



RESEARCH ARTICLE

## Socioeconomic Assessment of Mandarin Postharvest Loss: A Case of Gandaki Province, Nepal

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**Abstract:** This study focused on the socioeconomic assessment of mandarin postharvest loss in the Gandaki Province of Nepal. Two mandarin growing districts Tanahun and Syangja of Gandaki province were selected for study purposes. A simple random method of sampling was employed to select 45 mandarin farmers from each district making a total sample size of 90. Primary data were collected with the help of a pre-tested semi-structured interview schedule along with two focus group discussions and field observation of the mandarin orchard. Data were analyzed by using both descriptive and inferential statistics. This paper explored the mandarin production status, major post-harvest practices, marketing channels, and barriers to post-harvest technology adoption. The findings revealed that farmers were producing 5.4 tons of fresh mandarin each year earning around 50 thousand Nepalese rupees as profit from mandarin farming. Similarly, the result showed that the post-harvest loss was 8%-9% during the harvesting, grading, and packaging operation while a loss of 2%-3% was recorded during the transportation of mandarin from the production site to the wholesaler site. In total, loss ranging from 14%-18% was recorded in all chains of mandarin postharvest operations. Also, it was found that more than two-thirds (76.7%) of farmers practiced mandarin marketing based on pre-harvest contracts. The technical know-how of farmers about post-harvest technologies was a major challenge associated with the low adoption of mandarin post-harvest technologies. The concerned government agency, I/NGOs, and other organizations need to emphasize post-harvest loss issues by incorporating loss minimization activities in their program ensuring higher adoption of postharvest technologies by mandarin farmers and traders.

**Keywords:** Agro-pastoralists perception; Post-harvest; Mandarin; Technology; Adoption

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## 1. Introduction

Citrus, particularly mandarin fruit (*Citrus reticulata* Blanco) is one of the most important and highly commercial fruit crops in Nepal. Mandarin being a sub-tropical fruit is highly suitable for undulating and marginal topography of the country. It is grown widely in mid hills of Nepal covering 56 districts of Nepal. Mandarin plays a significant role in the national economy which contributes 0.97% share in AGDP and 0.33% in GDP <sup>[1,2]</sup>. Production and marketing of mandarin fruit is an important source of income not just for mandarin farmers and traders, but also provides seasonal employment for many agriculture laborers. Mandarin being a non-climacteric and perishable fruit, losses of mandarin fruit during harvesting, handling and marketing are reported to vary between different percentages. In Nepal the postharvest loss for citrus fruit was estimated from 15%-20% <sup>[3]</sup>. Minimizing postharvest loss of mandarin fruit is a very effective way to increase fruit availability and reduce the cost of cultivation for farmers which ultimately helps increase farmers' income.

Although mandarin has been grown widely as an important commercial fruit crop in mid-hilly terrain, farmers are not fully acquainted with orchard management and post-harvest practices. Despite the ecological advantage, the production of mandarin fruits is still insufficient to meet the domestic demand of the country. Mandarin cultivation provides a better profitable farming option to hilly farmers; however considerable attention has not been given to increasing post-harvest loss issues. Although the losses of mandarin fruits differ upon many factors as like management techniques, topography, climate, and varieties, the shelf life of horticulture production is greatly influenced by adopted postharvest management practices. Similarly, in the case of diverse farmers' economic conditions and the farmers' involvement in fruit production, there exist several issues related to production and post-harvest practices. The adoption of post-harvest technologies at the farmers' level demands awareness, knowledge and thereafter decision process. Mostly men are involved in decision-making tasks and most commonly those works which require more physical strength. Unlike this, emale are more likely expected to do manual and repetitive works which do not require more physical strength but encounter a lot of drudgeries <sup>[4]</sup>. The development of suitable post-harvest technologies and their wider adoption among all mandarin farmers is crucial into reducing post-harvest losses. Reducing post-harvest losses can bring more food without bringing additional land in production and all post-harvest horticulturist need to coordinate their effort with those involved in production to the marketing

system <sup>[5,6]</sup>. Although post-harvest is a worldwide issue, its challenge and impact are more prominent in developing countries like Nepal. Keeping this in view, a socio-economic assessment of mandarin post-harvest loss has been carried out to understand farmers' knowledge and practice on post-harvest activities and associated losses in different stages of mandarin post-harvest operations.

