

## Post-harvest Damage and Loss of Apples in Bhutan (Thimphu and Paro)

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### ABSTRACT

*Post-harvest loss of apple (Malus domestica) poses major challenge to agricultural marketing in Bhutan. Though various post-harvest interventions were made, it is still a challenge to tackle post-harvest losses due to unavailability of data on losses of apple in the different stages of supply chain. This study was conducted in the two major apple growing districts of Paro and Thimphu to determine the post-harvest loss in apple during the harvest and post-harvest operations and also to identify different factors contributing to these post-harvest damages and losses. A major portion of production is lost during harvesting and post-harvest handling stages, which includes transportation to depot, sorting, grading, packaging, storage and further transportation to the foreign markets in India and Bangladesh. The total post-harvest loss of apples in Bhutan is estimated at 73.10% of the total production. Of the total damages and losses, 12.78% of the fruits are completely damaged and are unacceptable for both consumption and marketing, while 60.32% of the fruits are partially damaged and can still be consumed and marketed. Only 26.90% of the total production reaches the market without any post-harvest damages or defects. Natural causes such as diseases, insect and bird damages and physiological disorders also significantly contributed to the total loss of apple (30.16%) during and after harvesting.*

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**Keywords:** Apple, Post-harvest damages and losses

### 1. Introduction

Food crops are living entity and they begin to deteriorate the instant they are separated from their parent plant. Post-harvest management techniques can largely determine the final quality of the produce and help in minimizing post-harvest losses (Wills & Golding, 2016). The post-harvest system should encompass the delivery of a crop from the time and place of harvest to the time and place of consumption, with minimum loss, maximum efficiency and maximum return for all involved in the supply chain (Masood, 2011). Post-harvest losses of horticultural crops pose a major challenge to agricultural marketing. It has been estimated that over 40% of fresh fruits and vegetables in Bhutan are lost due to poor post-harvest handling and management (Tobgay, 2005).

Most of the post-harvest losses of apple in Bhutan can be related to poor harvesting and handling operations. According to Thompson (2008), mechanical injuries from improper harvesting

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techniques and use of inappropriate tools result in loss of moisture from the fruits, causes physical damage and also increase the susceptibility of the fruits to decay causing microorganisms. In post-harvest handling, the initial process of storage right after harvest is critical. Every crop has its own storage temperature and optimum humidity requirement, and it is recommended to store produces of different nature separately to avoid unwanted chemical reactions (Kader, 2002). In general, the basic post-harvest handling principles are same for all crops; careful handling after harvest to avoid physical damages, culling to remove the damaged parts or damaged crops, pre-cooling and maintaining the desired cooling conditions (Kader, 2002; Thompson, 2008).

There is scope to significantly reduce the post-harvest damage and losses of fruits right from harvesting to end users or final market. Interventions can be made in the post-harvest operation activities as the fruits transit along the supply/value chain (Kader, 2002). Understanding the maturity indices of apples, selection of appropriate harvesting schedule and use of appropriate tools and techniques significantly help in minimizing post-harvest damages and losses (Kader, 2002).

The main objective of this study is to assess the post-harvest damage and losses of apple from harvesting till transportation (before being exported to international markets). This study is aimed to provide information on the portion of the produce damaged and lost during different stages of post-harvest handling and also determine the major causes and factors that contribute to post-harvest loss of apples in Thimphu and Paro.

Farmers, local and regional traders are involved in post-harvest practices such as harvesting, sorting, grading, packaging, transporting and storing. There are significant losses in terms of quality and quantity in each stage of post-harvest practice. For instance, in Afghanistan, the total post harvest loss of apples was estimated at 31% at the farmers' level while the loss was estimated at 40.7% when the fruit reaches the local traders (Masood, 2011). The level of damage and losses (quality and quantity/physical) is different among chain actors at different stages of the chain (Ilyas et al., 2007). Proper interventions at the different post harvest operations can help reduce post harvest losses which will ultimately contribute to increasing supply of apples without corresponding increase in the acreages under cultivation (Kader, 2002).

