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Quantifying postharvest loss of brinjal: A farm level study in Bangladesh

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ABSTRACT

Brinjal (eggplant) is a very common and popular horticultural crop in Bangladesh. This study reports on quantification of farm level postharvest loss of brinjal in two intensive growing districts Jamalpur and Rangpur of Bangladesh. It also outlines the determinants of brinjal postharvest loss and problems of brinjal farmers. A total of 144 farmers were considered for the study from purposively selected four villages. Total postharvest loss was quantified by evaluating quantitative and qualitative losses of brinjal. Farmers were found well acquainted with a range of postharvest practices such as definite point and stage of brinjal harvesting, sorting, grading and packaging. Morning was the most preferred time for harvesting and selling of brinjal in the survey areas. Distance selling and motor driving van for local selling were used by 25% and 23% of the respondents. Physical damage and physical appearance were the two basic criteria for grading of brinjal at farm level. Among the problems, absence of storage and lower prices of brinjal scored highest PFI 208 and 181, respectively from the possible range of 0 to 216. Farm level postharvest loss of brinjal was 13.90% of total production where full damages accounts for 9.16% alone. Infested by insect and rotten were the primary causes of full damages of brinjal in the survey area. The 4.73% of the total postharvest loss was due to partial damages of brinjal where skinning and bruising constitutes the maximum share. Due to postharvest loss brinjal farmers have to incur financial loss of Tk. 709.05 per decimal of brinjal cultivation. Total harvested amount, farmer's education, packaging and selling place were found significant factors for postharvest loss of brinjal in the survey area. It is recommended that government, research institution and Department of Agricultural Extension (DAE) should work jointly to educate farmers against postharvest loss of brinjal in Bangladesh.

Introduction

Global food production has increased remarkably. But still half of the population in the Third World does not have access to adequate food supplies. One of the important reasons for this is food losses occurring in the postharvest and marketing system. Estimates of the postharvest losses of food grains in the developing world from mishandling, spoilage and pest infestation are put at 25%. It means that one-quarter of what is produced never reaches the consumer for whom it was grown (Lichtfouse, 2015). Horticultural produce such as fruit, vegetables and root crops are perishable in nature. Therefore, the losses on this produce are a major problem in the postharvest chain. Postharvest value chain starts from production in the field to the food being placed on a plate for consumption. Postharvest activities include harvesting, handling, storage, processing, packaging, transportation and marketing (Mrema and Rolle, 2002). Both quantitative and qualitative losses occur at all stages in the postharvest system. These losses affect both producers (by reducing their share in the price paid by the consumer) and the consumers (by reducing the availability of fruits and vegetables and also through higher prices paid because of the increase in the transport cost, etc.). Besides, at the macro level, the economy would be losing millions of money due to total cost of the losses of fruits and vegetables (Gajanana *et al.*, 2011). The estimated postharvest losses of fruits and vegetables in developed countries are at 5-20% while it is 20-50% for developing countries (Muhammad *et al.*, 2012). In Bangladesh, postharvest losses of fruits and vegetables amount to 16.73-43.5%, which accounts for an annual loss of Tk. 34420 million (Hassan *et al.*, 2010; Kaysar *et al.*, 2016).

Brinjal (*Solanum melongena*) also known as eggplant, is one of the most important, popular and inexpensive year round vegetable crops grown in Bangladesh, second only to potato in production (Shelton *et al.*, 2018). It has been a staple vegetable in our diet which has a link with the social, cultural and economic lives of the rural people. It is an important vegetable for its commercial and nutritional value in the world as well as in Bangladesh (Rahman *et al.*, 2016). It is grown all over the world though Asia has the most concentration. From

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Asia, China is the largest producer followed by India which accounted to 56% and 26% of world's brinjal production (Meherunnahar and Paul, 2009). Although Bangladesh produced huge amount of brinjal, it is only a fraction of the world's production. It is grown on nearly 50,000 hectares in Bangladesh (Shelton *et al.*, 2018). Brinjal is highly perishable in nature. It should be sold and consume soon after harvest in order to avoid qualitative and quantitative losses. It is very susceptible to insect-pest infestation causing huge postharvest losses during transportation, grading, storing and selling (Haque *et al.*, 2004).

