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POSTHARVEST LOSS ASSESSMENT OF MAJOR FRUITS GROWN IN HILL REGIONS OF BANGLADESH

M. A. HOSSAIN[1], M. KHATUN[2], M. A. MATIN[3] AND M. F. DEWAN[4]

Abstract

The study was conducted for assessing postharvest loss of major fruits in different hill regions of Bangladesh. The study areas covered four hill districts, namely Rangamati, Khagrachari, Bandarban and Moulvibazar and six selected fruits, namely mango, jackfruit, litchi, banana, pineapple and orange. These fruits are grown intensively in hill regions compared to other parts of Bangladesh. Data were collected from 2050 fruit growers and 749 traders of eight (8) upazilas considering accessible and less accessible areas. At farmers and traders level, the total postharvest loss of banana, pineapple, orange, mango, litchi and jackfruit were 372, 274, 200, 243, 165 and 380 kg/mt which was accounted about 37%, 27%, 20%, 24%, 17% and 38% of total production respectively. The main postharvest losses at farm level were incurred due to severe attack of insect, bat, squirrel and monkey. For traders, major losses were incurred during transportation. On the basis of retail price, the annual economic loss was estimated as Tk. 2107.5 crore and the maximum loss was incurred for banana (Tk. 705.79 crore) followed by pineapple (Tk. 550.58 crore) and mango (Tk. 508.95 crore) and the lowest for orange (Tk. 1.12 crore). It is interesting to note that, transportation dummy, labour dummy and market demand dummy had negative and significant effect on the postharvest losses. If transportation facilities can be improved and market demand and labour availability can be increased, postharvest loss will be decreased to an acceptable level at the study areas.

Keywords: Hill regions, fruits, postharvest loss, and national loss.

1. Introduction

The hilly areas have the great potentialities for fruit cultivation. Higher yield can be attained by adopting modern technologies as well as to mitigate balanced nutrition of the farmer. Most of the fruits like pineapple, mango, banana, jackfruit, guava, papaya, malta, orange, pomelo, litchi, lemon etc. are grown in different hilly areas of Bangladesh. The characteristics of agricultural commodities like fruits are bulky in production and perishable in nature. The surplus production of different fruits grown in hill regions are not marketed in proper time due to lack of transport and infrastructural facilities. Due to seasonal glut and absence of proper marketing system, bulk amount of harvested produce

[1&3]Principal Scientific Officer, Agricultural Economics Division, Bangladesh Agricultural Research Institute (BARI), Gazipur, [2]Scientific Officer, Agricultural Economics Division, BARI, Gazipur, [4]Lecturer, Department of Economics and Poverty Study, Noakhali Science and Technology University, Noakhali, Bangladesh.

get wasted every year. Postharvest losses occur at different points from fruit harvest to marketing chain. The extent of loss varies with the type of commodity and its level of management. In most of the developing countries, the postharvest loss is very high and it is about 50% of fresh fruits and vegetable production. Even in developed countries like USA, Postharvest loss is up to 20% (Yahia and Oubahou, 2001). The postharvest loss of fruits and vegetables in Bangladesh ranged from 23.6% to 43.5% which accounts for an annual loss Tk. 3442 crore (Hassan, 2010). Similar losses of fruits and vegetables have also been reported from other Asia-Pacific countries, for example, 40% in India, 20-50% in Indonesia, 20-50% in Korea, 27-42% in the Philippines, 16-41% in Srilanka, 17-35% in Thailand and 20-25% in Vietnam (Rolle, 2006). In general, the postharvest losses of fruits and vegetables in the developing countries are substantial (24-40%) as compared to the developed countries (2-20%) (Sirivatanapa, 2006).

The loss of any harvested crops has enormous negative impact on the economy of the country. By developing and adopting the appropriate techniques of postharvest technologies, a large amount of money can be saved annually which can make a significant contribution in case of food security of Bangladesh. Improved postharvest practices will bring financial gain to the farmers as well as satisfaction to the traders and consumers.

