

# Assessment of Post-Harvest Losses of Major Fruit Crops at East Gojjam Zone, Amhara Region

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## Abstract

Ethiopia has suitable agro-ecology to grow both temperate and tropical fruit crops. However, fruit production activity is at infant stage in most parts of the country including in Northwestern Ethiopia and both small scale fruit producers and traders have very limited knowledge and skill on fruit production and postharvest handling practices. In this connection high amount of fruit is expected to be wasted due to several inappropriate production and postharvest handling practices. Therefore, the objectives of this study were to assess fruit causes and extent of postharvest losses at Debre Markos. The study was conducted in April 2017 using semi structured questionnaire. 150 respondents from Farmers, Retailer and Wholesaler were randomly selected among Debre markos and their surrounding fruit Farmers, Retailer and Wholesaler those operating in Debre markos city to obtain information on postharvest losses. The total postharvest loss of fruit at farmer, wholesale and retail level were found to be 24% of which the higher proportion of losses (35%) was observed at retail level while the loss at wholesale and farm levels were 14% and 21%, respectively. Very high losses were observed due to transportation, marketing and postharvest mishandling at market level. Therefore, multifaceted interventions such as capacity development, improved fruit production and harvesting practice, and proper storage and transportation facilities establishment are required to reduce postharvest loss and extend fruit shelf-life.

**Keywords:** Post-harvest, Proximate analysis and wholeseller

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## 1. INTRODUCTION

Ethiopia has suitable agro-ecology to grow both temperate and tropical fruit crops. However, fruit production activity is at infant stage in most parts of the country including in Northwestern Ethiopia and both small scale fruit producers and traders have very limited knowledge and skill on fruit production and postharvest handling practices. In this connection high amount of fruit is expected to be wasted due to several inappropriate production and postharvest handling practices. (Kughur et al. 2015)

According to FAO et al. (2012), The State of Food Insecurity in the World 2012, 870 million people were chronically undernourished during the years 2010-2012 and a majority is living in developing countries. The total percentage of people who does not have enough food in the world has declined since 1990 from 18.6 percent to 12.5 percent. In Western Asia, North Africa and Sub-Saharan Africa. However, an increase in undernourishment has taken place during the last years. In Sub-Saharan Africa 234 million persons, or 26.8 percent, did not have enough food available in 2010-2012 (FAO et al., 2012). Ethiopia is one of the Sub-Saharan African countries that are suffering from poverty and food insecurity as 40 percent of the population were undernourished during the years 2010 – 2012 (www, faostat, 1, 2014).

In order to reduce hunger and malnutrition and promote agricultural growth there is a great demand for investment and progress in the agricultural sector in many developing countries (FAO et al., 2012). Horticulture can be an important factor for economic development and contribute to increased food security and improve the populations' nutrition intake (Weinberger & Lumpkin, 2007). The growing population and changing dietary habits in Ethiopia has increased the demand for fruit (ILRI, 2011). Especially the demand for local fruits with higher quality for example mango, banana, papaya, apple and avocado are emerging. The fruit production in Ethiopia has been small compared to other crops but it has a great potential since the climate is favorable for many horticulture products (Berhel et al., 2010). Two examples of fruits were the production have increased with over 60 percent during the last 10 years in Ethiopia is avocado and mango (www, faostat, 2, 2014; www, faostat, 3, 2014). Food losses after harvest until the food reach the consumer are significant (www, FAO, 2, 2014). According to FAO (www, FAO, 2, 2014) post-harvest losses in developing countries can range from 15 percent up to 50 percent. Horticultural crops, such as fruits, are perishable products and therefore sensitive which leads to greater losses than for non-perishable crops (Parfitt et al., 2010). To increase food availability, it is therefore not enough to increase the productivity in agriculture there is also a need to lower the losses. A problem in the supply chain for fruits in Ethiopia is that the knowledge about post-harvest handling is limited and the post-harvest losses are high (ILRI, 2011; Wakijira, 2010). Losses occur in all post-harvest activities such as handling, storage, processing, packaging, transportation and marketing. Handling and processing of the food are of high importance in order to ensure food-safety reduce losses (Kader, 2003).