## 2. Methodology

### 2.1 Study Area

The research was conducted in two districts of Gandaki province. Out of eleven, nine districts of Gandaki province are somehow popular for mandarin production except for Manang and Mustang. Both Syangja and Tanahun districts were purposively selected for the study purpose as both districts rank first and second in terms of production area <sup>[1]</sup>. In total four locations were identified from two districts. Mygde and Shuklagandaki rural municipalities of Tanahun and Putalibazar and Arjunchaupari Municipalities of Syangja were selected for study purposes.

### 2.2 Primary Information

Primary data were collected by using pretested interview schedule administered to the 90 mandarin-growing farmers. Two focus group discussions were organized to get surplus and validate the information. Mandarin Orchard, collection centers were visited in the study site in two districts of Gandaki province. Apart from farmers, AKC and farmers' super zone program under PMAM-project was consulted for gathering all mandarin related information.

### 2.3 Secondary Information and Data Analysis

Mandarin-related reports, scientific papers and books were reviewed to get the required secondary information on mandarin post-harvest-related technology. Data entry and analysis were done by using Statistical Package for Social Science (SPSS) and Microsoft excel software package. Socio-demographic characters, mandarin production, and post-harvest loss were analyzed by using descriptive tools such as frequencies, percentages and mean as per need. Similarly, the barriers to the adoption of postharvest loss minimization technologies were ranked by using a five-point scale (Figure 1). The index related to the barrier factor was calculated by using the weightage average mean. The index of intensity was computed by using the following formula and ranking scale.

$$I_{\text{prob}} = \sum \text{Sifi} / N,$$

where,  $I_{\text{prob}}$  = Index value for intensity

$S_i$  = Scale value for the  $i$ th intensity

$F_i$  = Frequency of the  $i$ th intensity

$N$  = Total number of respondent

$I_{prob}$  = Index ( $0 < I < 1$ )

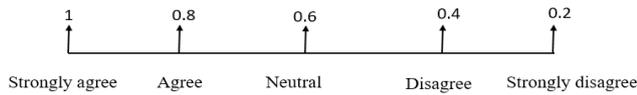


Figure 1. Five-point ranking scale.

### 3. Results and Discussion

#### 3.1 Study on Knowledge, Perception and Adoption of Postharvest Technology along the Supply Chain

##### 3.1.1 Descriptive Statistics of Variable

The descriptive statistics of variables include the demographic and socio-economic variables of surveyed households. Table 1 represents the mean, standard deviation and minimum maximum value of the given variables. Mainly age, gender, education, farming experience, migration and mandarin cultivation status were some major variables given in the table. Mainly the average age of the respondent was 52 years with an age range from 22 to 79 years. In the case of gender, the majority of them were male (80%). The literacy level of the surveyed households was classified as the number of schooling years. The result indicated that the average education level was 7 years of schooling. Also, outmigration for an employment opportunity is an important variable that indicates the status of household labor supply and household income status. The result showed that 43% of households had at least one member engaged in an overseas job. Similarly farming experience of respondent households can be considered an important variable as it is helpful in determining the choice behavior of farmers in adopting production and postharvest

technologies. In this study, it was found that farmers have been cultivating mandarin for 18 years on average. Farmers have been growing mandarin traditionally since long ago, however production areas may vary as per land area availability and interest of farmers. Likewise, on average, the number of parcels used for mandarin production was found 2.26 in the study area. The detail of the value is given in Table 1.