So, to compare with the previous studies an attempt had been made to analyse the present status of postharvest loss explaining the causes of postharvest loss both at farmers and traders level and also the factors responsible for this postharvest losses which will help in adopting appropriate interventions in reducing postharvest losses. Based on the postharvest losses, national economic loss as a whole was estimated on the basis of total production of the country for the year 2009-2010. Therefore, this study was undertaken with the following objectives:

i. To know the present status of postharvest losses of major fruits and their causes both at farmers and traders level;

ii. To find out the factors responsible for this postharvest losses;

iii. To estimate national economic loss per year.

2. Methodology

2.1 Study areas: The study areas covered four hill districts, namely Rangamati, Khagrachari, Bandarban and Moulavibazar where fruits are intensively grown compared to other parts of Bangladesh.

2.2 Sample size: From eight upazilas of four districts a total of 1230 growers were selected as sample farmers (Table 1). Another 820 farmers (Table 1) were selected whose gardens are more than 4 years old and presently they are

marketed their fruits in the markets. In the case of different intermediaries, a total of 746 samples were selected from both primary and secondary markets of which 240 were local traders, 144 bepari, 48 urban aratdars, 144 local retailers and 96 were urban retailers.

Table 1. Distribution of fruits growing farmers according to different locations

Name of fruits	Total sample (No)	Farmers who are cultivating different fruits							
		Khagrachari		Rangamati		Bandarban		Moulavibazar	
		Matiranga	Dighinala	Sadar	Naniarchar	Sadar	Ruma	Sreemongal	Juri
Banana	240	30	30	30	30	30	30	30	30
Pineapple	210	30	30	30	30	30	30	30	0
Orange	150	30	0	30	30	0	30	0	30
Mango	180	30	30	30	30	30	30	0	0
Litchi	210	30	30	30	30	30	0	30	30
Jackfruit	240	30	30	30	30	30	30	30	30
Total	**1230**	**180**	**150**	**180**	**180**	**150**	**150**	**120**	**120**
		Farmers who are presently marketed their fruits							
Farmer	820	120	100	120	120	100	100	80	80

2.3 Sampling technique: For selecting the farmers, simple random sampling technique and for intermediaries stratified proportionate random sampling technique for each group of intermediaries were followed. The farmers who possess more than 1 hectares of owned cultivable land and having the fruit garden (not less than 0.50 hectare) and depend on farming were selected as respondent farmers. The intermediaries werefaria, *bepari*, *paiker*, *aratdar*, wholesaler and retailer.

2.4 Postharvest loss assesment using multiple linear regression model: The data were collected from households on socioeconomic variables such as age, educational background, family members, occupation, earning person, average annual income. Information on different postharvest activities was collected from the respondents.Averages and percentages were used to compute the postharvest losses. Information about postharvest losses was obtained from the households during following operations: (i) harvesting, (ii) grading/handling (iii) loading/unloading and (iv) transportation. The total postharvest losses were estimated as a sum of all these losses. Functional analysis was carried out to examine the factors affecting postharvest losses at farm level in fruits, as used by Nag *et al.*, (2000) in chickpea. The following multiple linear regression function was specified in the present study:

$$Y_i = a + b_1X_{1i} + b_2X_{2i} + b_3X_{3i} + \ldots\ldots\ldots\ldots\ldots + b_{10}X_{10i} + e_i$$

Where,

Y_i = Postharvest losses of i^{th} fruits at farm level in kg per ha.

X_{1i} = Age of the farmers in years.

X_{2i} = Education of the farmers in schooling years.

X_{3i} = Total production of i^{th} fruits in M.tons.

X_{4i} = Weather dummy which takes the value '1' if the weather during harvesting was favourable and value '0', otherwise.

X_{5i} = Transportation dummy which takes the value '1' if transport facility was adequate and value '0' otherwise.

X_{6i} = Labour dummy which takes the value '1' if the labour availability during harvesting was adequate and value '0' otherwise.

X_{7i} = Training dummy which takes the value '1' if the farmer received training about production and value '0' otherwise.

X_{8i} = Distance dummy which takes the value '1' if the distance from farm to market was favourable and value '0' otherwise.

X_{9i} = Market demand dummy which takes the value '1' if the market demand was favourable and value '0' otherwise.

X_{10i}= Market place dummy which takes the value '1' if the market place was favourable and value '0' otherwise

a=intercept.

