from Addis Ababa/Adama (8), Adami-Tulu (3) and Meki (3) who were considered as wholesalers based on the volume of tomato they handle frequently on the chain. All wholesalers were men while majority of retailers were women which is in line with what Adeoye *et al.* (2009) found in their assessment result in Nigeria that more men were involved in wholesaling of tomato while more women were involved in retailing tomato. Their destination is different from short distance, Adama, longer distance Tigray and other part of the country.

From the total wholesalers, 71% of them started their establishments before five years ago and the rest of them within the last five years. Almost all the establishments were started from the

"Atikilt tera", Addis Ababa. Their response showed they have knowledge of the cause of loss and way of handling the crop. However, they load 84 to 90 boxes of tomato per truck/Isuzu and do not usually cover it from sun. Their positive side is that, they mostly travel in the coolest time of the day and at night. They face same problem of brokers' hindrance from information on quality and price of the fruit, though not much affected as the farmer does because of the profit they get by increasing price as compensation on their destination.

They replied that they face a loss of up to 5 or 6 boxes per truck at the final destination market due to many reason. Causes mentioned were market fluctuations being the major one, temperature, poor filling and sorting and others. In addition, about 1.5 to 2 boxes of loss found during loading and unloading. Based on the season, market fluctuation condition, there could be almost half loss of the fruit after long distance travel. Totally, 8.63% loss found from wholesalers starting from field loading up to unloading on the final destination considering the transportation, handling issues in between.

b. Retailers

A sample of 70 retail respondents, including roadside, shops and town traders were randomly interviewed. Among them 77% were women. Adeoye *et al*. (2009)reported similar trend of more women involved in retailing than men did in Nigeria. Age of most the retailers lay in the range of 15 to 40, which is in line with Mashau *et al.* (2012) who reported most (74%) women hawkers of the respondents in South Africa were in the middle age category. Involvement of women on production and marketing of vegetables, specifically tomato and onion is encouraging in the study area. Further involvement on wider production and marketing, like involving in wholesale is crucial although.

These chain actors are with many options, either buying the available tomato if demand is high or choose and deal any type of tomato available on the market, considering themselves as temporary traders who can shift to other crop or other commodities. They, of course, face the ripe tomato which is susceptible to damage and loss if demand is less together with the poor handling management and no storage facility. As a result, they sell with higher price to the final user to compensate the loss. Majority of them were with knowledge about the crop behavior and

the consequence. For that reason, they indulge to the market after studying the market condition, which helps them to escape from losing much.

The major problems observed from the market include: there was no sorting of diseased and damaged one while displaying for sell, damping on ground and mixing with other vegetables and unrelated commodities and so on. They believed that they could get enough profit from displaying more tomato so that they do not worry about the remaining. After they get more than what it costs them, either they sell it at low price or leave it for animal.

Figure 11: Tomato damped on ground in retail market displayed (a) and defected fruit due to insect and poor handling, Ziway market

Case Study 3: Loss assessment at Retailer level

Three boxes of tomato, one with *Sembersana* and two with *Cochoro*, were taken as a sample to observe the extent of loss and related causes damages including its shelf life. Due to the cost of tomato not affordable by this conductor, those boxes were owned by favoring traders and just taken as a sample and followed till the best reachable chain points. One box with *Cochoro* was taken to Addis Ababa, "Atikilt tera" market and then taken/bought by retailer, Mr. Ibrahim who own mini-Etfruit around "QuasMeda" and the other to Butajira. *Sembersana* was taken by retailer from Ziway and data was just taken as rough estimation due to market rash. The retailer gave an estimation of 6 kg of thrown tomato after the second day while the other was sold to consumer and other second retailer.

Amount of the tomato from the box sold was recorded and the number of defected and perished ones due to overripe was quantified. Having that specific box weight being 55 kg, the following trend was found. Defect in this context includes damaged by insect-pest or diseased. Technically, 24.75 kg (45%) of tomato loss from the sampled box was considerablyfound. However, the reality showed those considered loss like overripe, mechanically damaged and some of the other defects were sold mixed to those HH with small income sources. In that case, the loss found from Mr. Ibrahim shop was only from the over defected, over perished and some damaged tomatoes, which was 16.8%.

Table 23: Tomato loss during selling and factors from case study assessment

	Days				
Weight factors	**1st**	**2nd**	**3rd**	**4th**	
Weight, kg	55	47.25	43.25	36.25	
Loss found on the shop/Etfruit due to different reasons					**Total**
Mechanically damaged, kg	5	1.5	3	-	9.5
Overripe and/or perished, kg	1.5	2	4	6	13.5
Defected, kg	1.25	0.5	-	-	1.75
Total					**24.75**

Following the same trend but different day, 11.75% of loss was found from the other box of *Cochoro* taken to Butajira. It is noted that there is another source of tomato from Hinseno area to Butajira and Hosaena. The sample was fortunately taken on the time of tomato demand from the study area to Butajira. To bear in mind, the study area is major source of tomato all four direction of the country.

There was an assessment of tomato run by retailers in order to know the loss and related factors in possibly reachable retailers in the study areas. One trader/retailer runs an average of 8 boxes though ranges up to 12 boxes. Table 24shows a mean value of trader-concerned points/issues regarding tomato price, distance travelled and associated losses.

Table 24: Mean of box weight, distance and loss of tomato at retailers points in the study districts of East Shewa Zone

Variables	Modjo/Koka	Alemtena	Meki	Ziway	A.A./Adama	Overall	
	Mean ±SD	Mean ± SD	Mean ±SD	Mean± SD	Mean ±SD	Mean ±SD	p-value
Box run/Trader, Box	12.2±6.5^{a}	11.5±4.3^{ab}	8.7±2.8^{ab}	10.9±4.5^{ab}	8.1±3.2^{b}	10.1±4.5	0.049^{ns}
Price, birr/box, trader	339.0±49.1^{a}	234.0±23.2^{bc}	255.0±40.6^{b}	205.7±22.8^{c}	343.1±90.7^{a}	277.1±80.1	0.000**
Dist. tomato travel, km	17.9±7.1^{a}	17.9±4.4^{a}	14.0±5.2^{ab}	17.5±4.3^{a}	12.0±5.3^{b}	15.6±5.7	0.004**
Wgt of box alone, kg	7.0±1.4^{a}	6.1±0.9^{b}	5.7±0.9^{b}	5.9±0.6^{b}	5.5±0.7^{b}	5.9±1.0	0.001**
Wgt of box tomato, kg	57.2±2.0^{abc}	58.3±1.3^{ab}	57.0±1.4^{bc}	58.4±1.5^{a}	56.5±1.7^{c}	57.5±1.7	0.004**
Total Weight, kg	64.2±2.7^{a}	64.4±1.8^{a}	62.7±2.1^{ab}	64.3±1.7^{a}	61.9±2.3^{b}	63.4±2.3	0.003**
Loss during transport, %	1.45±1.0	1.43±0.7	1.94±0.8	1.43±0.7	1.50±0.6^{a}	**1.53±0.7**	0.432^{ns}
Loss during handling, %	1.50±0.9	1.4±0.4	1.3±0.3	1.5±0.3	1.3±0.2^{a}	**1.40±0.4**	0.158^{ns}
Total loss at trader, %	2.95±1.3	2.82±0.7	3.25±0.8	2.96±0.6	2.75±0.6	**2.91±0.8**	0.543^{ns}

Mean values bearing different superscript letters horizontally are significantly different (p<0.01)

According to the retailers' response, there was a significant difference (P<0.01) in distance that tomato travels with an overall mean of 15.6 km from field to the local market within the study districts and from its selling place to the final destination of "Gulit" or mini-Etfruit for those town and city traders.

The price of tomato between producer and retailers or traders was different that a significance difference. Even there was a difference (P<0.01) between retailers at different market locations. Boxes of tomato located at different position were significantly different between producers. Based on the assessment found, there was a total mean loss of 1.53% loss recorded during the 15.6 Km mean

distance coverage transport and 1.40% loss due to mishandling and others (Table 24). This is 2.93% total loss at retailers' level.

