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Studies on preharvest and postharvest practices of mango in Bangladesh

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ABSTRACT

An extensive survey was conducted to collect existing pre- and postharvest practices of mango. The survey was conducted using structured and pre-tested interview schedules at four levels of mango supply chain including growers, 'Bepari', wholesalers, and retailers. For growers' interview, four Upazilas of Chapai Nowabgonj (Chapai Nowabgonj Sadar, Shibganj, Bholahat, and Gomostapur) and two Upazila of Rajshahi (Charghat and Bagha) were selected. For 'Bepari', wholesalers, and retailers, the survey was carried out in local assemble markets of Chapai Nowabgonj and Rajshahi, wholesale and retail markets of Mymensingh and Dhaka. Results showed that 20-60% of the mango growers utilized more than 3 ha of land for growing mango in the surveyed districts. During the production, all mango growers applied pesticides to mango crop at 7-10 days interval. Importantly, 60-92% of the growers used growth regulating chemicals to increase yield. The major insect and disease were mango hopper and dieback, respectively. Results of the present survey indicated that 4-16% of the 'Bepari' and 2-4% of the wholesalers applied ethylene-liberating ripening chemicals like ethrel, Ripen (a.i. 80% ethephon) and calcium carbide for accelerating mango ripening. The price increase of mango was 45.83% in the supply chain before reaching the consumers. The profit margin of 'Bepari', wholesaler, and retailer level was 7.51%, 12.84%, and 16.06%, respectively in study areas.

Key Words: Mango, Pre-harvest practices, Postharvest practices and Postharvest loss.

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I. Introduction

The mango (*Mangifera indica* L.) is an important fruit crop in Bangladesh under *Anacardiaceae* family. This fruit tree also recognized as the national tree of Bangladesh. Mango is believed to be originated in South Asia or the Malayan archipelago (Salunkhe and Desai, 1984). The total area under mango cultivation in Bangladesh is 44365 ha and the total production is 11,65,804 metric tons (BBS, 2019).

Mango has some special features such as pleasant aroma, attractive color and delicious taste with high nutritional values, and these attributes make this fruit one of the unique items in the world market. This is also termed as the 'king of all fruits' (Shahjahan et al., 1994). Mangoes are rich sources of vitamins and minerals (Paramanik, 1995). It is also a moderate source of carbohydrate as ripe mango pulp contains 16.9% carbohydrate (Salunkhe and Desai, 1984). Per 100 g ripe mango contains 81 g moisture, 0.6 g protein, 0.4 g fat, 0.4 g minerals, 0.7 g crude fiber, 16.9 g carbohydrates, 74 kcal. energy, 14 mg calcium, 16 mg phosphorus, 1.3 mg iron (Gopalan et al., 1989). The quality attributes of mango largely determined by preharvest production factors, which include production location, soil type, irrigation, rootstock, shading, and nutrition (Holfman, 1998). According to Monselise and Goren (1987) similar types of production factors influence fruit qualities. They divided the production conditions into two classes, namely primary and secondary factors. The primary factors include climate, nutrition, and plant growth regulators, and the secondary factors include soil quality and management, rootstock, irrigation, pruning, and crop load manipulation. To assess and minimize the postharvest losses it is highly important to find out the existing pre and postharvest practices of produce. Presently modern technologies have been in place to augment fruit production and particularly use of ripening chemicals in accelerating fruit ripening. The socio-economic status of the different stakeholders in the mango business also merits investigation. In Bangladesh, some studies on postharvest behavior of mango have been conducted by several researchers (Absar et al., 1993; Hassan et al., 1998; and Sarder et al., 1998). But little information on existing pre- and postharvest practices of mango in Bangladesh. Therefore, the present study was undertaken to collect information about the existing pre- and postharvest practices of mango in Bangladesh.

