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Quantifying Postharvest Losses of Tomato: A Farm Level Study in Selected Areas of Bangladesh

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Tomato (*Lycopersicon esculentum* L.) is a popular vegetable in Bangladesh. The quality of tomato depends on its pre and postharvest operations. This paper reports on postharvest losses of tomato in four intensive tomato growing villages of Jamalpur and Rangpur districts of Bangladesh. Quantitative and qualitative postharvest losses were measured using descriptive and inferential statistics. It is revealed from the study that farmer harvested tomato at half ripe condition (40.3 per cent) in order to take the advantage of long shelf life and 64 per cent of them use plastic crate for packaging and transportation purposes. Irrespective of using traditional human pulling rickshaw or van, tomato farmers were using motor driving van (27.8 per cent) and rickshaw (20.8 per cent) to carry their product in the market. Farm level postharvest loss of tomato was 12.5 per cent, of which 8.9 per cent was due to full damage and the rest 3.6 per cent was due to partial damage of tomato. Rotten due to physical damage and disease followed by insect infestation were the major causes of postharvest loss in the survey area. Due to postharvest losses farmers have to incur financial loss of Tk. 152.5 per decimal of tomato cultivation. Factors like total harvested amount, family member, training and selling price of tomato were the main determinants of postharvest loss in the survey area. Lower prices, absence of tomato storage, white fly and viral infection were the most noteworthy problems in tomato cultivation. Developing proper storage system, fair price and efficient disease management are necessary to minimize farm level postharvest loss of tomato.

Keywords: Postharvest Loss, Tomato, Factors of Postharvest Loss, Farmer, Bangladesh

JEL Classification: Q13, Q12, C81

I. INTRODUCTION

Bangladesh is an overwhelmingly agro-based country where 65 per cent of its population lives in rural areas, who directly or indirectly depends on

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agriculture for their livelihood. Since independence in 1971, agriculture has been playing an important role in food security, poverty alleviation and employment generation. Bangladesh was not able to catch fully the benefit of green revolution in cereal production to substantially alleviate poverty and malnutrition (Karim, Rahman and Alam 2009). So, the government of Bangladesh is trying to depart from rice-led growth to several non-rice crops production base (Hoque 2000). Switching to year- round vegetable production can be an important alternative to generate incomes which eventually can perform an important role to alleviate poverty. More than 60 types of vegetables are grown in Bangladesh in three categories: (i) summer/rainy season vegetables, (ii) winter season vegetables, and (iii) all season vegetables. The 60-70 per cent of vegetables are produced in winter and most districts produce marketable surplus during this season (Weinberger and Genova II, 2005). Potato, tomato, brinjal, cabbage, cauliflower, gourds, spinach, beans, radish, carrot, cucurbits and plantains are some of the important vegetables grown all over Bangladesh. Among the vegetables, tomato is one of the most important vegetables, in terms of acreage, production, yield, commercial use and consumption (Karim, Rahman and Alam 2009).

Tomato is popularly grown in mid-August to mid-November, and December to mid-January is the appropriate time for harvesting. Tomato is highly perishable crop and 50 per cent of tomato production in tropical areas are lost between rural production and town consumption (Oyeniran 1988). Decay, external damage and harvesting at improper maturity stage are the principle causes for postharvest losses of tomato (Thorne and Alvarez 1982). Paradoxically, there have been a number of previous studies conducted in Bangladesh that have quantified postharvest loss of tomato. Hossain *et al.* (1999) found 8 per cent to 15 per cent and Khatun *et al.* (2014) found 15.4 per cent postharvest loss of tomato at farm level in some tomato growing areas of Bangladesh. Studies conducted in Ayes and Mallihar districts of Ankara mentioned that the losses in tomato during the harvest period varied from 5.2 to 9.8 per cent. It was pointed out that precautions taken by producers until the harvest maturity are not sufficient, and necessary measures should be taken also during harvest and after harvest period, in order to decrease or eliminate the losses (Tatlidil *et al.* 2003 and Khatun *et al.* 2014). But McKenzie, Peterson and Underhill (2017) found postharvest loss of tomato is between 40.3 per cent and 55.9 per cent in two commercial domestic supply chains in Queensland, Australia. While Parfitt, Barthel and Macnaughton (2010) reported postharvest losses in tomatoes from 18 per cent to 43 per cent in Egypt, a Cambodian study