$b_1, b_2, b_3, \ldots\ldots\ldots\ldots\ldots b_{10}$=Coefficients of the respective variable

i=1,2,3,…6 and 1= banana, 2=pineapple, 3=orange, 4=mango, 5=litchi, 6=jackfruit.

e_i = Random-error.

3. Results and Discussion

3.1 Postharvest loss at farmers' level

Postharvest losses of different fruits at different operational stages at farm level in hilly areas are shown in Table 2. For banana, the average loss per metric ton was 64 kg (6.4%) and highest loss (1.4%) was occurred due to spoilage. Major portion of losses were found due to rough handling at harvesting (1.3%) and insect attack (1.2%). For pineapple, the amount of losses per metric ton was 66 kg (6.6% of total production) and the highest amount of losses was observed at harvesting (1.4%) and spoilage loss (1.4%). A notable portion (0.8%) of

pineapple was rotten due to rain. In the case of orange, average losses per metric ton was 94 kg (9.4% of the total production). Farmers noted that highest loss (2.6%) was occurred due to insect attack. Spoilage loss (2.1%) was also prominent in orange.The total amount of losses for mango at farmers level was 98 kg/mt which was 9.8% of total production. Major loss of mango is occurred due to insect attack (3%), traditional harvesting system (1.7%) and spoilage loss (1.5). Postharvest losses for litchi were 84kg/mt (8.4% of total production). Major portion of losses is occurred due to insect attack (2.5%) and rough handling at harvesting stage (1.5%). Besides, remarkable portion of losses is occurred at grading (1%), storage (0.9%) and spoilage loss (1.3%).For jackfruit, per metric ton losses was 56 kg (5.6%)which is comparatively lower than other fruits and the highest amount of losses were observed due to insect attack (1.6%). Losses of jackfruit also occurred due to storage (0.6%), rough handling at harvesting (1%), delay selling (0.6%), grading (0.4%) and spoilage (0.5%).

For all fruits, the major postharvest loss occurred due to the attack of insect and pest at ripening stage (Table 2). Furthermore, a major portion of losses occured during harvesting and also due to spoilage during rainy season. This loss also occured due to lack of assembling point or temporary storage facilities for storage at market place.

Table 2. Postharvest losses of different fruits at farmers' level

Particulars	Fruits					
	Banana	Pineapple	Orange	Mango	Litchi	Jackfruit
Total yield (kg/ha)	33653	21156	23622	22253	9243	32498
Total loss (kg/ha)	2019(6)	1481 (7)	2212 (9)	2151 (10)	774 (8)	1826 (6)
Loss (kg/mt)	64 (6.4)	66 (6.6)	94 (9.4)	98 (9.8)	84 (8.4)	56 (5.6)
Harvesting loss (kg/mt)	13 (1.3)	14 (1.4)	10 (1)	17(1.7)	15(1.5)	10 (1)
Grading loss (kg/mt)	2 (0.2)	6 (0.6)	6 (0.6)	5 (0.5)	10 (1)	4 (0.4)
Storage loss (kg/mt)	4 (0.4)	7 (0.7)	7 (0.7)	6 (0.6)	9 (0.9)	6 (0.6)
Delay selling (kg/mt)	5(0.5)	6(0.6)	6(0.6)	7 (0.7)	5 (0.5)	6 (0.6)
Weight loss (kg/mt)	-	1 (0.1)	2(0.2)	3 (0.3)	-	-
Spoilage loss (kg/mt)	14 (1.4)	14 (1.4)	21 (2.1)	15 (1.5)	13 (1.3)	5 (0.5)
Loss due to insect attack (kg/mt)	12 (1.2)	6 (0.6)	26 (2.6)	30 (3)	25 (2.5)	16 (1.6)
Rotten due to rain (Kg/mt)	4 (0.4)	8 (0.8)	10 (1)	11 (1.1)	2 (0.2)	6 (0.6)
Other losses (Kg/mt)	10 (1)	4 (0.4)	6 (0.6)	4(0.4)	5 (0.5)	3 (0.3)

Note: Figures in the parentheses indicate percentage of total losses

Others indicate fruits damage by monkey, bat and squirrel

3.2 Postharvest losses at traders' level: The most important chain through which major amount of fruits (banana, orange, litchi and jackfruit) was transacted was Local trader-*Bepari*-*Paikar*-Urban retailer/Rural retailer-Consumer. For pineapple and mango the most important chain ofmarketingwas Local trader-*Paikar*-Urban retailer-Rural retailerand *Bepari*-*Paikar*-Urban retailer, respectively. For all fruits except mango, postharvest losses were found more in urban retailer level than other traders. The main reason for losses in urban retailer level was due to the poor storage facilities and delay selling of the product. Sometimes it required more time to dispose of due to large supply of the same product in the market.In case of mango the highest losses occured in case of *Bepari* followed by urban retailer. The major cause of postharvest losses for all traders were found to be due to carrying/transportation followed by delay selling and storage loss.