Regarding loss of tomato vis-à-vis distance between farm and local market, there was a positive expressive correlation (R^2=0.89) result found indicated on figure 12. The more box of tomato run, the less proper handling given the more the fruit exposed to damages and the more loss.

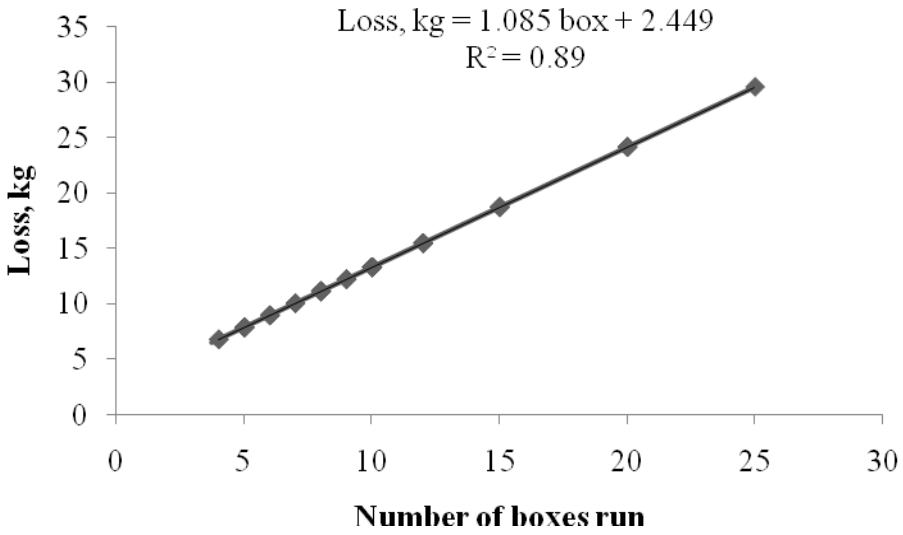

Figure 12: Relationship between numbers of boxes run by one trader Vs loss (kg)

4.4.4. Consumer

Regarding the awareness of consumers on post-harvest related issues, most of them (66.7%) do not have any reaction at all. The post-harvest issues are not given due attention. While some react (33.3%) showing no preference to buy produce poorly handled and with less quality (Table 25). This reaction of consumer showed significant difference (P<0.01) among consumers.

The response from the consumers shows almost the same trend. They depend on their preference. Size and color are the frequently observed in consumers' preference for the produce. Of course, all consumers in all districts prefer to purchase tomatoes at lower prices. There is a significant

difference (P<0.01) among consumers with respect to the cost of tomato. Majority of them react negatively while the rest of the respondents face no reaction towards the cost of the produce.

Table 25: Consumer demands differences of the study districts, East Shewa Zone

Characteristics	**Response**	Percent	X^2
Consumers' reaction to practice of postharvest handling & quality	No preference to buy	33.3[b]	11.00**
	No reaction	66.7[a]	
	Negative	78.8[a]	32.818**
How do consumers react to the cost of tomato?	No reaction	21.2[b]	

***Significant difference at P<0.01*

All respondents mentioned that there is a daily sign of unmet preference or demand of the consumers. The feedback from consumer is that the price goes-up due to many intermediaries involved in the chain. They do not buy tomatoes at a fair price because all intermediaries add their own additional costs, which adds up to the final price that consumers have to cover.

The national per capita annual availability and consumption of fruit and vegetables in Ethiopia is less than 21.7Kg per year (Ganry, 2009; WHO, 2011) which is much less than the minimum recommended level of i.e. >146Kg per year (400gram per capita per day (Ruel *et al.*, 2005). Extremely small quantities of horticultural crops are daily consumed in Ethiopia.

Besides the above-mentioned response of producers about consumption, samples of 129 consumers were also randomly interviewed for their attitude towards what they are consuming. Almost all had the same response that they do not even think of the issue postharvest handling. Almost all consumers responded that their concern is on the availability and accessibility of the fruit but not on the quality and the safety part of it. This does not mean that there is no preference for quality tomato to poorly handled one. Consumers from the main town/city mostly raise the reaction towards the cost of tomato. This cost issue is not observed much from consumers nearby the source because of many options to choose and as a result, cost does not go further from the affordability to the average consumer.

They very often buy small amounts, may be one or two kg of tomato for daily use per HH and due to that they do not give attention to quality, loss or other healthy issues. Few had an answer that they think of it but never bring it to the stage for discussion due to many reason. This showed that, everybody is thinking the post-harvest issue is not theirs but someone else's, but do not exactly know who.

4.4.5. Cafe and Hotels

From the main town and city, 96 café and hotels including small houses serving food as a business, were assessed and interviewed for their view on tomato consumption and handling issues. An average hotel buys a box of tomato for a maximum of two days use for customer service as salad, sauce with pasta-macaroni or "wet". Table 26shows there was a loss of 2 to 7 kg from each box. It happened due to the mix filling of over ripe and damaged tomato with the healthy one on farm or retail market that initiates perishing the other too.

Table 26: Tomato price, weight of box of tomato and loss at hotels and cafes in East Shewa Zone and vicinity town/city

Variables	Mojo/Koka	Alemtena	Meki	Ziway	A.A./Adam	Overall
	Mean ±SD	Mean ± SD	Mean ±SD	Mean± SD	Mean ±SD	Mean ±SD
Price, birr/box, H&C	342.0±62.2^{bc}	305.8±23.8^{c}	294.3±44.5^{c}	367.0±91.6^{b}	449.6±42.1^{a}	363.8±84.2
Wgt of box tomato, Kg	60.6±1.9^{b}	61.8±0.8^{ab}	62.3±2.1^{a}	62.7±1.6^{a}	54.0±1.4^{c}	60.3±3.7
Loss, %	6.5±0.9^{c}	6.1±1.0^{c}	5.5±0.8^{c}	7.4±0.9^{b}	10.2±0.9^{a}	7.3±1.1

H & C= hotels and cafés

A price of one box of tomato by the hotel/café showed a price difference of 188.5 birr and 86.7 birr additional from farmer and trader respectively (Table 26). The weight of one box of tomato on the point of café and hotels is with a mean of 60.3 Kg. From the assessment of the sampled hotels and cafes serving tomato in finished form, a mean total loss of 7.3% per box was found. From the sample areas, cafe and hotel from Addis Ababa and Adama recorded higher loss relative to the district towns. The reason could be due to the extent of damage, the more time

spent till it reaches through longer distance and through sun exposure together with the perishable nature of the tomato. Not to mention the poor handling given through the value chain, loss was higher. The weight of tomato box was statistically significant different between locations of the hotels/cafés but numerically not exaggeratedly significant. There was also a statistically significant different of price and loss of tomato.

Exports

Recently fruit and vegetables are becoming a new–major-economic activity creating jobs, export earnings and revenue (Ethiopian Flower Export, 2012) tomato being one of these, but production activities are mainly targeted to local markets and average export per annum had been only 5.8% of the total agricultural produce until 2006, which is mainly the contribution of state and private farms. Though, there is a very interesting and diverse export capacity to the neighboring countries like Djibouti, it is characterized by small holders and traders market with low quality and profit (Workafes, 2006). There is no covered assessment to be reported confidently regarding the current export of tomato due to access and budget insufficiency in this work, which can be done for the future. The tomato loss in East Shewa Zone study districts at different chain points and chain actors is shown in Table 27. The table shows the loss of tomato from producers, wholesalers, retailers, hotel and cafés with a total loss of 39.31%.

Table 27: Summary of tomato loss at different chain actors of the four districts of East Shewa Zone, Ethiopia (2011/12)

Chain actors	**Loss (%)**
Producers	20.45
Wholesalers	8.63
Retailers	2.93
Hotels and cafés	7.30
Total	39.31

4.5. Knowledge, attitude and practices of different actors with regard to post-harvest management of tomatoes

Knowledge, attitude and practices of different actors along the product chain with respect to post-harvest losses and their solution were assessed in view of devising mitigation strategies by concerned bodies.