II. Materials and Methods

An extensive survey was conducted at four levels of the mango supply chain, and the levels were growers, 'Bepari', wholesalers, and retailers. Growers of Sadar, Shibganj, Bholahat and Gomostapur of Chapai Nowabgonj Districts and Bhaga and Charghat of Rajshahi District were the population for in the present study. Names of the mango growers from major-growing block of each Upazila of the two districts were listed. Then 25 growers (sample) from the population were randomly selected for interviews. A total of 150 growers were interviewed. During the data collection from the 'Bepari', 25 mangoes 'Bepari' were randomly selected from each of the local assemble markets of Chapai Nowabgonj Sadar, Shibganj; and Gomostapur, Puthia in Chapai Nowabgonj and Rajshahi district, respectively. A total of 100 'Bepari' were interviewed. The wholesalers were randomly selected from Karwan Bazar and Badamtoli wholesale markets of Dhaka, Notun Bazar and Machoua Bazar of Mymensingh Sadar, and Charghat Bazar of Charghat Upazila, Rajshahi. A total of 100 wholesalers were interviewed. The retailers were randomly selected from Natun Bazar, Machoua Bazar and Charpara of Mymensingh Sadar, Sadarghat and Sutrapur of Dhaka, and Shaheb Bazar of Rajshahi district. A total of 100 retailers were interviewed. To collect information that is relevant to the present survey, four sets of interview schedules were prepared to keep the objectives of the research in mind. Four sets of interview schedules were designed for growers, 'Bepari', wholesalers, and retailers. The interview schedules were pre-tested in actual field conditions/situations, and necessary corrections, modifications and alternations were made before finally printing the schedules. The respondents' opinions were transformed into a master sheet to facilitate tabulation. Tabulation and computation were done based on categories developed. Qualitative data were converted into quantitative ones using suitable scoring (if required). For describing the collected information, categories were developed in relation to each of the selected respondents to have a better understanding of the characteristics of the growers, intermediaries and consumers. The data collected from the respondents were compiled, tabulated and analyzed in accordance with the objectives of the study.

III. Results and Discussion

Grower

In our country, growers' individual characters play an important role in the production and subsequent operations. The major results in relation to the individual are briefly discussed below.

Age: The age of mango growers ranged from 15 to above 50 years. According to the age, the growers were classified into four categories. In Chapai Nowabgonj and Rajshahi Districts, maximum mango

growers (44-72%) had an age range of 35-50 years (Table 01, Table 02). This was probably because the younger generation (<35 years) are more interested to be involved in other occupation like working abroad.

Education: Mango growers of the six Upazilas of Chapai Nowabgonj and Rajshahi were classified into six categories on the basis of their levels of education. Only 0-16% of the mango growers had higher education like graduation. By contrast, 20-36 and 8-36% of the mango growers were illiterate and can sign only, respectively (Table 03).

Table 01. Age of mango growers in four Upazilas of Chapai Nowabgonj District

Category of age (years)	C. N Sadar (n=25)	Shibganj (n=25)	Bholahat (n=25)	Gomostapur (n=25)
	%	%	%	%
15 to <25	0	8	0	0
25 to <35	16	16	20	20
35-50	44	72	52	64
>50	40	4	28	16
Total	100	100	100	100

C. N (Chapai Nowabgonj)

Table 02. Age of mango growers in two Upazilas of Rajshahi District

Category of age (years)	Bahga (n=25)	Charghat (n=25)
	%	%
25 to <35	32	8
35-50	60	64
>50	8	28
Total	100	100

These lower levels of education in the surveyed upazilas would possibly due to the fact that these upazilas are mostly mango growing areas, and people do not show much interest to educate them rather than involve in income generating activities like growing mangos or engage in mango trades.

Duration of mango cultivation: Results showed that 40-72% of the growers were involved in mango production for above 15 years, and only 12-48% of the growers for 10-15 years (Table 04). These results suggest that the majority of the growers started their occupation as mango growers from the very beginning of their life.

Land holdings: The total land possessed by the growers ranged from 0.02 to 3 ha. The land holdings were classified following the method of classification published by the Manual of Agriculture Extension Department (DAE, 1999). The categories of the farmers on the basis of occupied land were: marginal (0.02-0.2 ha), small (0.21-1 ha), medium (1.01-3 ha), and large (>3 ha). The landholding patterns of the growers are summarized in Table 05 and Table 06. Maximum growers (16-48%) of the surveyed area of Chapai Nowabgonj and Rajshahi were small followed by large (16-64%). However, all four categories of growers were found in the surveyed area (Table 05, Table 06). In the surveyed upazilas of Chapai Nowabgonj and Rajshahi, 16-48% of the growers utilized 0.21 to 1 ha of land for mango production followed by land more than 3 ha (20-60%). 20-40% of the mango growers of both districts had leased land. The percentages of leased lands under mango cultivation are shown in Table 07.

Modern cultivation techniques

Use of manures and fertilizers: Range of manures and fertilizers were used by the mango growers (Table 08). It was found that 100% of the growers of both districts used manures and fertilizer for the production of mango. Here it is found that use of organic manure is lower than inorganic fertilizer. It may be due to less population of cattle of the farmers and higher price of organic manure.

