Original Research Article

Post-Harvest Loss Assessment and Marketing Practices of Fruits: An Empirical Study of Maulvibazar District in Bangladesh

ABSTRACT

Aims: The present study is highlighted the post-harvest loss assessment and marketing practices of fruits at different stages of marketing and their impact on farmers' net price, marketing costs, margins, and efficiency of various intermediaries from both farmers and various intermediaries (*bepari,* wholesaler, and retailer).

Study Design: This article is a post-harvest loss assessment study and is placed on empirical analysis. It conducted post-harvest losses in farm and intermediaries' level and its market practices which impact on farmer's income, net price, marketing margin, and efficiency.

Place and Duration of Study: The study was conducted at Sreemangal Upazila of Maulvibazar district of Bangladesh. The study period was the harvesting season of lemon in April to May and pineapple from May to June 2019.

Methodology: The relevant data were collected from the farmers and intermediaries of lemon and pineapple of Maulvibazar District, Bangladesh. The sample size for lemon and pineapple was 240, where 80 farmers and 40 intermediaries were taken from four villages of Sreemangal Upazila in Maulvibazar district. Data were collected through simple random and purposive sampling techniques. After cleaning and correcting the data Microsoft Excel and Statistical Package for Social Science (SPSS) were used for analyzing the data.

Results: Total post-harvest loss of lemon was 20.57% and 23.99% for pineapple of total production at farm level. The highest loss was estimated at 87.93 kg/quintal at the intermediaries' level in the case of lemons, and 16.50 kg/quintal was for pineapples at farm level. Among different intermediaries, post-harvest loss of lemons was highest at the retail level (70.93 kg/quintal) and for pineapples at the wholesale level (9.18 kg/quintal). The net price received by the farmers for pineapple was greater than the net price received by the farmers for lemon. Before and after separating losses, according to the conventional method, the net price received by the farmers was Tk. 10.06/kg and 17.13/kg for lemon and Tk. 15.58/kg and Tk. 20.01/kg for pineapple. After taking into account the physical loss during retailing, the margin of the retailers is less (loss) than other intermediaries indicated that they incurred a net loss during the retail trade due to high post-harvest losses.

Conclusion: It has been shown that pineapple marketing is a more efficient system in terms of both operations and price than lemon. The total marketing cost was lower at farm level on lemon and pineapple compared to intermediaries' level. Marketing cost has been identified as the major constraint in the wholesale marketing channel, and bringing down the costs, particularly the loading and unloading and transportation charges as demonstrated in the marketing channel, will help reduce the price-spread and increase the producers' margin. The need for specialized transport vehicles for perishable commodities has been highlighted.

Keywords: Post-harvest loss, Marketing practices, Fruits, Farmers, Intermediaries, Maulvibazar district, Bangladesh.

1. INTRODUCTION

Bangladesh is bestowed with vast agricultural resources on account of its fertile land, well-irrigated plains, weather, and centuries-old farming tradition. Because of its central importance in the economy, the Government has identified agriculture as one of the four major drivers of growth. In FY 20-21, it contributes about 13.47 percent to the country`s Gross Domestic Product (GDP) and sustains the livelihood of more than 40.6 percent of the total labor force (BBS, 2020). According to an estimation, the total value of agriculture crops at the current factor cost is estimated at Tk. 1858131 million, divided into major crops Tk. 1111625 million and minor crops including horticulture Tk. 713307 million, which is 60.91% of the total value of all crops and 39.09% of the total value of minor crops (BBS, 2020).

Fruits and vegetables are important economic crops because they can be consumed locally, exported, and processed. Due to their biological characteristics, tropical fruits have a relatively high and rapid post-harvest loss. Bangladesh has a good environment in which to boost production and increase the productivity of these fruits. A great range of tropical and sub-tropical fruits abound in Bangladesh. Mango, jackfruit, blackberry, pineapple, banana, litchi, lemon, guava, custard apple, wood apple, elephant apple, golden apple, Indian berry, papaya, tamarind, melon, watermelon, cashew nut, pomegranate, plum, rose apple, Indian olive, and Indian jujube are the most commonly cultivated fruits in Bangladesh (BBS, 2020). They play a significant role in human nutrition, particularly as sources of vitamins, minerals, dietary fiber, and antioxidants, and their role in improving nutritional status needs no emphasis. Among the horticultural crops, at present, fruits recorded, the total area under fruits cultivation is 1482000 acres, growing per annum at 4948 metric tons in 2017-18 and producing from 1347000 acres to 4548 metric tons in 2018-19 (BBS, 2020). Consumption of a variety of fruits and on a daily basis is highly recommended because of associated health benefits, which include reduced risk of some forms of cancer, heart disease, stroke, and other chronic diseases. But the average per capita requirement of fruit per day is 100 g, whereas the availability is only 44.7 g in Bangladesh at the national level (HIES, 2010; BBS, 2020).