##### 3.1.2 Mandarin Farming

Information regarding total mandarin plants, number of fruiting plants, sold quantity and annual income from mandarin was collected during the household survey. The result showed that farmers have been cultivating mandarin plants from 30 to 2500 in number. The average holding of the mandarin plant by farmers was 294 plants per household while the value decreases to 178 plants if considering only fruiting mandarin plants per household (Table 2). Most of the farmers have been cultivating mandarin as a major farming business and one of the important sources of household income. In most cases, farmer earned their income by selling fresh fruit to traders and pre-harvest contractors. The finding indicated that on average farmers sold 5.3 tons of mandarin per year. Also, results showed that mandarin has contributed 50 thousand per year to farmers' annual profit by selling fresh mandarin.

##### 3.1.3 Social Class (Caste)-wise Number of Mandarin Plants

There exists a social class category in most societies. In this study, three major classes were identified, Brahmin/Chettri, Janajati and Dalit. Among them majority of respondents were Brahmin/Chettri (62%), followed by Janajati (22%) and Dalit (16%) (Table 3). The Brahmins/Chettri was the dominating caste in the surveyed area as shown below in the table. The results showed that among

Table 1. Demographic variables.

Variables	Value	Mean	Std. Deviation	Minimum	Maximum
Age of respondent	Year in number	51.58	13.680	22	79
Education	Years in number	6.96	4.762	0	17
Outmigration	Abroad, yes = 1, otherwise = 0	0.43	0.498	0	1
Experience in mandarin farming	Years in number	18.30	10.883	1	45
Total cultivated land	Land area in ropani*	12.51	12.885	0	92
Land allocated for Mandarin	Land area in ropani	8.40	9.97	1	80
No. of parcel for Mandarin	Number of parcel	2.26	1.32	1	7

\* Ropani = 508.74 m<sup>2</sup>

Source: Field survey (2020).

**Table 2.** Mandarin plant and annual income.

Variables	Value	Mean	Std. Deviation	Minimum	Maximum
Total Mandarin plants (fruiting and non-fruiting)	Number of plant	293.53	357.92	30	2500
Fruiting mandarin plants	Number of fruiting plants	177.18	275.40	0	2000
Last season mandarin production	Production in kg	5481.13	12175	0	75000
Last season sold mandarin	Sold mandarin in kg	5380.19	12195.67	0	75000
Total annual profit from mandarin	Annual profit in NPR	49475	144818.93	0	950000

Source: Field survey (2020).

**Table 3.** Caste-wise mandarin plants.

Caste	N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Brahmin/Chettri	56	317.16	420.799	56.232	30	2500
Janajati	20	277.10	239.271	53.503	30	750
Dalit	14	222.50	189.643	50.684	50	600
Total	90	293.53	357.921	37.728	30	2500

Source: Field survey (2020).

three groups, Brahmins have a higher average holding of mandarin plants in their orchards than others.