Use of plant growth regulators: The interviewed growers were found to apply growth regulators to get a higher yield of mango. The rates of application varied from 10-15 mL/10-16 L of water (Table 09). Maximum growers of the surveyed area applied growth regulators from the stage of flowering to

the entire harvesting season (60-92%). The use of plant growth regulators is highest in Chapai Nowabgonj Sadar (92%) and lowest in Bholahat (60%). The growth regulators used by the growers were Planofix, Biogreen, Okozim, Bioferty, Litocin, and Voxal Super.

Table 03. Levels of education of mango growers in Chapai Nowabgonj and Rajshahi District

District/Upazila	Level of education						Total	
	Illiterate	Signature	Class I to <V	Class V to <SSC	S.S.C to <Graduation	Graduation		
Chapai Nowabgonj (n=25 in each location)								
C. N Sadar	%	36	28	4	8	20	4	100
Shibganj	%	28	8	8	20	20	16	100
Bholahat	%	20	20	4	24	24	8	100
Gomostapur	%	20	36	0	16	16	0	100
Rajshahi (n=25 in each location)								
Bagha	%	20	16	0	48	16	8	100
Charghat	%	32	16	24	16	12	0	100

Table 04. Duration of mango cultivation in Chapai Nowabgonj and Rajshahi Districts

District/Upazila	Duration of mango production				
	1-<5 Y	5-<10 Y	10-<15 Y	>15 Y	
Chapai Nowabgonj (n=25 in each location)					
C. N Sadar	%	4	28	28	40
Shibganj	%	4	28	12	56
Bholahat	%	0	12	16	72
Gomostapur	%	0	8	24	68
Rajshahi (n=25 in each location)					
Charghat	%	0	28	24	48
Bagha	%	0	8	48	44

Table 05. Categories of landholdings of mango growers

District/Upazila	Categories of landholdings (ha) of growers				
	Marginal (0.02-0.2)	Small (0.21-1)	Medium (1.01-3)	Large (>3)	
Chapai Nowabgonj (n=25 in each location)					
C. N Sadar	%	16	40	28	16
Shibganj	%	12	28	24	36
Bholahat	%	16	40	20	24
Gomostapur	%	8	16	12	64
Rajshahi (n=25 in each location)					
Charghat	%	8	48	28	16
Bagha	%	0	36	44	20

Table 06. Land areas of growers under mango cultivation

District/Upazila	Categories of landholdings (ha)				
	Marginal (0.02-0.2)	Small (0.21-1)	Medium (1.01-3)	Large (>3)	
Chapai Nowabgonj (n=25 in each location)					
C. Sadar	%	20	28	16	36
Shibganj	%	16	48	12	24
Bholahat	%	20	48	12	20
Gomostapur	%	8	16	16	60
Rajshahi (n=25 in each location)					
Charghat	%	12	40	28	20
Bagha	%	16	24	32	28

Table 07. Percentage of land taken as lease by mango growers

District/Upazila	Mango grower	
	Yes	No
Chapai Nowabgonj (n=25 in each location)		
C. N Sadar	%	20
Shibganj	%	24
Bholahat	%	20
Gomostapur	%	40
Rajshahi (n=25 in each location)		
Charghat	%	20
Bagha	%	24

Use of pesticide: It was found that out of six upazilas 100% growers of mango of Chapai Nowabgonj and Rajshahi use insecticide and fungicide to control the insects and diseases of mango which cause increasing the cost of production. Growers apply insecticides and pesticides at the rate of 10-15 mL/16-20 L starting from flowering to harvesting. Spray dose sometimes exceeds the recommended dose. However, some growers (4-48%) were found to use the sex pheromone trap to control fruit fly (Table 10).

Table 08. Manures and fertilizers used by the mango growers of Chapai Nowabgonj and Rajshahi District

District/Upazila		Organic manures and inorganic fertilizers									
		CD	MOC	Urea	TSP	MoP	ZnSO ₄	Gypsum	DAP	Boron	*Others
Chapai Nowabgonj (n=25 in each location)											
C. N Sadar	%	64	0	92	84	88	12	20	20	8	0
Shibganj	%	52	20	96	92	92	32	12	40	32	28
Bholahat	%	44	0	88	8	76	12	48	4	0	4
Gomostapur	%	56	0	60	64	64	12	0	32	0	12
Rajshahi (n=25 in each location)											
Charghat	%	32	0	100	80	96	4	0	4	8	8
Bagha	%	28	0	92	92	92	8	16	0	0	4