found losses between 22.5 per cent and 23 per cent in a comparative study between traditional and modern tomato supply chains. Postharvest losses of tomatoes in Ghana ranged from 20 to 25 per cent (Bani, Josiah and Kra 2006, WFLO 2010), in Benin 28 per cent (IITA 2008), 7.8 per cent in Rwanda (WELO 2010), 20 per cent in Pakistan (Rehman, Khan and Jan 2007), 18 per cent in Jordan (EI-Assi 2002) and in Saudi Arabia it is 17 per cent (Al Kahtani and Kaleefah 2011).

Research in postharvest activities to reduce losses at different stakeholder level is important. Different postharvest operations like sorting, grading, packaging, cooling, storage, proper loading and unloading are very important loss reducing activities in vegetable supply chains. But these are hardly used in Bangladesh, which results 23.6 per cent to 43.5 per cent fruits and vegetables postharvest losses after harvest (Hasan 2010). Besides, a huge amount of harvested vegetable gets wasted every year due to seasonal oversupply and absence of proper marketing system. At the same time, postharvest losses in conventional method of packaging are much higher compared to improved and cool chain method. The percent of postharvest losses of tomato is 22 per cent in conventional method, whereas it is 17.7 per cent in improved method (Matin *et al.* 2016).

A number of challenges are making tomato cultivation unprofitable in most of the developing countries, especially in Bangladesh. The challenges may come either in production, post-harvest, marketing or a combination of any of these functions. Postharvest loss and risk relating to the cost of cultivation integrate economic losses to the farmers and all stakeholders related to tomato production and marketing. There is a lack of precise estimation of postharvest losses in Bangladesh. So, the specific objectives this study are:

1. to document the associated problems of tomato cultivation;
2. to estimate the postharvest loss of tomato at farm level; and
3. to identify the determinants of postharvest loss of tomato.

II. MATERIALS AND METHODS

2.1 Study Area

The present study was conducted in four purposively selected villages from Jamalpur and Rangpur districts of Bangladesh. These villages were selected based on intensive growing of tomato. The study areas are presented in Table I.

TABLE I

GEOGRAPHICAL COVERAGE OF THE STUDY

Location	Sample size
Jamalpur	
Maheshpur Village	36
Islampur Village	36
Rangpur	
Makkipur village	36
Khaprikhal village	36
Total	144

Source: Author's estimation.

2.2 Sampling Procedures and Sample Size

Required number of respondents were selected based on purposive random sampling. For the present study, a sample size of 144 was considered taking 36 from each selected village (Table I). Respondents' selection was based on two criterions: farmers who have at least 3 years of tomato cultivation experience and were willing to provide information. All the respondents were winter tomato producers. Data and information were collected from the selected respondents from 1 February to 30 April 2018.

2.3 Problem Face Index (PFI) of Farmers

Problem faced index was constructed to evaluate the weight of the individual problem of tomato producers. Respondents were asked to respond to four alternative responses to each of the selected problems as "severe problem," "moderate problem," "little problem" and "no problem," as done by Azad (2013). Scores were assigned as 3, 2, 1 and 0 respectively to the alternative responses. In order to measure score for particular problem, PFI was measured by using the following formula:

$$PFI = (P_s \times 3) + (P_m \times 2) + (P_l \times 1) + (P_n \times 0)$$

where PFI = Problem Faced Index, P_s = Number of respondents faced severe problem, P_m = Number of respondents faced moderate problem, P_l = Number of respondents faced little problem, P_n = Number of respondents faced no problem