Postharvest losses of banana at traders' level

As banana is a highly perishable product and it stays comparatively more time to the traders,postharvest losses at intermediaries' level were much higher than farm level. Highest losses of banana were found in case of urban retailers (8.9%) and comparatively lower losses were found in case of rural retailers (3.2%). Total 30.8% losses were found at traders' level (Table 3). Highest 8.8% loss was occurred in case of carrying banana from one area to another. This is because of having poor road and transportation facilities in the hill areas. In Ethiopia Mebratie et.al (2015) estimated postharvest losses as higher at retailers level (56% of total loss) while the wholesale and farm levels' losses were 27% and 17%, respectively.

Table 3. Postharvest losses of banana at different intermediaries level (kg/mt)

Particulars	Local Trader	Bepari	Paiker	Urban Retailer	Rural Retailer	Total loss
Loading/Unloading	5 (0.5)	8 (0.8)	9 (0.9)	6 (0.6)	7 (0.7)	35 (3.5)
Carrying	12 (1.2)	38 (3.8)	21 (2.1)	9(0.9)	8 (0.8)	88 (8.8)
Grading & Packing	8 (0.8)	6 (0.6)	6 (0.6)	-	5 (0.5)	25 (2.5)
Storage loss	20 (2)	5 (0.5)	6 (0.6)	29 (2.9)	6 (0.6)	66 (6.6)
Delay Selling	20 (2)	6 (0.6)	4 (0.4)	30 (3)	3 (0.3)	63 (6.3)
Spoilage loss	7 (0.7)	4 (0.4)	2 (0.2)	15 (1.5)	3 (0.3)	31 (3.1)
Total loss	72 (7.2)	67 (6.7)	48 (4.8)	89 (8.9)	32 (3.2)	308 (30.8)

Note: Figures in the parentheses indicate losses in percentage

Postharvest losses of pineapple at traders' level

Postharvest losses of pineapple at intermediaries' level were much higher than farm level. Total losses at traders' level were found 20.8%. Highest losses of

pineapple were found in case of urban retailers (9.6%) and comparatively lower losses were found in case of rural retailers (2.5%). (Table 4). Highest (5%) losses were occurred in case of carrying pineapple from one area to another. This is because of having poor road and transportation facilities in the hill areas. A noticeable portion of pineapple was lost due to delay selling (4.6%).

Table 4. Postharvest losses of pineapple at different intermediaries' level (kg/mt)

Particulars	Local trader	*Paiker*	Urban retailer	Rural retailer	Total
Loading/Unloading	10 (1)	8(0.8)	9(0.9)	6 (0.6)	33 (3.3)
Carrying	18(1.8)	12 (1.2)	14 (1.4)	6(0.6)	50 (5)
Grading & Packing	8(0.8)	5(0.5)	8(0.8)	5 (0.5)	26 (2.6)
Storage loss	10(1)	6 (0.6)	26 (2.6)	2 (0.2)	44 (4.4)
Delay Selling	3(0.3)	7(0.7)	30 (3)	6 (0.6)	46 (4.6)
Spoilage loss	-	-	9(0.9)	-	9 (0.9)
Total loss	49 (4.9)	38 (3.8)	96(9.6)	25(2.5)	208(20.8)

Note: Figures in the parentheses indicate losses in percentage

Postharvest losses of orange at traders' level

Postharvest losses of orange at intermediaries' and farm level were more or lesssimilar. Total losses at traders' level were found 10.7%. Highest losses were found in case of urban retailers (5.4%) and comparatively lower losses were found in case of local traders (0.6%) (Table 5). Highest (2.6%) losses were occurred in case of carrying one area to another. This is because of having poor road and transportation facilities in the hill areas. A noticeable portion of losses were found due to delay selling (2.1%) and spoilage losses (2.1%).