It was assumed before assessment, that they did not have enough knowledge of the major causes of losses and growers had limited exposure of experience about the basic post-harvest handling practices of reducing the loss. However, most of the respondents responded that they know, through experience, that they face several factors of pre-and post-harvest. There were producers who stated that they practice covering their tomato during transporting with donkey cart from field to the local market (Figure 8). They knew exposure to sun affects their tomato badly and result in monetary loss. In addition, they try to sort the badly damaged fruits from healthy ones, even during harvesting. These can be considered as best practices.

The problem is they were not fully aware of the summative effect of every cause of postharvest losses on the final qualitative and quantitative loss. Moreover, most producers during field sorting and filling, they leave sorted cult tomatoes in right in field or feed it to animals and/or sell to small scale traders of the local market with throw-away price.

Some solutions practiced by producers for frequently occurring problems on field and after harvest were forwarded. Beside the financial problem, they try to practice routine activities on field to the best possible as long as they can manage with what they have (money, knowledge, experience, etc.). Example, they sort diseased or over perished produce to reduce the normal fruit; they harvest after they get a buyer which guarantees their selling confidence regardless of the argument on quality, price depreciation and filling boxes over; covering the boxes of tomato with available materials on cart while taking to local market practiced by some producers.

The roadside market is open to any trader so that there is no interference from intermediaries and producers nearby the major roads can also sell their produce freely other than retailers who mostly are not producers. Most cultural or practices previously being practiced are now

becoming better through trainings from agricultural offices. What is left to improve is working on post-harvest handling practices and marketing system through cooperation within and with others, working with Unions, NGOs and other governmental institutions.

4.6. Major Production and post-harvest handling constraints of tomato

Based on the response of producers, the major constraint in the production of tomato was shortage of affordable and reliable input chemicals. Unlike other agricultural inputs like seed, chemicals were found in local markets. However, the variability in price and the poor quality were reported to affect the use of chemicals in tomato production in the study areas. Usually, the quality of chemicals was subject to adulteration, as there is no any mechanism in place especially quality assurance in the retail of chemicals. The recent increase in price of fertilizer and in some cases shortage and/or late arrival in the market has considerably affected the use of fertilizer in the production of horticultural crops especially vegetable crops (Dawit and Hailemariam, 2006).

The major cause of tomato loss was identified to be due to market delay. Majority of the respondent mentioned post-harvest loss of tomato was associated with market problem followed by unprecedented climatic fluctuation like heavy rainfall and flooding in farms next to rivers (Table 28).Market delay being a serious problem, field loss after harvest precedes all points of the chain and accounts for high loss recorded. Adeoye *et al*. (2009) reported physiological, pathological and mechanical damages as major causes of economic losses of tomatoes.

Table 28: Response of farmers on the major causes of tomato loss in the studied districts

Characteristics	Response	Study Districts				Total	X^2
		Lume	Bora	Dugda	A/Tulu		
Points of major causes of losses of tomatoes,	Market delay	12	12	21	29	74	6.344**
	Climatic conditions	3	8	10	4	25	
Major contributor of loss occurred after harvest	Loss due to left on field	15	20	31	33	99	

From the problem ranking matrix (Table 29), it can be seen that first problem of tomato production is brokers/middlemen interference. The second is market fluctuation followed by the sum of perishable nature of the crop and cost of the production inputs like fertilizer, pesticide, motor-pump, seed and others.

Table 29: Problem Ranking Matrix of major problems of tomato

	Components	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Value**	**Rank**
1	Perishable nature of tomato	X	1	3	1	1	1	7	1	9	**5**	3rd
2	Lack of transport		X	3	2	2	6	2	8	9	**3**	5th
3	Market problem			X	3	3	3	3	3	9	**7**	2nd
4	Disease and pest				X	5	7	8	9	**2**	8th	
5	Packaging problem					X	7	6	9	**3**	5th	
6	Cost of input						X	7	9	**5**	3rd	
7	Training and credit access problem							X	9	**3**	5th	
8	Brokers/middlemen								X	**8**	1st	

The 4th is also the sum of transportation problem, packaging material problem which is wooden rough surface & frequently used poor handled, and the problem of proper training on critical farming operations and as per they mentioned, the credit problem. The respondents response imply not the absence but fear they have on how they are going to pay it back when they face a problem of natural problem and market fluctuation. The 5th rank was problem of disease and pest problem. The first and major problem of the producers was the involvement of brokers or intermediaries, though functioning as communicator bidirectional. Government is trying to initiate roadside market expansion for the benefit of the producers.

Based on the East Shewa Zone agricultural office report, producer response, districts' agricultural office and official observation, the general major constraints can be seen as production and market constraints. The production constraints observed were;

- ✓ Lack (poor)of improved seeds, lack of well-planned operation, input supply (generally on vegetable) and timely supply of inorganic fertilizers through government channel (i.e. lack of attention on seed supply from the union direction);
- ✓ poor preparation of seed, management of soil fertility, know-how of the farmers on the importance of cultural practices, post-harvest handling and the ignorance of the extent and causes of loss;
- ✓ Lack of awareness on the construction and utilization of improved storage and due to its high amount of harvest farmers face construction capital that can accommodate huge amount of produce.

The market constraints observed were poor knowledge on cost benefit analysis of production system (when to produce, what to produce, how to produce and for whom to produce and price setting) by most producers; and high perishable of the crop brings market limits (it does not go long market range).

There was poor know-how of farmers on crop diversification in relation with market demand which resulted in surplus production of tomato and less demand in return leads to selling with low price otherwise loss of the crop. There is a frequently observed practice on farmers that they prefer to produce a crop that can give high economic return like tomato the same time as others do. In times like this surplus production of the same crop is high throughout the market, which cannot be related with market demand, which in turn results on high loss.

Lack of competent farmers cooperatives on market issues (i.e. lack of awareness creation for their respective members, production supply, information dissemination systems and strategies); there was no visibly observed attention given by the government to this product as other exportable agricultural products; lack of cold chain/storage for high way transport; lack of awareness on pre- and post-harvest technologies. Many pulling back factors hinder the improvement of the production, quality, handling and delivery of sufficient tomato production to the end consumer. These includes limited market share of the products (majority of the produce only sold on local market) and less/no know-how of consumers towards the consumption of

tomato together with the careless handling of the crop by involved actors in between and of course the lack (or less plus poor) of expansion of agro-processing industries in the country.

Figure 13: Harvested tomato fruits exposed to different causes; roadside (a), field sorting (b) and delay (c)

Figure 13 shows tomato fruits exposed to different causes of postharvest loss at roadside(Figure 13a),field sorting (Figure 13b)and delay(Figure 13c). Workers handle it carelessly both at field and market level. The sorted fruit is also damped on ground.

4.7. SWOT Analysis

Figure 14: Group discussion with women (a) and men (b) tomato producers

From the discussion and observation with group of producers and basic informants, some basic strength, weakness, opportunities and threats (SWOT) were extracted that may help in setting solutions to intervene in the major chain. As a result, general weakness and strengths of actors and available opportunities were pointed out. Issues which were considered as threats to the producers and other economic related issues are also inspected. The main results of the SWOT analysis are listed in Table 30.