A few studies were found which quantified postharvest losses of brinjal at farmers and intermediary level. Haque *et al.* (2004) assessed postharvest loss of brinjal in some brinjal growing areas of Bangladesh where it found 7% farm level brinjal loss and 15% at intermediary level. Kaysar *et al.* (2016) found postharvest loss of brinjal is 23.38% in some brinjal growing areas of Bangladesh. But very little information is available on farm level postharvest practices and activity wise postharvest losses of brinjal. Limited data is also available on the postharvest losses based on different causes. This study reports the information on postharvest practices and postharvest losses of brinjal at farm level based on practices and causes. Therefore, the present study has been undertaken to (i) document the associated problems of brinjal cultivation at farm level, (ii) assess farm level postharvest losses of brinjal based on postharvest practices and underneath causes, and (iii) identify the determinants of postharvest loss of brinjal at farm level.

Materials and Methods

Vegetables selection

Postharvest loss is currently the obvious part of every vegetable. The main reason is differences in shelf life. Brinjal is one of the most used vegetables of Bangladesh. But this is very much vulnerable to postharvest losses. So, brinjal was taken under consideration in order to investigate its farm level postharvest losses.

Selection of study area and sample distribution

Rangpur and Jamalpur districts of Bangladesh are noted for brinjal cultivation. So for the sake of present study four villages were selected from both the districts based on the intensity of brinjal cultivation. The study area and sample distribution are presented in Table 1. Respondents were selected purposively. A total of 144 brinjal farmers were selected with the help of respective upazila agricultural extension office. Thus each selected village was composed of 36 farmers. These respondents were selected based on two criteria: farmers who had at least 5 years of brinjal cultivation and were willing to act as sample respondents.

Table 1. Geographical coverage of the study

Vegetables	Loation-1 (Jamalpur district)	Sample Size	Location-2 (Rangpur district)	Sample Size	Total Sample
Brinjal	Maheshpur Village	36	Makkipur village	36	72
	Islampur Village	36	Khaprikhal	36	72
Total		72		72	144

Data collection

Data were collected from the sample respondents by using pretested structured interview schedule during 15th February to 30th April, 2018. The schedules had three sections: (i) postharvest practices (ii) postharvest loss and (iii) factors affecting postharvest losses. Reports of BBS, published articles, newspaper, reports and unpublished thesis were also used to gather necessary information for the study.

Data entry and analysis

After completing data collection, each interview schedule was carefully checked by the researcher. After inspecting all the schedules, they were entered into the Microsoft Excel data sheet. Basic statistical tools were used for analysis the data to fulfill the objectives.

Analytical techniques

Problem face index (PFI) of farmers

Brinjal farmer face a number of problems from the cultivation to the selling. But significance of these problems may not be same for all the farmers. In order to know the significance of each problem Problem Faced Index (PFI) was calculated. Respondents were asked to respond to four alternative responses '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
Ps = Number of respondents faced severe problem
Pm = Number of respondents faced moderate problem
Pl = Number of respondents faced little problem
Pn = Number of respondents faced no problem

Postharvest losses assessment

A number of studies have assessed loss of different vegetables such as Haque *et al.* (2004), Hassan *et al.* (2010), Kader (2013), Khatun *et al.* (2014), Kaysar *et al.* (2016), which were mostly based on field survey. Matin

et al. (2016) measured both the quantitative and qualitative loss of vegetables through physical monitoring. The present study quantified both quantitative and qualitative losses of brinjal by considering different stages of postharvest operation. Again losses were separated into their respective causes. The basis for this quantification was field survey. Stages of quantitative damages include collection, cleaning, sorting, grading, packaging, storing and transportation. Damages of brinjal are divided into two types- full physical damages and partial physical damages. Full physical damages were known as quantitative losses. It is occurred from farm level to retail level. Full physical damages were taken into consideration to quantify total quantitative loss of brinjal. Partial physical damages were considered as qualitative losses. This is based on a number of causes such as insect, disease, rotten due to pathogen attack, over mature, spot, bruising and shrinking. These two physical damages together constitute total postharvest loss of brinjal at farm level.