Fruits like pineapple and lemon are the highest value fruit crop in terms of international trade, and these are produced all over the world. They grow particularly well in areas with sufficient rainfalls or irrigation to sustain growth, and freezing conditions are not severe enough to kill the tree. In Bangladesh, the major fruits, including the citrus growing region, comprise some areas of Maulvibazar. Prospects for fruits cultivation in Maulvibazar appear bright as the atmospheric and soil condition and are becoming a seasonal fruit hub with enormous potentiality for developing a food processing sector. Presently, it supplies more than 65% of the citrus fruits of the country than other districts. In 2018-19, fruits were cultivated on 11031 acres of land and produced 56908 metric tons in Maulvibazar district fruits under cultivation where land occupied for pineapples and lemons were 1110 acres and 872 acres and produced 6308 and 9894 metric tons, respectively (BBS, 2020).

But one of the main reasons attributed to lower availability is the large quantity of post-harvest losses that occur at various stages of marketing, ranging from 15 to 50 percent (FAO, 2013). Post-harvest loss is a “measurable quantitative and qualitative loss of a product at any moment during the post-harvest chain” and includes the “change in the availability, edibility, wholesomeness or quality of the food that prevents its consumption” (Adeoye *et al.,* 2009; Buyukbay *et al.,* 2010). At every point in the post-harvest chain, quantitative losses (weight or volume) and qualitative losses (changing physical traits and

qualities) can occur. Economic losses are exacerbated by a decrease in the monetary value of the product due to a decline in quality or quantity (Akhter *et al.,* 1996). Both qualitative and quantitative losses occur from pre-harvest to post-harvest through processing, storage, distribution, and delivery to the customer (Amiruzzaman, 1990). Post-harvest losses not only diminish the farmer's portion of the final price and result in a loss of revenue, but they also reduce consumer availability. This results in a higher price, leaving the consumer with few options.

Bangladesh grows a wide range of fruits and vegetables due to its tropical and sub-tropical environment. Unfortunately, due to post-harvest losses, a significant amount of the cultivated produce never reaches to the consumers. According to a recent study by Mollah *et al.,* (2018), post-harvest losses in food grains are estimated to be 15%, while losses in fruits and vegetables are believed to be 20–25%. These losses might be as high as 40% for very perishable fruits and vegetables.

Many studies have been conducted on post-harvest losses of fruits and vegetables based on small scale experiments but do not reflect the real situations. In Bangladesh, post-harvest losses of bananas were 21.67% Tangail District (Saha *et al.,* 2021) and mango was 25-45% at Chapainawabganj and Gazipur (Alam *et al.,* 2019). Banana, pineapple, orange, mango, litchi, and jackfruit, post-harvest losses in hill regions were estimated to be about 37%, 27%, 20%, 24%, 17%, and 38%, respectively (Hossain *et al.,* 2017). This post-harvest losses impacts both producers (lower proportion of consumer price) and consumers (reduced availability and higher prices). The cost of preventing losses is less than the cost of generating the same additional quantity of fruits; hence reducing post-harvest losses is a complementary technique of expanding production. As a result, there is little doubt that massive amounts of fruits and vegetables are thrown away each year. The majority of the data is based on experiments done at various research stations and universities. The majority of crop loss data comes from third-party sources. The quantity and quality of data available hampered the accuracy of yield reduction predictions in most cases. As a result, compiling credible yearly crop loss estimates for any crop has proven impossible (Mollah *et al.,* 2018).

A few studies calculated post-harvest losses at each stage of the marketing process of different fruits in different countries (Gajanana *et al.,* 2002; Murthy *et al.,* 2003; Murthy *et al.,* 2004; Ilyas *et al.,* 2007; Murthy *et al.,* 2007; Gajanana *et al.,* 2008; Davara & Patel, 2009; Murthy *et al.,* 2009; Molla *et al.,* 2012; Sudharshan *et al.,* 2013; Nayak *et al.,* 2018). But in Bangladesh, particularly in the Maulvibazar district, no empirical study has been yet conducted to measure post-harvest loss assessment and marketing practices of fruits (i.e., lemon and pineapple) at different stages of marketing and their impact on farmers' net price, marketing costs, margins, and efficiency of different intermediaries. Given the above backdrop, it is necessary to understand post-harvest loss assessment and marketing practices of fruits in the Maulvibazar district. In this present investigation, we tried to explicitly estimate the extent of post-harvest losses of fruits at different stages of marketing and to measure the impact of such estimation procedure on farmers' net price, marketing costs, margins, and efficiency. Thus, the overall objective was to assess the post-harvest losses of fruits in physical and economic terms at different stages of marketing and their impact on farmers' net price, marketing costs, margins, and efficiency of different intermediaries in the Maulvibazar district of Bangladesh.

2. MATERIAL AND METHODS

2.1 Selection of the study area and sample

The study was conducted in the Sreemangal Upazila of Maulvibazar district of Bangladesh including five villages namely Sadar, Mohajirabad, Khakiachara, Radhanagar, and Dilbornagar as the lemon (local, bilati, china) and pineapple (honey queen and giant queen) are mostly growing in this respective area of Bangladesh. The present study included farmers and different market intermediaries such as *bepari,* wholesalers, and retailers. For the selection of sample farmers, simple random sampling techniques were used and for intermediaries, the purposive sampling techniques were followed. Out of 160 selected farmers, 80 were of lemon and 80 were pineapple, and out of 80 market intermediaries, 40 were of lemon, and 40 were pineapple.

