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Pre and Post-harvest Losses of Tomato in Punjab: Insights from Field Survey

G. Kaur and P. Kaur

Department of Economics and Sociology, Punjab Agricultural University, Ludhiana-141 004, India
E-mail: kaurguri428@gmail.com

***Abstract*:** The study was carried out to quantify the pre and post-harvest losses of tomato in Punjab. Multistage stratified and purposive sampling was used to select the 200 respondents from 21 villages of Patiala and Amritsar district of Punjab during the period, 2020-21. Blight assault accounted for the majority of output losses at the farm level (18.95%), followed by fruit borer attack (14.85%), unfavorable weather conditions (11.89%), and fruit cracks from excessive rain (3.44%). The proportion of the losses from total production was 6.18 percent at producer level, 2.60 percent at trader's level out of which 1.82 percent losses were at commission agent cum wholesaler level and 0.76 percent at retailer's level of the total quantity marketed. At various stages of production and marketing, the total post-harvest losses in tomatoes were 8.76 percent. Age of the farmer had a negative and significant coefficient (0.865) taken into account as one of the independent factors impacting post-harvest losses at the farm level. Inadequate labour (19.93) and inadequate transportation facilities (16.98) were the factors having positive and significant effect on the extent of post-harvest losses at farm level. The negative and significant coefficient (-39.154) of dummy variable for the district shows that on an average post-harvest losses of Amritsar district was significantly lower than Patiala district. The negative and significant coefficient (-15.772) of dummy variable for farm size categories indicating that the post-harvest losses in medium farm size category were lower than the large farm size category. It is recommended that providing scientific post-harvest handling and management training to vegetable farmers, together with chances for value addition, will improve their livelihoods and revenue. Extension services should be provided to the farmers regarding effective post-harvest management techniques that enhance their technical proficiency and enable them to manage post-harvest operations with precision. Pest and disease activity accounted for a larger portion of post-harvest losses on farms. Thus, it is advised that farmers apply integrated pest management techniques. More and more small and large processing units must be built in the state in order to reduce post-harvest losses.

Keywords: Tomato, Post-harvest, Losses, Factors, Punjab

Tomato (*Lycopersicon esculentum*) is a widely consumed vegetable crop worldwide. In many of the developing nations, it is a source of income for rural and peri-urban farmers. It is universally used in many parts of the world using several recipes in food processing and several industries (Sisay et al 2022). Globally, 41.37 million tonnes of tomatoes were processed into value-added products, according to the world processing tomato council (2019-20). The total tomato production in India during 2022-23 was approximately 21.18 million tonnes from 845 thousand hectares, which was declined by 2.3 percent from the previous year (FAO 2023).The decrease can be attributed to factors such as erratic weather conditions, pest and disease outbreaks, and rising input costs. India contributes 11% of the world's tomato production. Despite being the second largest producer of tomatoes in the world, India processes less than one per cent of its production (NHM 2017). Tomato pulp and paste products are imported by Indian manufacturers at high prices which entails an import duty of 30 percent (Subramanian 2016). Low quality, perishability of the crop, lack of cold storage system, lack of presence of remunerative prices, and unavailability of fresh tomatoes (Kumari et al 2022) are the barriers for processing industries in India. Therefore, a systematic marketing is required to mobilize the surplus of tomato crop with an aim to reduce the post-harvest losses significantly.

Post-harvest losses are a matter of concern. Tomato growers observed that post-harvest losses are critical for loss reduction, value addition, food security, employment creation, and income generation. Post-harvest technology is an essential component of the agriculture production and utilization system. Therefore, the nation needs a post-harvest technology revolution. Overall, post-harvest losses in India were estimated at around INR 926.51 trillion (Jha et al 2015). Among vegetables, the estimated post-harvest losses ranged from 4.82 percent in tapioca to 11.61 per cent in tomato (Ilori et al 2016, Krishna et al 2022, NABCONS 2022). Farm operations such as harvesting and sorting/grading resulted in post-harvest losses. Lack of proper storage and improper handling practices by various stakeholders in market channels were the major contributing factors towards postharvest losses. The cold chain infrastructure for

vegetables in the country was still at a very nascent stage, special focus is needed for reduction in post-harvest losses as well as for retention of good quality as desirable by the consumers (NABCONS 2022).