Table 5. Postharvest losses of orange at different intermediaries' level (kg/mt)

Particulars	Local trader	*Bepari*	*Paiker*	Urban retailer	Rural retailer	Total
Loading/Unloading	2 (0.2)	3 (0.3)	2 (0.2)	8 (0.8)	3 (0.3)	18 (1.8)
Carrying	2 (0.2)	7 (0.7)	5 (0.5)	8 (0.8)	5 (0.5)	26 (2.6)
Grading & Packing	1 (0.1)	2 (0.2)	1 (0.1)	3 (0.3)	-	7 (0.7)
Storage loss	1 (0.1)	3 (0.3)	1 (0.1)	12 (1.2)	4 (0.4)	21 (2.1)
Delay Selling	-	4 (0.4)	-	15 (1.5)	4 (0.4)	21 (2.1)
Spoilage loss	-	2 (0.2)	-	10 (1)	1 (0.1)	14 (1.4)
Total loss	6 (0.6)	21(2.1)	9 (0.9)	54(5.4)	17(1.7)	107(10.7)

Note: Figure in the parentheses indicate losses in percentage.

Postharvest losses of mango at traders' level

Postharvest losses of mango at intermediaries' level were found 14.5% which was higher than farm level. Highest losses of mango were found in case of

beparilevel (7.2%) which was about half of the total losses at traders' level and comparatively lower losses were found in case of paikers level (1.9%) (Table 6). Highest (5.5%) losses were occurred in case of carrying mango from one area to another. Poor road and transportation facilities in the hilly areas are the major causes of losses at traders level. A noticeable portion of mango was lost due to storing mango at traders' level (2.6%).

Table 6. Postharvest losses of mango at different intermediaries' level (kg/mt)

Particulars	*Bepari*	*Paiker*	Urbanretailer	Total
Loading/Unloading	14 (1.4)	5 (0.5)	3 (0.3)	22 (2.2)
Carrying	40 (4)	8 (0.8)	7 (0.7)	55 (5.5)
Grading & Packing	4 (0.4)	3 (0.3)	-	7 (0.7)
Storage loss	9 (0.9)	3 (0.3)	14 (1.4)	26 (2.6)
Delay Selling	5 (0.5)	-	17 (1.7)	22 (2.2)
Spoilage loss	-	-	13 (1.3)	13 (1.3)
Total loss	72 (7.2)	19 (1.9)	54 (5.4)	145 (14.5)

Note: Figure in the parentheses indicate losses in percentage

Postharvest losses of Litchi at traders' level

Postharvest losses of litchi at intermediaries' level were 8.1% which is similar to farm level (Table 7). The perishability of this fruit is attributed to immense physiological changes after harvest (Momen *et. al*., 1993). Amiruzzaman (1990) reported that postharvest losses of fresh fruits including litchi in Bangladesh is 25-50%, while it is only 5-25% in developed countries (Khader, 1992). Highest losses of litchi were found in case of urban retailer (4.3%) and comparatively lower loss was found in case of bepari (0.9%) (Table 7). Molla *et. al.* (2010) reported that average losses of litchi at growers, beparies, arathdars, retailers, and and consumers level were found as 13%, 4.25%, 7.75%, 4.10%, and 7.50% respectively. Highest (2.6%) losses were occurred in case of carrying litchi from one area to another. This is because of having poor road and transportation facilities in the hill areas. A noticeable portion of litchi was lost in the time of grading and packing (1.9%).

Table 7. Postharvest losses of Litchi at different intermediaries' level (kg/mt)

Particulars	Localtrader	*Bepari*	*Paiker*	Urbanretailer	Ruralretailer	Total
Loading/Unloading	-	2 (0.2)	4 (0.4)	8 (0.8)	4 (0.4)	18 (1.8)
Carrying	1 (0.1)	3 (0.3)	3 (0.3)	12 (1.2)	7 (0.7)	26 (2.6)
Grading & Packing	-	4 (0.4)	2 (0.2)	9 (0.9)	4 (0.4)	19 (1.9)
Storage loss	-	-	2 (0.2)	-	-	2 (0.2)
Delay Selling	-	-	-	8 (0.8)	2 (0.2)	10 (1)
Spoilage loss	-	-	-	6 (0.6)	-	6 (0.6)
Total loss	1 (0.1)	9 (0.9)	11 (1.1)	43 (4.3)	17 (1.7)	81 (8.1)