2.2 Methods of data collection and analysis

Data on post-harvest losses and market practices were collected from the above areas during the harvesting season of lemon in April to May and pineapple from May to June, 2019. In addition to primary data, secondary data were also collected from various publications like government reports, published articles, different organizations, and web searching. Then the collected data were summarized, compiled, and analyzed by using MS Excel and Statistical Package for Social Science (SPSS).

2.3 Analytical Techniques

2.3.1 Analysis of Marketing Costs, Margins and Post-harvest losses of fruits:

In the present investigation, based on the definition of post-harvest losses associated with the marketing chain (Acharya & Agarwal, 2001; Kohls & Uhl, 2002), post-harvest losses of lemon and pineapple at different stages of marketing were calculated by using descriptive statistics like average, mean, percentage in the study area. Information about post-harvest losses was obtained from the households during the following operations: (i) stage of harvesting, (ii) harvesting time, (iii) storage, (iv) packaging, and (v) transportation. The total post-harvest loss was estimated as a sum of all these losses.

2.3.2 Analysis of Marketing Costs and Margins:

Considering microelements of cost at different stages, the following modified formula was used to estimate the post-harvest losses.

2.3.3 Marketing Loss:

Losses at various levels of marketing are not expressly addressed as a cost item in traditional estimating techniques. It is either accounted for as part of the farmer's net income or as the market intermediaries' margin. The following formulas were used to estimate losses independently in value terms at different stages of marketing, as well as producers' share and marketing margins.

2.3.4 Farmer's Net Price:

The net price received by the lemon and pineapple farmers was estimated as the difference in gross price received them and the sum of marketing costs incurred and the economic value of fruits (i.e., lemon and pineapple) loss during the harvesting, grading, transportation, and marketing (George, 1972). Thus, the farmer's net price was explained mathematically as per equation (1):

$NP_F = GP_F - \{C_F + (L_F \times GP_F)\}$

Or, $NP_F = (GP_F) - (C_F) - (L_F \times GP_F)$……(1)

Where,

NP_F = Net price received by the farmers (Tk. /kg)

GP_F = Gross price received by the farmers or wholesale price to farmers (Tk. /Kg)
C_F = Cost incurred by the farmers during marketing (Tk. /Kg); and
L_F = Physical loss in produce from harvest till it reaches the assembly market (per kg)

2.3.4 Marketing Margins:

The margins of market intermediaries include profits and returns, which accrue for trading facility provided and establishment after adjusting the marketing losses due to marketing (Ganjana, 2002). The general expression for estimating the marketing margin of the intermediaries is given below:
Intermediaries margin = Gross price (sale price) – Purchase price (cost price) – Cost of marketing – Loss in value during wholesaling
Net marketing margin of wholesaler is given mathematically by the equation as used by Murthy et al. (2007) in banana (2):
$MM_W = GP_W – GP_F – C_W – (L_W \times GP_W)$
Or, $MM_W = [\{GP_W – GP_F\} – \{C_W\} – \{L_W \times GP_W\}]$……..……(2)
Where,
MM_W = Net margin of the wholesaler (Tk. /Kg)
GP_W = Wholesalers' selling price or purchase price of retailer (Tk. /Kg)
GP_F = Gross price received by the farmers or wholesale price to farmers (Tk. /Kg)
C_W = Cost incurred by the wholesalers during marketing (Tk. /Kg), and
L_W = Physical loss in the produce at the wholesale level (per kg)
The net marketing margin of the retailer is given by equation (3) as said by Chandra (1994):
$MM_R = GP_R – GP_W – C_R – (L_R \times GP_R)$
Or, $MM_R = [\{GP_R – GP_W\} - \{C_R\} - \{L_R \times GP_R\}]$…….(3)
Where,
MM_R = Net margin of the retailer (Tk. /Kg)
GP_R = Price at the retail market or purchase price of the consumers (Tk. /Kg)
GP_W = Wholesalers' selling price or purchase price of retailer (Tk. /Kg)
L_R = Physical loss in the produce at the retail level (per kg), and
C_R = Cost incurred by the retailers during marketing (Tk. /Kg).
The first bracketed term in equations (1), (2), and (3) indicates the gross return, while the second and third bracketed terms indicate the cost and the loss at different stages of marketing, respectively. Thus, the total marketing margin of the market intermediaries (MM) was calculated by the following equation (4):
$MM = MM_W + MM_R$ ……...(4)
Similarly, total marketing cost (MC) incurred by the farmer/seller and by various intermediaries was calculated as per equation (5):
$MC = C_F + C_W + C_R$……..…..(5)
Total marketing loss (ML) in value of produce due to injury/damage caused during handling of products from the point of the harvest till it reaches the consumers was estimated as per equation (6):
$ML = [\{L_F \times GP_F\} + \{L_W \times GP_W\} + \{L_R \times GP_R\}]$……....(6)