## **2. Materials and Methods**

### **2.1 Study area**

The survey data was collected from the apple orchards of eleven major apple-growing villages; Gebjana, Jepchu, Drugyel, Pangbisa, Wochu, Shari, Dawakha, Hongtsho, Yusipang, Gemina, Tsaphuunder Paro and Thimphu districts of Bhutan through random sampling technique. The altitude of these selected orchards range from 2200 – 2400 m thus making these places highly suitable for growing apple (Meisami-asl, Rafiee, Keyhani, & Tabatabaefar, 2009).

## 2.2 Data collection

The study was done quantitatively through field survey and data collections. Field staffs of NPHC collected the data from the various apple orchards, collection depots and marketing places in the eleven apple growing villages during the apple-harvesting season.

## 2.3 Primary data

The primary data was collected through field survey. Survey of 18 apple orchard owners and exporters/suppliers were done through pre-structured sampling sheet. Two random samples from each selected site (orchards/exporters and suppliers) were taken with three replicates for each sample. The data was collected from these samples to assess the damages and losses incurred in the four different operations: (i) harvesting, (ii) field to depot transportation, (iii) sorting, grading and packaging and (iv) depot to market transportation. Further damages and losses caused by natural factors such as physiological disorder, bird and insect damages and disease were also assessed.

## 2.4 Data analysis

Data was analyzed using Web Agri Stat Package (WASP 2.0), and the results are presented in charts, graphs/figures and tables.

# 3. Results and Discussion

## 3.1 Post-harvest handling damage and loss of apples

Harvesting damages account to 18.5% of the total damages whereas 30.54% of the apples get damaged while transporting from the field to the depot (Figure 1). Bruises and punctures can be noticed on most of these fruits damaged during harvesting and transportation. The damage during harvesting can be attributed mainly to the use of inappropriate harvesting tools and poor harvesting technique (Kader, 2002). A significant part of the loss during transportation can be attributed to poor transportation modes and the poor road conditions (Kader, 2002).

The post-harvest quality and composition of fruits can be significantly affected by the time of harvesting and the methods of harvesting. Mechanical injuries from improper harvesting techniques and inappropriate tools will accelerate moisture loss from the fruits (Thompson, 2008). Selection of an appropriate time of harvesting is also very important. Harvesting during extreme heat or during rainfall can adversely affect the post-harvest quality of fruits (Thompson, 2008). Harvesting early may result in shriveling of fruits and formation of bitter pit during storage and may also result in lack of flavor on ripening, while late harvesting can result in flesh breakdown and increased susceptibility to rot (Wills & Golding, 2016). Proper harvesting management includes selection of a favorable harvesting time in relation to climatic condition and harvest maturity, use of appropriate harvesting tools and techniques and sound implementation of effective quality control (Kader, 2002; Thompson, 2008). Post-harvest management techniques can largely determine the final quality of the produce and can significantly help in minimizing post-harvest losses (Wills & Golding, 2016), thus it is important

to understand the proper harvesting methods and use of appropriate harvesting tools and equipment.

Damage during sorting, grading and packaging accounted to 37.15%, and final depot to market transportation contributed to 42.94% (Figure 1). Rough handling during sorting, grading and packaging, use of inappropriate containers and improper storage are the main factors contributing to these damages.

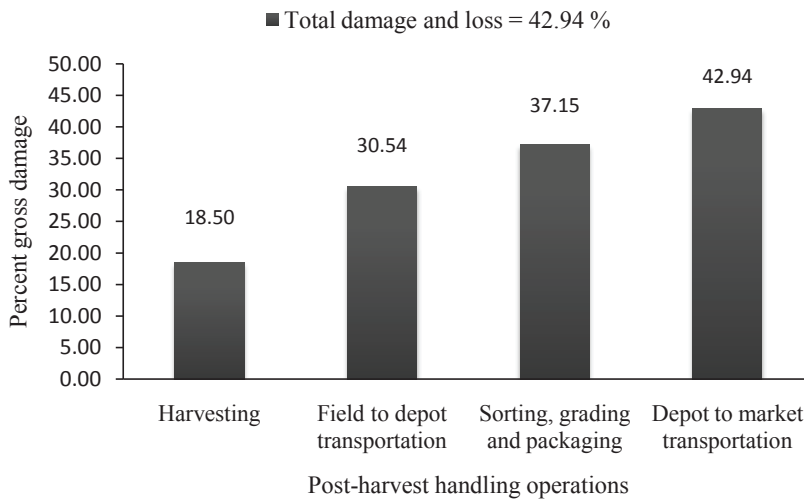


Figure 1. Post-harvest damage of apple during harvesting, handling and transportation