2.4 Postharvest Losses Assessment

Quantitative loss of different vegetables was measured by a number of previous studies (Amiruzzaman 1990, Kader 1992, Hasan *et al.* 2010, Khatun *et al.* 2014, Kaysar *et al.* 2016) which were mostly based on field survey. Matin *et al.* (2016) estimated both the quantitative and qualitative loss of vegetables

through physical monitoring of vegetable lots. The present study quantified both quantitative and qualitative losses of tomato by considering different stages of supply chain and these losses were then separated into the causes of postharvest losses. The basis for this quantification was field survey. Stages of quantitative damages include collection, cleaning, sorting, grading, packaging, storing and transportation. Damages of tomato are divided into two types: full physical damage and partial physical damage. Full damage, also known as quantitative losses, occurred at farm level to retail level, was taken into consideration to quantify total quantitative loss of tomato. Again, partial damage considered qualitative losses was taken into consideration by a number of causes such as insect, disease, rotten due to pathogen attack, over mature, spot, bruising, shrinking and damages by bird. The total postharvest loss was quantified by adding both the quantitative and qualitative loss of tomato.

2.5 Financial Loss Assessment

Financial loss due to postharvest losses of tomato was measured by using the following formula:

$$F_l = Q_{fd} \times P_{fd} + Q_{pd}(P_{fd} - P_{pd})$$

Where

F_l = Financial loss (Tk/decimal), Q_{fd} = Amount of full damaged tomato (kg/decimal), P_{fd} = Price of full damaged tomato (Tk/kg), Q_{pd} = Amount of partial damaged tomato (kg/decimal),and P_{pd} = Price of partial damaged tomato (Tk/kg)

2.6 Determinants of Farm Level Postharvest Losses

The present study adopted a functional analysis to examine determinants of farm level postharvest losses of tomato as done by Nag, Nahatkar and Sharma (2000), Khatun *et al.* (2014) and Kaysar *et al.* (2016). The following Cobb-Douglas type multiple linear regression function was fitted for the present study:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots\ldots\ldots + \beta_9 X_9 + \mu_i$$

where Y = Postharvest loss of tomato (kg/farm), α = Constant term, X_1 = Total harvested amount (kg/farm), X_2 = Education (year of schooling), X_3 = Total family member (no.), X_4= Farming experience (year), X_5= Selling price (Tk/kg), X_6= Vehicle type dummy (pulled van=0, others = 1), X_7= Packaging dummy (traditional packaging=0, improved packaging = 1), X_8= Training dummy (got training = 0, no training = 1), X_9= Selling place dummy (farm level = 0, market level = 1), β_1, β_2 . . . . . β_9 = coefficients of the independent variables, and μ_i = Error term.

III. RESULTS AND DISCUSSION

3.1 Technologies and Practices regarding Postharvest Loss of Tomato

In order to reduce postharvest losses in tomato cultivation farmers have their own systems and age-old practices. Table II shows current postharvest practices and available technologies of tomato among the study respondents. Farmers mostly collect tomato in the morning (37.5 per cent), followed by evening (29.2 per cent). Tomato was harvested in different growth stages. The lion share was harvested in half ripe condition (40.3 per cent), followed by mature green (22.2 per cent) and full ripe condition (20.8 per cent). Study like Khatun *et al.* (2014) found 96 per cent of tomatoes harvest at matured stage in Bangladesh. Farmers in the study area were using a number of different materials for packaging, of which 63.9 per cent were using plastic crate. When farmers harvest tomatoes in mature green stage, they have to stock them. They stocked on the land covered with piece of cloth (90.3 per cent). They told that it brings good colour and uniform ripening. Most preferred selling time for tomato was morning (43.1 per cent), followed by evening (36.1 per cent). Farmers used motor driving van (27.8 per cent) and motor driving rickshaw (20.8 per cent) for transporting of tomato as these two vehicles are very popular and common even in the rural areas. Vehicle (40 per cent) and animal drawn cart (60 per cent) were used to transport tomato in Ethiopia (Emana *et al.* 2017). Khatun *et al.* (2014) showed that 71 per cent of the harvested tomatoes were transported by human pulling van in some tomatoes growing areas of Bangladesh.