Note: Figures in the parentheses indicate losses in percentage

Postharvest losses of jackfruit at traders' level

Postharvest losses of jackfruit at intermediaries' level were much higher than farm level. Total losses at traders' level were found 32.4%. Highest losses of jackfruit were found in case of bepari and urban retailers (9.5%) and comparatively lower losses were found in case of rural retailers (2.3%). (Table 8). Highest (15.1%) losses were occurred in case of carrying jackfruit from one area to other. This is because of having poor road and transportation facilities in the hill areas. A noticeable portion of jackfruit was lost in the time of loading/unloading and storing at traders' level (6.2%).

Table 8. Postharvest losses of Jackfruit at different intermediaries' level (kg/mt)

Particulars	Localtrader	*Bepari*	*Paiker*	Urbanretailer	Ruralretailer	Total
Loading/Unloading	12 (1.2)	18 (1.8)	16 (1.6)	13 (1.3)	2 (0.2)	62 (6.2)
Carrying	25 (2.5)	45 (4.5)	32 (3.2)	43 (4.3)	7 (0.7)	151 (15.1)
Grading & Packing	5 (0.5)	10 (1)	9 (0.9)	-	-	23 (2.3)
Storage loss	6 (0.6)	13 (1.3)	6 (0.6)	25 (2.5)	9 (0.9)	62 (6.2)
Delay Selling	-	9 (0.9)	-	10 (1)	5 (0.5)	23 (2.3)
Spoilage loss	-	-	-	4 (0.4)	-	3 (0.3)
Total loss	48 (4.8)	95 (9.5)	63 (6.3)	95 (9.5)	23 (2.3)	324 (32.4)

Note: Figures in the parentheses indicate losses in percentage

3.3 Total Postharvest losses

The postharvest losses of banana, pineapple, orange, mango, litchi and jackfruit at traders level were worked out as 308 kg, 208 kg, 106 kg, 145 kg, 81 kg and 324 kg per ton respectively (Table 9). The total loss that represent about 30.8%, 20.88%, 10.6%, 14.5%, 8.1% and 32.4% of total volume of fruits handled by different intermediaries.Total post- harvest losses of banana, pineapple, orange, mango, litchi and jackfruit were found 37%, 27%, 20%, 24%, 17%, and 38%, respectively.

Table 9. Postharvest losses at farmers and traders level (kg/mt)

Fruits	Farmers loss (kg/mt)	Traders loss (kg/mt)	Total loss (kg/mt)
Banana	64 (6.4)	308 (30.8)	372 (37)
Pineapple	66 (6.6)	208 (20.8)	274 (27)
Orange	94 (9.4)	106 (10.6)	200 (20)
Mango	98 (9.8)	145 (14.5)	243 (24)
Litchi	84 (8.4)	81 (8.1)	165 (17)
Jackfruit	56 (5.6)	324 (32.4)	380 (38)
All Average	77 (7.7)	195 (19.5)	272 (27.2)

Note: Figures in the parentheses indicate losses in percentage

3.4 National economic loss assessment

Both at farmers and traders level, the total postharvest lossesfor banana, pineapple,orange ,mango, litchi, and jackfruit were 372, 274, 200, 243, 165, and 380 kg/mt (Table 10).The total economic loss of major fruits was calculated on the basis of the latest production data obtained from BBS 2010. Based on harvest price,national economic loss was estimated to be Tk. 922.17 crore.The maximum loss was incurred for mango (Tk. 364.12 crore) and the lowest for orange (Tk. 0.37 crore). Similarly, on the basis of retail price, the total economic loss was estimated to be Tk. 2341.66crore and the maximum loss was incurred for banana(Tk. 705.79 crore) followed by pineapple (Tk. 550.58 crore) and mango (Tk. 508.95 crore) and the lowest for orange (Tk. 1.12 crore). In monetary term, the prices prevailing in retail market is always higher than the farm harvest price. So in retail level, the postharvest losses were highest. Actual economic loss was again estimated considering 10% acceptable loss both at farmers and traders level. By considering 10% acceptable loss, the total postharvest losses were estimated Tk. 829.95 crore/year at farm harvest price and Tk. 2107.50 crore/year at retail price.

