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A study on the causes of apple *(Malus Domestica)* fruit loss at Chencha Woreda of Gamo Gofa Zone, Southern Ethiopia

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Apple (*Malus domestica*) is a temperate climate fruit tree grown in the highland climates. Specifically, it is widely and largely cultivated in the Gamo Gofa administrative zone at Chencha woreda in Ethiopia. Although there is inadequate information regarding the cause of fruit loss, some other details reveal the production status of the fruit in the area. This study was aimed at assessing the causes of apple fruit loss at harvest, transport and storage conditions in the study area. Survey was done in selected twenty kebeles known for high apple fruit production. A total of 60 respondents (males and females) were purposely pre-selected with the help of woreda agricultural extension experts based on their experience in producing the fruit. Group discussion, interviews and field observation were held. Farmers were interviewed using easy and relaxed questionnaires. Data was analyzed using SPSS software version 20. From total respondents interviewed, 46.7, 53.3 and 43.3% of them reported fruit bruise and wound while harvesting, lack of appropriate box/bag during transport, absence of storage facility respectively accounted for the maximum loss of the fruit in the study area. Only 8.3, 10 and 11.7% of total respondents reported loading and unloading during transport, knowledge gap on how to pick the fruit at harvest along with apple varieties under cultivation and during storage aas factors for the loss of fruit. Therefore, provision of training on fruit postharvest management and handling, harvesting containers, bag/boxes and developing of storage technologies (local/improved) are vital.

Key words: Fruit loss, harvesting, transport, storage.

INTRODUCTION

Apple (*Malus domestica*) is a temperate climate fruit tree native to many parts of Europe and Asia. The leading apple growing country is China, producing about 41% of the world's apples, followed by the United States (Ferenc, 2008). Apple fruit tree was first brought to Chencha area in the Gamo hills by missionaries (Kale-Hiwot Church) about 60 years ago. Even though Ethiopia is not found in the temperate zone, temperate fruits like apple, pear and plum are currently widely adapted, grown and produced in Ethiopian highlands of the different regions by virtue of

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high altitude. The Chencha area, a district (Woreda) in the Gamo Gofa administrative zone of the southern region of Ethiopia, has nearly 50 years of experience in growing highland fruits including apple, pears and plums (Timoteos, 2008). Specifically, in Ethiopia apple is a widely and largely cultivated temperate fruit grown in the Gamo Gofa administrative zone at Chencha woreda. Following the expansion of its production in Chencha and other areas, there is a growing demand for apple in central and local markets in Ethiopia (Seifu et al., 2014).

Chencha district is conducive to producing more than 100 varieties of apples and also serves as a resource base for the rest of the country (Timoteos, 2008). According to Seifu et al. (2014), appropriate standards for tree management and agronomic practices have not been determined for successful apple fruit production in Chencha area. However, yields varied depending on varieties, age, tree management (pruning and training) and agronomic practices (watering, cultivation, manure application, disease and insect pest management) applied. However, the area is with such long years of experience in apple fruit tree production and management the fruit loss is very high during harvesting, transporting and storage time. Even though many factors accounted for the loss of apple fruit in the study area, these are the critical postharvest factors responsible for the loss of the fruit and the cause should be studied.

The production of apple fruit in the area have been impacting the livelihood and serves as a source of income for growers and small holders. The quality and condition of produce sent to market and its subsequent selling price are directly affected by the care taken during harvesting and field handling. However, there are many biotic and abiotic factors that could cause fruit loss and affects the fruit quality in Chencha district. According to Timoteos (2008), lack of capacity, knowledge and skills in fruit tree management, harvesting, transportation and storage systems were the identified problems that constrain the quality of apple production and marketing in the area, and needs intervention strategies to improve the system. Behailu and Sabura (2017) reported complete harvest and sale due to lack of storage facility as the common practice. These, at a time, creates a higher supply and lower demand in the market which results in lower fruit price and lower income to producers. Fruits are sold at farm gate price by producers and through different actors in the market chain reaches consumers at local and distance markets. Harvesting of the fruit in the study area have been done using hand picking by mere selection of the ripe fruit from the tree not considering maturity index factors. In the study area, while harvesting and transporting fruit bruise, breakage and wound are the commonly faced problems, these subsequently affects the fruit size, shape, color, quality and resulted in poor price (Woreda Agriculture and Rural Department Office - WARDO, 2014). In order to maintain quality and keep loss of fruit harvesting, transporting and storage should follow the basic principles and operations.