In Punjab, tomato cultivation is one of the vegetable alternatives to wheat and paddy crop rotation. Depleting water table, escalating soil degradation, ecological problems and stagnation in the yields of the crops are the result of the intensive use of inputs and monoculture in the cropping system of Punjab (Bhatt et al 2016). Tomato is grown on an area of 10.4 thousand hectares with a production of 269.9 thousand tonnes (GoP 2022). It is one of the important vegetable crop after potato (47.36%), cauliflower (7.50%), pea (7.28%) and onion (3.80%) bestowing more than 50 percent of the total production of Punjab (GoP 2022).

Given the high perishability of tomatoes, growers must decide how to dispose of the crop as soon as it is harvested. Majority of the farmers has to rely on the markets, where prices are extremely volatile whenever there is a market glut and even a small delay in disposal can result in significant post-harvest losses to the produce (Grover et al 2003). Due to this, the current state of the market begs the question of why, despite record output levels, we have not been able to treat our farmers fairly (Tiwari et al 2021). It is crucial to give post-harvest loss procedures the same consideration as production procedures. Any decrease in post-harvest losses will undoubtedly enhance the economy's net food availability, which is of immense value and will serve to raise both the producer's returns and the consumer's satisfaction. A study of this kind will make it possible to identify the issue clearly, provide solutions, and ultimately cut down on overall waste. With this context, the current study was carried out to quantify the pre and post-harvest losses of tomato in Punjab.

MATERIAL AND METHODS

The study was primarily based on primary data collected during the period 2020-21.Two districts namely Patiala and Amritsar of Punjab state were selected purposively as these districts were contributing highest production and area of tomato cultivation. Multistage stratified random sampling technique was used for the selection of sample. Two blocks from each district i.e. Jandiala and Raiyya from Amritsar and Sanaur and Patiala from Patiala district were selected where the density of tomato growers were higher. From these selected blocks, the villages/cluster of villages with the highest concentration of tomato growers from each block were selected i.e. twenty-one villages were chosen randomly for data collection. Fifty tomato growers were randomly chosen from each designated block, 100 each from both the districts. Thus, making a total sample of 200 tomato growers were interviewed personally at the farms. The data was summarized using suitable statistical measures such as averages and percentages. For various operations such as harvesting, handling, and transportation, farmers were also asked for information about post-harvest losses. Last but not least, the sum of all these losses was assessed to be the overall post-harvest losses.

Functional Analysis

Multiple linear regression: The functional analysis was conducted to investigate the factors influencing post-harvest losses at the farm level as used by Nag et al 2000, Kumar et al 2006, Begum et al 2012, Khatun et al 2014, Alidu et al 2016. A multiple linear regression analysis was used for the present study.

$Y=a+b_1x_1+b_2x_2+b_3x_3+b_4x_4+b_5x_5+b_6x_6+b_7x_7+b_8x_8+b_9x_9+b_{10}x_{10}$

Where,

Y=Total Post-harvest losses (quintals), x_1= Age of the farmers (years)

x_2=Education of the farmers (years), x_3=Production (quintals)

x_4=Farm size (acres),x_5= Labour dummy (inadequate =1,0=adequate)

x_6=Weather dummy (inadequate=1,0=adequate), x_7= Transportation dummy (inadequate=1,0=adequate)

x_8=Dummy district (D_1=1forAmritsarand0=Patiala), x_9= Dummy farm size category (D_2=1for large and 0 for otherwise)

x_{10}=Dummy farm size category (D_3=1for medium and 0 for otherwise)

Table 1. Selected districts, blocks, villages and number of respondents, Punjab, 2020-21

Districts	Blocks	Selected villages	No. of villages in the cluster	Sample size
Amritsar	i) Jandiala	Teerthpur, Mallkpur, Wadhala johl, Chappa ram singh, Nawan pind, Fatehpur rajputan	6	50
	ii) Raiyya	Dhyanpur, Usma, Bhlaipur purba, Mehtampur, Sudhar rajputa, Sherbagha, Bheni ramdayal, Wadhala kala, Nangli kala, Nangli khurd, Jodhe	11	50
Patiala	i) Patiala	Lalucchi and Nwi Lalucchi	2	50
	ii) Sanaur	Sanaur and Asarpur	2	50
Grand total			21	200