2.3.5 Marketing Efficiency:

The most commonly used measures are conventional output to input ratio, Shepherd's ratio of value (price) of goods marketed to the cost of marketing (Shepherd, 1965), and Acharya's modified marketing efficiency formula (Acharya & Agarwal, 2001). As the reduction of loss in

itself is one of the important efficiency parameters, there is a need to consider this component explicitly in the analysis to improve the measures of marketing efficiency ratios used for comparing alternate markets/channels. Therefore, the present study incorporated 'marketing losses' as one of the components in the denominator of the formula suggested by Acharya and Agarwal (2001) to measure marketing efficiency. The modified formula was expressed as equation (7):

$ME = NP_F/MM+MC+ML$ ……(7)

The definitions of NP_F, MM, MC and ML were the same as in expressions (1), (4), (5) and (6).

Where,

ME = Marketing efficiency

NP_F = Net price received by the farmers (Tk. /Kg)

MC =Total marketing costs (Tk. /Kg)

MM = Net marketing margins (Tk. /Kg)

ML = Total marketing loss

3. RESULTS AND DISCUSSION

3.1 Marketing Practices and Channels

The marketing of lemon and pineapple begins when the product leaves the farm and ends when it reaches the final consumers. It is more than buying and selling. Rather, it is a series of important business activities that transform a farm producer's product into several finished products desired by the consumer. The results indicate that 90 percent of the farmers sell their fruits to the market through direct sales of the produce because direct sales benefit the producers more than contract sales.

A marketing channel is a process of selling different commodities at different stages, which involves several traders like producers, *beparis, aratdars,* wholesalers, and retailers. The facts cannot be denied that a long chain of traders makes marketing operations less efficient and more costly, as each trader has their role and share. Packing material and transportation costs are the major components of the marketing costs (Singh, 1994). The four most common distribution channels observed in the study areas were:

Channel I: Farmer→ *Bepari*→ *Aratdar* → Wholesaler→ Consumer

Channel II: Farmer→ Wholesaler→ Consumer

Channel III: Farmer→ Wholesaler → Retailer→ Consumer

Channel IV: Farmer→ *Bepari*→ *Aratdar* → Wholesaler → Retailer→ Consumer

Description of Participants

Farmers: Farmers produce lemon and pineapple and sell their produce to the *beparies* through *aratdar.* Sometimes, they sell their expected crops directly to the *beparies* based on orchard areas, i.e., the number of productive trees in the orchard.

Bepari: *Beparies* are either the local person or come from other districts like Dhaka, Chattogram, Khulna, Jessore, Barisal, etc. Depending on involvement in harvesting, they are

of two groups. One of them is involved in harvesting, but another one is not. The first group of *beparies* bought harvested lemon and pineapple from growers and other intermediates in the local markets through the local *aratdars*. In contrast, the second group of the *beparies* bought advanced crops (orchards) directly from the growers or other intermediates and harvested lemon and pineapple by their management. Both groups of *beparies* dispatch lemon and pineapple mostly to *aratdars* to other big markets.

Aratdar: *Aratdar* or commission agents provide a critical service in amassing sufficient quantities of product from many farmers for marketing to larger wholesalers and retailers. They also play a role in quality control. Typically, the *aratdar* does not pay the farmer until after he has sold the product, minimizing his risk. The *aratdar* or commission agent charges commission at the rate of 5% and other charges, including market fee, transportation cost, labour charges, and others.

Wholesaler: Wholesalers of lemon and pineapple operate between *aratdar* or commission agents and retailers. Wholesalers operate exclusively from the larger market towns and typically buy from many traders who, in turn, may have bought their produce at the farm gate. Wholesalers work closely with the *aratdar* or commission agents. He buys the products through the *aratdar* or commission agents and sells in smaller lots to the same as well as distant markets to his buyers, retailers, and consumers.

Retailer: Retailer is the last link in the lemon and pineapple marketing. Retailers have a permanent or seasonal shop in the local bazaars or urban or city markets. Retailers in growing areas buy lemon and pineapple directly from the growers to *beparies* or *beparies* through a*ratdars.*

3.2 Post-harvest losses

Most losses of fresh produce occur between leaving the farm and reaching the consumer. These losses may be caused by complete wastage of the product or by lower prices due to reduced quality. The cost of these losses is also important as the product's value increases several-fold from the farm gate to the final consumer, so post-harvest losses are even more significant.

3.2.1 Post-harvest loss at farmers' level

Post-harvest losses of different fruits at different operational stages at the farm level in study areas are shown in Table 1. For lemon, the total loss was 37.46 kg/quintal per hectare, and the highest loss (30.62%) was occurred due to insect attack. The major losses were due to weight loss (18.69%) and delayed selling (17.38%). For pineapple, the total amount of losses was 16.50 kg/quintal per hectare (6.6% of total production), and the highest amount of losses was observed at delay selling (26.12%) and spoilage loss (24.91%). A negligible portion (1.58%) of pineapple was rotten due to rain during the rainy season.

