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## **Economic Analysis of Post-harvest Losses in Marketing of Vegetables in Uttarakhand<sup>§</sup>**

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### **Abstract**

The study has examined the nature and extent of post-harvest losses in vegetable supply chain in the Kumaon division of Uttarakhand. Multistage cluster sampling has been used for selection of 80 vegetable growers, 40 farmers from the hilly region and 40 farmers from the bhabhar region. The sample has also included 25 market functionaries. Twelve major vegetables have been selected for the study. The maximum aggregate post-harvest losses have been found in tomato, followed by potato, brinjal, chilly, French bean and pea. The study has suggested that establishment of producer co-operatives to handle various activities relating to production and marketing of vegetables would help in reducing post-harvest losses.

**Key words:** Post-harvest losses, Uttarakhand, Vegetable supply chain, Tomato, Potato, Brinjal, Chilly, French bean, Pea

**JEL Classification:** Q13, Q12, Q18

### **Introduction**

The growing importance of vegetables in India's economy can be well appreciated in terms of their rising domestic demand on account of increase in population and per capita income; their increasing export potential; need for providing employment opportunities in the rural area, and vegetables being relatively more remunerative crops. While domestic and export demand is steadily rising, the production and marketing of vegetables face tremendous uncertainties on several counts. The production of most of the vegetables is seasonal and highly localized in favour of agro-climatic conditions in the country. The extremely perishable nature of

vegetables results in inability on the part of producer to manage supply in the assembling markets. Further, the large distances that separate the production area and the sub-optimal post-harvest technology management (including the method of picking/plucking/digging/harvesting, grading, packing, storing and transporting), a large proportion of vegetables is lost or spoiled at various stages of post-harvest activities. According to Verma and Singh (2004), the overall losses in vegetables can be up to 25 per cent of total production. Severe losses occur because of poor transportation facilities, lack of know-how, poor management and improper market facilities or due to careless handling of the produce by farmers, market intermediaries and consumers (Gauraha and Thakur, 2008; Singh *et al.*, 2008). The study by Karim and Wee (1996) had revealed that well managed post-harvest activities for vegetables led to higher yields and profits to producers. It is therefore, important that the post-harvest practices be given as much attention as production practices.

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The Uttarakhand state offers enormous opportunities to practise vegetable crops as it has several inherent and unique advantages in terms of agro-climatic conditions and rich biodiversity. However, local varieties, rainfed production, improper input-mix and traditional practices characterize the present status of agricultural technology in the state. The vegetables are grown in every district of the state without any organized back up of post-harvest management techniques like packaging, storage, transport and marketing. The state also suffers from poor infrastructure, poor accessibility to technology, lack of irrigation infrastructure, incidence of small and fragmented landholdings and low investment capacity of farmers. All this lead to low productivity and high spoilage of vegetables. Therefore, keeping all these problems into consideration, a study on post-harvest losses of vegetables was undertaken. The study will help in assessing the extent of losses, which in turn will facilitate development of proper measures to reduce post-harvest losses at different stages, from production to consumption stage. Very few studies have been attempted to assess the extent of losses at different stages. The study will be helpful to policymakers, administrators and industrialists as well as researchers in carrying out improvement in crop production and post-harvest technologies aimed at minimizing these losses.

## Methodology

The present study was conducted in the Kumaon division of Uttarakhand state. Since the region has vast potential for production, marketing and export of vegetables, it was purposively selected for the present study. For selection of vegetable growers and market functionaries multistage cluster sampling was used. At the first stage, one principal vegetable market, namely Haldwani market based on maximum annual arrival of vegetables was selected. At the second stage, two primary markets out of six were selected for the present study. These were: Haldwani old vegetable market and Bhowali market. The two primary markets were selected purposively in consultation with officials of Mandi Samiti, Haldwani. At the third stage, four clusters of villages (2 near the road and 2 at least 3 km away from the road) feeding the primary or secondary market were selected purposively considering the status of vegetable production. Eight clusters of villages in total were selected for the study. Considering the

geographical condition of the area, out of 8 clustered villages, 4 were selected from the hilly region and 4 from the bhabhar region. Finally, 10 farmers per cluster were selected randomly. Thus, the sample size was consisted of 80 vegetable growers, comprising 40 farmers from the hilly region and 40 farmers from the bhabhar region.

The sample also included market functionaries of each category, viz. commission agents, wholesaler-cum-commission agents and retailers. Ten wholesale-cum-commission agents were included in the sample. Five retailers each from secondary as well the two selected primary markets were taken for the study. As such total numbers of retailers selected were 15.