*Others (Farm Yard Manure, Bone meal, Sulfo organic, water hyacinth); CD (Cowdung), MOC (Mustard Oil Cake), TSP (Triple Super Phosphate), MoP (Muriate of Potash), DAP (Diammonium Phosphate), ZnSO₄ (Zinc Sulphate); Due to duplication and overlapping sources exceed 25

Table 09. Use of plant growth regulators by the mango growers

District/Upazila	Yes	No
Chapai Nowabgonj (n=25 in each location)		
C. N Sadar	%	92
Shibganj	%	60
Bholahat	%	60
Bagha	%	68
Rajshahi (n=25 in each location)		
Charghat	%	72
Gomostapur	%	76

Insects of mango: The most serious insect of mango was mango hopper (48-100%). Hopper attack is higher in Gomostapur (100%) and lowest in Bagha (48%). Fruit fly also found as a serious pest of mango (37-84%), highest in Bholahat 84% and lowest in Bagha 37% (Table 11). Now a day the stem borer also seems as an important pest of mango. These findings are supported by (Hassan, 2010a).

Diseases of mango: Now a days the most dangerous disease of mango is dieback (60-92)% followed by gummosis (32-52)% in the both two surveyed districts (Table 12). The highest dieback infected area was Chapai Nowabgonj (92%) and Gomostapur (92%). The highest gummosis infected area was Bagha (72%) and the lowest infected area was Charghat (32%).

Table 10. Pesticides used by mango growers in Chapai Nowabgonj and Rajshahi

District/Upazila		Yes	No
Chapai Nowabgonj (n=25 in each location)			
C. N Sadar	%	100	0
Shibganj	%	100	0
Bholahat	%	100	0
Gomostapur	%	100	0
Rajshahi (n=25 in each location)			
Charghat	%	100	0
Bagha	%	100	0

Table 11. Commonly found insects of mango

District/Upazila		Mango Hopper	Mango Weevil	Fruit fly	Stem borer	Mango defoliator	Others*
Chapai Nowabgonj (n=25 in each location)							
C. N Sadar	%	60	12	76	48	20	4
Shibganj	%	72	56	80	36	0	4
Bholahat	%	72	12	84	64	0	4
Bagha	%	48	4	37	36	16	0
Rajshahi (n=25 in each location)							
Charghat	%	64	16	80	20	8	0
Gomostapur	%	100	68	40	40	16	0

*Others (Leaf cutting weevil, Mosquito). Due to duplication and overlapping sources exceed 25

Table 12. Commonly found diseases of mango in Chapai Nowabgonj and Rajshahi

District/Upazila		Dieback	Gummosis	Gall	Anthracnose	Powdery mildew
Chapai Nowabgonj (n=25 in each location)						
C. N Sadar	%	92	68	12	20	44
Shibganj	%	80	36	8	36	36
Bholahat	%	88	48	16	20	0
Gomostapur	%	92	56	6	56	8
Rajshahi (n=25 in each location)						
Bagha	%	68	72	4	12	20
Charghat	%	60	32	8	28	12

N.B Due to duplication and overlapping sources exceed 25

Use of ripening chemicals: Results showed that 4-16% of the respondents were involved in mango ripening in the respective Upazilas of Chapai Nowabgonj and Rajshahi districts respectively by using chemicals like Calcium carbide, Ripen, Ethrel. Others sold mangoes to the intermediaries at the mature unripe stage (Table 13 and Table 14). These findings are in contrast with (Hassan, 2010b).

Methods of ripening: In case of chemical ripening Calcium carbide is used by the mango growers (4-20%) followed by Ripen (0-12)% and Ethrel (0-12)%. 4-32% growers use straw in traditional ripening and 60-92% sale unripe mature mango (Table 14).