Table 1: Post-harvest losses of lemon and pineapple at farmers' level

(Kg/quintal)

Particulars	**Lemon**		**Pineapple**	
	Quantity Loss (Kg/quintal)	Percent loss	Quantity Loss (Kg/quintal)	Percent loss
Harvesting Loss	2.95	7.88	3.81	23.09
Grading and sorting loss	2.21	5.89	0.00	0.00
Storage loss	1.33	3.55	1.99	12.06
Delay selling	6.51	17.38	4.31	26.12
Weight loss	7.00	18.69	1.05	6.36

Spoilage loss	3.65	9.74	4.11	24.91
Loss due to insect attack	11.47	30.62	0.97	5.88
Rotten due to rain	2.37	6.33	0.26	1.58
Others	0.00	0	0.00	0
Total Loss	37.46	100.00	16.50	100.0
Total Area (ha)	1.21		1.23	
Average yield (quintal)	286.12		107.09	

Source: Authors estimation, 2019

3.2.2 Post-harvest losses at intermediaries' level:

The most important chain through which a major amount of fruits (lemon and pineapple) was transacted was *bepari-aratdar*-wholesaler-retailer-consumer. In this study, post-harvest losses were found more at the retailer level than other intermediaries. *Aratder* had no post-harvest losses for lemon and pineapple as he just helped sell the fruits of *beparis* to other intermediaries. The main reason for losses at the retailer level was the poor storage facilities and delay in selling the product. Sometimes it requires more time to dispose of due to the large supply of the same product in the market. The major causes of post-harvest losses for all traders were found to be due to carrying/transportation followed by delay selling and storage loss.

3.2.2.1 Post-harvest losses of lemon at intermediaries' level

In the case of both fruits, post-harvest losses at the intermediaries' level were lower than the farm level. The highest losses of lemon were found in the retailers' level (70.93 kg/quintal), and comparatively lower losses were found in the wholesalers (4.78 kg/quintal) and *beparis'* level (12.22 kg/quintal). Total 87.93 kg/quintal losses were found at intermediaries' level of lemon. The highest 68.74% and 30.08% loss occurred in case of storage loss at *bepari* and retail level and 63.13% spoilage loss at the wholesale level, respectively (Table 2). This loss also occurred due to the lack of assembling points or temporary storage facilities at the marketplace.

Table 2: Post-harvest losses of lemon at different intermediaries' level

(Kg/quintal)

	Bepari		**Wholesaler**		**Retailer**		**Total**	
Particulars	Quantity Loss	Percentage	Quantity Loss	Percentage	Quantity	Percentage	Quantity Loss	Percentage
Harvesting Loss	0	0	0	0.00	0	0.00	0.00	0
Grading and sorting loss	3.27	26.75	0.72	15.24	8.67	12.23	12.66	100
Storage loss	8.4	68.74	0.00	0.00	21.33	30.08	29.73	100
Delay selling	0	0.00	0.46	9.74	8.00	11.27	8.46	100
Weight loss	0	0.00	0.00	0.00	0.00	0.00	0.00	0
Spoilage loss	0.54	4.41	2.98	63.13	13.6	19.17	17.12	100
Loss due to insect attack	0	0.00	0.62	13.13	0.00	0.00	0.62	100
Rotten due to rain	0	0.00	0.00	0.00	19.33	27.25	19.33	100
Others	0	0.00	0.00	0.00	0.00	0.00	0.00	0

Total Loss	12.22	100	4.78	100	70.93	100	87.93	100

Source: Authors estimation, 2019

3.2.2.2 Post-harvest losses of pineapple at intermediaries' level

Post-harvest losses of pineapple at intermediaries' level were much lower than the farm level. Total losses of intermediaries' level were found 13.12 kg/quintal for pineapple. The highest losses of pineapple were found in the wholesalers' level (9.18 kg/quintal). Comparatively, lower losses were found at *beparis'* (2.01 kg/quintal) and retailers' level (1.93 kg/quintal). The highest (26.37%) and (25.81%) losses were occurred in case of spoilage loss and rotten due to rain at *bepari* and wholesale level. A noticeable portion of pineapple was lost due to delayed selling and spoilage loss at the retail level (37.82%) (Table 3).