Table 30: SWOT Analysis Matrix

Strength	Weakness
• High yield potential of the crop for local and export • Suitability of the land for production and vicinity to major markets • Show-up of Investors and private producers with best practice • Self preparation of seedlings • Flourishing of linkage between cooperatives, unions and farmers • Labor • Increasing demand of consumers towards vegetables (tomato) • Training, financial services are available	• Shortage of improved pre-& post-harvesttechnologies • No/Poor value addition activities • Absence of awareness on post-harvest technology • Lee productive cultural practices • Lack of practiced training implementation of training on practice • Poor Market information • Inability to be organized in marketing groups • Lack of organized information flow • Absence of cold storage & lack of transporting truck • Poor quality packaging materials • Overloading (unit per box, truck)
Opportunities	**Threats**
• Potential to increase area and productivity • Organized cooperative in input supply (as loan & support) and technical support • Area with Flat land & high water source • Improving road access • Short season, high value crop& high returning crop in small size land for low income household • Shining of newly established farmer Unions • Involvement of women (gender balance)	• Market problem/fluctuation • Chemical & fertilizer use (dose, time, frequency and appropriateness); chemical adaptation with the diseases • Disease problem but lack of know-how on protection • Lack of information and blocked by brokers (with hiding of information) on price…leads to loss • Lack of capital by the major small scale but highly involved tomato producers • Lack of coordination within & b/n farmers and buyers • Poor Technology dissemination in country level • Lack of implementation of training on practice • Poor record keeping on production and loss of the crop vis-à-vis the major causes

5. CONCLUSIONS AND RECOMMENDATION

5.1.Summary and Conclusion

The study was conducted to assess the post-harvest losses in tomato in selected districts of East Shewa zone, Ethiopia. Tomato being one of the major vegetable crops in the Eastern Shewa Zone, it is produced widely in many places of the Rift Valley Region and serves as a major means of income for the livelihood of vegetable farming local households. Despite the favorable climatic conditions and the high production of tomato supplying to majority of the country's market, the management system on delivering the crop to local and export consumption is not that much attractive. Post-harvest loss of the crop is one setback problem on the production and supplying sufficient amount in reducing food shortage and attaining food sustainability.

A total sample respondent of 408 was used for this assessment, from producers to consumers, based on the questionnaires and discussions. Significant samples of women were involved relatively. There was an observation that respondents were in the literate range of primary and secondary school.

Result of the assessment showed that most of the farmers picked their crop in morning and transported their produce to outside markets in wooden boxes using donkey cart and/or pickup/truck as a mode of transportation. Most of the tomato growers and traders were badly informed of tomato post-harvest handling/management, of course, some are ignorant. The estimated post harvest loss of tomato in the study area at different chain actors/points was 39.31% (20.45% producers, 8.63% wholesalers, 2.93% retailers, and 7.3% from hotels and cafes) of the total production starting from producers to hotels and cafes. These losses may occur on field, during picking, handling, transportation, etc.

The figure is considering loss relating scientific view that what type of fruit to be grouped as loss. However, operationally or in real situation, the loss could be less than what was found because of the different level of consumers' economic condition. Some buy quality produce

while those HH with less income source buy including fruits with damage and use it for daily consumption and even it is used in the small cafés for sauce.

The major factors that contribute to tomato quality defect and its loss were like market fluctuation together with the perishable nature of the crop; interference of many middle men; lack of awareness on post-harvest handling practices, and less consideration on the effect of sum of every single cause of loss in many points of the chain from field loss to market problem loss. Mixing ripen, over ripe and green tomato, large crates and delays during transport and marketing: appear to be the main sources of losses in this study. Tomato waits mostly for half-day delay due to the market problem, but it frequently waits from half to one whole day.

Cultural practices of the producers in the study area is financial status level dependent and the practices are more of technology requiring which is hardly adopted and practiced by most of the producers. The major disease and pests faced by the producers are early and late blight, aphid, bollworms and others that result reducing its marketability, which in turn is considered loss. The absence of pre-and post-harvest treatment is one indication of poor postharvest handling practices in the field of tomato production.

Degree of maturity is a determinant point for time of harvesting and picking at any time of the day for the sake of making the produce ready for transport. The market demand together with the fruit color is a criterion for harvesting of the fruit, but mixed picking of mature and immature, over-ripe and ripe, damaged and healthy was observed both on field and on market. The basic practices of sorting or grading of the fruit after harvest, cooling and using proper fill-up of the packaging materials was not that much encouraging, though economically not affordable and not practicable by most small scale producers.

The packaging material is wooden box, which reduces the stability nature of the fruit. The box is heavy weighing and rough and due to fluctuated fill-up of the fruit, it plays a big role for the total loss of tomato due to mechanical damage and other defects. There was difference in weight of the box between the producers and traders on the retail level, which might be due to the loss caused by water loss of the fruit or the theft by the trader from the producers.

Piling levels of tomato-filled boxes can also result in additional losses. There was mean loss of 5.7% and 3.6% from the bottom and middle piled tomato box due to the mechanical rupture, bruise occur on the fruit by the roughness together with due to the heavy weight of the box. Cart with pack animals is used as mode of transportation by most producers who sell on the nearby local markets while others who deal on farm truck takes their produce based on the accessibility of the road from the field. However, there was no significant difference on loss between using pack animal and truck. The absence of tomato store are; due to less production, perishable nature of the produce, and there is no modern technology knowledge to store and finance problem to build one.

Most pre- and post-harvest practices of the chain actors were found to be significantly affecting the tomato production and resulted on loss. There was significant difference between the different points, field loss being the major contributor than the others. There was a significant loss difference between districts as well, highest being in Lume districts due to absence of proper adoption of using of staking as other districts do, vicinity to city/towns and involved in other businesses and other reasons.

Traders (wholesalers and retailers), also contribute significantly to the loss of the fruit. Loading/unloading practice, transporting with poor handling together with the over loading of the truck, results in losing the tomato fruit on their hand and also after it reaches on the final market due to the damage caused by combination of high temperature and mechanical. The loss at retailers and wholesaler levels was due to market fluctuations, temperature, poor filling and sorting and others reasons.

Analysis revealed that all management practices employed in the field and market, were not significant except covering the tomato while taking to market using available material, which should be practiced by the long distance traders. The blooming of Unions can help improving production and supply of tomato and reducing loss. Producers who sell their produce to local market and brokers face more loss than those selling to Unions. In addition, those participating in organizational or non-organizational services are with less tomato loss due to the awareness created and application of the training on practice than those who do not participate.

This study has analyzed the determinants of post-harvest losses in tomato production in selected districts of East Shewa zone. The result indicates that most of the identified factors have significant impact on post-harvest losses. Therefore, there is a great need to reduce the losses in the study area. There is also a good opportunity for production and post-harvest and/or processing in the study area with vegetable, tomato sector through the application of both modern and traditional processing technologies. Taking advantage of these opportunities will require working in linkage with each other for mutual benefit, producers to traders to processors to consumers, and that strong flow chain be developed to help producers and traders create and adopt technologies and skills. Supportive government policies and strategies must also be there to play key role.

5.2. Recommendation

Actions need to be taken in order to reduce the post-harvest loss of tomato and develop tomato producer-market flow channel in specifically and for vegetables in general. Technical application and awareness creation together with improved linkage of producer-extension/government-trader-consumer are major points to consider. Thus:

- Producers need to be trained on the latest appropriate and affordable technologies starting from those small and medium scale techniques of packaging, transporting of tomato, and advanced techniques and methods of post-harvest handling.
- Provision of improved mode of transportation and storage to minimize losses in tomatoes
- Skillful training for the farmers on post-harvest operations would greatly help in reducing the post-harvest losses in the crop. The establishment of small-size cold storage units using locally available materials in the production area would help reduces the post-harvest losses.

- Introduction of proper storage and its arrangements at wholesale, cooperative and retail level on the local market are needed.

- Filling of boxes of tomato should be to the safe level so that there will not be any mechanical damage of the fruit while pilling the boxes during harvesting/picking and filled sorting, market display, and transporting to short as well as longer distance.
- Applying proper sorting/grading, transportation, packaging system and creating awareness on credit and other services use if the needed objective on loss reduction of tomato is planned to meet.
- Government role is required on setting a means of fruit and vegetable inspection, rule and regulations with its means of application, strategies regarding production and marketing of, specially the small-scale producers and frequent follow-up of its application.
- Encouragement of Farmers' Unions and working in link/cooperation with producers' Unions, other concerned bodies, and Government can help in motivating the small scale producers to produce, handle their produce properly, practice cultural practice to the best possible in reducing the loss and deliver to the market/consumer is vital.
- Awareness creation on diverting/twisting attitude of all chain actors towards benefit gain from consuming tomato together with it quality/safety regarding the health and economic impact it will have, if not properly handled should be worked.
- Encourage on that research should work towards generating improved technologies i.e. varieties with higher shelf life beside its productivity and cropping system.