Financial loss assessment

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

Factors affecting farm level postharvest losses

The present study adopted a functional analysis to examine factors of postharvest losses of brinjal as done by Nag *et al.* (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:

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

Where,
Y = Postharvest loss of brinjal (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 (head load=0, others = 1)
X_7 = Packaging dummy (traditional packaging=0, improved packaging = 1)
X_8 = Training dummy (get training= 0, no training= 1)
X_9 = Selling place dummy (farm level = 0, market level = 1)
$\beta_1, \beta_2 . . . . \beta_9$ = coefficients of the independent variables
μ_i = Error term

Results and Discussion

Technologies and practices regarding postharvest loss

Table 2 represents farmer's practices and relevant technologies in brinjal cultivation. It is evident from the table that most of the farmers (41%) harvest brinjal in the morning as they get enough time to take preparation for selling. They collected brinjal mostly in tender stage (83%) whereas Haque *et al.* (2004) found that farmers collected brinjal mostly at matured stage (92%). But according to the present study brinjal farmers harvested brinjal at mature green by 17%.

Table 2. Technologies and practices in brinjal cultivation

Items of operation	Percentages of respondents
Time of harvesting from the field	
Morning (6.00 am to 11.00 am)	41
Afternoon (12.00 pm to 3.00 pm)	15
Evening (4.00 pm to 6.00 pm)	8
Anytime of the day	36
Point of harvesting	
Tender	83
Mature green	17
Material used for assembling in the field	
Plastic crates	21
Bamboo cage	12
Plastic sack	19
Jute sack	16
Silver bowl	32
Storing after harvest	
Under the trees	5
Covered with piece of cloth	0
Placing in open sky	95
Time of selling	
Morning (6.00 am to 11.00 am)	40
Afternoon (12.00 pm to 3.00 pm)	18
Evening (4.00 pm to 6.00 pm)	29
Anytime of the day	13
Time of transportation	
Morning (6.00 am to 11.00 am)	36
Afternoon (12.00 pm to 3.00 pm)	38
Evening (4.00 pm to 6.00 pm)	7
Anytime of the day	19
Night	
Type of vehicle used in transportation	
Head load	6
Manual van	19
Motor driving van	23
Bicycle	10
Motor driving rickshaw	17
Open pick up or truck	25
Means of harvesting	
Hand	100
Basis of Grading	
Physical appearance	74
Physical damage	26
Basis of sorting	
Size	86
Disease/insect	14

For assembling the brinjal from the field farmer mostly used silver bowl (32%) followed by plastic crates (21%) and plastic sack (19%). Most of the farmers (95%) were found to place harvested brinjal in the open sky. The most favored time for selling was morning when 40% of the respondents sold the harvested brinjal. Second most important time for selling was evening when 29% of the farmers were fond of selling brinjal. As morning and evening were the most favored time for selling so most of the transportation was held in morning (36%) and afternoon (38%). Brinjal of Rangpur and Jamalpur is very famous in Bangladesh. It is moved to different districts. So, the study found open pick up or truck as the most used mode of transportation (25%) in the survey areas. Manual van (19%) and motor driving van (23%) were also famous for local transportation. Binjal farmers in the survey area didn't use any tools for harvesting. All they harvested brinjal through hand picking. They fell comfortable through hand. But 7% brinjal farmers in Jashore used knife to collect brinjal as noted by Haque *et al.* (2004). It is evident from Table 2 that most of the farmer was found to grade their brinjal on the basis of two criteria e.g. physical appearance (74%) and physical damage (26%).

Problems faced by brinjal farmers

Brinjal farmers faced a number of problems of which 12 were selected based on the degree of severity. The rank order of these problems is presented in Table 3. The observed Problem Faced Index (PFI) in brinjal cultivation ranged from 60 to 208 against the possible range of 0 to 216. The most severe problem was absence of storage system. During peak season the market is overloaded with brinjal which was much higher than the demand. This drastically reduces the prices within a very short period of time. Absence of storage compelled them to accept huge brinjal losses each year. A similar finding was found in Kaysar *et al.* (2016) where inadequate cold storages and lack of long time storage facilities were the main problems listed by 100% and 90% brinjal farmers respectively. Lower price was the second most severe problem for brinjal farmers. Sometimes prices were too low that farmers reluctant to harvest brinjal from the field. Besides brinjal farmers have little or no bargaining power in price fixation. The prices were mainly controlled by the (local trader) foria or bepari who came from other places to buy brinjal directly from the farmer's land. The other problems for brinjal producer includes shortage of labour, disease, cold in winter, high prices of inputs, lack of quality seed, etc. (Table 3).

