

Research Paper

# Estimation of Post-harvest Losses and their Management Strategies Adopted by the Vegetable Cultivators

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## ABSTRACT

The present study estimated the post-harvest management of selected vegetables in Karnataka. The study was based on primary data collected for the year 2021-22 from 15 farmers for each crop, in both open and protected conditions and from two major vegetable producing districts of the state. The data pertaining to wholesaler and retailer were collected from 15 wholesaler and 15 retailers from each districts who were involved in marketing of vegetables. Descriptive statistics was the analytical tools adopted for the analysis of the data which includes percentages and averages. The reduction in post-harvest loss in protected cultivation was due to controlled environment in protected condition. Similarly, the post-harvest loss was higher in wholesaler against retailer because the huge quantity handling of vegetables found at wholesaler. Results depicted that the difference in post-harvest loss under open cultivation and protected cultivation are 14.13 kg/q, 6.27 kg/q, 14.64 kg/q and 14.93 kg/q of tomatoes, capsicum, cucumber and french beans, respectively. In between wholesaler and retailer, the difference in post-harvest losses are 4.43 kg/q, 2.47 kg/q, 7.40 kg/q and 2.57 kg/q for tomato, capsicum, cucumber and french beans respectively. Findings shows that the post-harvest management practices followed by farmers are harvesting at proper stage, use of crates for transportation, establishing better storage facilities and processing of mechanically damaged products. Similarly, the post-harvest management practices followed by market intermediaries are cold storage, better transportation facilities, procurement of good quality material, usage of cushioning material and other better management practices. The establishment of small sized cold storage units and employing better transportation facilities led to reduction in post-harvest losses which in turn led to additional returns to farmers and market intermediaries.

## HIGHLIGHTS

- ① The post-harvest loss was found higher in the case of open cultivation compared to protected cultivation practices.
- ② At market intermediaries the major post-harvest loss was found to be at wholesaler level across all the selected vegetables in the study area.

**Keywords:** Post-harvest losses, farm level, wholesaler level and retailer level

The post-harvest losses of fruits and vegetables are the matter of critical issue for India's agriculture sector. However, this is a widespread occurrence that occurs in almost all developing countries and it has also occurred in developed countries. Another

impediment for addressing the situation is that in

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most developing countries, including India there is lack of the research and technical guidelines for the farmers and there is no awareness regarding post-harvest losses and the farmers neglected the issue in the field level because of lack of knowledge regarding post-harvest management of the horticultural crops (Kumar *et al.* 2006). The respiration rate of the horticultural crops are higher compared to agricultural crops and hence, the shelf life of the horticultural crops are less and the produce deteriorate early.

The various factors affecting the post-harvest losses may be the harvesting time, harvesting situation, weather condition, harvesting methods, tools used for harvesting, health of the plant, storage facility, etc. During the market glut situation majority of the produce thrown on roads. This is one situation usually seen in tomato, onion, potato and some other crops (Sharma *et al.* 2011). Instead of creating this situation and experiencing huge monetary loss, one can go for processing. Processing is the sun-rising sector at current situation; post-harvest technology has always been a part of agriculture's natural development processes. In the supply of vegetables from producer to reach ultimate consumer, different market intermediaries were found such that at each level of movement of vegetables the losses occurred during handling of vegetables. At each stages of the product movement, the losses happened due to various factors. The study aimed to access the post-harvest losses of tomato, capsicum, cucumber and french beans in both open and protected cultivation as well as the post-harvest losses at wholesaler and retailer level were evaluated in such a way that, the post-harvest management practices followed by farmers, wholesalers and retailers were tapped. This in turns helps the farmers, wholesalers, retailers, policy makers, industrialists and administrators to identify the critical factors for post-harvest losses and establish the required measures to overcome them. With this background the present study was carried out with the specific objective of studying the post-harvest management of products produced in both the environments.