5.3.Future line of work

Major points frequently revealed by respondents and checked by field and market observation still practiced on the chain of the study area, which require intervention by concerned bodies, are fair market links and some production & post-harvest handling related practices in general. Inappropriate practices of major point of the chain are cause and consequences of one to another. An intervention of concerned bodies, of course, everyone is crucial on those critical points. Such as market settlement; improved technology introduction and hastened development to tackle the pre- and post-harvest risks; development of quality control and standard at all levels of chain. Forming tomato producer market groups working on their problem to solve at small and medium scale level is basic of all. Introduction and adoption of a new practical at small-scale level

system, setting-up of tomato, and vegetable in general, information system in the study area and in the country as whole; and other linkage creation is must.

This piece of work is a knocking stone for the future and an introduction for the next step of the field worker, researcher or anyone else on post-harvest handling of tomato. Therefore, it is forwarded that;

- This is one piece of work, which is done only on specific crop, cropping season & one run and not with enough information & not supportive enough to recommend mitigations directly. Further repeat of this work at different location of the same or different season is to be done so that adequate information on the crop post-harvest loss extent, causes & gaps are pointed-out and means of loss reductions are designed nationwide.
- Effect of packaging material, on post-harvest loss, quality, and consumer acceptance tomato should be done and proper type and size of package is to be created with reduced loss of the fruit with, less quality defect and affordable by the average small scale producer.
- Introducing shading on a field heat management.

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APPENDICES

Annex 1: List of FGD and Key informants in the study areas

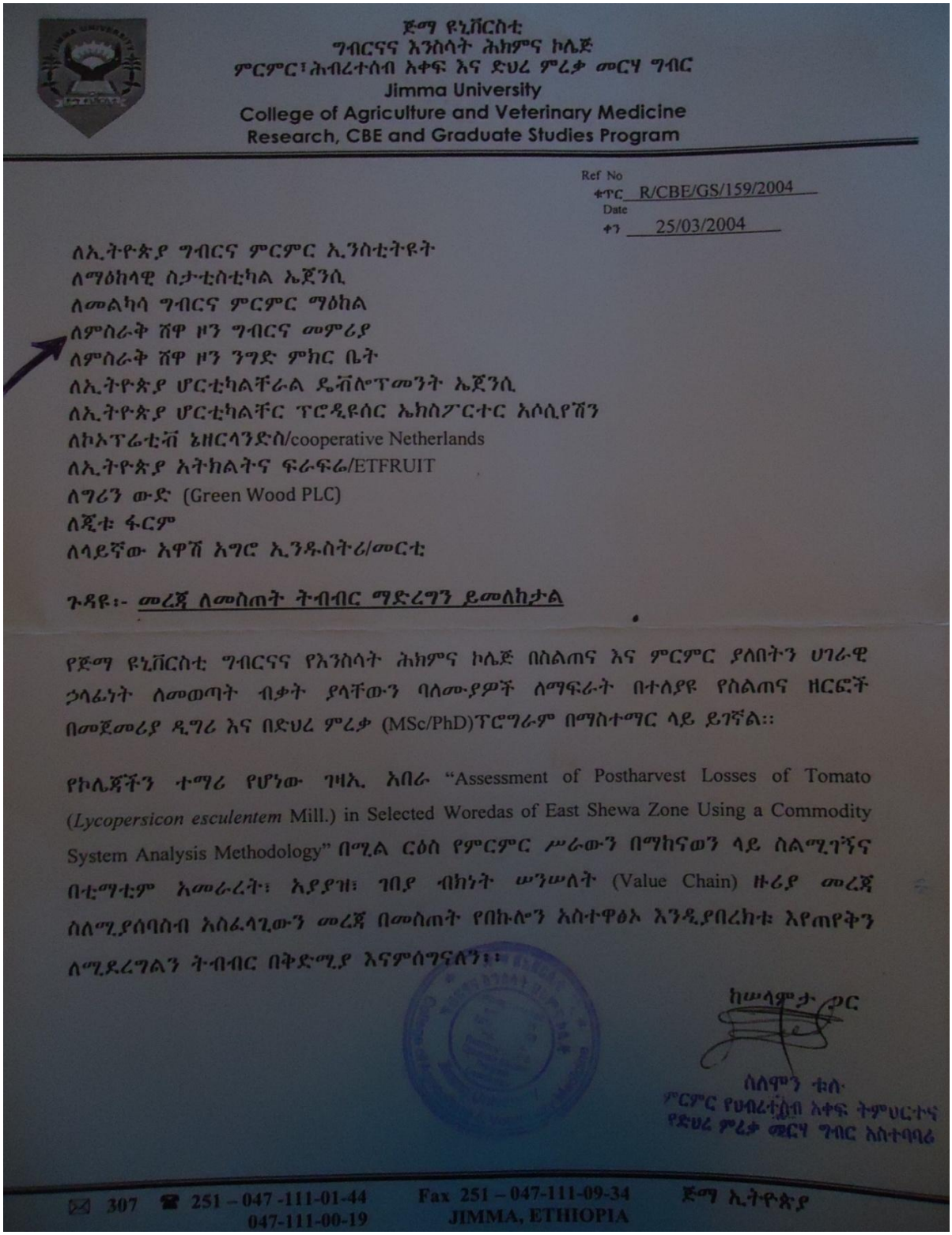
S. No.	**Farmers Group Discussion**	**Number of Interviewee**		
		Men	Women	Total
1	**Koka**Kebele (LumeWoreda)	11	4	
2	**Kenteri**Kebele (Bora Woreda)	7	3	
3	Kebele (DugdaWoreda)	6	3	
4	**Abomsa**Kebele (Adami-Tulu Woreda)	8	4	
	Total	32	14	**46**

	Key informants	
1	East Shewa Zone Agricultural Office	3
2	LumeWoreda Agricultural Office	2
3	Bora Woreda Agricultural Office	2
4	DugdaWoreda Agricultural Office	2
5	Adami-Tulu Woreda Agricultural Office	4
6	MelkasaAgiricultural Research Center	5
7	Ethiopian Horticulture Producers-Exporters Association	1
8	Ethiopian Horticultural Development Agency	5
9	Meki-Batu Union	2
10	ETFRUIT	1
11	Green Wood Plc (Hawassa)	2
12	Jittu Horticulture (Hawassa and Debrezeit)	2
13	Genesis Farms (Debrezeit)	1
Total		**32**

No	**Name of Key informants**	**Position**
1	SelamawitKetema	National Vegetable Research Coordinator and Melkassa Horticulture Sector head (MSc)
2	YosefAlemu	Vegetable Researcher (MSc), Melkassa
3	JibichoGeleto	Vegetable project Researcher (BSc), Melkassa
4	AsmareDagnew	Horticulture PhD Researcher, Melkassa
5	WeldayHailu	Food Technologist, Melkassa

Source: Survey result (January, 2012)

Annex 2: Letter of Recommendation to Collect Data from Relevant Chain Actors



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Jimma University
College of Agriculture and Veterinary Medicine
Research, CBE and Graduate Studies Program

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ለኢትዮጵያ ግብርና ምርምር ኢንስቲትዩት
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ለኢትዮጵያ ሆርቲካልቸር ፕሮዲዩሰር ኤክስፖርተር አሶሲየሽን
ለኮኦፕሬቲቭ ኔዘርላንድስ/cooperative Netherlands
ለኢትዮጵያ አትክልትና ፍራፍሬ/ETFRUIT
ለግሪን ውድ (Green Wood PLC)
ለጂቱ ፋርም
ለላይኛው አዋሽ አግሮ ኢንዱስትሪ/መርቲ

ጉዳዩ፡- <u>መረጃ ለመስጠት ትብብር ማድረግን ይመለከታል</u>

የጅማ ዩኒቨርስቲ ግብርናና የእንስሳት ሕክምና ኮሌጅ በስልጠና እና ምርምር ያለበትን ሀገራዊ ኃላፊነት ለመወጣት ብቃት ያላቸውን ባለሙያዎች ለማፍራት በተለያዩ የስልጠና ዘርፎች በመጀመሪያ ዲግሪ እና በድህረ ምረቃ (MSc/PhD)ፕሮግራም በማስተማር ላይ ይገኛል።