Several vegetable crops are cultivated in the Kumaon division in different seasons. For the present study, only major vegetables grown in the study area were considered. The selection of major vegetables was done on the basis of total annual production of different vegetables in the Nainital district. Thus, pea, tomato, potato, French bean, cauliflower, cabbage, onion, chilly, radish, capsicum, okra and brinjal were selected for the study.

The study was based on the primary data collected from the selected farmers, wholesalers and retailers involved in the marketing using a pre-structured schedule by personal interview method. Data from the different agencies were collected during 2008-2009.

## Analytical Technique

In the study post-harvest losses in vegetables have been estimated at different stages. The losses were estimated to find out which vegetable incurred the maximum loss, as well as at which stage. Simple statistical tools like averages and percentages were used in the study.

## Results and Discussion

### Post-harvest Losses in Vegetables

The post-harvest losses were estimated first at producer level, and then at trader level. The losses at producer level have been estimated at different stages, viz. harvesting, grading & packing, handling & transportation and marketing; whereas the losses at trader level have been estimated at loading-unloading, transportation, grading and selling stages. The results of the analysis have been presented in Tables 1 to 5.

### Post-harvest Losses in Vegetables at Producer Level

The post-harvest losses on farms of hilly and bhabhar farmers have been tabulated in Tables 1 and 2, respectively and at aggregate level these have been presented in Table 3.

#### Post-harvest Losses on Hilly Farms

A perusal of Table 1 reveals that the sample vegetables varied in nature, from semi-perishables like potato, cauliflower, cabbage, onion to highly perishables like tomato. Therefore, the extent of losses varied from vegetable to vegetable as well as at different stages. On the overall basis, the maximum loss was estimated in tomato (17.46%), followed by French bean (11.46%), pea (10.06%), chilly (9.89%), cauliflower (9.40%), onion (8.99%), potato (6.94%), cabbage (5.33%), capsicum (4.59%) and radish (3.89%). On studying the losses at different stages, it was observed that in tomato, onion, pea, potato, radish, capsicum and cabbage, the maximum loss was at the harvesting stage. The French

bean, cauliflower and chilly registered maximum losses at the handling & transportation stage.

#### Post-harvest Losses on Bhabhar Farms

The result of post-harvest losses in vegetables on the bhabhar farms, presented in Table 2, reveal that maximum loss was in tomato (15.11%), followed by brinjal (11.00%) and okra (8.54%). The cauliflower and onion registered the lowest post-harvest losses of 7.71 per cent and 5.82 per cent, respectively. Across different stages, it is revealed that tomato, okra and onion registered highest losses at the harvesting stage, while in French bean, maximum loss was recorded at the handling & transportation stage. The remaining vegetables, viz. brinjal and cauliflower registered maximum loss at the grading & packaging stage.

#### Post-harvest Losses on Overall Sample Farms

Table 3 presents the overall scenario of post-harvest losses at different stages on sample farms. The maximum post-harvest loss of 15.16 per cent was found

**Table 1. Post-harvest losses in vegetables on farmers of hilly region**

Vegetables	Total production	Stages				Total losses
		Harvesting	Grading & packing	Handling & transportation	Marketing	
Pea	20.22	0.98 (4.87)	0.21 (1.05)	0.75 (3.70)	0.09 (0.44)	2.03 (10.06)
Tomato	38.38	2.98 (7.76)	0.82 (2.13)	2.68 (6.98)	0.23 (0.60)	6.70 (17.46)
Potato	122.86	4.38 (3.56)	1.69 (1.38)	-	2.46 (2.00)	8.53 (6.94)
French bean	19.88	0.79 (3.97)	0.16 (0.81)	1.23 (6.16)	0.10 (0.51)	2.28 (11.46)
Cauliflower	6.78	0.09 (1.39)	0.25 (3.67)	0.18 (2.66)	0.11 (1.68)	0.64 (9.40)
Cabbage	40.62	0.68 (1.68)	0.59 (1.46)	0.40 (0.98)	0.50 (1.22)	2.17 (5.33)
Onion	6.04	0.30 (4.97)	0.15 (2.48)	-	0.09 (1.54)	0.54 (8.99)
Chilly	5.90	0.19 (3.17)	0.10 (1.63)	0.27 (4.56)	0.03 (0.53)	0.58 (9.89)
Radish	13.50	0.35 (2.59)	0.18 (1.30)	-	-	0.53 (3.89)
Capsicum	2.25	0.04 (1.93)	0.02 (0.89)	0.04 (1.78)	-	0.10 (4.59)

Note: Figures within the parentheses show percentages to total production

**Table 2. Post-harvest losses in vegetables on farmers of bhabhar region**

(in quintals)