It is clear that the damages in the fruits keep on increasing as the fruits travel through different post-harvest operations. With this data, it can be concluded that the estimated gross post-harvest damage in apple during the different post-harvest handling operations is 42.94%.

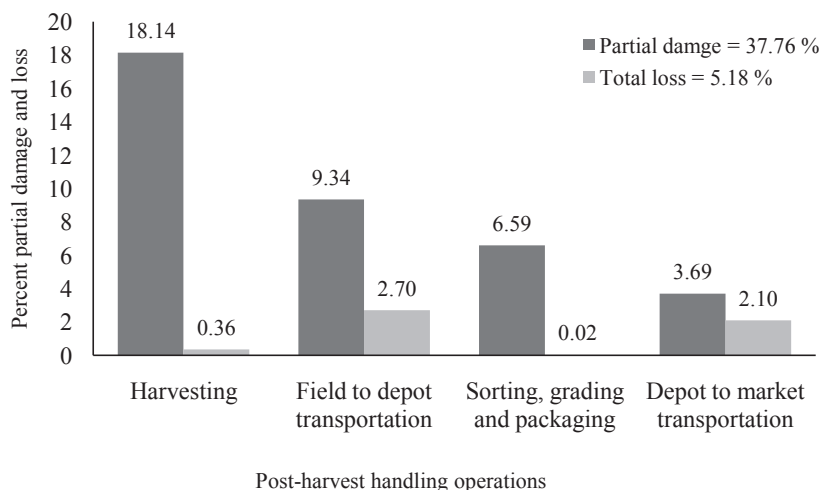


Figure 2. Partial damage and total loss during harvesting, handling and transportation

The gross damage of the apples after the post-harvest handling operations accounted to 42.94% (Figure 1), which includes partial damage (37.76%) and total loss (5.18%) (Figure 2).

### 3.2 Post-harvest damage and loss of apples due to natural causes

Post-harvest damage of apples due to diseases, physiological disorders and insect and bird damages accounted to 30.16% of the total post-harvest damage. Post-harvest loss of apple due to birds and insects stands at the highest (39.79% of the total damages due to natural causes) followed by physiological disorders (37.33%), and diseased at 22.88% (Figure 3).

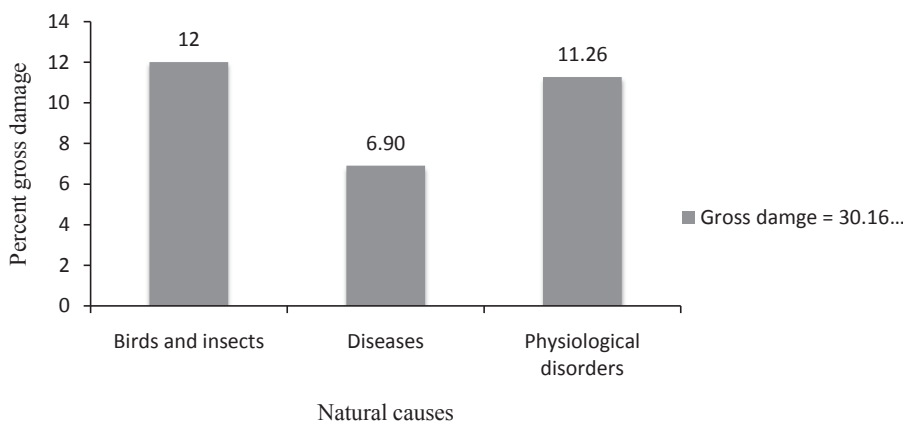


Figure 3. Post-harvest damage of apples due to natural causes

The gross damage of the apples due to natural causes stands at 30.16% (Figure 3), which includes partial damage (22.56%) and total loss (7.60%) as reflected in Figure 4. Only 26.90% of the apples reach the market without any defects.