የኮሌጃችን ተማሪ የሆነው ገዛኢ አበራ "Assessment of Postharvest Losses of Tomato (*Lycopersicon esculentem* Mill.) in Selected Woredas of East Shewa Zone Using a Commodity System Analysis Methodology" በሚል ርዕስ የምርምር ሥራውን በማከናወን ላይ ስለሚገኝና በቲማቲም አመራረት፣ አያያዝ፣ ገበያ ብክነት ሠንሠለት (Value Chain) ዙሪያ መረጃ ስለሚያሰባስብ አስፈላጊውን መረጃ በመስጠት የበኩሎን አስተዋፅኦ እንዲያበረክቱ እየጠየቅን ለሚደረግልን ትብብር በቅድሚያ እናመሰግናለን።

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Annex 3: Producers' Interview Schedule for CSAM -Analysis in East Shewa Zone

Remark: *The personal profile obtained from respondents with regard to the theme will be kept confidential and will not have any consequence on the respondent in any ways. Please give correct answers to the following questions.*

Instructions to Enumerators

- *Make brief introduction before starting any question, introduce yourself to the farmers, greet them in local ways and make clear the objective of the study.*
- *Please fill the interview schedule according to the farmers reply (do not put your own feeling).*
- *Please ask each question clearly and patiently until the farmer gets your points.*
- *Please do not use technical terms and do not forget local units.*

Objectives of the study

To identify determinants of the post-harvest loss and causes

Identification

Districts: 1. Lume 2. Bora 3.Dugda 4.Adami-Tulu

Name of the HHH (Code): _____

Profile of the respondent

1. Age: _____
2. Sex: 1. Male 2. Female
3. Marital status 1. Married 2. Unmarried 3. Divorced 4. Widowed
4. Family size of the HHH
5. Educational status of the respondents 1. Illiterate 2. Read and Write 3. 1^0 school (1-6) 4. 2^0 school (6-12) 5. Preparatory/technique and above

I. Pre-harvest

1. Pre-production

1.1. Importance of the crop

1.1.1. Production system in practice. 1= Sole 2= Intercropping 3= Backyard garden 4= Plantation

1.1.2. What is the source of water for tomato production? 1=irrigation 2= rainfall

1.1.3. What relative importance/rank does tomato have regarding production/marketing/ consumption?

1.1.4. In which month is tomato demanded/valued by the market/consumer? A. fasting, B. all the time, C. winter, D. summer

1.1.5. What amount of land do you have for tomato production? A. Backyard only, B. quarter hectare, C. half hectare, D. one hectare, E. more than one hectare

1.1.6. How much do you get/produce per hectare, in quintals?

1.1.7. To whom do you sell your produce? A. to local market, B. to Brokers C. to wholesalers D. to consumers, E. to Unions F. to processors

1.1.8. How much do you sell one Box of tomato?

1.1.9. How far does the produce travel from field to the nearby market?

1.1.10. Is the price satisfactory with respect to your cost of production? A. Yes, B. no

1.1.11. Who determine the price of the crop? A. Farmers themselves B. Broker C. Wholesaler D. Government

1.2. Government policies

1.2.1. Does the government policy encourage tomato production? A. Yes, B. no

1.2.2. What is its role? A. providing training, land & seed B. Market settlement, C. facilitating infrastructure, D. E. supplying equipments

1.2.3. Is government involved on settling of the current market for the farmer's benefit? 1.Yes 2.No

1.2.4. Are there laws, regulations, encouragement on producing or marketing the crop? A. Yes, B. no

1.2.5. Does the policy practically working on existing price supports or controls, banned pesticides or residual limits for the sake of handling the crop? 1. Yes 2. No

1.2.6. Are there any organizations/institutions involved related to production and/or marketing tomatoes? A. Yes B. no

1.2.7. If yes, do you participate and get benefit from it? A. Yes B. no

1.2.8. What do the Organizations provide you? A. inputs B. Credit C. training &technical advice D. others

1.2.9. What benefits or services do they provide you? A. On time collection of produce B. information on market cost C. reducing cost of transportation D. reduce waiting time of produce after harvest E. all benefits

1.3. Environmental conditions

1.3.1. Does the local climate, soils or other factors limit the quality of your production? A. Yes B. no

1.3.2. What types of environmental condition affect your tomato production? A. Soil B. temperature C. rain fall/

1.3.3. Is there any specific problem regarding the local condition? A. Yes B. No

1.3.4. If yes, what kind of problems? A. Shortage of Water B. shortage of land C. in adequate road D. improper market condition E. transportation cost F. others, specify

1.3.5. Are the cultivars produced appropriate for the location? A. yes B. no

1.3.6. Is the location of your farm appropriate for production and marketing of the tomato? A. Yes B. no

1.3.7. If no, what is the problem? A. Distance from market B. transportation facility C. shortage of water D. disease problem E. soil infertility F. others, specify

1.4. Availability of planting materials

1.4.1. Source of planting material 1. Agricultural development office 2. Buying from market 3. Preparing own seed 4. Buying and preparing own seed 5. Others, specify

1.4.2. Trend of production and cropping pattern during the past 5 years?

1.1.1. Are the seeds/planting materials with adequate quality? A. Yes B. no.

1.1.2. If no, what is the problem? A. Low quality of the crop B. disease susceptibility C. non adaptable D. Low productivity E. longevity/short shelf-life

1.1.3. Can you obtain adequate supplies when you need? A. Yes B. no.

1.1.4. If no, what is the reason for not obtaining the available adequate supplies? Because of 1.less availability 2. Own ignorance/neglecting 3. High cost 4. Others, specify

2. Production

2.1. Farmers' general cultural practices

2.1.1. How often do you produce tomato per year? A. Once B. twice C. three times

2.1.2. What method of watering system do you use majorly? A. Irrigation B. rainfall C. other

2.1.3. If irrigation, which type? A. furrow B. Drip C. hand watering D. Sprinkler

2.1.4. How do you prepare your land? A. Oxen Plowing and finishing manually/hand digging B. Tractor plow C. hand digging only

2.1.5. How often do you plough?

2.1.6. When do you plant?

2.1.7. Do you practice intercropping and crop rotation? If yes with what type of crop?

2.1.8. Do you apply any fertilizer? A. Yes B. no

2.1.9. If yes, which type?

2.1.10. Do you apply any chemicals? A. Yes B. no

2.1.11. Which type and at what rate?

2.1.12. For what purpose do you apply? A. For weeds B. for insect-pest and for diseases

2.1.13. From any of the farming practices in use, which of them have an effect on produce quality? A. Irrigation B. weed and disease control C. fertilization practices D. others, specify

2.1.14. How do they affect it? A. reducing its yield due to under/over application B. damaging the plant before and after flowering/fruiting C. reducing its resistance/making it delicate D. All the above three E. others, specify

2.1.15. What are the constraints of production?

2.2. Disease and pests

2.2.1. Are there any problems in the field during production? A. Yes B. no

2.2.2. If yes, which of them would be the major ones?

2.2.3. What is their characteristic? A. Competition for nutrient B. consuming and damaging C. Infecting D. Others

2.2.4. Did you come across with their effect on the quality of produce? A. Yes B. no

2.2.5. What types of symptom/sign do they show on the produce?

2.3. Pre-harvest treatments

2.3.1. Do you practice any pre-harvest treatments to the fruit? A. Yes B. No

2.3.2. What kinds of pre-harvest treatments might affect postharvest quality? A. Residual effect of chemicals B. over watering C. under watering D. mechanical damage by human or animal

2.4. Production costs

2.4.1. What is your average estimated total cost of production (for Inputs, labor, and others)?

2.4.2. What is your net income from tomato?

II. Postharvest

3. Postharvest handling

3.1. Harvesting:

3.1.1. How long does it take to harvest?

3.1.2. Which type of stage do you use for home consumption? A. Mature green B. breaker C. turning D. pink E. light red F. full red G. any stage but mature