In order to define post-harvest losses, it is important to do a systematic analysis of the production and handling system and therefore the supply chain for the product (Bell et al., 1999). For tropical food supply chains

for products such as mango and avocado there are common features and characteristics (Ruben et al., 2007). There is often large variations in the supply of products and variability in product quality due to different growing seasons, weather changes and production technology used. The production is mostly scattered and undertaken by a large number of small farmers which are producing for local markets with a limited amount of traders. To reach more central markets there is commonly a large number of middlemen between the producers and consumers (Shukla&Jharkharia, 2013).

The access to information, new production technology, credit and external services are constrained in many supply chains in developing countries and the infrastructure are often weak (Trienekens, 2011). Major causes for food waste are insufficient operational activities within supply chains, such as handling, storage and transportation (Murthy et al., 2009). In food supply chain management, the major concerns are post-harvest losses. An efficient supply chain management can therefore be a way to decrease post-harvest losses (Shukla&Jharkharia, 2013). In many developing countries there is a demand for more knowledge about postharvest loss management and implementation of improved post-harvest technologies (Kitinjo et al., 2011).

## 1.2 Problem statement

As stated in the previous section there is a great need of increased food security in Ethiopia and the horticulture production can be part of solving this problem. Research also shows that post-harvest losses contribute to undernourishment and food insecurity in developing countries. The losses occur within the whole supply chain due to limited resources such as post-harvest technology, knowledge and infrastructure (Parfitt et al., 2010). The losses for horticulture products, such as mango and avocado, are more complex as they are perishable products and depending on climate conditions (Van der Vorst & Beulens, 2002; Salin, 1998). Horticulture can apart from increasing food security also be an opportunity to increase the income for small-holder farmers. In order to increase food security, it is not enough to increase the productivity in agriculture but there is also a great need to lower the losses (Parfitt et al., 2010). Horticulture research has historically focused on how to increase the production and little emphasis has been made on how to minimize post-harvest losses (Kitonja et al., 2011). The amount of losses within a supply chain is dependent on activities such as handling, storage, processing, packaging, transportation and marketing (Kader, 2003). It is though not only the activities undertaken by the actors within the chain that affect the performance (Trienekens, 2011). The interactions between the actors and external factors such as governance structures, market access, infrastructure and information flow also have impact on the performance and level of efficiency to reduce the losses.

Higher postharvest losses not only reduce the availability of fruits but also result in increase in per unit prices of the produce and thus limit the accessibility by the majority of community segments. Kughur et al. (2015) pointed out the multiple effects of postharvest loss as going beyond the loss of the actual crop to include loss in the environment, resources, labor needed to produce the crop and livelihood of the individual involved in the production process. However, it is important to note that much is being invested to production compared to postharvest handling, though 30 to 50% of the produce is wasted in few days after harvest. So far there are very limited reports on the causes and amount of fruit postharvest loss in Ethiopia. However, there was no information on the cause and extent of fruit post-harvest loss in Debre Markos. Therefore, the present study was conducted to assess post-harvest losses of major fruit at Debre Markos market.

## 2. Material and methods

### 2.1 Study area

The study was conducted in Debre Markos market in the year 2017. Debre Markos, the capital of East Gojjam Administrative Zone is located in the northwest of the capital city of Ethiopia, Addis Ababa at a distance of 300 Km and 265 Km to the capital of Amhara Nation Regional State Bahir Dar. The Geographical location of the study area is located between 10°17'00" to 10°21'30" N Latitudes and 37°42'00" to 37°45'30" E longitudes and its elevation ranges in altitude from 2350-2500 meters above sea level. The town has 1380 mm average annual rainfall and minimum and maximum temperatures of 15 °C and 22°C, respectively.

### 2.2 Sampling Procedure and research design

150 respondents from Farmers, Retailer and Wholesaler were randomly selected among Debre markos and their surrounding fruit Farmers, Retailer and Wholesaler those operating in Debre markos city. The survey was conducted in April 2017 using semi-structured questionnaire following individual interview method.