Table 10. Annual economic loss of fruits occurred at harvest and postharvest stages

Particulars	Banana	Pineapple	Orange	Mango	Litchi	Jackfruit	Total
Production (mt)	818254	234493	2666	1047849	64995	1005164	4173421
Loss at farmers&traders level in study areas (kg/mt)	372	274	200	243	165	380	1634
Total national loss (mt)	304390	64251	533	254627	10724	381962	1016487
Harvest price (Tk./mt)	6017	25809	6920	14300	88542	2978	
Retail price (Tk./mt)	23187	85692	21000	19988	180208	10000	
Total loss based on harvest price (crore Tk.)	183.15	165.83	0.37	364.12	94.95	113.75	922.17
Total loss based on retail price (crore Tk.)	705.79	550.58	1.12	508.95	193.26	381.96	2341.66

3.5 Factors affecting postharvest losses at farm level

For studying the influence of different socio-economic features of farmers on postharvest losses at the farm level, a multiple linear regression analysis was carried out. The estimated regression coefficients are presented in table 11 to table 13. The variations in 10 independent variables included in the regression model explained nearly 59per cent in the total postharvest losses in banana, 68 per cent in pineapple, 59 per cent in orange, 79 per cent in mango, 75 per cent in

litchi and 69 per cent in jackfruit. The F-ratio was significant in all cases, indicating thereby the good fit of the regression models.

Table 11. **Estimated values of coefficients and related statistics of multiple linear regression model for postharvest losses of banana and pineapple at farmers' level**

Explanatory variables	Banana		Pineapple	
	Coefficients	P-value	Coefficients	P-value
Intercept	10.034**	0.052	12.071**	0.053
Age of the farmer(years) X_1	0.039	0.193	6.722	0.539
Education (Schooling years) X_2	0.432	0.372	0.790	0.695
Total production (M.ton) X_3	0.820	0.489	**10.005***	0.065
Weather dummy X_4	1.029	0.702	**-0.192****	0.053
Transportation dummy X_5	**-0.043*****	0.002	**-0.034****	0.040
Labour dummy X_6	0.925	0.429	**-1.294*****	0.000
Training dummy X_7	1.043	0.792	0.009	0.649
Distance dummy X_8	**-1.503****	0.040	**-1.002****	0.024
Market demand dummy X_9	**-0.294***	0.063	**-0.139*****	0.001
Market place dummy X_{10}	0.043	0.673	0.943	0.709
N	90		120	
R^2	0.592		0.682	
F value	17.850**		27.042**	

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

It is clear that in case of banana (Table 11) and litchi (Table 13), the variables like transportation dummy, distance dummy and market demand dummy were negatively significant which indicate that with the increase of transportation facilities and market demand, postharvest loss will decrease. Again, if the distance from farm to market is favourable to the farmer, postharvest loss will also decrease.

In case of pineapple (Table11) the variables like weather dummy, transportation dummy, labour dummy, distance dummy and market demand dummy were negatively significant which indicate that with the increase of transportation facilities, labour availabilities and market demand, postharvest loss will decrease. If the weather and distance from farm to market is favourable to the farmer, postharvest loss will decrease. Total production had positive and significant relationship with total postharvest losses which indicates that, with the increase of production of pineapple, postharvest loss will increase.

Table 12. **Estimated values of coefficients and related statistics of multiple linear regression model for postharvest losses of orange and mango at farmers level**

Explanatory variables	Orange		Mango	
	Coefficients	P-value	Coefficients	P-value
Intercept	-6.750***	0.000	0.642**	0.023
Age of the farmer (years) X_1	1.250	0.430	0.239	0.234
Education (Schooling years) X_2	0.893	0.690	0.094	0.109
Total production (M.ton) X_3	**7.843***	0.070	**8.034****	0.042
Weather dummy X_4	-2.095	1.007	1.027	0.639
Transportation dummy X_5	**-0.043****	0.045	**-0.039*****	0.003
Labour dummy X_6	**-0.375****	0.050	**-0.005***	0.067
Training dummy X_7	0.008	0.200	1.752	0.920
Distance dummy X_8	0.002	0.870	-0.829	0.439
Market demand dummy X_9	**-1.039*****	0.005	**-0.052****	0.042
Market place dummy X_{10}	0.007	1.002	2.701	0.597
N	90		180	
R^2	0.592		0.790	
F value	17.850**		20.430**	