Vegetables	Total production	Stages				Total losses
		Harvesting	Grading & packing	Handling & transportation	Marketing	
Tomato	1684.74	117.76 (6.99)	26.58 (1.58)	108.03 (6.41)	2.16 (0.13)	254.53 (15.11)
Okra	42.41	1.63 (3.83)	1.60 (3.76)	0.40 (0.94)	—	3.62 (8.54)
Cauliflower	69.17	0.95 (1.37)	1.67 (2.41)	1.63 (2.36)	1.08 (1.57)	5.33 (7.71)
Brinjal	152.00	6.84 (4.50)	9.12 (6.00)	0.76 (0.50)	—	16.72 (11.00)
French Bean	30.00	0.90 (3.00)	0.20 (0.67)	1.13 (3.75)	0.16 (0.53)	2.39 (7.95)
Onion	136.67	4.33 (3.17)	2.00 (1.46)	—	1.62 (1.18)	7.95 (5.82)

Note: Figures within the parentheses show percentage to total production

**Table 3. Post-harvest losses in vegetables on overall farmers**

(in quintals)

Vegetables	Total production	Stages				Total losses
		Harvesting	Grading & packing	Handling & transportation	Marketing	
Pea	20.22	0.98 (4.87)	0.21 (1.05)	0.75 (3.70)	0.09 (0.44)	2.03 (10.06)
Tomato	872.53	61.14 (7.01)	13.87 (1.59)	56.06 (6.42)	1.21 (0.14)	132.27 (15.16)
Potato	122.86	4.38 (3.56)	1.69 (1.38)	-	2.46 (2.00)	8.53 (6.94)
French bean	20.66	0.80 (3.86)	0.16 (0.80)	1.22 (5.89)	0.11 (0.51)	2.29 (11.06)
Cauliflower	17.18	0.24 (1.38)	0.49 (2.82)	0.42 (2.46)	0.28 (1.60)	1.42 (8.27)
Cabbage	40.62	0.68 (1.68)	0.59 (1.46)	0.40 (0.98)	0.50 (1.22)	2.17 (5.33)
Onion	71.35	2.32 (3.25)	1.08 (1.51)	-	0.86 (1.20)	4.25 (5.95)
Chilly	5.90	0.19 (3.17)	0.10 (1.63)	0.27 (4.56)	0.03 (0.53)	0.58 (9.89)
Radish	13.50	0.35 (2.59)	0.18 (1.30)	-	-	0.53 (3.89)
Capsicum	2.25	0.04 (1.93)	0.02 (0.89)	0.04 (1.78)	-	0.10 (4.59)
Okra	42.41	1.63 (3.83)	1.60 (3.76)	0.40 (0.94)	-	3.62 (8.54)
Brinjal	152.00	6.84 (4.50)	9.12 (6.00)	0.76 (0.50)	-	16.72 (11.00)

Note: Figures within the parentheses show percentage to total production

in tomato, followed by French bean (11.06%), brinjal (11.00%), pea (10.06%), chilly (9.89%), Okra (8.54%), cauliflower (8.27%), potato (6.94%), onion (5.95%), cabbage (5.33%), capsicum (4.59%) and radish (3.89%). Amongst different stages, tomato, pea, okra, potato, onion, radish, capsicum and cabbage recorded maximum losses at the harvesting stage. However, Sharma *et al.* (1995) had reported maximum post-harvest losses at grading & packing stage in Himachal Pradesh. The brinjal and cauliflower registered maximum losses at the grading & packaging stage, while French bean and chilly had maximum losses during the handling & transportation stage.

#### Post-harvest Losses in Vegetables at Trader Level

In this section the post-harvest losses at the wholesale and retail levels have been discussed. The

wholesale transactions in vegetables were being performed from early morning till around 11 am every day. The wholesaler-cum-commission agents were found not taking title in the case of green vegetables in the study area, except in potato and onion. The functionaries informed that they lost up to 10 per cent in potato and 7 per cent in onion during storage and about half of the quantity was sold without storing for a long period. Therefore, the half of these losses, viz. 5 per cent and 3.5 per cent were considered the losses at wholesale level for potato and onion, respectively. The losses at retail level were also worked out and have been presented in Table 4. It was found that loss was registered maximum by tomato (8.03%), followed by okra (7.09%), chilly (6.86%), pea (6.31%), capsicum (5.84%), brinjal (5.81%), French bean (5.67%), cauliflower (5.16%), potato (4.94%), onion (4.32%), cabbage (3.32%) and radish (2.63%). As far as losses