Farmers harvested tomato with their hand fully (100 per cent). Knife, scissor or any other tools were not found in survey areas for harvesting tomato. But Khatun *et al.* (2014) found 2 per cent of tomatoes in Dinajpur, Jessore and Comilla districts were collected by both hand and knife. After harvest farmers grade tomato on the basis of half ripe (44.4 per cent), full ripe (20.8 per cent), looking good (19.4 per cent) and physical damage (15.3 per cent). Khatun *et al.* (2014) observed size and disease infected as the most used basis for grading tomato in their study areas; 40.3 per cent of the farmers in the study areas sorted tomato based on *kancha pucca* condition and 38.9 per cent sorted on the basis of size of the tomato. The packaging materials used in the survey areas were silver bowl for field collection (29.2 per cent), plastic sack (22.2), plastic crate (16.7 per cent), jute sack (18.1 per cent), etc. Farmers in developing countries mostly use large green leaves, clay pots, woven cane baskets, wooden crates, cardboard crates, cardboard boxes, plastic buckets, nylon sacks, jute sacks and polythene

bags for tomato packaging (Arah *et al.* 2015). Khatun *et al.* (2014) found bamboo cage as the most used packaging materials in Dinajpur, Jessore and Cumilla districts of Bangladesh.

TABLE II
POSTHARVEST PRACTICES IN TOMATO CULTIVATION

Items	% of respondents	Items	% of respondents
Time of harvesting from the field		**Means of transportation**	
Morning (6.00 am - 11.00 am)	37.5	Head load	2.8
Afternoon (12.00 pm - 3.00 pm)	4.2	Manual van	12.5
Evening (4.00 pm - 6.00 pm)	29.2	Motor driving van	27.8
Anytime of the day	29.2	Bicycle	1.4
Point of harvesting		Motor driving rickshaw	20.8
Tender	5.6	Open pick up or truck	23.6
Fully mature	11.1	Animal driving cart	11.1
Mature green	22.2	Means of harvesting	
Half ripe	40.3	Hand	100
Full Ripe	20.8	**Basis of Grading**	
Types of material used for packaging		Looking good	19.4
Plastic crates	63.9	Fully ripen	20.8
Bamboo cage	11.1	Half ripen	44.4
Plastic sack	12.5	Physical damage	15.3
Jute sack	5.6	**Basis of sorting**	
Plastic net bag	6.9	Size	38.9
Storing after harvest		Kancha pucca (half ripening condition)	40.3
Under the trees	4.2	Disease/insect	20.8
Covered with piece of cloth	90.3	**Packaging materials**	
Placing in open sky	5.6	Jute sack	18.1
Time of selling		Plastic sack	22.2
Morning (6.00 am - 11.00 am)	43.1	Bamboo cage	5.6
Afternoon (12.00 pm -3.00 pm)	12.5	Bamboo basket	8.3
Evening (4.00 pm to 6.00 pm)	36.1	Plastic crate	16.7
Anytime of the day	8.3	Silver bowl	29.2
Time of transportation			
Morning (6.00 am - 11.00 am)	43.1		
Afternoon (12.00 pm - 3.00 pm)	36.1		
Evening (4.00 pm - 6.00 pm)	9.7		
Anytime of the day	11.1		

Source: Field Survey, 2018.