3.1.3. Which type of stage do you use for market? A. Mature green B. breaker C. turning D. pink E. light red F. full red G. any stage but mature

3.1.4. What are the indices of harvesting (maturity indices) your tomato? A. Size B. color C. crop calendar D. others, specify

3.1.5. At what time of the day do you harvest? A. Morning B. noon time C. evening D. anytime of the day

3.1.6. Why do you choose the specified time of harvest? A. To prevent transpiration and respiration B. for the sake of early transportation C. because we just do it on that time D. others, specify

3.1.7. What kind of material/containers do you use for harvest? A. any basket B. wooden box C. plastic box D. sacks E. others, specify

3.1.8. Who harvests the produce? A. Men of the household B. women C. children D. whole family E. hired labor

3.1.9. Is the produce harvested at the proper maturity for the intended market? A. Yes B. no

3.1.10. If yes, what is the difference between tomatoes for home consumption and market/processing? A. Red-ripe for home and mature half red for market B. No differentiation for all C. have no idea

3.2. Grading, sorting and inspection

3.2.1. Do you sort and grade after harvest or before selling? A. Yes B. no

3.2.2. If you do not sort and grade, why? A. Not to decrease the amount of produce B. Because I don't expect price difference C. others, specify

3.2.3. If yes, what do you sort from what? A. Ripe from unripe B. Mature from immature C. Damaged from healthy and Diseased from healthy

3.2.4. Why do you sort? A. To reduce damage of the whole produce and to get good price B. To satisfy customers C. To increase the quality/attractiveness of the produce D. To compete for good price with other suppliers

3.2.5. Who sorts the crop?

3.2.6. Where is it sorted? A. Right in the field B. Pack house C. On the market D. others, specify

3.2.7. What happens to the cult? A. used for home consumption B. for animal feed C. sell it at low price D. use it for compost E. others, specify

3.2.8. How do you grade your produce? A. Based on maturity B. based on size C. based on color D. others

3.2.9. Which one is your first grade for local market (size and color)? A. big and red C. Big and Red ripe B. over mature C. mature green D. no specification

3.2.10. Which one is your first grade for long distance market? A. Mixed B. red-ripe C. light red

3.2.11. Have you ever faced value (price) change as your quality/size grades change? A. yes B. no

3.2.12. Is there any voluntary or mandatory body exists for inspection of your product? A. yes B. no

3.2.13. What will happen to the harvested produce if you don't sort or grade?

3.3. Postharvest treatments

3.3.1. Do you apply any postharvest treatments to your produce before taking to store or market? A. yes B. no

3.3.2. If yes, what kind of treatment? A. cleaning B. pre-cooling C. other chemical treatments

3.3.3. Are treatments appropriate for the product? A. yes B. no

3.3.4. Did you take any training about postharvest treatments? A. Yes B. no

3.3.5. If yes, was the training helpful? A. yes B. no

3.3.6. Who provides the training? A.NGO B. Agriculture office C. Research center D. others, specify

3.4. Packaging

3.4.1. How do you pack your produce when you take it to market and storage?

3.4.2. What kind of packages is used? A. sacks B. wooden boxes C. plastic Boxes D. others, specify

3.4.3. Do you use the previous used packing materials again? A. yes B. no

3.4.4. If yes, why is the reason? A. Because of cost of the material B. Because the material is cleaned/treated C. Others, specify

3.4.5. How much does the wooden box alone weigh?

3.4.6. How much does the product of one box weigh?

3.5. Cooling

3.5.1. Do you cool your produce after harvesting and before taking it to sell? A. Yes B. no

3.5.2. If yes, what method do you use to cool it? A. Shade tree B. water bath C. cooling room D. others, specify

3.5.3. How do you think the produce should be cooled?

3.5.4. Is there any temperature-measuring instrument? A. Yes B. no

3.5.5. If no, how do you know the produce is cooled?

3.6. Storage

3.6.1. Do you store tomato? A. yes B. no

3.6.2. If no, why? A. Less production B.

3.6.3. If yes, in what type of storage facility? A. wooden box in cooled area B. sacks in cooled area C. wooden box in ambient condition D. any material in ambient condition E. others, specify

3.6.4. For how long can you store? A. 1- 2 days B. 3-4 days C. 4-6 days D. >6 days

3.6.5. Do you clean and keep your storage's hygiene? A. yes B. no

3.6.6. Under what conditions (packaging, temperature, RH, physical setting, hygiene, inspections, etc.)?

3.7. Transport

3.7.1. How far does the produce travel/transported?

3.7.2. What type of transportation means do you use? A. vehicle/Isuzu B. pack animals C. human head D. Others, Specify

3.7.3. How many times is produce transported to reach the market? A. once B. twice C. three times D. More than three times

3.7.4. How is produce loaded and unloaded? A. container B. Pile/dumped C. Others, specify

3.7.5. Is there any loss of the produce during loading and unloading? A. yes B. no

3.7.6. If yes, how much do you guess, in box?

3.8. Delays/waiting

3.8.1. Are there any delays during handling? A. yes B. no

3.8.2. If yes, at which point do you think is mostly waiting/delaying? A. on field B. on storage C. when taking from field to market

3.8.3. If yes, for how long? A. half day B. one day C. two days D. more than two days

3.8.4. Under what conditions? A. open sun B. on bulk and open sun exposure C. under cooled condition/shade areas

3.8.5. What kind of side effect do you think would result from delays of the produce? A. Quality and quantity loss B. Reduction in price C. Reduction on the encouragement of producing the produce D. Others, specify

3.9. Agro-processing

3.9.1. Do you have any training or awareness on the processing of the crop? A. Yes B. No

3.9.2. If yes, how and did you get it useful?

3.9.3. If no, what is the problem?

4. Marketing

4.1. Market intermediaries

4.1.1. To whom do you sell? A. To collectors/brokers B. directly to consumers C. To local market D. To Unions E. To Wholesalers F. others, specify

4.1.2. Who determines price of the produce? A. Farmers themselves B. Brokers C. Wholesalers/collectors D. Government E. others, specify

4.1.3. Who do you think are the handlers of the crop between producers and consumers? A. Brokers or collectors B. wholesalers C. retailers

4.1.4. How long do they have control of produce? A. Until price get high B. Until price agreement is done C. both "A & B" D. Others, specify

4.1.5. How do they handle it? A. very good B. fairly C. No attention/care and with ignorance

4.1.6. Who is responsible for losses? A. Producers or farmers themselves B. retailers C. collectors or brokers D. wholesalers E. consumers F. All of the actors in the chain

4.1.7. Who suffers financially after all? A. Producers or farmers B. retailers C. wholesalers D. consumers E. producers and consumers

4.1.8. Where is the place to sell? A. farm gate B. local market C. town D. roadside E. others, specify

4.1.9. What type of mode of transport do you use? A. donkey/cart B. Vehicle C. human (being carried)

4.1.10. Does your produce have preferred quality by buyers? A Yes B. No

4.1.11. If No, what interventions are needed to attract better price? _____

4.1.12. What are the problems of marketing? Put them in rank* A. Lack of market B. low price C. Storage D. Lack of market information E. Brokers hinder fair sales F. Perish ability nature of the crop G. Others

4.1.13. How do you make decision as to when to harvest the crop? A. Maturity B. Market price C. Fear of theft D. others (specify) ___

4.1.14. What determines to sell the products to your customers? A. Price B. Proximity C. Fair Scaling D. Others (specify) ___

4.1.15. If you do not find buyers for your product, what do you do to your produce? A. Take home back B. Store it at the market place C. Sell it at lower price D. Dump it at market E. Other specify

4.1.16. Do you negotiate on price? A. Yes B. No

4.1.17. Availability and/or sufficiency of extension/ advisory services. Areas of intervention; production, post-harvest, marketing or processing?