### 3.1.4 Training Received by Mandarin Farmers

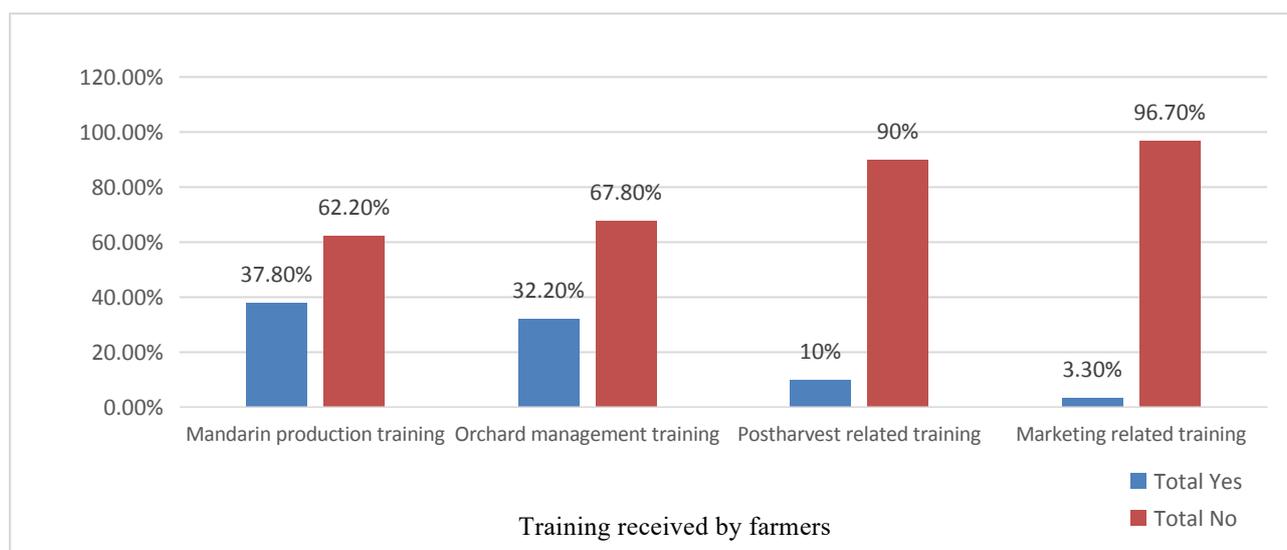
Figure 2 showed that farmers received a different kind of mandarin training. Among them, most farmers had received mandarin production-related training (37.8%) followed by orchard management training (32.2%). The percentage of farmers getting postharvest training was quite less as compared to production and orchard management training. Only 10% of farmers were trained in postharvest knowledge and skills. Likewise training on the marketing-

related issue was negligible, and only 3.3% of farmers were lucky to receive such training. These low percentages indicated that concerned institutions and programs had given less priority to postharvest and market-related training.

## 3.2 Mandarin Postharvest Operation, Farmer’s Knowledge and Practice

### 3.2.1 Harvesting Criteria, Time and Collection

Harvesting criteria are considered the beginning step of the postharvest operation. The different types of harvesting criteria may affect the postharvest quality of mandarin



**Figure 2.** Training received by mandarin farmers.

to some extent. The result showed that most farmers follow mandarin harvesting based on the color of the fruit (54%) followed by the order of traders (28%). Also some farmers decide to harvest mandarin as per market price.

The timing of mandarin harvesting could affect the shelf life of mandarin after harvest. In most cases, farmers do harvest mandarin fruit in the late morning time (53.3%), however still many farmers (45.6%) harvest fruits in the midday time. Higher temperatures during midday time and subsequent handling practices could affect the post-harvest quality of mandarin. Similarly, the result showed that after harvest, the majority of farmers used a plastic crate to collect the harvested fruits followed by a local bamboo bucket (38%) (Figure 3). However, still some farmers were using jute/plastic sacks to collect the mandarin.

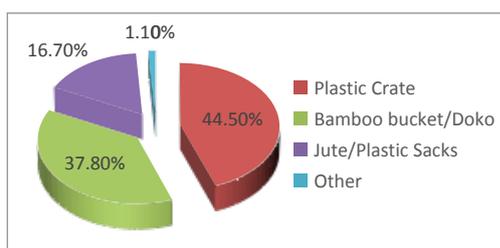


Figure 3. Collection of mandarin fruits after harvest.

### 3.2.2 Sorting of Mandarin after Mandarin Harvest

Mandarin sorting after harvesting helps to avoid mixing fresh and healthy fruits with diseased and damaged fruits. Generally commercial farmers were more aware of sorting operations than normal farmers. The result depicted that almost 89% of farmers performed sorting operations separating 2.2% of mandarin as damaged and diseased ones.