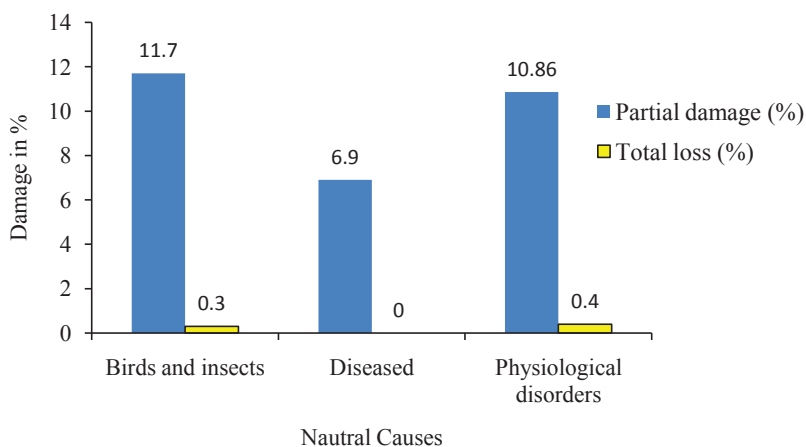


Figure 4. Partial damage and total loss due to natural causes

### 3.3 Economic impact of the post harvest damage and loss of apples

Revenue of Nu 69.17 Million was generated in 2016-2017 from the export of 2659.21 Mt of apples (DRC, 2017; MoAF, 2017). Taking this into account, if the partially damaged fruits (4849.12 Mt) are also considered exported a total loss of Nu. 26.72 Million (Table 2) was incurred from the fruits (1027.38 Mt) which could not reach the market due to post harvest losses.

Table 1. Total postharvest loss of apples

Sl No.	Factors	Loss (%)	Partial damaged (%)	Total damaged (%)
1	Handling Operations	5.18	37.76	42.94
2	Natural causes	7.60	22.56	30.16
	Total	12.78	60.32	73.10

Table 2. Estimate of economic loss due to post-harvest losses of apples (Bhutan, 2016-17)

Sl. No	Apples produced (Mt)	Postharvest partial damage (Mt)	Economic losses (Million Nu.)	Postharvest losses (Mt)	Economic losses (Million Nu.)
1	8,039.00	4,849.12 (60.32%)	NA	1,027.38 (12.78%)	26.72

Note: Cost estimation was done on the basis of Nu. 26.01 per kg of apple exported.

## 5. Conclusion

The total post-harvest damage of apple in the two districts of Thimphu and Paro (Table 1) stands at 73.10% of the total production. While 42.94% of the post-harvest damage is incurred during harvest and post-harvest handling operations, 30.16% of the fruits are damaged due to natural causes like diseases, physiological disorders and damages caused by birds and insects. Of the total losses and damages, 12.78% of the fruits are completely damaged and are unacceptable for both consumption and marketing, while 60.32% of the fruits which are partially damaged can still be consumed and marketed. Only about 26.90% of the total production reaches the market without any post-harvest damages or defects.

Wastages of food through post-harvest losses not just translate into human hunger but also result in lesser revenue generation for the growers (FAO, 2013). A major portion of the produce is lost due to poor harvest handling-management of apples during harvest and after-harvest handling. Rough handling by the operators involved throughout the supply chain contributes to almost half of the post-harvest damages and loss in apples. All the handlers along the supply chain need to be trained on proper methods of harvesting and handling practices through awareness and capacity building programs. Post-harvest losses due to natural causes and physiological disorders can also be minimized through introduction of superior varieties, proper pest and disease management of fruit crops, including that of birds attack, and through good orchard management practices. Pre-harvest interventions such as selection of improved varieties (disease and pest resistant), pest and disease treatments and Integrated Pest Management strategies could significantly help in reducing these post-harvest damage and losses in apple.

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