## METHODOLOGY

The present study focused on post-harvest management of selected vegetables produced under both open and protected conditions. The

study was conducted in Karnataka based on primary data collected for the year 2021-22. Kolar and Belagavi districts were selected for the study as they were the highest vegetable producing districts in Karnataka. The vegetables were selected based on highest production data from 2017-18 to 2019-20 (triennium average). Tomato, capsicum, cucumber and french beans were selected for the study. The necessary primary data were collected from 15 farmers for each crop, in both open and protected conditions and from each district. The data pertaining to wholesaler and retailer were collected from 15 wholesaler and 15 retailers from each districts who were involved in marketing of vegetables. The data were collected with the help of well-structured schedule, separately prepared for farmers and market intermediaries. Descriptive statistics was adopted for analysis of data collected from farmers and market intermediaries which includes the averages and percentages to estimate post-harvest losses.

## RESULTS AND DISCUSSION

The post-harvest losses in the selected vegetables have been evaluated and presented here. The evidence elicited from a random sample of 30 growers each in open and protected cultivation of tomato, capsicum, cucumber and french beans, 15 wholesalers and 15 retailers for each district was the basis for estimation of post-harvest losses in these crops at different stages. The post-harvest losses calculated for total quantity of 100 Kg of product in each of the crops, each production conditions and wholesaler and retailer also. The post-harvest losses selected vegetables at different stages are presented in Table 1.

### Post-harvest losses of tomatoes at different levels

The total post-harvest losses of tomatoes estimated at farm level for every 100 kg of tomatoes were about 24.13 kg under open cultivation and 10 kg under protected cultivation environments. This revealed that post-harvest loss was more in open cultivation against protected cultivation because of the poor management practices under open cultivation (Table 1). The farmers those who are practicing open cultivation of tomatoes need to adopt the better management practices to avoid

**Table 1:** Post-harvest losses in selected vegetables at different levels (kgs)

Sl. No.	Type of losses At Farm Level	Tomato		Capsicum		Cucumber		French Beans	
		O	P	O	P	O	P	O	P
1	Total quantity of produce	100	100	100	100	100	100	100	100
2	Quantity of good produce	75.87	90.00	72.70	78.97	75.73	90.37	75.33	90.26
3	Bird damage	4.73	1.20	4.70	3.17	4.57	1.33	3.80	0.96
4	Rotting	3.83	1.47	4.03	2.67	3.93	1.53	3.77	1.63
5	Mechanical injury	3.40	1.43	4.07	2.80	3.73	1.37	3.53	1.33
6	Overmaturity	3.37*	1.77*	3.90	4.90	3.67	1.53	4.37	1.80
7	Pests and diseases attack	5.63	2.50	7.37	4.30	5.23	2.33	5.90	2.43
8	Packing, storage and transportation	2.47	1.43	2.90	2.80	2.63	1.30	2.93	1.36
9	Others	0.70	0.20	0.33	0.40	0.50	0.23	0.37	0.20
<b>Total PHL at farm level</b>		<b>24.13</b>	<b>10.00</b>	<b>27.30</b>	<b>21.03</b>	<b>24.27</b>	<b>9.63</b>	<b>24.67</b>	<b>9.74</b>
10	<b>At wholesaler and retailer level</b>	<b>W</b>	<b>R</b>	<b>W</b>	<b>R</b>	<b>W</b>	<b>R</b>	<b>W</b>	<b>R</b>
11	Total quantity of produce	100	100	100	100	100	100	100	100
12	Quantity of good produce	90.07	94.50	91.70	94.20	88.77	96.17	90.73	93.30
13	Storage loss	1.87	1.13	1.53	1.27	2.63	0.63	1.23	1.27
14	Rotting	2.60	0.93	2.40	1.07	2.43	0.80	2.27	1.13
15	Transportation loss	2.80	1.90	2.33	1.73	2.67	1.17	3.23	1.83
16	Pests and diseases attack	0.93	0.60	0.97	0.77	1.77	0.50	1.60	1.20
17	Physical damage and packaging loss	1.03	0.73	0.87	0.80	1.27	0.57	0.73	1.13
18	Others*	0.70	0.20	0.20	0.20	0.47	0.17	0.20	0.13
<b>Total PHL at wholesaler and retailer level</b>		<b>9.93</b>	<b>5.50</b>	<b>8.30</b>	<b>5.83</b>	<b>11.23</b>	<b>3.83</b>	<b>9.27</b>	<b>6.70</b>