**Table 4. Post-harvest losses in vegetables at retail level**

Vegetables	Average Quantity purchased	Stages					Total loss
		Loading-unloading	Transportation	Grading	Selling		
Tomato	9.01	0.16 (1.79)	0.072 (0.80)	0.066 (0.73)	0.424 (4.71)	0.723 (8.03)	
Potato	72.67	-	1.111 (1.53)	1.745 (2.40)	0.734 (1.01)	3.590 (4.94)	
Onion	27.33	-	0.383 (1.40)	0.418 (1.53)	0.380 (1.39)	1.181 (4.32)	
French bean	2.03	0.01 (0.67)	0.01 (0.37)	0.02 (1.15)	0.07 (3.48)	0.12 (5.67)	
Cauliflower	6.67	0.047 (0.70)	0.067 (1.01)	0.129 (1.93)	0.101 (1.51)	0.344 (5.16)	
Cabbage	6.03	0.038 (0.63)	0.046 (0.76)	0.054 (0.90)	0.062 (1.03)	0.200 (3.32)	
Pea	8.75	0.05 (0.52)	0.06 (0.67)	0.10 (1.15)	0.35 (3.97)	0.55 (6.31)	
Chilly	1.5	0.01 (0.71)	0.01 (0.85)	0.02 (1.15)	0.06 (4.15)	0.10 (6.86)	
Radish	2.40	0.027 (1.13)	0.015 (0.63)	0.011 (0.46)	0.009 (0.40)	0.063 (2.63)	
Capsicum	1.97	0.01 (0.35)	0.01 (0.37)	0.02 (1.15)	0.08 (3.97)	0.12 (5.84)	
Okra	11.70	0.084 (0.71)	0.102 (0.87)	0.139 (1.11)	0.504 (4.31)	0.829 (7.09)	
Brinjal	4.73	0.041 (0.87)	0.042 (0.93)	0.028 (0.60)	0.164 (3.47)	0.207 (5.81)	

Note: Figures within the parentheses show percentage to total quantity

**Table 5. Total Post-harvest losses in vegetables**

(per cent)

Vegetable	Losses at different levels			
	Grower	Wholesaler	Retail	Total
Tomato	15.16	-	8.03	23.19
Potato	6.94	5.00	4.94	16.88
Onion	5.95	3.50	4.32	13.77
French bean	11.06	-	5.67	16.73
Cauliflower	8.27	-	5.16	13.43
Cabbage	5.33	-	3.32	8.65
Pea	10.06	-	6.31	16.37
Chilly	9.89	-	6.86	16.75
Radish	3.89	-	2.63	6.52
Capsicum	4.59	-	5.84	10.43
Okra	8.54	-	7.09	15.63
Brinjal	11.00	-	5.81	16.81

at different stages were concerned, the maximum losses were estimated during the selling stage in most of crops, except potato, onion, cauliflower and radish. The maximum loss during selling stage was registered in tomato.

### Total Post-harvest Losses in Vegetables

The aggregate post-harvest losses in sample vegetables were calculated by taking together the losses at producer level, wholesale level and retail level. Table 5 reveals that post-harvest losses were maximum in tomato (23.19%) and minimum in radish (6.52%). Hazarika (2006) has also observed maximum post-harvest losses in tomato. The potato ranked second in the list registering 16.88 per cent loss, followed by brinjal (16.81%), chilly (16.75%), French bean (16.73%), pea (16.37%), okra (15.63%), onion (13.77%), cauliflower (13.43%), capsicum (10.43%) and cabbage (8.65%). Across different levels, it was found that the losses were maximum at the grower level in all the vegetables, except capsicum. Similar results were obtained by Gajanana *et al.* (2006) and Kumar *et al.* (2006). On the contrary, Hazarika (2008) has reported maximum post-harvest loss at the middleman level in Assam.

### Conclusions and Policy Implications

The study has estimated post-harvest losses in major vegetables grown in Uttarakhand. At producer level, the post-harvest losses have been found maximum in

tomato (15.16%) followed by French bean (11.06%), brinjal (11.00%), pea (10.06%) and minimum in radish (3.89%). At the retail level also, tomato has registered maximum loss, followed by okra, chilly and pea. The maximum aggregate post-harvest losses have been found in tomato, followed by potato, chilly, pea and minimum in radish. Across different stages, the losses have been found maximum at the grower level in all the vegetables, except capsicum. The spoilage/loss of vegetables at the grower level results from lack of his knowledge about proper post-harvest management. Improper grading, packing, lack of storage and inadequate transportation facilities contribute more to the problem. One of the most important causes of post-harvest losses is harvest at inappropriate maturity, resulting in erratic ripening and poor quality. Therefore, there is an urgent need of training the vegetable growers on scientific post-harvest techniques, if the vegetable production is to be sustained on a profitable basis in the region.

The study has suggested that one possible solution to tackle these problems could be the establishment of producer co-operatives to handle various activities relating to production and marketing of vegetables. This will not only help reduce the post-harvest losses but will also increase the bargaining power of growers in marketing. It will help them in adopting consumer-oriented approach to vegetable marketing.

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