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

In case of orange and mango (Table 12) and jackfruit (Table 13), the variables like transportation dummy, labour dummy and market demand dummy were negatively significant which indicate that with the increase of transportation facilities, labour availabilities and market demand, postharvest loss will decrease. Total production had positive and significant relationship with total postharvest losses which indicates that, with the increase of production of fruits like mango, orange and jackfruit, postharvest loss will increase.

It is interesting to note that, transportation dummy and market demand dummy were negatively significant for all fruits in all locations. If these facilities like transportation, market demand and labour availability can be increased, postharvest loss will decrease at the study areas. Scarcity in storage and transportation infrastructure resulted in 25-40 percent postharvest losses that shrinks supply and put pressure on prices.

Table13. **Estimated values of coefficients and related statistics of multiple linear regression model for postharvest losses of litchi and jackfruit at farmers' level.**

Explanatory variables	Litchi		Jackfruit	
	Coefficients	P-value	Coefficients	P-value
Intercept	15.228***	0.001	3.019**	0.053
Age of the farmer (years) X_1	-0.780	0.901	0.872	0.672
Education (Schooling years) X_2	0.815	0.875	-0.734	0.220
Total production (M. ton) X_3	0.058	0.632	9.073	0.782
Weather dummy X_4	-0.728	0.557	1.792	0.900
Transportation dummy X_5	**-0.543****	0.053	**-0.472*****	0.001
Labour dummy X_6	0.039	0.542	**-0.927***	0.067
Training dummy X_7	0.495	0.352	0.027	0.697
Distance dummy X_8	**-0.870****	0.030	0.407	0.824
Market demand dummy X_9	**-0.156***	0.073	**-0.039****	0.043
Market place dummy X_{10}	0.782	0.791	0.053	0.789
N	210		210	
R^2	0.751		0.692	
F value	22.032***		32.029**	

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

4. Summary

At farmers and traders level, the total postharvest loss of banana, pineapple, orange, mango, litchi and jackfruit were 372, 274, 200, 243, 165, and 380 kg/mt which was accounted about 37%, 27%, 20%, 24%, 17% and 38% of total yield respectively. The main Postharvest losses were incurred due to severe attack of insect and severe attack of bat, squirrel and monkey for farmers. For traders, major loss was incurred during transportation. On the basis of retail price, the total economic loss was estimated as Tk. 2341.66 crore and the maximum loss was incurred for banana (Tk. 705.79 crore) followed by pineapple (Tk. 550.58 crore) and mango (Tk. 508.95 crore) and the lowest for orange (Tk. 1.12 crore). It is interesting to note that, transportation dummy and market demand dummy were negatively significant for all fruits in all locations. If these facilities like transportation, market demand and labour availability can be increased, postharvest loss will be decreased to an acceptable level at the study areas. Lack of technical knowledge about Postharvest activities, severe attacks of insect and pest, attacks by bat, squirrel, monkey, storage facilities, transportation facilities, lack of agro processing industries and low prices were identified as the major constraints in the hill areas of Bangladesh.

5. Recommendations

The following policies/suggestions should be implemented which deserves immediate attention for reducing the existing postharvest loss of major fruits in hill regions of Bangladesh:

- An appropriate training programme on different postharvest activities like handling, grading, packaging, carrying etc. should be provided with a view to increasing the efficiency as well as awareness of the farmers and traders.
- Storage facilities should be established in hilly areas to ensure fair price of their product. Private entrepreneur should come forward to establish storage facilities at the important fruit concentrated areas and different wholesale and retail markets. Facilities should be developed for one to two days reservation for unsold fruits at market place.
- Transportation and communication system should be developed through constructing of different feeder road. Low cost quick transportation facilities will ensure to carry fruits from farmyard to local market place or in distant bigger market for the farmers and intermediaries where they are likely to get better price for their products.

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