3.2 Problems Faced by Tomato Farmers

Problems of tomato farmers are presented in Table III. The selected twelve problems faced by the respondents were ranked on the basis of their severity. The observed PFI for tomato ranged from 54 to 193 against the possible range of 0 to 327. On the basis of PFI, lower price of output was the most severe problem of tomato farmers, followed by absence of tomato storage, white fly infestation, viral infection, shortage of labour, etc.

TABLE III

RANK OF PROBLEMS FACED BY TOMATO FARMERS

Problems	Extent of problem faced				PFI	Rank
	High problem (3)	Medium problem (2)	Little problem (1)	No problem (0)		
Lower prices of output	49	21	4	0	193	1
Absence of tomato storage	44	14	14	0	174	2
White fly infestation	32	24	12	4	156	3
Viral infection	36	15	12	8	150	4
Shortage of labour	32	10	20	10	136	5
Disease	35	18	6	15	147	6
Too much supply in the peak season	25	23	12	12	133	7
High prices of inputs	24	14	28	6	128	8
Adulterated inputs	12	36	18	6	126	9
Too much cold in winter	9	18	27	18	90	10
Lack of quality seed	7	14	30	21	79	11
Lack of technical support	9	0	27	36	54	12

Source: Filed Survey, 2018.

3.3 Farm Level Postharvest Loss of Tomato

Farm level postharvest losses of tomato based on postharvest operations are presented in Table IV. This was calculated on total harvested amount. The total postharvest loss was accounted to 12.5 per cent, of which 8.9 per cent was due to full damage and the rest 3.6 per cent was due to partial damage. The highest percentages of losses were in sorting and grading stages (4.7 per cent), followed by storing stage (2.9 per cent). The maximum share of postharvest loss in partial damage was in storing stages (1.8 per cent), followed by sorting and grading stages (0.98 per cent). No full or partial damage was found in cleaning and packaging stages of tomato. Harvest and postharvest losses of tomato at national level of India were enumerated by Nanda *et al.* (2012). They mentioned 9.9 per cent loss of tomato in farm operations, of which 1.7 per cent, 1.1 per cent, 3.2 per cent, 0.8 per cent and 3.1 per cent were in harvesting, collection, sorting/grading,

packaging and transportation stage respectively. McKenzie, Peterson and Underhill (2017) found highest incidence of postharvest loss at harvesting and grading stages of the tomato supply chain. Jha *et al.* (2015) conducted a study in eight agro-climatic zones of India to estimate the postharvest loss of tomato and they found minimum loss of 9.8 per cent in southern plateaus and hilly region (Karnataka) and highest loss of 18.3 per cent in western plateaus and hilly region (Maharashtra) of India. According to this study, the losses in different regions of India varied between 10 and13 per cent, which is nearly similar to the present study. Gautam *et al.* (2015) conducted a study on status of postharvest loss of vegetables in Bangladesh, Cambodia and Nepal, and observed 27 per cent, 26 per cent and 26 per cent tomato loss respectively.

TABLE IV

FARM LEVEL POSTHARVEST LOSS OF TOMATO BASED ON POSTHARVEST OPERATIONS

Items	Quantity (kg)	%	Items	Quantity (kg)	%	Items	Quantity (kg)	%
Harvested amount (kg)	38,990	100.00	Harvested amount (kg)	38,990	100.00	Harvested amount (kg)	38,990	100.00
A. Full damage (kg)			B. Partial damage (kg)			C. Total damage (kg) = (Full damage+ partial damage)		
Collection	110	0.28	Collection	123	0.32	Collection	233	0.60
Cleaning	0	0.00	Cleaning	0	0.00	Cleaning	0	0.00
Sorting & grading	1,849	4.74	Sorting & grading	381	0.98	Sorting & grading	2,230	5.72
Packaging	0	0.00	Packaging	0	0.00	Packaging	0	0.00
Store	1,141	2.93	Store	710.5	1.82	Store	1,851.5	4.75
Transportation	356	0.91	Transportation	185	0.47	Transportation	541	1.39
Total	3,456	8.86	Total	1,399.5	3.59	Total	4,855.50	12.45

Source: Field Survey, 2018.