Table 3. Rank of problems faced by brinjal farmers

Problems	Extent of problem faced				PFI	Rank
	High problem (3)	Medium problem (2)	Little problem (1)	No problem (0)		
Absence of storage	64	8	0	0	208	1
Lower prices	44	21	7	0	181	2
Shortage of labour	44	14	14	0	174	3
Disease	28	30	9	9	153	4
Too much cold in winter	30	20	13	9	143	5
High prices of inputs	28	20	10	14	134	6
Lack of quality seed	23	24	16	8	133	7
Too much supply in the peak season	38	0	19	15	133	7
Viral infection	24	0	27	21	99	8
White fly infestation	16	16	16	24	96	9
Adulterated inputs	0	32	30	10	94	10
Lack of technical support	0	0	60	12	60	11

Source: Field survey, 2018

Farm level postharvest loss

The present study estimated farm level postharvest losses of brinjal at different stages of postharvest practices shown in Table 4. Total postharvest loss was quantified by summing up full damages and partial damages of brinjal. The total postharvest loss of brinjal was 13.90% of total production of which 9.16% was due to full damages followed by 4.73% in partial damages. The maximum share of losses in case of full damages was mainly for sorting and grading (3.44%) followed by transportation (2.56%) and packaging (2.15%) of brinjal. In case of partial damages, the lion share of losses was in collection stages (1.02%). Negligible partial damages were occurred during storing and transportation stages.

Studies in Bangladesh like Kaysar *et al.* (2016), Hasan *et al.* (2010) and Haque *et al.* (2004) found 12.51%, 6.9% and 7% postharvest loss for brinjal at farm level. Institute of Postharvest Technology of Sri Lanka revealed that postharvest loss of brinjal at grower level in Sri Lanka in 2002 was 10.99% and in Fiji it was 15% at production level (Prasad, 2015). Mitrannavar and Yeledalli (2014) found 6.63% farm level postharvest loss of brinjal in Karnataka state of India. But in Jordan this was 19.4% as stated by Kitinoja and Kader (2015) in PEF white paper 15-02. So it can be concluded that postharvest loss of brinjal among different regions ranges from 6-19%.

Postharvest losses of brinjal based on causes of damages

Table 5 quantified postharvest loss of brinjal based on different causes. The lion share of postharvest losses for full damages of brinjal was due to insect infestation (3.15%) followed by rotting (1.89%) and bird attack (1.70%). On the other hand, skinning and bruising constitutes the maximum share of partial damages of brinjal by 2.30% and 1.28% respectively.

Table 4. Farm level postharvest loss of brinjal based on postharvest activities

Items	Brinjal	
	Quantity (kg)	%
Total harvested amount (kg) Total land area = 253 decimal	49140	100
A. Full damage (kg)		
Collection	189	0.38
Cleaning	0	0.00
Sorting & grading	1692	3.44
Packaging	1056	2.15
Store	306	0.62
Transportation	1259.43	2.56
Total	4502.43	9.16
B. Partial damage (kg)		
Collection	499	1.02
Cleaning	0	0.00
Sorting & grading	743	1.51
Packaging	473	0.96
Store	189	0.38
Transportation	422.07	0.86
Total	2326.07	4.73
C. Total damage (kg)		
Collection	688	1.40
Cleaning	0	0.00
Sorting & grading	2435	4.96
Packaging	1529	3.11
Store	495	1.01
Transportation	1681.5	3.42
Total Postharvest loss (kg)	6828.50	13.90

Source: Field survey 2018

Financial loss of farmers due to postharvest losses

Brinjal farmer have to bear a significant financial loss due to postharvest loss. Table 6 presents farm level financial loss of brinjal farmers due to full and partial damages of brinjal. The total financial loss was Tk. 709.05 per decimal of brinjal cultivation of which 95.54% was due to full damage and the rest 4.46% was for partial damages of brinjal.

Determinants of farm level postharvest losses

Determinants of postharvest loss of brinjal for the present study were illustrated by the Table 7. Coefficients of multiple determination (R^2) of the logarithmic regression model was found 0.994 which implied that 99% of the variation in postharvest loss at farmer's level can be explained by the variables included in the model.