*Note:* Others include accidental loss, loading and unloading loss, leakage, etc., O means open cultivation and P means protected cultivation, \* indicates over ripe in case of tomato, W means wholesaler and R means retailer, others\* include accidental loss, loading and unloading loss, leakage, etc...

post-harvest losses. The post-harvest losses due to pests and diseases was experienced more in open cultivation (5.63 kg) compared to protected cultivation (2.50 kg), due to controlled environment conditions in protected cultivation. Bird damage was more in open cultivation (4.73 kg). Rotting caused huge loss under open cultivation (3.83 kg) compared to protected cultivation (1.47 kg). This might be due to attack of micro-organisms easily to fresh produce and spread rapidly, because the products heaped in farm would lead to moisture formation and cause rotting in fraction of time. Handling of the produce was suspected to be harsh in open cultivation, so tomatoes were lost due to mechanical injury in both open (3.40 kg) and protected cultivation (1.43 kg). These findings are in line with the study conducted by Sharma and Singh (2011), where in tomato suffered maximum losses at farm level.

The post-harvest losses were calculated for 100 kg of produce and the quantity of good produce obtained at wholesaler level was 90.07 kg and at retailer level was 94.50 kg. The declared post-harvest loss was more at wholesaler level compared to retailer level (Table 1). Transportation loss, storage

loss and loss due to rotting together constituted around 73 per cent of loss at wholesaler level and 72 per cent loss at retailer level. This signifies more post-harvest losses are because of poor market infrastructure. Tomatoes are the important vegetable crops and proper handling of them after harvest plays very important role in providing better returns to the intermediaries. The transportation losses among the wholesalers were more as they transport commodities to longer distances but retailers transport smaller quantities and also to smaller distances. The results conveyed that there is a shortage of storage facility at wholesaler and retailer level. Hence, the establishments of sufficient capacity cold storages are required at different levels. The rotting loss occurred due to escape of overmatured fruits during sorting and grading. Therefore, careful grading, sorting and cleaning are the essential activities required at wholesaler and retailer level.

### Post-harvest losses of capsicum at different levels

The results from Table 1 revealed that out of every 100 kg of capsicum harvested, 72.70 kg and 78.97

kg of good produce were obtained from open cultivation and protected cultivation of capsicum respectively. Major loss had happened due to pests and diseases attack (7.37 kg), bird damage (4.70 kg) and mechanical injury (4.07 kg) in open cultivation. While in protected cultivation significant loss was due to over maturing (4.90 kg), pests and disease attack (4.30 kg) and bird damage (3.17 kg). It was noticed from the table that the loss occurred due to over maturity was reported higher in protected cultivation (4.90 kg) because in protected cultivation farmers experienced higher yield against open cultivation and harvesting was a tedious task which causes escape of fruits from the harvest. The left over fruits become over matured in next round of harvest. The post-harvest losses of capsicum was higher in open cultivation (27.30 kg) because other external factors like climatic factors, bird damage and losses due to pests and disease were more which led to maximum losses in open cultivation. It was astonishing to observe bird damage is quite sizable in protected cultivation (3.17 kg) also. Many of the protected structures were old and farmers give less attention for the holes created in the nets. Birds enter through these openings and damage fruits. Therefore, proper care needs to be taken to mind these nets regularly to minimize post-harvest losses in protected environment.

It could be identified that around 91.70 kg of good produce was extracted at wholesaler level and 94.20 kg at retailer level from an average of each 100 kg of produce handled by each of the intermediaries as shown in Table 1. Major post-harvest loss occurred due to rotting, transportation and storage loss at these levels. These results indicate lack of storage facilities in potential vegetable producing areas especially cold storages and lack of reefer vans for transportation. The rotting loss caused due to utilization of fully packed containers for transportation. The moisture created inside the package resulted in development of microbes causing rotting. The usage of perforated carrying materials would avoid the rotting loss. The wholesaler's post-harvest loss was more compared to retailers, because wholesaler handles huge quantity of vegetables compared to retailer. Lack of care towards maintenance as well as lack of storage facility and lack of good transportation facilities led to huge post-harvest losses at wholesaler level.