On the other hand, Sankar (2002) conducted experiments in the Odissa state of India to determine the extent of postharvest losses occurring at different stages of handling, and transportation of tomato was found to be 30.3-39.6 per cent. This paper concluded that the maximum quantity of losses occurred during transportation from rural to urban markets. Postharvest loss of tomato in Himachal Pradesh was reported to be 24.8 per cent of the total production (Singh and Vaidhya 2005). The losses were more at production level.

3.4 Postharvest Losses of Tomato Based on Causes of Damages

A number of different causes are responsible for full and partial damage of tomato in the survey areas. Table V represents these causes into full and partial damage. The lion share of full damage was due to rotten (2.6 per cent), followed by insect infestation (1.5 per cent) and bird attack (1.4 per cent). On the other hand, too much ripen (1.2 per cent) and bruising (1.1 per cent) were the main

reasons for partial damage of tomato. But due to insect, disease or rotten no partial damage was found in tomato. This is because tomato damaged by insect, disease or rotten cannot be consumed. Study like Getinet, Workneh and Woldetsadik (2011) have reported that high postharvest losses of tomato were due to poor packaging, inadequate storage facilities and poor means of transportation using human labour, donkeys and mules, public transport and rented trucks, whereas diseases and insect pests were the major problems affecting tomato postharvest losses along the tomato supply chain in Ehiopia (Emana *et al.* 2017).

TABLE V
FARM LEVEL POSTHARVEST LOSS OF TOMATO BASED ON CAUSES OF DAMAGE

Items	Quantity (kg)	%	Items	Quantity (kg)	%	Items	Quantity (kg)	%
Harvested amount (kg)	38,990	100.00	Harvested amount (kg)	38,990	100.00	Harvested amount (kg)	38,990	100.00
A. Full damage (kg)			B. Partial damage (kg)			C. Total damage (kg) = (Full damage+ partial damage)		
Insect	580.1	1.49	Insect	0	0.00	Insect	580.1	1.49
Disease	418	1.07	Disease	0	0.00	Disease	418	1.07
Rotten	1,023.2	2.62	Rotten	0	0.00	Rotten	1,023.2	2.62
Over mature	348.05	0.89	Over mature	472	1.21	Over mature	820.05	2.10
Spot	9	0.02	Spot	313.5	0.80	Spot	322.5	0.83
Bruising	63.5	0.16	Bruising	414	1.06	Bruising	477.5	1.22
Shrinking	484	1.24	Shrinking	55	0.14	Shrinking	539	1.38
Bird	530.15	1.36	Bird	145	0.37	Bird	675.15	1.73
Total	3,456	8.86	Total	1,399.5	3.59	Total	4,855.50	12.45

Source: Field Survey, 2018.

3.5 Financial Loss of Farmers due to Postharvest Losses of Tomato

Postharvest loss leads to a significant financial loss to the tomato farmers. Table VI represents financial losses of tomato among the survey respondents due to full and partial damage of tomato. The total financial loss of tomato cultivation was Tk. 152.45 per decimal, of which 86.4 per cent was due to full damage and the rest 13.6 per cent was for partial damage of tomato. Jha *et al.* (2015) estimated the economic value of quantitative loss of 45 crops/commodities in India at average annual prices of 2014 where they showed Rs. 3,666 crores as monitory value of the losses in tomato.

TABLE VI

FARM LEVEL FINANCIAL LOSS OF TOMATO

Sources of Financial loss	Quantity (Tk/decimal)	Percentages
Loss due to full damage	131.67	86.4
Loss due to partial damage	20.78	13.6
Total loss	152.45	100.0

Source: Filed Survey, 2018.