RESULTS AND DISCUSSION

Pre and Post-harvest losses in tomato: Overall losses at the producer level were 14.26 quintals/acre contributing 49.15 percent share of the total pre and post-harvest losses (Table 2). The production losses at the farm level were highest due to blight disease (17.64%) in Patiala district whereas the incidence of fruit borer attack (21.24%) was highest in Amritsar district. The losses at the producer level were highest in Patiala district (43.23%) as compared to Amritsar district (39.48%). The total losses during marketing operation at the producer's level were estimated to be 6.60 quintals/acre which was 22.75 percent share of the pre and post-harvest losses. Out of the total losses, the transportation losses were highest i.e. 3.48 quintals/acre accounted for 11.99 percent share of the total pre and post-harvest losses. Total losses at the producer's level during marketing operation were 20.80 quintals/acre accounting for 71.90 percent of the total pre and post-harvest losses. The losses at the commission agent cum wholesaler level were estimated to be 56.78 quintals/acre which was 19.92 percent share of the total pre and post-harvest losses. The losses which were found highest in the case of Amritsar district constituted about 20.53 percent of the total losses. The estimated losses at the retailer level were estimated at 2.37 quintals/acre which was 8.16 percent of the total pre and post-harvest losses. Overall per acre, pre and post-harvest losses were estimated to be 29.01 quintals/acre out of which 30.32 quintals/acre from Patiala district and 26.59 quintals/acre from Amritsar district respectively. Overall percent losses from the total production were estimated as 8.60 percent.

Percent losses in tomato at different stages of production and marketing: In Patiala district, the proportion of losses at the producer level was estimated to be 8.10 per

Table 2. Pre and post-harvest losses in tomato at different stages of production and marketing

Particulars	Patiala district		Amritsar district		Overall	
	Losses (quintals/acre)	% loss	Losses (quintals/acre)	% loss	Losses (quintals/acre)	% loss
Losses at producer level						
Cracks	1.00	3.29	00.00	00.00	1.00	3.44
Fruit borer attack	4.31	14.21	5.65	21.24	4.31	14.85
Blight disease	5.35	17.64	4.85	18.23	5.50	18.95
Adverse weather condition	3.45	11.37	00.00	00.00	3.45	11.89
Sub-total	13.11	43.23	10.50	39.48	14.26	49.15
Losses during marketing operation						
Harvesting injuries	3.20	10.55	1.91	7.18	1.77	6.10
Grading/sorting	1.23	4.05	1.49	5.60	1.35	4.65
Transportation	3.64	12.00	4.33	16.28	3.48	11.99
Sub-total	8.07	26.61	7.73	29.07	6.60	22.75
Total losses at producer's level	21.18	69.85	18.23	68.55	20.86	71.90
Losses at marketing level						
Commission-agent cum wholesaler level						
Handling	2.39	7.88	2.35	8.83	2.25	7.75
Sorting/thrown	1.58	5.21	0.35	1.31	0.53	1.82
Transportation	2.00	6.59	2.76	10.37	3.00	10.34
Sub-total	5.97	19.68	5.46	20.53	5.78	19.92
Retailer level						
Sorting/thrown out	0.66	2.17	1.08	4.06	0.45	1.55
Transportation	0.39	1.28	0.63	2.36	0.52	1.79
Rotting and spoilage due to multiple handling	2.12	6.99	1.19	4.47	1.40	4.82
Sub-total	3.17	10.45	2.90	10.90	2.37	8.16
Total pre and post harvest losses	30.32	100	26.59	100	29.01	100.00
% losses of the total production	8.37		8.86		8.60	

cent share of the total production (Table 3). After the sale by the farmers in the market, the quantity sold by commission agent cum wholesaler to the retailer was 346.65 quintals and quantity of produce ultimately reached the consumer was estimated at 343.48 quintals. The proportion of losses at trader's level was 2.60 per cent share of the total quantity marketed. The total pre and post-harvest losses were estimated to 8.25 per cent share of the total production. In Amritsar district, the quantity of produce sold from producer to consumer through various channels was 273.10 quintals and the per cent loss at producer level were estimated 6.07 per cent share of the total production. The per cent loss at trader's level from the total marketed quantity was 2.98 percent and the total pre and post-harvest losses in Amritsar district from the total production were 9.05 per cent which were higher than that in Patiala district. Overall 8.76 per cent losses were occurred at various stages of production and marketing. Among total losses, 69.86 per cent of losses occurred at farm level followed by 19.68 per cent and 10.46 per cent at commission agent cum wholesaler level and retailer level, respectively.

Factors affecting post-harvest losses: Multiple linear regression was conducted to examine the impact of various socioeconomic factors on post-harvest losses at the farm level. The post-harvest losses (dependent variable) at the farm level were calculated as quintals of output lost per acre (Table 4). One of the independent variables determining post-harvest losses at the farm level was age of the farmers, with a negative and significant coefficient (0.865). The farmer's experience in post-harvest handling grows with age which reduces post-harvest losses. It suggests that growing older has a detrimental impact on post-harvest losses. The variable in the model also took the farmer's number of years of formal education into account. The amount of schooling was negatively correlated (coefficient = -0.166) with post-harvest losses at the farm level. The post-harvest losses on farms diminish with every 1% increase in education because more educated farmers will have better access to information about post-harvest procedures.