### 3.2.3 Management of Sorted Mandarin

Farmers performing sorting operations were asked

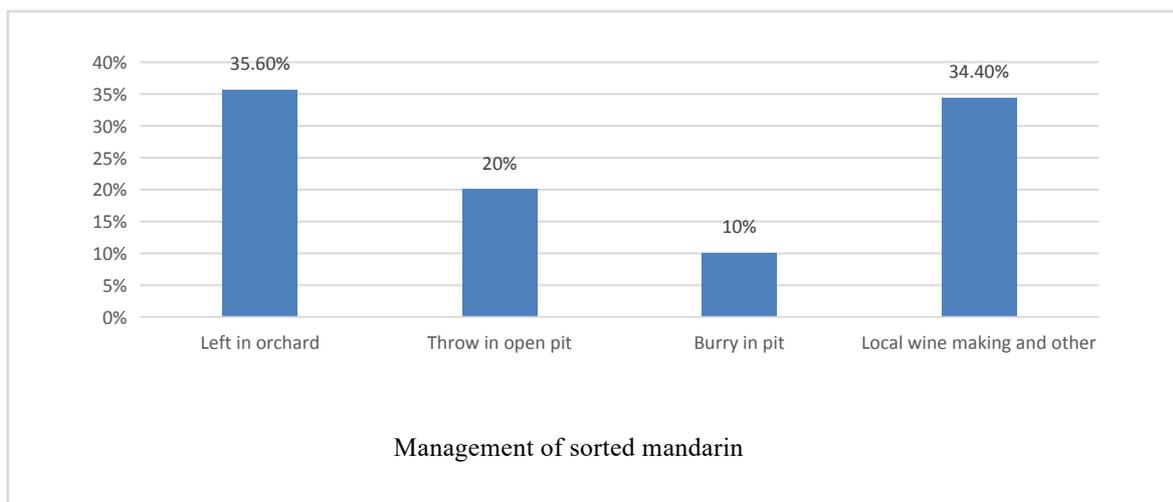


Figure 4. Management of sorted mandarin by farmers.

to know what they do with sorted fruits. The findings showed that more than one-third of farmers (35.6%) did nothing with sorted fruits and left those decayed fruits in the orchard. In general, it is not suggested to leave those affected fruits in the orchard as it helps to spread disease infection and create a favorable environment for the pest population (Figure 4). Similarly, the result indicated that 34.4% of farmers were utilizing those sorted mandarin by making local wine. Among wine-making households, it became a source of small income for female member by selling homemade wine to local hotels and neighbors.

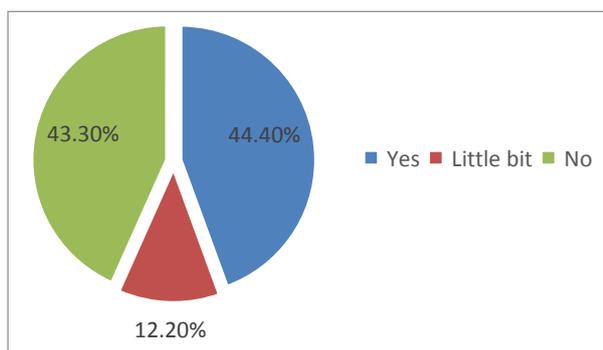
### 3.2.4 Mandarin Grading and Criteria for Grading

Mandarin grading is one of the important and popular postharvest operations among commercial mandarin growers. In this case selling purpose-graded mandarin fetches higher price than non-graded mandarin. Among surveyed farmers, almost all farmers (96%) had been practicing grading operations. The common method of mandarin grading at a local level is a traditional method. The first choice of a farmer to grade their mandarin is based on the size and shape of the fruits. Farmers grade their fruits by deciding on the greater size, middle size and smallest size (locally called Jethi, Maili and Kanchi). Besides, some farmers also perform grading operations based on the color of fruits (24.4%) followed by damage made by inspecting pests (16.3%) and physical injury (12.8%).