### 2.3 Preparation of structured questionnaires

For the loss assessment study this research was used a standard and well prepared tool published by FAO. A postharvest loss assessment method as Commodity Systems Assessment Methodology (CSAM) was originally developed by Jerry LaGra (1990), and modified during its implementation over the course of many years. Modification of some components into our local context has been made.

## 2.4 Data Collection

Both qualitative and quantitative data including sex, age, education level and length of fruit marketing experience of respondents, type of fruit they are selling, type of packaging material, transportation method, storage facility, source of fruit, percentage of fruit loss, percentage fruit loss in different seasons, possible uses of over-ripen fruits, and measures taken by respondents to reduce postharvest losses were collected using the questionnaire.

## 2.5 Data Analysis

The data generated from the questionnaire was analyzed using a template before applying descriptive statistics of frequency and percentage (Trochim, 2006). Statistical Package for the Social Sciences (SPSS) and STATA 8 program were used to generate data.

## 3. RESULTS AND DISCUSSION

### 3.1 PRODUCERS

#### 3.1.1 Time of harvesting

The results for harvesting time of the fruits presented in Table shows the respondents (34.21, 31.58, 28.83 and 5.26%) harvest fruits early in the morning, Evening, Anytime of the day and Afternoon respectively. Kereth et al. (2013) reviewed that 95% of farmers harvested fruits in the morning in a study conducted in Bagamoyo district of Tanzania.

Harvesting in the afternoon has been reported to be a cause of high postharvest losses because of high temperatures and evaporation which causes the fruit to shrink, thus affecting the marketing quality. Similar results have been reported by Genova et al. (2006) and Kereth et al. (2013) that harvesting activities should be completed during the coolest time of the day, which is usually in the early morning and produce should be kept shaded in the field and handled gently.

In study area 26.39, 18.42, 17.27 and 7.89% of respondent harvest fruit at the stage of full ripe, Green mature, half mature and immature respectively.

#### 3.1.2 Types of fruit Crop in study area

The fruit grown in the study area include Mango Avocado Apple and Banana as shown in table above. They reported that (60.53%, 21.85, 10.53 and 7.89 %) of farmers who participated in the study are cultivated Mango, Avocado, Banana and Apple respectively.

#### 3.1.3. Fruit packaging materials

Fruit packaging has significant importance in reducing postharvest losses through protecting fruits from mechanical damage, undesirable physiological changes and pathological deterioration during storage, transportation and marketing. In the study area, farmers use different packaging materials to transport and store fruit crops. About 60.08 30.09 6.67 3.33 % respondents reported, Basket, Sack/bag, Leaf Plastic cart as their fruit packaging materials, respectively. Seid et al. (2013) reported sack as the major fruit packaging material in South Wollo zone, Ethiopia. Transporting fruits without packaging material will increase fruit spoilage by predisposing the fruit to mechanical damage during loading and unloading as well as during driving on rough road.

#### 3.1.4 Method of transportation to local store

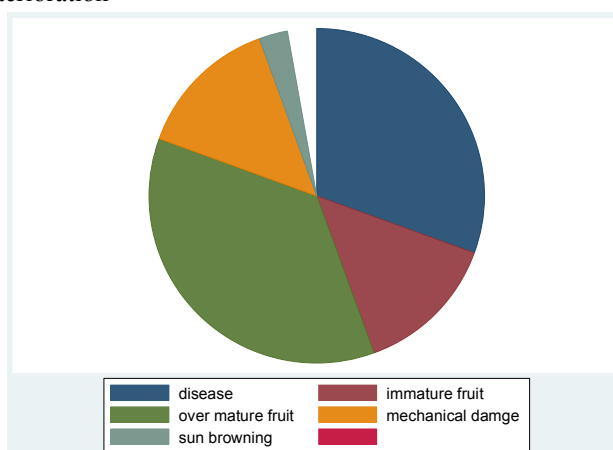
Farmers transport both from distant and nearby areas. Therefore, they are using different transportation methods in above table about 42.11, 34.21, 21.05, % of respondents reported that fruits are transported using women's back, using animal driven cart, and using man shoulder usually from distant areas. All transportation methods predispose fruits to heat buildup and mechanical damage. Therefore, the present fruit transportation method contributes for fruit postharvest loss. Seid et al. (2013) reported pack animals as major transportation system of fruit from production site to the local market in South Wollo zone, Ethiopia.