Retailers handle smaller quantities of the produce and based on their experience they handle required quantity of produce and hence could minimize post-harvest losses.

### **Post-harvest losses of cucumber at different levels**

Around 76 kg of good produce was obtained from open cultivation and around 90 kg of good produce from protected cultivation of cucumber in the study area from every 100 kg fruits harvested. Major loss occurred under open cultivation was due to pests and diseases attack (5.23 kg), especially fruit fly, which creates tiny hole in the fruit making them unacceptable by wholesalers and private companies. The other reasons for losses were bird damage (4.57 kg) and rotting (3.93 kg). Under protected cultivation, the major reasons for post-harvest loss were pests and diseases attack (2.33 kg) and over-maturity (1.53 kg). Cucumber is mainly consumed as salad, therefore, matured fruits are rejected by the consumers. Timely harvesting plays very important role in post-harvest management of cucumber. Rotting of fruits (1.53 Kg) is another serious issue of post-harvest losses due to microbial activity during storage. Hence, facilitation of better storages are recommended to the farmers.

Table 1 also provides information on post-harvest losses of cucumber at wholesaler and retailer level. The quantity of good produce obtained by the wholesaler level and retailer level were 88.77 kg and 96.17 kg for every 100 kg of produce handled by them respectively. The top most reason for post-harvest losses of cucumber at wholesaler level was transportation loss, storage loss and rotting. Lack of cold chain logistics has led to substantial losses at market intermediaries level. As that of wholesaler, at retailer level also transportation loss and loss due to rotting of fruits were the major causes for post-harvest losses. Cucumber contains high level of water and respiration rate is also higher, which creates fast deterioration and rotting. Cucumber fruits are harvested when they are tender, which is the requirement of the consumers. More post-harvest losses were notice at wholesaler level as compared to retailer level. Along with storage loss rotting and storage loss, pest and disease attack and physically damage and packaging loss also contribute substantially to post-harvest losses at

wholesaler level. Therefore, careful handling and transportation at wholesaler and retailer level with modern technologies is needed to reduce losses and the retailers should transit as early as possible to reach the consumer.

### **Post-harvest losses of french beans at different levels**

Table 1 also reflects the post-harvest losses due to different reasons both at open cultivation and protected cultivation practices for every 100 kg of french bean harvested. A cursory look at the table suggests that around 75.33 kg and 91 kg of good produce were obtained from open cultivation and protected cultivation respectively. Mainstream of losses was occurred due to pests and disease attack (5.90 kg), bird damage (3.80 kg) and over matured pods (4.37 kg) in open cultivation of french beans. Pod borer, pod bug and anthracnose were the major pests and diseases affecting french bean crop in the study area. Under protected cultivation loss due to pests and disease attack, though it was not of the same scale as that of open cultivation, was the major factor accruing to post-harvest losses. Pests and diseases (2.43 kg) should not occur under protected environment. The farmers using protected structures might not be giving proper care for the maintenance of these structures, which in turn might have allowed pests and diseases causing agents to enter into the protected area and might have affected the plants. Some of the pathogens are soil borne and they later affect the crop. Regular inspection and upkeep of the structures and regular sterilization of the soil would reduce the post-harvest losses and improve the profits. Farmers need to be educated in these lines to reduce the losses.

It is also witnessed from the Table 1 that, around 91 kg of good produce was extracted at wholesaler level and 93 kg at retailer level for every 100 kg of french beans handled by them respectively. Faulty transportation, loss due to rotting and pests and diseases attack were the factors causing huge losses at wholesaler as well as retailer level. Usage of unsuitable containers and rough roads cause damage to the french beans leading to making them unsuitable for market. Construction of all-weather road network from production centres to consumption centres is needed to reduce the losses. Quality containers need to be used to reduce

brushing, bruising and damaging of beans while transportation and handling.