One of the factors influencing the magnitude of post-harvest losses at the farm level is the availability of workers at the time of harvest. If the farmer believed he could access the necessary number of man hours at the necessary time to complete harvesting activities, the availability of labour was deemed satisfactory. The dummy variable with value one if the farmer felt there was insufficient labour available for harvesting was used to gauge the level of labour availability. As a result, the variable's coefficient, which was 19.93, indicated that it had a favourable impact on farm-level post-harvest losses. The dummy variable was incorporated into the model that took the value one if the farmer lacked adequate transportation facilities to assess the impact of transportation facilities on post-harvest losses. The post-harvest losses at the farm level were positively and significantly impacted by this variable's coefficient (16.983), indicating that farms with adequate transportation facilities experience fewer post-harvest losses. The farmer had enough transportation if he had no issues with the roads or the mode of conveyance. The dummy variable's negative and significant coefficient (-39.154) for the district demonstrates that, on average, post-harvest losses in Amritsar were much lower than in Patiala. The negative and significant coefficient (-15.772) of dummy variable for farm size categories indicating that the post-harvest losses in medium farm size

Table 3. Percent losses in tomato at different stages of production and marketing

(Per acre in quintals)

Particulars	Patiala district	Amritsar district	Overall
Expected production	395.49	318.32	358.06
Losses at producer level	21.18	18.23	20.86
Total actual production	374.31	300.09	337.20
Total marketed quantity	352.62	281.46	317.04
Losses at commission agent cum wholesaler level	5.97	5.46	5.78
Quantity sold to retailer	346.65	276.00	311.26
Losses at retailer level	3.17	2.90	2.37
Quantity sold to consumer	343.48	273.10	308.89
Total post-harvest losses	30.32	26.59	29.01
% loss at producer level	5.65	6.07	6.18
% loss at traders level	2.60	2.98	2.58
(i) % loss at commission agent cum wholesaler level	1.69	1.93	1.82
(ii) % loss at retailer level	0.91	1.05	0.76
% loss (TPHL)	8.25	9.05	8.76

Table 4. Factors affecting post-harvest losses at farm level

Parameters	Estimates
Intercept	133.120*** (27.899)
Age (years)	-0.865** (0.379)
Education (years)	-0.166 (1.145)
Production (quintals)	0.0108 (0.061)
Farm size (acres)	0.098 (1.376)
Dummy (D_1=1for Amritsar and 0=Patiala)	-39.154* (9.904)
Dummy (D_2=1for large and 0for otherwise)	-12.762 (9.367)
Dummy (D_3=1for medium and 0for otherwise)	-15.772* (8.516)
Labour dummy (1=inadequate,0=adequate)	19.936* (7.417)
Weather dummy(1=inadequate,0=adequate)	4.800 (9.363)
Transportation dummy (1=inadequate,0=adequate)	16.983** (7.748)
$_R2$	0.25
F-value	5.955***

***, **,*significant at 1,5,10 percent level respectively
Figures in the parentheses indicate the standard error

category was lower than the large farm size category. Nearly 25% of the variation in the total post-harvest losses for tomatoes may be attributed to variations in the independent variables included in the regression model. The F-ratio was significant at one per cent level of significance indicating the goodness of fit of the regression model.

CONCLUSIONS

The pre and post-harvest losses in tomato varied from 0.76 per cent to 6.18 per cent. Maximum losses were observed at producer level (6.18%) followed by commission agent cum wholesaler level (1.82%) and retailer level (0.76%). Throughout different stages of production and marketing, the cumulative post-harvest losses in tomatoes amounted to 8.76 percent respectively. It should be recommended that in order to reduce post harvest losses, the state government/horticulture department should build adequate cold storage facilities for perishable commodities. This will not only minimize the losses but allow better price realization of primary producers. Educating the vegetable growing farmers on scientific post-harvest handling and management including value addition opportunities which will enhance their income and livelihoods. Pest and disease activity accounted for a larger portion of post-harvest losses on farms. More and more small and large processing units must be built in the state in order to reduce post-harvest losses. The farmers need extension services regarding effective post-harvest management techniques. This will enhance their technical proficiency and enable them to manage post-harvest operations with precision.

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