#### 3.1.5 Time until loading to market

Above table shows that produce storage prior transporting to the market ranged from 1 hr to a maximum of one day. These results show that some farmers (zero storage time) harvested and delivered to the market at the same time without storing the produce at the farm. Considering that none of the farmers in the study area have cold storage facilities at their farms, storage of produce for long periods such as One day as reported in Table above is a contributory factor to high postharvest losses. This will result in rapid quality loss of the fruits especially in summer when temperatures are generally high. Minimizing the time spent keeping harvested produce at the farm will help in reducing postharvest losses as suggested by Kader (2005) who argued that as the time the produce stays in the market increase from the time of purchase, its deterioration also increases.

About 57.69, 18.53, 15.79 and 15.79% of respondents reported heaping under shade and covering with leaf, heaping in open air, heaping in open space and covering with leaf and others materials respectively.

Fig 1 factors for quality deterioration



Parameter		Freq.	Percent
Type of packing material	Leaf	2	6.67
	Basket	10	60.08
	Sack/bag	9	30.09
	Plastic cart	1	3.33
Time until loading to market	< 2 hr	18	47.37
	half a day	18	14.37
	one day	2	2.63
Store until loading	heaping in open space and covering with leaf	6	15.79
	heaping under shade and covering with leaf	22	57.69
	heaping in open air	4	18.53
	others material	6	15.79
For whom you sell	collectors	5	13.16
	wholesalers	2	4.26
	cooperatives	2	4.28
	retailers	21	55.26
	consumers	8	21.08
Why you prefer whole buyer	better price	13	34.21
	customers	9	23.68
	quality discrimination	1	2.63
	large volume of purchase	15	39.17
You sell all	yes	9	23.91
	No	29	76.12
Why not all	quality problem	21	58.33
	low price	3	13.66
	own consumption	2	12.61
	reduced interest of buyer	2	13.1
	quality discrimination	1	2.63
Reason for reduced quality	improper production practice	10	43.24
	inefficient care during harvesting and transportation	16	51.35
	inadequate storage facilities	3	5.41
Percentage fruit of unsuitable for market	10 %	9	23.68
	20%	14	36.84
	30%	13	34.21
	40%	2	5.26

Table 1. factors that contributing postharvest loss at farmer level with respected loss percentages

### 3.1.6 Factors for quality deterioration

Causes of fruit postharvest losses are usually interrelated. Therefore, respondents requested to rank causes of fruit postharvest losses in terms of their contribution on fruit spoilage. These responses are given in Table 1, About 36.11, 30.56, 13.89, 13.11 and 4.26% of respondents ranked over mature fruit, mechanical damage,

Immature fruit and sun browning as cause for high postharvest losses. From these observations, it is evident that the major factor causing the loss of the produce was mature fruit followed by mechanical damage and immature fruit finally poor quality of the produce. Our findings substantiate the report by Mbuk et al. (2011) who reported that mechanical damage and softening had significant effect on postharvest losses of fruit. Similarly, FAO (2004), mechanical damage identified as important determinants for the postharvest loss fruit.

### 3.1.7 Percentage of fruit unsuitable for market

Table 1 shows that the percentage of fruits lost at farmer level: on average, 24% of the fruit were lost. Kughur et al. (2015) reported 35 to 45% postharvest loss on fruit and vegetable in Nigeria. About 33.3% postharvest loss is not affordable for a country with large number of food insecure population.

## 3.2 RETIELAR RESULT DISCUSSION

As indicated in Table 2 and figure 2, climate and seasonal conditions, harvesting and handling techniques, packaging, storage and transportation and market situations were mentioned by almost equal proportion of respondents. Factors such as disease and Mechanical damage was mentioned by relatively less number of respondents.