### 3.2.5 Farmers' Knowledge on Mandarin Processing Operation

Due to its perishable nature, the processing of horticultural crops is considered one of the key operations addressing postharvest loss issues. Further it helps to add monetary value to the product too. Although processing operation in mandarin is quite popular, farmers in the

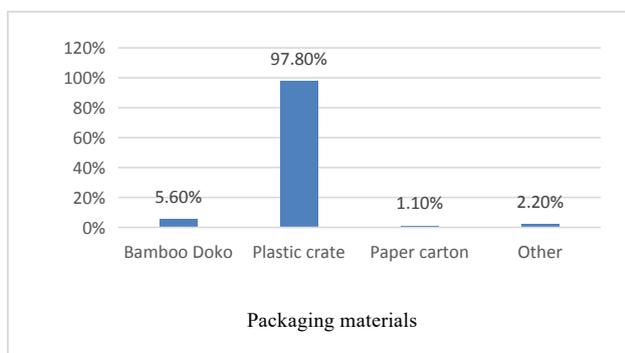
studied area were found to be less aware. Only 45% of farmers knew it while 43% of farmers were unaware of it (Figure 5). The reason behind less awareness among farmers might be due to no surplus production in the main season. All the products get marketed easily, local and pre-harvest contractors play the lead role in marketing activity.



**Figure 5.** Farmers’ knowledge on mandarin processing operation.

### 3.2.6 Packaging Materials for Mandarin

Plastic crate use was highly popular among mandarin farmers. Almost 98% of farmers had adopted plastic crates as a means for mandarin packaging. The types of packaging materials use greatly determine the extent of damage during subsequent handling, storage and transportation. Among different materials, some farmers (5.6%) were using a bamboo bucket (*doko*) followed by paper cartoons (1.1%) (Figure 6). In the past decade, farmers used to face significant loss of mandarin annually due to not adopting proper packaging materials, but the trend of using plastic create has increased rapidly these days. However, still some farmers are forced to use a local bamboo bucket and even jute sacks due to the unavailability of plastic create. In some cases, carrying mandarin in the plastic crate was found difficult due to difficult hilly terrain.



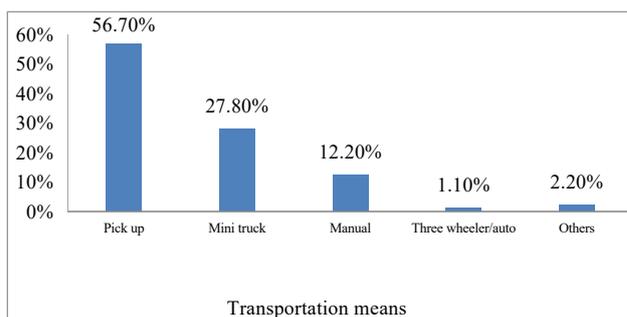
**Figure 6.** Packaging materials use for mandarin.

Although plastic crates are simple and common pack-

aging materials, their availability at local a level is questionable. In general, the cost for one piece of the crate goes from 400 to 700 Nepali rupees which can hold up to 20-22 kg of mandarin. However the durability of crate was reported to be less satisfactory for farmers. Also for a local contractor, the life span of one crate is no more than one year and for wholesalers at the national level; one crate can be used hardly for six months only.

### 3.3 Mandarin Transportation

Depending upon packaging materials means of transportation, road condition and temperature a large volume of loss occurs during mandarin transportation. Figure 6 revealed that pick-up was the most used means of transportation for mandarin. Apart from a pickup, 28% farmers were using mini trucks and 12% of farmers were transporting mandarin manually (Figure 7). The result suggested that farmers’ preference was higher for pick up and still some farmers were not connected with vehicle transportation.



**Figure 7.** Transportation means for Mandarin.

### 3.4 Mandarin Marketing

Farmers act as the primary producer of mandarin. In general, farmers were involved as primary sellers whereas contractors, traders were primary buyers. Mainly farmers, and preharvest contractors/traders were the main actors involved in the marketing of mandarin, however, the role of traders was always dominating in purchasing mandarin from producers and supplying it to other districts [7]. The result showed that more than two third of farmers (76.7%) preferred mandarin marketing by means of contractors. Those pre-harvest contractors usually visit the farmers’ field after a few months of fruiting and negotiate the total value of the whole orchard with the producers. Different criteria such as the number of fruit trees, number of fruits per tree, shape, etc were used by both contractors and producers to finalize the monetary value of the orchard. After contract fixation, farmers were free to look after their mandarin; all tasks like harvesting, grading, packaging

and transporting of fruits were done pre-harvest harvest contractors. Although the contract basis of marketing was popular among farmers the profit margin of farmers had been compromised greatly. Farmers preferred pre-harvest contracts because of the low risk associated with harvesting and transportation.