It could be concluded that transportation loss, rotting and storage loss were the major components causing huge losses at wholesaler and retailer level in all the selected vegetables. This clearly signifies that there is a shortage of transportation facilities and cold storage facilities. The establishment of better transportation facility and cold storage facility by any private agencies or public sector organizations could make a way to reduce the post-harvest loss at market level.

### **Post-harvest management practices followed by farmers and market intermediaries**

The results concerning to post-harvest management practices followed by farmers are epitomized in Table 2. Majority of respondents followed harvesting of produce at proper stage to reduce the post-harvest losses. This might help the produce to reach the ultimate consumers at right time with preferred quality. Use of crates for transportation of produce was another management practices followed by the farmers in which, the crates created proper space to fruits and pods to occupy in them, which in turn reduces the post-harvest loss. Establishment of better storage facilities with ambient storage conditions would reduce the storage loss. Processing of mechanically damaged fruits and pods, like preparation of pickles, would result in value addition to vegetables. Quite a negligible proportion of the farmers followed the practices like harvesting during early morning or late evening and careful handling of the produce to reduce post-harvest losses. Looking in to the results, it is understood that there is strong need for extension and advisory services to the farmers regarding post-harvest management practices to reduce the losses. Hassan and Ramady (2015) also of the opinion that post-harvest management practices including harvesting, handling, packaging, storage and hygiene of fruits and vegetables are necessary to have better value to the products.

Table 2 also summarizes the post-harvest management practices followed by different market intermediaries, arise with the aim to reduce post-harvest losses. Around 40 per cent of the market intermediaries store the vegetables in cold storage. The market intermediaries, especially retailers,

**Table 2:** Post-harvest management practices carried by farmers and market intermediaries (n=240 for farmers and n=60 for market intermediaries)

Sl. No.	Post-harvest management practices followed by farmers	Response	Percentage
1	Harvesting at proper stage	115	47.92
2	Use of crates for transportation	85	35.42
3	Establishing better storage facilities	63	26.25
4	Processing of mechanically damaged fruits and vegetables	46	19.17
5	Others	8	3.33
Sl. No.	Post-harvest management practices followed by market intermediaries	Response	Percentage
1	Cold storage	24	40.00
2	Better transportation facilities	19	31.67
3	Procurement of good quality material	15	25.00
4	Usage of cushioning material	14	23.33
5	Better management practices	11	18.33
6	Others*	8	13.33

**Note:** Others include harvesting time and careful handling of produce and others \* include reducing transportation distance and direct procurement from farmers' field.

utilize the refrigerator for cold storage of vegetables, wherein the retailers handle the produce in smaller quantities. About 32 per cent of them employed better transportation facilities like transportation through the refrigerated vans. Procurement of better quality material would be the first step to achieve less loss. Utilization of cushioning material during packaging to reduce transit loss and better management practices like careful maintenance of storage area and hygiene conditions would reduce the post-harvest loss. Still the gap is very wide, which suggests that many of the intermediaries are negligent in handling of the produces after harvest, which is the most important parameter in reducing the post-harvest losses. Arah and Ahorbo (2016) in their study revealed that harvesting, precooling, washing, disinfecting, sorting and grading, packaging, storing and shipping plays a vital role in preserving quality and extending shelf life at all levels of product movement.

## CONCLUSION

The post-harvest loss occurs due to faulty methods of harvesting, cleaning, storage, transportation and storage of vegetables. The study endeavored to estimate the post-harvest losses and to tap post-harvest management practices followed by farmers and market intermediaries in Karnataka. The total post-harvest loss was found higher in open cultivation compared to protected cultivation at the farm level due to controlled environment

conditions in protected cultivation. Transportation and storage loss at the wholesaler and retailer levels was found higher, hence, the adoption of proper modern transportation facilities for transportation of produce to distinct areas and the establishment of small-sized storage units in the vegetable production units would help in reducing storage losses. Zero energy cool chambers technology developed by ICAR can be adopted by small-sized retailers and consumers also instead of refrigerators which causes damage to the environment.

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