Post-harvest loss and quality deterioration of horticultural crops occurred due to lack of proper care, use of inappropriate harvesting equipment and materials and lack of motivation and interest to improve and upgrade the harvesting and handling techniques from time to time. Problems related to packaging, storage and transportation facilities as factors for horticultural crops loss and quality deterioration were stated by the respondents. Marketing situation as major cause of post-harvest loss and quality.

Table 2. factors that contributing postharvest loss at Retailer level with respected loss percentages

Parameter		Freq.	Percent
Amount of fruit bought	50kg	31	75.61
	100 kg	9	21.95
	200kg	1	2.13
Amount of fruit sold	50-69 kg	29	79.74
	70-89kg	6	14.63
	90-100kg	6	14.63
You sell all fruit you bought	no	39	95.12
	yes	2	4.88
Reason if you couldn't sell all the fruit you bought (if the above answer is No )	poor quality	29	67.99
	own consumption	2	4.88
	reduced market demand	11	26.83
If the reason is poor quality prioritizes	softening-rotting-MD	5	12.20
	softening--MD-rotting	14	34.15
	Md-rotting-softening	22	53.66
Percentage unsuitable for market	10 %	7	17.07
	15 %	21	51.22
	20%	13	31.71
Percentage of fruits which is consumed at home	3 %	35	85.37
	6 %	4	9.76
	7 %	1	2.44
	10 %	1	2.44
Supply shortage	Yes	33	80.49
	No	8	19.91
In Which season the Supply shortage encounter	Summer	19	46.34
	Winter	22	53.66
Seasonality of demand	Yes	19	13.34
	No	22	53.66
In which season the demand raise	Summer	23	56.10
	Winter	18	43.90
In which season the demand fail	Summer	17	41.46
	Winter	24	58.54
Is the Price vary	Yes	28	68.29
	No	13	31.71
When the price rise	Summer	21	51.22
	Winter	20	48.78