### 3.5 Post-harvest Loss at Different Stage of Post-harvest Operation

Since mandarin is a perishable and non-climacteric fruit, it shows great losses after harvesting. Worldwide postharvest loss of fruits and vegetables are high, but the rate is even higher for developing nation. The questions on perceived postharvest loss at different steps of postharvest operation were asked to mandarin farmers to assess the loss calculation. The study reported that higher loss was observed at the harvesting stage (3.14%) followed by transportation (2.95%) and the lowest loss was found in the packaging operation (1.20%). In total, mandarin post-harvest loss from harvesting to transportation stage was 11.41% in the first stage of marketing (Figure 8).

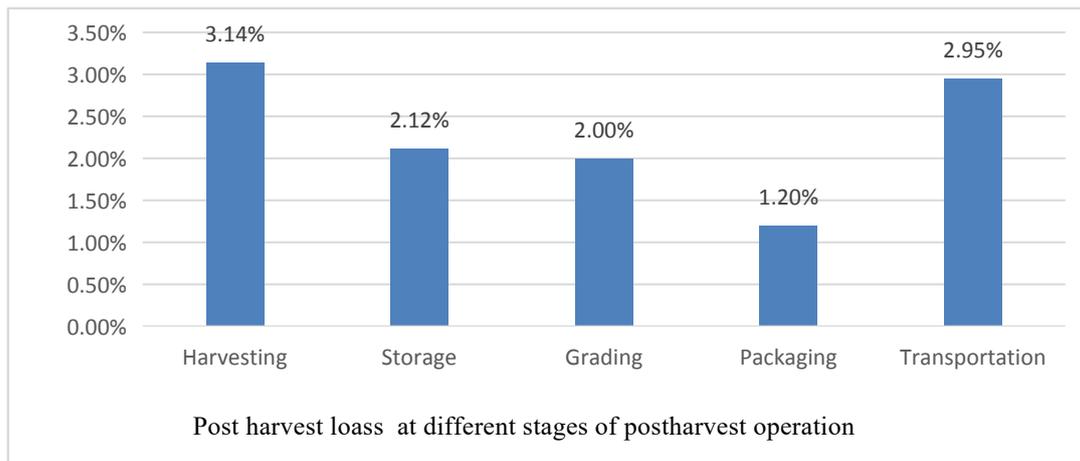


Figure 8. Post-harvest loss at different stages of postharvest operation.

Table 4. Barrier to the adoption of postharvest loss minimization technology.

Barrier	Score/Frequency					Index value	Rank
	1	0.8	0.6	0.4	0.2		
Lack of reliable extension service	16	47	10	1	16	0.70	III
Lack of knowledge about PH technologies	38	49	1	0	2	0.87	I
Credit constraint	10	36	29	2	13	0.33	V
Unwillingness to adopt technologies	6	32	31	3	18	0.61	IV
High cost of technology adoption	13	50	22	1	4	0.75	II

Source: Field survey (2020).

### 3.6 Barrier to Postharvest Technology Adoption

Nepal faces the great postharvest loss of mandarin annually due to not adopting proper handling practices during different stages of postharvest operations. Minimizing these losses is only possible when farmers start adopting postharvest loss-minimizing technologies. As farming is subsistence in nature, the problems of mandarin farmers are mostly associated with a lack of technical knowledge related to production and marketing [8,9]. However, at the field level, farmers hesitate to adopt available postharvest technology due to technical and other reasons. The study results showed that a lack of knowledge of postharvest technology was the most important barrier to adopting available postharvest technologies (Table 4). Further, farmers believed that adopting those technologies was more expensive for them and also lack of reliable extension service had made farmers more reluctant to technology adoption.