Table 5. Farm level postharvest loss of brinjal based on causes of damages

Items	Brinjal	
	Quantity (kg)	%
Total harvested amount (kg) Total land area = 253 decimal	49140	100
A. Full damage (kg)		
Insect	1548	3.15
Disease	257.93	0.52
Rotten	927	1.89
Over mature	220.5	0.45
Shrinking	715	1.46
Bird	834	1.70
Total	4502.43	9.16
B. Partial damage (kg)		
Insect	154	0.31
Disease	157	0.32
Over mature	88.07	0.18
Skinning	1132	2.30
Bruising	631	1.28
Shrinking	164	0.33
Total	2326.07	4.73
C. Total wastage (kg)		
Insect	1702	3.46
Disease	414.93	0.84
Rotten	927	1.89
Over mature	308.57	0.63
Spot	1132	2.30
Bruising	631	1.28
Shrinking	879	1.79
Bird	834	1.70
Total loss	6828.50	13.90

Source: Field survey, 2018

Table 6. Financial loss of brinjal farmers due to postharvest loss

Sources of Financial loss	Quantity	Percentages
Loss due to full damage (Tk/decimal)	677.42	95.54
Loss due to partial damage (Tk/decimal)	31.63	4.46
Total loss (Tk/decimal)	709.05	100

Source: Field survey 2018

The coefficients of total harvested amount were found positive and significant at 1% level, indicating that 1% increase in total harvest of brinjal, keeping other factors constant, would result in an increase of postharvest loss by 1.46%. The influence of respondent's education was found significant and negative linkages with the postharvest loss. It means that as the education of the farmer improved the amount of postharvest loss will be reduced while other things remaining the same. Among the dummy variable selling place was found positive and significant at 10% level. This implied that as much as farmer shifted their product from farm level to market level postharvest loss was also increased due to the distance and transportation. Accordingly, packaging dummy was also found significant at 10% level. It implies that shifting from traditional to improve packaging, postharvest loss was reduced significantly. The significance of F value at 1% level implies that the variation in postharvest loss of brinjal depends mainly

upon the explanatory variable included in the model. Studies like Kaysar *et al.* (2016) found sale price, farming experience and transportation dummy were negatively significant indicate that with the increase of sale price (1 Tk/kg), farming experience (1 year) and transportation facilities, the postharvest loss will be decreased. This study also found total production and weather dummy had positive and significant relationship with total postharvest losses which indicates that, with the increase of production of brinjal and weather is unfavorable during harvest, postharvest loss will be increased.

Table 7. Estimated values of coefficients and related statistics of Cobb Douglas type production model for post-harvest loss of tomato

Regression variables		Regression coefficient	t-statistic	p-value	Standard error
Intercept	α	-2.276	-0.107	0.915	21.225
Total harvested amount	X_1	0.146***	73.370	0.000	.002
Respondents Education	X_2	-1.032**	0.269	0.019	3.841
Total family member	X_3	1.143	0.360	0.720	3.172
Farming experience	X_4	-0.696	-0.619	0.539	1.124
Selling price	X_5	0.192	-0.849	0.400	0.226
Vehicle type dummy	X_6	-9.977	-0.725	0.472	13.752
Packaging dummy	X_7	-5.605*	0.415	0.080	13.499
Training dummy	X_8	15.373	1.112	0.272	13.822
Selling place dummy	X_9	0.327*	-0.019	0.085	17.469
Number of observations			144		
R^2			0.994		
F (144, 9)			793.185***		

'***','**', and'*' denote 1%, 5% and 10% level of significance

Conclusion and Recommendation

Once harvested, horticultural crops are very much prone to degradation. A range of postharvest practices have to practice immediately after harvest to reduce this degradation. The matter of postharvest loss of horticultural crops is important as it affects both producers and consumers. Among the horticultural crops brinjal is one of the most popular vegetable crops in Bangladesh. Cultivation of brinjal is thus one of the primary sources of income for both rich and poor farmers. So, like production and growth, its postharvest loss is also important. In order to reduce postharvest loss of brinjal, farmers in the survey areas are habituated with a number of postharvest practices including cleaning, sorting, grading, packaging and preserving. Full damages and partial damages of brinjal constitute total postharvest loss of brinjal in the survey areas. Sorting and grading were the stages when maximum share of postharvest loss of brinjal due to full damages occurred. In order to help farmer to reduce postharvest loss government and private organization should come forward to establish postharvest storage facilities of vegetables including brinjal in urgent basis. It is also necessary to monitor the price of brinjal between farm gate and terminal market. Education is important for the farmer. Government should take appropriate steps to educate the farmer about modern postharvest handling and practices. Research institution should demonstrate the new idea of reducing postharvest loss of brinjal at farm level.

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