Fig 2 types of packaging material of fruit

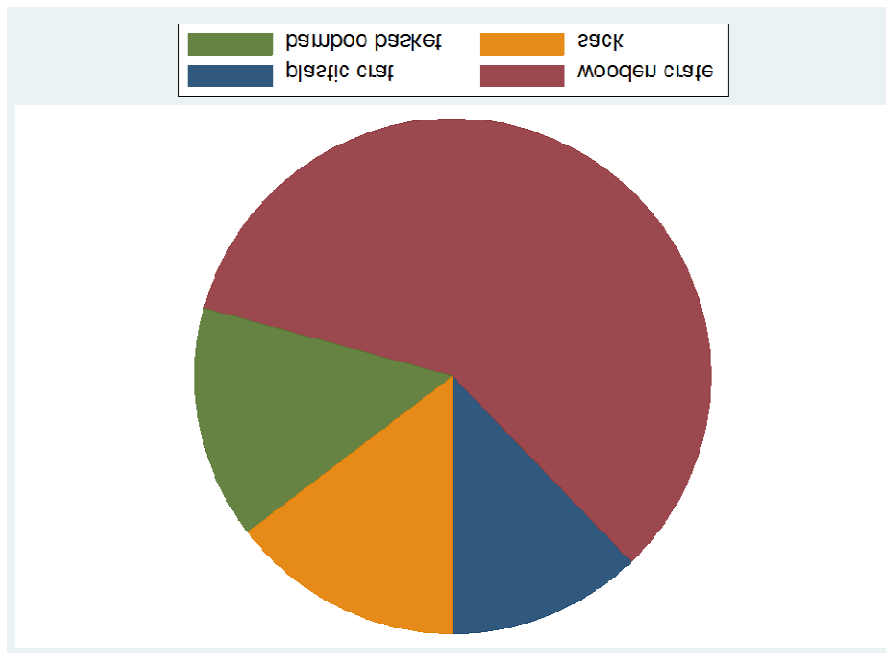


Fig 3 types of storage material used to Store fruit

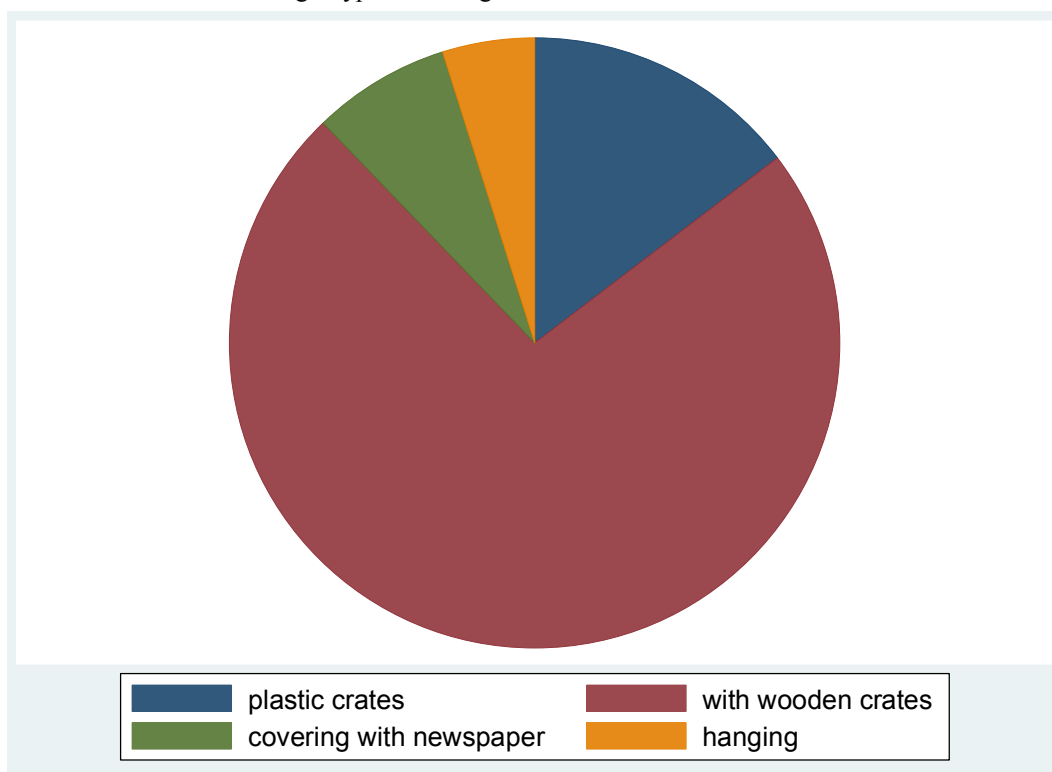
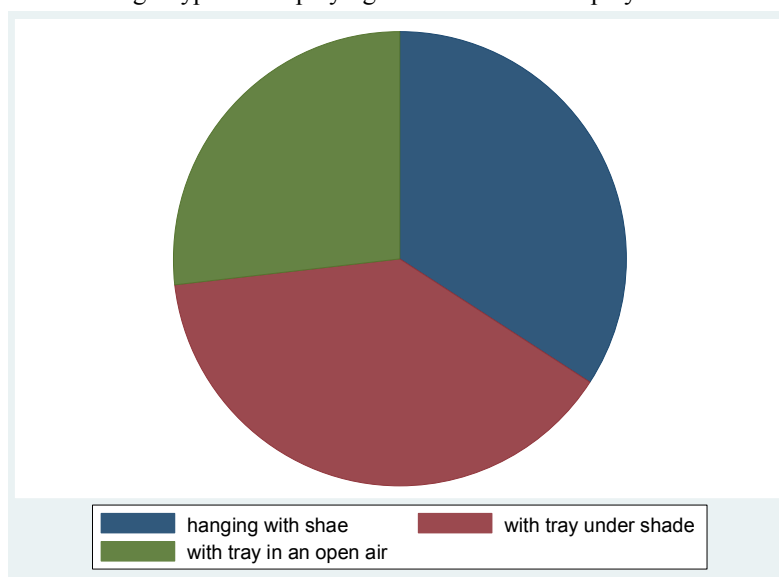