Table 3: Post-harvest losses of pineapple at different intermediaries' level

(Kg/quintal)

Particulars	***Bepari***		**Wholesaler**		**Retailer**		**Total**	
	Quantity Loss	Percentage	Quantity Loss	Percentage	Quantity Loss	Percentage	Quantity Loss	Percentage
Harvesting Loss	0.00	0	0.00	0	0.00	0.00	0.00	0
Grading and sorting loss	0.19	9.45	0.71	7.73	0.00	0.00	0.90	100
Storage loss	0.28	13.93	1.11	12.09	0.48	24.87	1.87	100
Delay selling	0.00	0.00	1.71	18.62	0.73	37.82	2.44	100
Weight loss	0.26	12.93	0.92	10.02	0.00	0.00	1.18	100
Spoilage loss	0.53	26.37	0.72	7.84	0.73	37.82	1.98	100
Loss due to insect attack	0.27	13.84	0.00	0.00	0.00	0.00	0.00	0
Rotten due to rain	0.25	11.04	2.37	25.81	0.00	0.00	2.62	100
Others	0.51	12.44	1.65	17.97	0.00	0.00	2.16	100
Total Loss	2.01	100	9.18	100	1.93	100	13.12	100

Source: Authors estimation, 2019

3.2.2.3 Total post-harvest and marketing losses

The post-harvest losses occurring at field level were worked out as 37.46 kg/ quintal in lemon and 16.50 kg/quintal in pineapple. The maximum post-harvest loss was observed at the farm level and estimated Tk. 978.86 for lemon and Tk. 936.71 per quintal for pineapple compared with intermediaries' level. The post-harvest losses occurring at intermediaries' level of lemon and pineapple were 87.93 kg/quintal and 13.12 kg/quintal, respectively. Their monetary value loss was estimated as 84.37 per quintal for all lemon intermediaries and Tk. 16.56 per quintal for all pineapple intermediaries in the study areas (Table 4). Murthy *et al.* (2009) found in their study that the post-harvest losses of mango were 15.59 percent at farm level, 8.89 percent at ripening/storage, and 5.25 percent at retail levels, in case of grapes 7.31 percent at farm level, 4.24 percent during transit and wholesale level and 2.85 percent at the retail level. For, banana the post-harvest losses were 5.53 percent, 6.65 percent at the wholesale market and 16.66 percent at retail marketing levels. And pomegranate lowers was 9.86 percent at the farm level, 10.10 percent at wholesale, and 15.48 percent at the retail levels which was due to small and immature fruits harvesting, lack of storage facilities, and fungal diseases. Saha *et al.* (2021) claimed that the postharvest losses of bananas in the

marketing chain were obtained as 3.33% at farmer's level, 5.17% at *aratdar's* level and 16.36% at retailer's level. The gross post-harvest losses of bananas from harvesting to consumption were obtained as 21.67% of total production. The main causes of the post-harvest losses were mechanical and physical damages of bananas at the farm and wholesaler's levels, while over-ripening was the main cause at the retailers' level. Another similar finding illustrated by Molla *et al.* (2010) estimated that the post-harvest losses were reported mainly at harvesting (8.0%), handling from orchard to selling point by the growers and *beparis'* involved in harvesting (4.61%) and after buying to consumption by the consumers (7.5%). Considering the channels involved in litchi marketing, the growers and/or *beparis'* engaged in harvesting had the highest percent of losses (16% in Dinajpur, 12% in Ishurdi, and 11% in Natore) followed by the consumers (7.5%). A study on the assessment of post-harvest losses of bananas grown in Gujarat discovered 5.86% transportation and handling losses at the trader level (Davara & Patel, 2009). Molla *et al.* (2012) discovered that post-harvest losses averaged 2.13 %, 9.0 %, 7.25 %, and 2.5% to 3% at the grower, *beparies* (long channel), *aratdars,* and consumer to retailer levels, respectively. According to Ilyas *et al.* (2007) found that total losses in apples transported from Quetta, Swat, and Murree to the Faisalabad market were found to be 23, 20, and 25%, respectively and total losses in banana transported from Nawabshah, Mirpur Khas, and Hyderabad to the Faisalabad market were 37, 39, and 43%, respectively.

Table 4: Post-harvest and marketing losses of lemon and pineapple at farmers' level and intermediaries' level

Fruits	Farmers loss (kg/quintal)	Farmers loss (Tk. /quintal)	Intermediaries' loss (kg/quintal)	Intermediaries' loss (Tk./quintal)	Total Loss (kg/quintal)	Total Loss (Tk./quintal)
Lemon	37.46	978.86	87.93	84.37	125.39	1063.23
Pineapple	16.50	936.71	13.12	16.56	26.62	953.27

Source: Authors estimation, 2019

3.3 Impact of Post-harvest Losses on Farmers' Net Price, Costs, Margins and Efficiency

Generally, marketing costs and margin investigation do not clearly account for post-harvest losses at various stages of marketing. As a result, these costs are absorbed in the farmers' net margins or the market intermediaries' margins. The profit margins of market intermediaries are always overestimated as a result of this. This study aimed to estimate marketing margins more precisely by accounting for losses separately. The farmers' net price, margins of market intermediaries, price spread, and efficiency indicators as estimated by the new methods have been presented in Table 5.