### 3.7 Marketing Channel and Postharvest Loss

Mandarin reaches consumers' hands through the in-

involvement of different actors like producers, preharvest contractors, wholesalers and retailers. The route through which mandarin from orchard to consumers is marketed is commonly called a marketing channel. In the study site, the majority of mandarin farmers preferred contract-based marketing to preharvest contractors or local traders. A postharvest loss of 8%-9% was recorded for harvesting, grading and packaging operation. A loss of 2%-3% was noted during the transportation of mandarin from the production site to the wholesaler site. The study showed that the total postharvest loss of mandarin within the chain goes up from 14% to 18% (Figure 9). The study done by Gangwar <sup>[10]</sup> in India also found that aggregate post-harvest losses of kinnow mandarin from orchard to consumer in two different market ranges from 14.87% in Delhi market to 21.91 in Bangalore market.

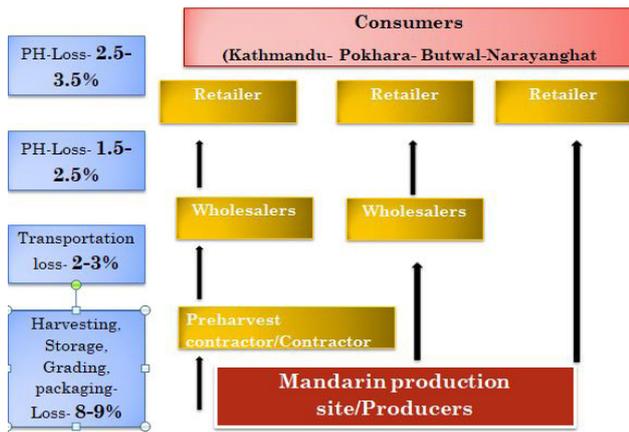


Figure 9. Marketing channel and postharvest loss.

### 3.8 Economic Gain

The observed postharvest loss of mandarin was 14% to 18% within the chain from production to consumer site. As per production data, the country had produced 0.17 million MT of mandarin with productivity of 10.30 MT/Ha <sup>[11]</sup>. The the loss of mandarin in different stages of post-harvest operations indicates not only the loss of fresh produce but also loss of money in importing mandarin from a foreign country. The two ways loss caused by a higher rate of postharvest loss can be minimized is by increasing the adoption of postharvest loss minimization technology at the farmer’s level. In general, it was estimated that reducing postharvest loss by at least 7% would be a direct gain of 620 million annually. If it was the case, it would also check Nepalese currency to go out of the country for importing mandarin.

## 4. Conclusions

Mandarin contributes as a high-value fruit crop in the hilly area of Nepal from east to west helping cash earning for marginalized and poor farmers. The study indicated post-harvest loss ranges from 13%-18% in different stages of post-harvest operation. Although various that post-harvest technologies have been recommended, farmers face a great loss of mandarin annually due to not adopting proper post-harvest technologies during different stages of post-harvest operation. Most farmers had adopted plastic crates as one of the viable means of post-harvest technologies. Uses of the plastic crate have increased rapidly these days playing an important role in minimizing post-harvest loss of mandarin to some extent. Promoting postharvest technologies within farmers’ and traders’ practices could be the best solution to reduce the direct loss of fresh mandarin fruits which ultimately minimizes the import quantity of mandarin from a foreign country. Similarly, there exist issues of higher price spread in the mandarin value chain. Poor marketing systems and weak institutional mechanisms could be major reasons behind it. Reliable extension service should be made easily available and extensional personnel should be regularly trained with recent postharvest management technologies. To make an impact, concerned programs and organization need to incorporate postharvest management activities in their programs ensuring that mandarin farmers and traders can be better involved in reducing postharvest loss.

### Author Contributions

The corresponding author took the lead in writing the manuscript while all other co-authors provided critical feedback and helped in analysis, interpretation, and manuscript preparation.

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### Data Availability

All data are available in the main text or in the supporting materials, whereas raw data can be obtained from the corresponding author upon request.

## Conflict of Interest

The authors disclosed no any conflict of interest.

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