Fig 4 types of displaying material used to display fruit



## Discussion

The horticultural crops are inherently liable to deteriorate under different climatic and other circumstances due to their high moisture content (Kitinoja and Kader, 2002). Moreover, as they are biologically active and carry out transpiration, respiration, ripening and other biochemical activities, they tend to lose and deteriorate through time. This makes the post-harvest losses to occur in the field, packing areas, in storage, during transportation and marketing. Severe losses occur because of environmental conditions, poor facilities, lack of know-how, poor management, weak marketing processes or simply due to carelessness of farmers. Proper storage conditions, temperature and humidity are needed to lengthen the storage life and maintain quality of horticultural crops (Kitinoja and Kader, 2002). This has a negative effect on most horticultural products as a major factor for post-harvest loss and quality deterioration. Horticultural crops may be characterized as being either climacteric or non-climacteric, depending on their respiratory pattern. Climacteric fruits can be harvested when mature but before the onset of ripening. After the climacteric, the respiration rate slows down as the fruit ripens and develops quality (Sirivatanapa, 2006).

Mechanical damage during harvest can become a serious problem by disposing it to decay, increasing water loss, respiration and ethylene production rates, which leads to deterioration (Kitinoja and Kader, 2002). Bruises and other mechanical damage affect appearance and also provide entrance to decaying organisms (Olayemi et al., 2010).

The majority of respondents seem to harvest during relatively appropriate time concerned with temperature and humidity, although night or early morning harvesting is used to lower internal temperatures and used for reduction of the energy needed for subsequent cooling (Kitinoja and Kader, 2002).

The severe horticultural crop post-harvest loss and quality deterioration were recorded mostly during harvesting followed by marketing, transporting, storage and in some cases through the entire channel. This is because fresh produce after harvest continues the process of respiration and transpiration until its reserved food and water are exhausted (Sirivatanapa, 2006). This physiological process is influenced by temperature, composition of surrounding air, and humidity of environment. Although harvesting was carried out by hand rather than machine, some horticultural crops can be severely damaged by careless and inappropriate harvesting. Absence of the use of maturity index as a standard cause high post-harvest loss and quality deterioration (Kitinoja and Kader, 2002).

The use of transportation on rough road and open and closed lorry including public buses causes mechanical damage to horticultural crops as a result of vibrations and high temperature (Singh and Singh, 1992). The use of poor packaging material that restricts ventilation will also cause post-harvest loss and quality deterioration of horticultural crops (Olayemi et al., 2010). The desired level of development in horticulture has not been achieved because of a number of constraints. Due to absence of proper storage and marketing facilities, and seasonal surplus, farmers are forced to sell their products at thrown-away prices and at the earliest opportunity after harvest (Wei et al., 2001). This also forces producers to sell their horticultural crops at very low prices for their customers. Furthermore, the lack of ability in business planning, lack of marketing knowledge and the perishability of their products contribute to their weak influential position in the supply chain (Wei et al., 2001).

The estimated post-harvest losses of fruits and vegetables range from 20% to 40% (Wiersinga and de Jager, 2009). Increased returns to growers might come from proper management after harvest (Wiersinga and de Jager, 2009).

The increasing horticulture production can contribute to the commercialization of the rural economy and creates many jobs. However, expanding the scale of horticulture production is often hindered by lack of market access, market information and many biological factors (Abay, 2007). BezabihandHadera, (2007) also argued seasonal production to be inversely related to price. Information on price, product demand, product supply, market place and buyers and sellers should be gathered.

### 3.3 Postharvest loss at wholesale level

All respondent from wholesaler side distribute banana. fruit Mechanical damage was also mentioned by majority of the wholesalers (60%) as the main cause for fruit(banana) loss at wholesale level while failure to pulp softening and improper maturity were noted by the remaining 25% and 15% of the respondents, respectively (Figure 2). The processes of fruit handling and packing from harvest through transport and marketing might contribute for mechanical damage to banana at whole sale market. Poor handling, unsuitable containers, improper packaging and transportation are indicated to easily cause bruising, cutting, breaking, impact wounding and other forms of injury leading to fruit deterioration (delAguilaet al., 2010). Similar results were reported by Ilayaset al. (2007) stating higher mechanical damage to bananas at whole sale and retail marketing than at harvesting level within the supply chain.