4.2.Market information

4.2.1. Do handlers and marketers have access to current prices and volumes in order to plan their marketing strategies? A. yes B. no

4.2.2. How do you know? Radio B. person to person communication C. others

4.2.3. Is there any recordkeeping in the tomato production? A. yes B. no

4.2.4. Is information accurate, reliable, timely, and useful to make decision? A. yes B. no

4.3.Consumer demand

4.3.1. What specific consumer preference did you came across about the produce? A. Sizes B. flavors C. colors D. maturities E. others, specify

4.3.2. What other criteria and preferences do consumers show while coming to the market beside the crop characteristic? A. Quality grades B. packages types of the produce C. package sizes D. other characteristics, specify

4.3.3. How do consumers react to the use of postharvest handling and certain qualities of the produce? A. no reaction B. more complain C. insult D. discussion

4.3.4. How do consumers react to the cost of tomato? A. positive B. negative C. no reaction

4.3.5. Are there any signs of unmet demand and/or over-supply? A. yes B. no

4.3.6. If yes, what could be the reason? A. less production B. poor postharvest handling C. others, specify

4.4.Exports

4.4.1. Do you sell to export purpose? A. yes B. no

4.4.2. What criteria should the crop specifically fulfill in order to be exported? A. green mature B. red ripe C. other, specify

End of the interview

Thank you so much for responding to the questions.

Name of the Enumerator: _____

Date of Interview: _____

Annex 4: Traders' Interview for CSAM- Analysis in East Shewa Zone

1. Districts/town/city: _____
2. Sex? _____; Age _____
3. How long have you practiced on tomato trading? _____ Years
4. What is your source of Tomato? 1. Farmer/producers 2. Other traders 3 own production
5. When do you do your business? 1. Year round 2. When purchase price becomes low 3.During high supply 4. Other (specify)_____
6. Why do you prefer this crops' marketing? Because of 1. The crop's better quality to deal with 2. High supply and profit 3. Pushed by others' getting benefit 4. by coincidence
7. How do you sale your produce? 1. Direct to the purchaser 2.Through broker 3. Any buyer 4. Other (specify) _____
8. Who sets the price? 1. Traders themselves2. Brokers 3. Negotiation
9. What is your packaging material? 1. Sisal sack 2. Plastic sack 3. Basket 4. Wooden boxes
10. How do you deal with suppliers and/or producers? 1. Giving better price 2. Negotiating and discussing further 3. Fair scaling/ weighing 4.Never thought of special treatment
11. How far does the produce travel/transported till you sell it, in km?
12. Do you have shops/ shades to sell your Tomato? 1. Yes 2. No
13. For how long does it stay/wait until sold totally or if not sold, in days?
14. What do you do, if the product is not sold on time? 1. Through it 2. Take to another market 3. Sell it at lower price 4. Take back home and Sell it on other market day
15. How much box do you run and sell per day? How much does one box product weigh?
16. How much is price of 1 kg and box of Tomato, in Birr?
17. How do you load/unload on truck? 1. with container 2. Piled/dumped 3. Others, specify
18. Is there any loss of the produce during loading and unloading? 1. Yes 2. No
19. How much loss did you come across, kg/box?
20. What are the major reasons/causes for the loss? Put them in order of importance/rank 1. Market fluctuation 2. Nature of the crop (perishable) 3. Sun exposure 4. Diseases, defects due to poor handling during transportation 5. Poor Market-display problem
21. What are the Marketing and post-harvest problems that you face? 1. Credits and saving 2. Training about handling 3. Storage 4. Transportation 5. Brokers who increase the price in between and also delaying the crop-decrease the quality and shelf-life of the crop

End of the interview

Thank you so much for responding to the questions.

Name of the Enumerator: _____

Date of Interview: _____

Annex 5: Consumers' Interview for CSAM- Analysis in East Shewa Zone

1. Districts/town/city
2. Is tomato consumed in your family? 1. Yes 2. No
3. If yes, Experience in tomato consumption? _____ Years
4. From whom do you buy tomato? 1. Wholesalers 2. Retailers 3. Processors; 4. Brokers 5. Others specify)
5. What are the constraints hindering consumption of Tomato, Rank? Supply shortage; shortage of income; lack of storage at home; poor product handling; lack of market information; brokers hinder fair sales; low quality of the crop; less awareness about the importance of the crop but consuming by default
6. Do you know the benefits of consuming tomato? 1.Yes 2.No
7. What is your preference to consume tomato product? 1.Yes 2.No
8. Do you have information on how it is produced and handled? 1. Yes 2. No
9. Do you have information on Prices? 1. Yes 2. No
10. What is your preferred criterion on tomato? 1. Size 2. Color/maturity 3. No criterion
11. How sensitive are you to fluctuation of tomato price? 1. Very sensitive (increase/ decrease in small price changes my inclination to tomato purchase) 2.Moderately sensitive 3.Slightly sensitive 4. Not very sensitive (large price increase won't change my inclination to the fruit purchase)

End of the interview

Thank you so much for responding to the questions.

Name of the Enumerator: _____

Date of Interview: _____

Annex 6: Checklist for Farmers' Group Discussion in Tomato Chain Analysis

I. Group members should:

- ✓ *Respect others and their views*
- ✓ *Strive to be honest and transparent*
- ✓ *Recognize and acknowledge social reactions*

II. The Moderator should

- ✓ *Act as catalyst between individuals of the group*
- ✓ *Strive to enhance capacity of rural people in analysis of problems and opportunities*

- ✓ *Find ways of integrating dominant and quiet people and makes sure that all group members are able to express their opinions*
- ✓ *Make sure that the group keeps to the topic but flexible in handling additional information*
- ✓ *Take care of time management*
- ✓ *Listen carefully to any group member and does not much*

1. Evaluation matrix for SWOT analysis

Districts_____

Strengths of production and post-harvest handling of Tomato	Weakness of production and post-harvest handling of Tomato
• •	• •
Opportunities on production & post-harvest handling of Tomato	**Threats on production & post-harvest handling of Tomato**
• •	• •

2. What is your possible solution to rectify the weakness and threats?

_____

Annex 7: Checklist for Traders Focus Group Discussion

Woreda _____ Kebele _____ Date _____
Name of interviewee _____ Title of the interviewee _____

1. How do traders influence farmers' participation in tomato value chain?
2. What are the major problems in marketing of tomato?
3. Who is responsible for the above problem?
4. What is the quality trend of tomato, improving or deteriorating? Who is responsible for the problem?
5. How much is the loss under your condition/market?
6. How these problems can be solved?

Annex 8: Checklist for Consumers Focus Group Discussion

1. What are the factors that influence consumers demand?
2. What is the trend for tomato demand over the past 5 years? Why?
3. What are the major constraints for service deliveries?

4. What opportunities do exist in tomato development?

5. Is there sufficient supply in quantity, quality, timeliness and prices of tomato?

Annex 9: Checklist for <u>Hotel/Cafe</u> Focus Group Discussion

Districts _____; Kebele _____Date _____

1. How much kg/boxes of tomato do you use daily? And what amount of it is lost?
2. What is the reason for the loss? And what are major constraints of the market?
3. Did you ever take time to think about the use, quality and other cares for tomato?
4. Is there sufficient supply in quantity, quality, timeliness and prices of tomato?

Annex 10: Key Informant Discussion with Research Centers (MARC)

Districts **_____;Kebele _____ Date _____**
Name of interviewee _____ Title of the interviewee _____

1. What are the technologies (variety, agronomic practices and post harvest technologies and soft Knowledge) developed on tomato?
2. What major outputs are achieved on transferring these technologies?
3. What are the major challenges encountered on the actions?
4. Current trend in terms of quality and quantity?
5. Which cultivar/variety is mostly used by the producers?
6. Is there any recorded measured loss of tomato? If yes, how much?
7. Any means of reducing the loss?

Annex 11: Key Informant Discussion with Horticultural Experts (Districts and Zone)

Name of interviewee _____Title of the interviewee _____ Date_____

1. What are the major activities of your office?
2. What are the threats for Tomato extension service and input supply?
3. What are the most important constraining infrastructures affecting tomato production?
4. What are the possible solutions to solve these problems?
5. What are the frequently asked questions coming every time?
6. If available, what is the role of farmers' training centers (FTCs) on tomato production and handling? How?
7. What outputs are achieved on dissemination of tomato technologies; pre-production, postharvest handling, processing and using?