Table 13. Use of ripening chemicals by the mango growers in Chapai Nowabgonj and Rajshahi

District/Upazila		Yes	No
Chapai Nowabgonj (n=25 in each location)			
C. N Sadar	%	8	92
Shibganj	%	4	96
Bholahat	%	8	92
Gomostapur	%	16	84
Rajshahi (n=25 in each location)			
Bagha	%	16	84
Chargaht	%	16	84

Table 14. Methods of ripening of mango in Chapai Nowabgonj and Rajshahi

District/ Upazila	Chemical ripening			Traditional ripening		
	Ripen	Calcium carbide	Ethrel	Straw cover	Sale mature hard mango	
Chapai Nowabgonj (n=25 in each location)						
C. N Sadar	%	0	8	0	4	88
Shibganj	%	4	0	12	32	72
Bholahat	%	0	20	4	16	60
Gomostapur	%	8	8	0	32	56
Rajshahi (n=25 in each location)						
Bagha	%	4	0	4	12	92
Chargaht	%	12	4	0	20	68

NB. Due to duplication and overlapping sources exceed 25

Buyers of mango from the growers: Maximum growers (84-100%) sold their mango at a mature green stage to the 'Bepari'. Few growers sold to the Faria (0-12%) (Table 15). Growers do not sale mango to the retailer.

Table 15. Buyers of mango fruits from the growers

District/Upazila	Buyer of mango				
	Faria	Bepari	Wholesaler	Consumer	
Chapai Nowabgonj (n=25 in each location)					
C. N Sadar	%	0	88	0	12
Shibganj	%	8	100	10	0
Bholahat	%	4	100	0	0
Gomostapur	%	12	84	8	4
Rajshahi (n=25 in each location)					
Bagha	%	4	92	0	4
Chargaht	%	0	92	12	8

NB. Due to duplication and overlapping sources exceed 25

'Bepari'

The 'Bepari' of mango plays an enormous role in mango marketing. The survey on 'Bepari' was done in different marketing locations such as Puratan Bazar of Chapai Nowabgonj Sadar, Kansat of Shibganj, Rohonpur Station Bazar of Gomostapur in Chapai Nowabgonj District, Banashor Bazar of Puthia in Rajshahi District. The major results in relation to the individual characteristics of the 'Bepari' are briefly discussed below.

Age: The age of the mango 'Bepari' ranged from 15 to above 50 years. Based on the age of the 'Bepari' were classified into four categories. Around 36-68% of 'Bepari' was 35-50 years old as shown in Table 16.

Table 16. Age of mango 'Bepari'

Category of age (years)	Chapai Nowabgonj (n=25 in each location)			Rajshahi (n=25 in each location)
	C. N Sadar (%)	Gomostapur (%)	Kansat (%)	Banashor Bazar (%)
15 to <25	4	0	0	0
25 to <35	32	12	16	16
35-50	36	76	68	68
>50	24	12	16	16
Total	100	100	100	100

Education: Mango growers of the four Upazilas of Chapai Nowabgonj and Rajshahi were classified into five categories based on the level of education. Only 4-16% of the mango 'Bepari' had higher education. Besides that, 4-32% growers were from Class I to less than V, 20-36% growers were from Class V to less than S.S.C in both Districts of Chapai Nowabgonj and Rajshahi (Table 17). Here it was also found that illiterate 'Bepari' was less. This may be due to the profit from the mango business 'Bepari' needs to have a minimum level of education. Besides that, education would help to minimize the postharvest loss of mango.

Place of purchase of mango: ‘Bepari’ purchase produce both from the assemble markets or from the growers’ at field. The present study revealed that the maximum ‘Bepari’ purchased mango from the growers’ field 36-84% and 16-64% purchase from the assemble markets (Table 18).

Table 17. Education level of mango ‘Bepari’ in three Upazilas of Chapai Nowabgonj and one upazila of Rajshahi district

District/Upazila		Level of education					Total	
		Illiterate	Signature	Class I to <V	Class V to <SSC	S.S.C to <Graduation		Graduation
Chapai Nowabgonj (<i>n=25 in each location</i>)								
C. N Sadar	%	12	32	20	28	4	4	100
Gomastapur	%	16	28	4	36	16	0	100
Kansat	%	24	32	8	28	8	0	100
Rajshahi (<i>n=25</i>)								
Banashor Bazar	%	12	32	32	20	4	0	100

Types of packaging materials used for mango: Different types of packaging materials are used during transport of mango, namely plastic crates and bamboo baskets. Now-a-days, the ‘Bepari’ of mango are interested to use the plastic crates through which the loss is minimized. This is also economic and reusable as compared to those of bamboo baskets. It was found that 16-44% ‘Bepari’ used plastic crates and 72-84% ‘Bepari’ used bamboo baskets as packaging material (Table 19).

Grading of mango: 12-36% ‘Bepari’ graded mangoes. However, 64-80% ‘Bepari’ did not grade their mangoes (Table 20).