Growers should be skillful and have knowledge of how to harvest, transport and store the fruit to get quality apple fruit at the end. In Chencha district, there were no improved postharvest handling methods that have been developed and the loss was becoming very high due to inappropriate handling, harvesting, transportation and storage of the fruit. Thus, in this survey, specific factors that cause fruit loss during harvesting, transportation and storage of the fruit were studied at Chencha woreda of Gamo Gofa zone.

MATERIALS AND METHODS

Description of the study area

The survey was conducted in Gamo Gofa administrative zone of Chencha woreda, Southern Nations, Nationalities and Peoples Region (SNNPR). Chencha woreda is located in the Gamo Gofa administrative zone of the SNNPR of Ethiopia with an altitude ranging between 1600-3200 masl. Apple has become a very valuable crop in the area and is highly cultivated over large hectares. It has two agro-ecological zones: ‘dega’ (2300 – 3200 masl, 82%) and ‘woina dega’ (1500-2300 masl, 18%); with total area of 37,650 ha. The population of the woreda is 125,628 (Female: 66,363 and Male 59,263) and 21,655 households, of which 2461 households are female headed. It is one of the most populous districts in the zone. The major means of livelihood is subsistence agriculture followed by traditional weaving and causal labor employment (WVE, 2012). The woreda encompasses 50 (45 rural and 5 urban) administrative kebeles. The mean annual temperature and rainfall of the study areas are 22.5°C and 810 – 1600 mm/annum respectively.

Data collection, sampling and survey methods

Survey was done to assess factors that were contributed for loss of the fruit in the study area. The questionnaires were prepared to collect information about the causes of fruit loss during harvesting, transporting and storage of the fruit. Twenty potential apple fruit growing kebeles and three model farmer respondents from each kebeles’ were purposely preselected in the study area with help of woredas’ agricultural office extension experts. A total of 60 farmer respondents were listed in a separate sheet and used for the interviewee.

The survey data were collected with the help of validated and pre-tested interview scheduled through personal interviews by the researcher team and with the help of the woreda agricultural extension experts. The interviews and discussions were conducted in the local language (Gamugena). The causes of fruit losses at harvest, transport and storage condition were asked and recorded and discussions were made with respondents.

Methods of data analysis

The descriptive statistics was used and data were presented in percentages and tabulation form. The data were coded and entered in SPSS software version 20.

Table 1. Respondents' gender and household status.

Gender and household status	Frequency	%
Male led household	44	73.3
Female led household	16	26.7

Source: Own survey result (2016).

Table 2. Respondents' educational status.

Educational status	Frequency	%
Primary	15	25.0
Junior	12	20.0
High School	14	23.3
Diploma	11	18.3
Illiterate	8	18.3

Source: Own survey result (2016).

RESULTS AND DISCUSSION

Respondents' gender, household and educational status

From the total purposely pre-selected twenty potential apple fruit growing kebeles, 60 model farmers' respondents were interviewed and among this, 26.7% were females and 73.3% were males (Table 1)' this implied that most of the households in the area were headed by male than female. As indicated in Table 2, from the total, 25, 23.3, 20 and 18.3% of respondents were found to have attained primary, high school, junior education and diploma holders respectively. Only 13.3% of the respondents were illiterate. The finding showed that a large portion of the households attained primary and high school education. In line with this, Seifu et al. (2011) reported that most of the sampled respondents (39.8%) attained primary school education and 26.6% were above secondary school. Contrary to this study, they reported that a significant portion of the respondents (33.7%) had never been to school.