3.3.1 Farmers' Net Price

Table 5 shows that the net price received by the farmers for pineapple was greater than the net price received by the farmers for lemon. Before and after separating losses, according to the conventional method, the net price received by the farmers was Tk. 10.06/kg and 17.13/kg for lemon and Tk. 15.58/kg and Tk. 20.01/kg for pineapple. These findings were inconsistent with the study by Murthy *et al.* (2007) and they found that according to the conventional method, the net price received by farmers for banana in Karnataka was Rs. 8.68/kg in the cooperative channel and Rs. 8.36/kg in the wholesale channel before separating losses. After separating losses, the net price received by farmers was getting lower which was Rs. 7.96/kg in the cooperative channel and Rs. 7.70/kg in the wholesale channel. They claimed that it was possible due to low marketing costs, particularly commission fees and transportation costs. The producers' share in the consumer price was estimated at 29 percent and 40 percent for lemon and pineapple, respectively. Before selling

to wholesalers, the defective fruits were separated during sorting and grading in the traditional method. There was no accounting for the worth of such rejects. Farmers usually do not receive any money for such produce. In the present analysis, post-harvest losses during grading and transit from field to assembly market were accounted for and valued at current prices. Depending on the marketing method, the extent of such losses ranged from Tk. 0.5/kg to Tk. 5/kg for lemon and Tk. 10/kg to Tk. 15/kg for pineapple.

3.3.2 Market prices

Pricing is an important function in buying and selling of any commodity. Fixing lemon and pineapple prices through open bargaining and the ongoing market price was commonly practiced in the study areas. The cost of lemon and pineapple mainly depends on its size, and grading specification is large, medium, and small. Both demand and supply affected the price, which indicated that the lemon and pineapple market was more or less competitive. It was found that the best quality of lemon and pineapple was sold at higher prices. In the present study, the average sales price received by farmers was Tk.1909 per quintal for lemon and Tk. 2608 per quintal for pineapple (Table 5).

3.3.3 Marketing Costs

For lemon and pineapple the total marketing cost was lower at farm level and estimated at Tk. 196 and Tk. 607 per quintal compared to Tk. 234 and Tk. 368 at intermediaries level. Transportation from the field to the wholesale market of the study area was accounted for 27.54%, followed by 23.82% for market toll costs and 4.33% for loading and unloading of the total costs, respectively, at the lemons farm level. For pineapple, the highest cost incurred is Tk. 516.80 per quintal for loading and unloading, which was 38.49 percent of the total costs (Table 5).

In the case of the cost of market intermediaries, the highest cost was incurred at the wholesalers' level at Tk. 1869.05 for lemon, which was amounted to 85.69% of the total costs of intermediaries. Similarly, 46.08 percent on loading and unloading on the value of the produce and 17.02 percent and 2.99 percent deduction on storage in case of transportation and carrying purpose were the major components of the marketing costs incurred by the intermediaries on pineapple. Marketing costs of intermediaries together accounted for 21 and 17 percent of the total marketing cost for lemon and pineapple, respectively (Table 5). Murthy *et al.* (2009) found in their study that the marketing costs ranged from Rs. 2944/ton in mango to Rs. 5664/ton in pomegranate. The cost of marketing in banana and grape worked out to Rs. 4360/ton and Rs. 4630/ton, respectively.

Table 5: Impact of post-harvest losses on farmers' net price, margin, efficiency and price-spread in lemon and pineapple

(Tk. /kg)

Particulars	Before separating losses		After separating losses	
	Lemon	Pineapple	Lemon	Pineapple
Farmers' net price received	10.06	15.58	17.13	20.01
Cost of marketing				
Farmers	1.96	6.07	1.96	6.07
Bepari	0.46	0.63	0.46	0.63
Wholesaler	1.83	2.67	1.83	2.67
Retailer	0.05	0.38	0.05	0.38
Sub Total	2.34	3.68	2.34	3.68
Total	4.30	9.75	4.30	9.75

Producers' Shares in consumer price	29.44	39.61	50.13	50.88
Profit margin				
***Beparis'* margin**	3.38	1.83	2.36	2.00
Wholesalers' margin	0.96	1.47	1.81	1.82
Retailers' margin	6.48	6.73	6.59	7.04
Sub Total	10.42	10.03	10.76	10.86
Marketing efficiency	0.19	0.54	0.61	0.78
Consumers purchase price	33.60	40.00	33.60	40.00
Price Spread	23.54	24.42	16.47	19.99

Source: Authors estimation, 2019

3.3.4 *Beparis'*, Wholesalers' and Retailers' Margin:

In this study, the total marketing margin of intermediaries was Tk. 6678.97 for lemon where retailers' portion was highest which was accounted on Tk. 3045.90 for pineapple and the total margin was Tk. 31292.19. The highest margin amounted for wholesaler which was Tk. 13506.98. This margin also included the post-harvest losses at the *bepari,* wholesale and retail levels. Separating the post-harvest loss from the margins and accounting for it as a separate item reduced the *beparis'* margins from Tk. 2442.20 per kg to Tk. 2178.60 per kg, wholesalers' margins Tk. 1190.92 per kg to Tk. 320.11 per kg and retailer's margin from Tk. 3045.90 per kg to Tk. 2856.78 per kg (Table 5). The less value for retailers than other traders indicated that they incurred a net loss during the retail trade due to high post-harvest losses. The rotting of fruits due to rain and lack of storage was the major cause of these losses. The other reasons for increased losses were delay selling that is fruits need to be sold within 2-3 days to avoid price falling during retailing.