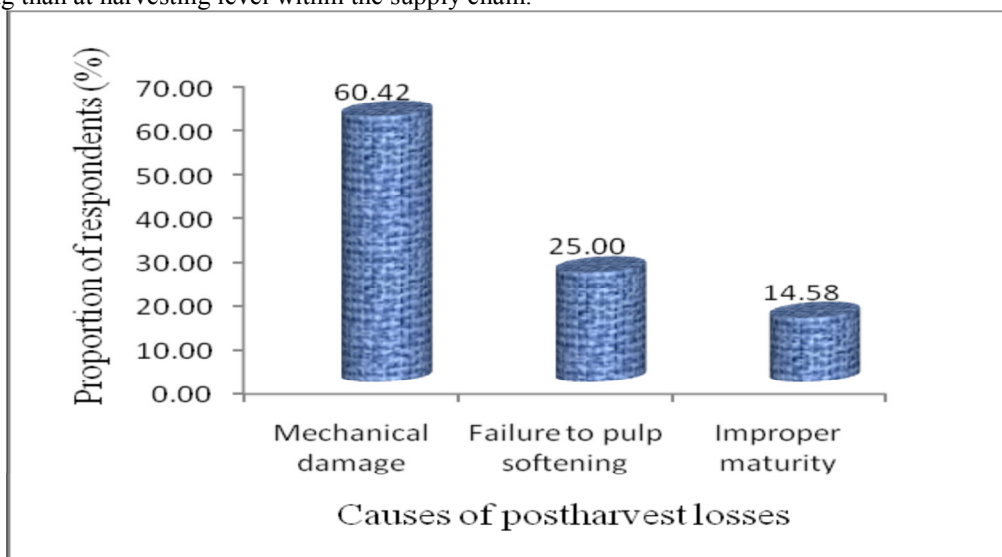


Figure 5. postharvest loss of banana at wholesale level.

### 3.4 Extent of losses

The total postharvest loss of fruit at farmer, wholesale and retail level were found to be 24% of which the higher proportion of losses (35%) was observed at retail level while the loss at wholesale and farm levels were 14% and 21%, respectively. The high percentage loss observed at the retail level could be accounted for the cumulative effect of improper handling from harvest to retail level. The perishable nature of ripe fruits also makes the problem worse at the retail level. The relatively lower magnitude of loss at farmer and wholesale level could be explained by the fact that farmers and wholesalers are mostly dealing with green fruits. Moreover, the damage is prevalent later at ripening; green fruits are more tolerant to handling problems. Similar to this, lower losses were reported by Wanjari and Ladaniya (2004) for unripe bananas compared to the ripe ones.

Table 4. Postharvest loss of banana at farm, wholesale and retail level

Supply chain	Loss %	Share in total (%)
Farm level	4.5	17
Wholesaler level	7.1	26.8
Retailer level	14.9	56.2
Total	25.5	100

## 4. SUMMERY AND CONCLUSSION

Ethiopia has suitable agro-ecology to grow both temperate and tropical fruit crops. However, fruit production activity is at infant stage in most parts of the country including in Northwestern Ethiopia and both small scale fruit producers and traders have very limited knowledge and skill on fruit production and postharvest handling



practices. In this connection high amount of fruit is expected to be wasted due to several inappropriate production and postharvest handling practices. Inappropriate storage, packaging and transportation practices are identified as principal causes for the 24 % fruit postharvest loss in the study area. About 24% postharvest loss is not affordable for a country with 1 food insecure population. Therefore, efforts required on fruit storage and transportation infrastructures establishment, fruit processing, and capacity development to reduce the recorded high fruit postharvest loss and make available for consumers throughout the year.

## 5. RECOMMENDATION

In general, the mishandling during harvesting, packaging, transportation and storage and unfavorable climatic condition and contamination are causing mechanical, pathological and physiological damage. The support given for the improvement and reduction of post-harvest loss and quality deterioration of horticultural crops from concerned bodies is low and insufficient. Therefore, urgent intervention to the existing problems is highly required. In addition, an effective and efficient intervention policies and strategies need to be developed.

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