Fruit loss while harvesting

Apple fruit deterioration as well as quantity/physical losses starts from harvesting. The result showed in Table 3 revealed that from the total interviewed, 46.7, 25, 18.3 and 10% of the respondents reflected bruise and wound, lack of fruit picking bags, knowledge and awareness gap among fruit growers on how to pick the fruit are factors for the deterioration of apple. The respondents revealed that the causes vary in degree of fruit loss. In this finding, the respondents (46.7%) interviewed revealed that fruit bruise and wound due to either dropping or throwing fruit against other fruit or other surfaces, along with finger bruise contributed a lot to loss of the fruit. They claimed that this is probably due to improper hand harvesting, climbing on fruit tree and pulling down the fruit bearing branches. Harvesting of the fruit has been achieved in the area by hand picking and pulling down the fruit bearing branches According to Kupferman (2006), bruise has been a problem since apples were first harvested and harvesting activities play a major role in bruise development. In agreement to Wills et al. (2007), apple fruit is vulnerable to physical injury and hand harvesting is mostly used for fresh market. Lack of fruit picking bags (25%) is also another factor that leads to the loss of the fruit during collecting and harvesting since dropping of fruits thus results in mechanical damage to the fruit. According to Mitcham and Mitchell (2002), dropping of the produce is a common cause of impact damages. During the discussion, the respondents (18.3%) informed that breakages of fruit bearing branches when farmers' climbs on tall fruit trees or bend the branches mainly due to the lack of ladder while harvesting is responsible for loss of the fruit. This method disturbs the tree, usually causing other fruits to fall down to the ground and possibly leads to significant bruising. In line with this, Thompson (2003) has stated it is difficult to harvest the apple fruits which are bearing on trees and conventionally the picker would carry a ladder and use that to reach the fruit. Only 10% of the respondents confirmed that knowledge and awareness gap among fruit growers of how to pick the fruit is another factor for the loss of produce by creating unnecessary mark or damage on the surface of the fruit while detaching the fruit from the tree. According to Timoteos (2008), lack of capacity, knowledge and skills in fruit management and harvesting is one of the constraints that lead to fruit loss in the study area.

Fruit loss during transport

Handling and transport, represents a serious hazard to quality and has the potential to significantly reduce the value of the product (Van Zeebroeck et al., 2007). In this finding, as presented in Table 4, and from the total interviewed, 43.3, 33.3, 15 and 8.3% of the respondents reported that lack of appropriate bag/boxes, fruit bruise and wound, poor transportation system along with loading and unloading, respectively accounted for the loss while transporting the fruit. In this study, the respondents (43.3%) explained that apple fruit produced in the study area has been marketed by different actors in the market chain until it reaches the consumer; however, no designed boxes or bags are available to bring the fruit to distant and nearby places. Therefore, after harvesting, the apple fruit still faced different challenges that would result to loss and damage of the fruit. The respondents confirmed that sacks and locally prepared material from bamboo "kirechat" are mostly used as a box or container.

Table 3. Respondents' response about the causes of fruit loss while harvesting.

Cause of fruit loss	Frequency	%
Bruises and wounds	28	46.7
Lack of fruit picking bags	15	25.0
Breakages of fruit bearing branches during harvesting	11	18.3
Knowledge and awareness gap of how to pick the fruit	6	10.0

Source: Own survey result (2016).

Table 4. Respondents' response about the causes of fruit loss during transportation.

Cause of fruit loss	Frequency	%
Lack of appropriate box or materials	26	43.3
Bruises and wounds	20	33.3
Poor transportation system	9	15.0
Loading and unloading	5	8.3

Source: Own survey result (2016).

Table 5. Respondents' response about the causes of the fruit loss during storage.

Cause of fruit loss	Frequency	%
No storage system adopted or introduced	32	53.3
Lack of appropriate storage box	13	21.7
Shrinkage and weight loss	8	13.3
Varieties cultivated	7	11.7

Source: Own survey result (2016).

They reported that even tough disposable "carton'', which is left from other use, was used as a bag/boxes to bring the fruit to distant places since the maximum weight load per small carton size results in the fruit bruised, suffocated and heated due to maximum temperature inside carton. However, there are cooperatives engaged in fruit marketing and have been using plastic containers for collection of the fruit from their members, though this is insufficient and small in number. In line with the study, Mohammad (2011) reported that improper bags used by farmers possibly results in damages to the fruits.