3.3.5 Price spread and producers and different actor's shares (%) in consumer's taka

The price spread usually refers to the difference between the price paid by the consumer and the price received by the producer for an equivalent amount of farm product. This spread consists of marketing costs and margins of intermediaries. Thus, it is a device that indicates how much is received by the producer out of every taka spent by the consumer and what portion goes into the coffers of intermediaries (Sahaf, 1987). That means,

Producer's share in retail price = (Net amount received by the producer/total amount paid by the consumers) × 100

In this study, it was observed that consumers paid high prices at the retail level, but the producer got only 29% for lemon and 40% for pineapple of the prices that the consumers paid. The intermediaries, particularly retailers, turned out to be the major beneficiaries in the study area. Different intermediaries' of lemon and pineapple got 71% and 60% of the share of marketing margin (Table 5). This is not unlikely for a perishable, bulky, and raw commodity like lemon and pineapple. This finding was consistent with the study of Murthy *et al.* (2009) where they claimed that the price spread was highest in pomegranate, i.e., Rs.13,460/ton and the major contributory factor was the intermediaries' margin (58 percent). Murthy *et al.* (2007) also found in their study that the price spread was Rs.7.48/kg in the wholesale channel before separating out the marketing losses, which was 47 percent of the consumers' price. The producers' share in consumers' price was higher (66.67%) in cooperative than wholesale (52.78%) and the marketing of bananas through the co-operative channel was more efficient since the price spread was lower.

3.3.6 Marketing Efficiency:

An increase in this ratio would represent improved efficiency and vice-versa. A reduction in the cost for the same level of satisfaction or an increase in satisfaction at a given cost would improve efficiency.

A higher level of consumer satisfaction even at a higher marketing cost may mean increased marketing efficiency if the additional satisfaction derived by the consumer outweighs the extra cost incurred on the marketing process. Marketing efficiency in this context may be termed as the pricing efficiency of the marketing system. The relationships between marketing costs and marketing margins and that between gross margins and prices in spatially separated markets between or different stages of marketing reflect this aspect of marketing efficiency. It was observed from Table 5 that the marketing efficiency ratio was higher for pineapple, which was 0.54 and 0.78, than lemon, and 0.19 and 0.61 before and after separating the losses mainly because of higher price realization by the farmers due to reduced marketing costs. In this present study, although both fruits markets were not efficient the pineapple market was found more efficient in case of before and after separating the losses in comparison with the lemon market in the study area. This finding was consistent with the study by Murthy *et al.* (2009) where they found that the grape markets were found to be more efficient than mango, banana, and pomegranate as reflected in the higher ratio (2.13) because of lower marketing costs and intermediaries' margins. In mango, markets were found inefficient as reflected by the ratio of less than one.

4. CONCLUSION AND SUGGESTIONS

The study concludes that fruits play a significant role in farmers' income, food and nutritional security, and ensure employment to large numbers of people. Estimation of post-harvest losses is important as it helps identify the causal factors and provides ways and means to reduce the losses. These losses occur at all stages resulting in farmers' income losses, deterioration in quality, reduced nutritional value, and high costs to consumers. Hence, there is an urgent need to reduce post-harvest losses by adopting appropriate policies, technologies, and regional cooperation. At the farmer level, the highest loss occurred in the harvesting period because huge quantity of fruits was affected by the insect, rotten and unscientific method of harvesting operations. At the retail level, fruit loss occurred during selling time, resulting in a large volume of product loss for delayed selling and spoilage. The absence of post-harvest treatment, lack of storage facilities, and low price of fruits, poor packaging, and unsuitable transportation facilities were the major problems in study areas faced both farmers and intermediary's level. Reduction of post-harvest loss has become the prime issue to increase the availability of fruits and vegetables. A significant portion of the produce is lost, but it can be overcome by processing into different products. The processing methods are simple if practical training and demonstration are provided to the farmer's community. The policy should also be encouraged the gender groups to improve and adapt to the latest technology. It will play a vital role in reducing post-harvest losses of fruits. Solving the post-harvest food distribution problems will require cooperation and effective communication among all the research, extension, and industry personnel involved. Post-harvest horticulturists need to coordinate their efforts with those of production horticulturists, agricultural marketing economists, engineers, food technologists, and others interested in various aspects of the production and marketing system. In most cases, solutions to existing problems in the post-harvest handling system require using available information and applying available technologies at the appropriate scale rather than conducting new research or developing new technologies.

ETHICAL APPROVAL

This article is original and contains unpublished materials. The corresponding author confirms that all of the authors have read and approved the manuscript and no ethical issues are involved.

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ACRONYMS, ABBREVIATIONS

et al.: Et alia (L.) and others
etc. : Etcetera
i.e. : That is
Tk. : Taka (Bangladeshi Currency)
Rs. : Rupee (Indian Currency)