3.6 Determinants of Farm Level Postharvest Losses

Table VII presents the determinants of postharvest loss of tomato in the survey areas. Coefficients of multiple determination (R^2) of the logarithmic regression model was found 0.73, which implied that 73 per cent of the variation in postharvest loss at farmers level can be explained by the variables included in the model. The coefficient of total harvested amount was positive and significant at 1 per cent level, indicating that a 1 per cent increase in total harvest of tomato, keeping other factors constant, would result in an increase of postharvest loss by 1.4 per cent. The influence of total family member was found negative and significant at 10 per cent level, implying that an increase of family member by 10 per cent would decrease postharvest loss of tomato by 3.5 per cent. This means that more of the helping hand of the farmer can save more of the harvested tomato. Among the dummy variables, availability of training was found negative and significant at 1 per cent level. This implied that as much as farmer was trained up in postharvest management, it would reduce postharvest loss of tomato. The significance of F value at 1 per cent level implies that the variation in postharvest loss of tomato depends mainly upon the explanatory variable included in the model. Arah *et al.* (2015) found temperature, relative humidity, combination gases, postharvest calcium chloride application and physical handling as postharvest factors affecting the quality of tomatoes after harvest. This paper also identified fertilizer application, pruning, maturity stage, cultivar type and irrigation type as preharvest activities that affect postharvest shelf life and qualities of harvested tomato fruits. Besides, Jha *et al.* (2015) found market forces as more effective factors for higher losses of tomato. Khatun *et al.* (2014) found sale price of tomato, farming experience and packaging dummy had negative and significant relationship with total post-harvest losses of tomato in Bangladesh, while total production and rainfall dummy had positive and significant relationship with total post-harvest losses.

TABLE VII

ESTIMATED VALUES OF COEFFICIENTS AND RELATED STATISTICS OF COBB DOUGLAS PRODUCTION MODEL FOR POST-HARVEST LOSS OF TOMATO

Regression variables		Regression coefficient	t-statistic	p-value	Standard error
Intercept	α	10.661	-.486	.329	20.212
Total harvested amount	X_1	1.40***	12.220	.000	.011
Education	X_2	0.831	.455	.651	17.876
Total family member	X_3	-3.466*	-.130	.097	2.764
Farming experience	X_4	9.078	.915	.364	9.922
Selling price	X_5	0.986*	.156	.076	6.302
Vehicle type dummy	X_6	2.879	.499	.619	5.666
Packaging dummy	X_7	-0.305	-.512	.610	5.736
Training dummy	X_8	-0.415***	-.733	.016	5.654
Selling place dummy	X_9	6.295*	.747	.098	8.255
Number of observations			72		
R^2			0.73		
F (72, 9)			18.324***		

Source: Authors' estimation.

Note: ***, **, and * denote 1%, 5% and 10% level of significance respectively.

IV. CONCLUSION AND RECOMMENDATIONS

Identifying the stages and causes of postharvest losses of tomato is a key to improve tomato postharvest management and in turn enhancing profitability of tomato growers in Bangladesh. A significant portion of harvested tomato damage is recorded each year at farm level, of which some are due to full damage and some are under partial damage. Highest incidence of full and partial damage is at sorting and grading stages, followed by store and transportation stages of tomato from farmyard to local and urban market. The study reveals high losses of tomato, due to rotten, over mature, insect, disease, bruising, shrinking, etc. Due to postharvest loss of tomato, the value of financial loss of farmers is Tk. 152.45 per decimal of tomato cultivation. It is revealed that total harvest, training, family member and selling price are postharvest factors that affect the quality of tomatoes after harvest. Several postharvest technologies and practices are available to the farmer's hand to reduce postharvest losses, which includes mode of transportation, packaging, grading, sorting, etc. But farmers have to struggle a lot in the peak season to get a better margin, as price is far lower than the profitable margin. Besides, lack of storage, white fly infestation and viral diseases led to a significant financial loss in tomato production each year. Crop diversification, fair price and postharvest management training are some of the important suggestions for reducing postharvest losses of tomato at farm level.

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