According to respondents (33.3%), bruise and wound was probably due to fruits constantly hitting the side of the container, fruits hitting each other, along with excess loading are factors for the deterioration of the fruit during transportation. Similarly, Knee and Miller (2002) reported that during fruit transportation, bruising is the major postharvest mechanical damage problem. Dynamic forces during fruit transport and handling cause is by far the most bruise damage (Van Zeebroeck et al., 2007). They reported also that poor transportation system (15%) due to speeding vehicle on rough road, sudden starting or stopping of vehicle, vibration of the vehicle causing load movement also accounted for the loss of the fruit. In general, they confirmed that public transport or "Isuzu Track" have been used to bring the fruit to distant places; and sometimes, animals or in animal-drawn carts and manpower (mostly females' for long distances) were used for local market, which would damage and enhance the deterioration until the fruit reaches the consumer. 8.3% of respondents also revealed that loading and unloading during transportation is another factor for deterioration of the fruit. They confirmed that fruit loading mostly done from the outside, exposure to unnecessary heat shock, little or no care during loading and unloading, overloading and throwing or dropping are factors for the loss of fruit. Public transport vehicles or Isuzu Track was the main means of transport used. According to Van Zeebroeck et al. (2007), every time there is an unloading of the container a danger exists for impact with other fruit, containers and equipment used to sort and pack the fruit.

Fruit loss during storage

The results shown in Table 5 from the total interviewed

revealed that 53.3, 21.7, 8 and 7% of respondents reported lack of storage system, lack of appropriate box, weight loss and shrinkage and varieties under cultivation, respectively as factors responsible for deterioration of the fruit. From the total respondents interviewed, 53.3% of the respondents confirmed that since there is no storage system adopted or introduced in the study, harvesting is mainly dependent on the availability of market and subsequent harvesting would occur in different period of time depending on the fruit maturity and the available market. Similarly, Girmay et al. (2014) in their research finding described that absence of cold storage in study area limited the availability of the fruit throughout the year. In line with this, Behailu and Sabura (2017) reported that since there are no storage facilities in the area, to balance the demand and supply, fruits are sold at farm gate price by producers and through different actors in the market chain. The complete harvest and sale at a time creates a higher supply and lower demand in the market which results in lower income to producers. On the contrary, 21.7% of the respondents reflected that if appropriate box is available, the fruit can be stored at their homes for 3 – 4 weeks and retailed for consumers. According to Mohammad (2011), retailers store their apples in their shops for 1.5 months as an average, and have no proper storage room to control the relative humidity and temperature.

From the total, 8% of the respondents reported that fruit weight loss and shrinkage, along with retailers storing of their apples at their homes are factors for the loss of the fruit. They confirmed that this is due to the improper stage of maturity at picking and handling of the fruit before storage. According to Kader (2006), picking and handling will help reduce crop losses. Weight loss and decay during storage can greatly affect marketability. Weight loss during storage depends on fruit maturity at harvest time (Ghafir et al., 2009; Schrader et al., 2009). Only 7% respondents notify that the fruit from some varieties (Crispin) are easily more prone to deteriorate and lost than others after harvested. In line with this Seifu and Berhanu (2014) reported appropriate varieties need to be selected in terms of shelf life and resistant to diseases and insect pests. Variety selection remains the most important hindering factor for successful apple production in Chencha area.

CONCLUSION AND RECOMMENDATION

Quality loss and deterioration as well as quantity/physical losses start from harvesting of apples. The study confirmed that fruit bruise and wound, lack of appropriate bag/boxes, and lack of storage facility are the main factors responsible for loss of fruit during harvesting, transport and storage respectively. Lack of postharvest storage facilities in the study area are one of the limiting factors for fruit loss. Improper handling of the fruit during harvesting, transportation and storage were serious problems to the producers. Growers should be skillful and have knowledge about how to harvest, transport and store their fruit to get quality apple fruit and high price at the end. The study showed that provision of training on the fruit postharvest management and handling, harvesting containers, bag/boxes and developing of storage technologies (local/improved) are vital and a call for higher institutions, NGOs and governments. There should be intervention polices and integrated approach to reduce the loss of the fruit in the study area.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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