Mode of transport of mango from the growers’ field to the market: Mangoes are transported from growers’ field to the local assemble markets and to the destination markets through rickshaw, van, cycle and truck. Truck (84-100%) was found to be the main transport vehicle to carry produce from the place of purchase to the destination markets (Table 21). No ‘Bepari’ was found to use a refrigerated covered van to carry perishables despite the fact that refrigerated van is used to carry perishables in developed countries, and many of our neighboring countries. Measures to be taken so that refrigerated covered van could be introduced into our marketing channel to reduce huge postharvest loss and maintain the quality of perishables.

Table 18. Place of purchase of mango fruits by the ‘Bepari’

Purchase place	Chapai Nowabgonj (<i>n=25 in each location</i>)						Rajshahi (<i>n=25</i>)	
	C. N Sadar		Gomastapur		Kansat		Banashor Bazar	
	Growers’ field	Assemble market	Growers’ field	Assemble market	Growers’ field	Assemble market	Growers’ field	Assemble market
%	64	36	52	48	84	16	36	64

*G. field means growers field

Measures taken to reduce transport damage: ‘Bepari’ (100%) used various leaves to reduce damage during transport to distant markets (Table 22). 24-88% ‘Bepari’ used straw to reduce postharvest loss during transport from one place to another place (market). 12-56% of the ‘Bepari’ used paper during packaging of mango. Straw was found better than paper in respect of the reduction of postharvest loss.

Table 19. Types of packaging materials used by ‘Bepari’

Category	District/Upazila			
	Chapai Nowabgonj (<i>n=25 in each location</i>)			Rajshahi (<i>n=25</i>)
	C. N Sadar	Gomastapur	Kansat	Banashor Bazar
None	12	16	28	8
Plastic crates	40	16	44	24
Bamboo basket	76	84	80	72

NB. Due to duplication and overlapping sources exceed 25

Table 20. Grading of mango fruits by the 'Bepari'

Category	District/Upazila			
	Chapai Nowabgonj (<i>n=25 in each location</i>)			Rajshahi (<i>n=25</i>)
	C. N Sadar	Gomastapur	Kansat	Banashor Bazar
Grading	12	20	20	36
No grading	88	80	80	64

Use of ripening chemicals by the 'Bepari': Results showed that 4-12% of the 'Bepari' used ethylene and 4-16% used calcium carbide for rapid mango ripening. Though the 'Bepari' knew that the uses of ripening chemicals are harmful to human health but they use for getting more profit (Table 23). 80-92% 'Bepari' did not use ripening chemicals. These findings corroborate with the findings of other researches by (Hassan, 2010c).

Mode of transport to destination markets: Most of the 'Bepari' of the surveyed area used truck as a long-distance transport vehicle (84-100%) in the surveyed area of Chapai Nowabgonj and Rajshahi Districts. Less number of 'Bepari' used the bus as transport vehicle (4-16%). No 'Bepari' used air-conditioned van for transport of mango (Table 24).

Buyers of mango from the 'Bepari': From 'Bepari', maximum buyers were the wholesalers (80-88%). Some retailers (20-68%) also purchased mango from the 'Bepari' (Table 25).

Table 21. Mode of transportation used by 'Bepari' to carry fruits from the growers' field to the assemble markets

Mode of transport	Districts/Upazila			
	Chapai Nowabgonj (<i>n=25 in each location</i>)			Rajshahi (<i>n=25</i>)
	C. N Sadar (%)	Gomostapur (%)	Kansat (%)	Banashor Bazar (%)
Rickshaw	12	16	0	0
Van	40	92	20	36
Truck	52	0	92	72
Bus	0	0	4	0

Table 22. Precautionary measures taken to reduce damage during transport

Packaging materials	District/Upazila			
	Chapai Nowabgonj (<i>n=25</i>)			Rajshahi (<i>n=25</i>)
	C. N Sadar (%)	Gomostapur (%)	Kansat (%)	Banashor Bazar (%)
Paper	12	56	12	20
Straw	24	36	88	80
Cloths	0	4	0	0

NB. Due to duplication and overlapping sources exceed 25

Table 23. Use of ripening chemicals by the 'Bepari'

Category	Districts/Upazila			
	Chapai Nowabgonj (<i>n=25 in each location</i>)			Rajshahi (<i>n=25</i>)
	C. N Sadar (%)	Gomostapur (%)	Kansat (%)	Banashor Bazar (%)
None	80	88	92	80
Ethylene	12	8	4	4
Calcium carbide	8	4	4	16

Table 24. Mode of transport to the destination markets

Mode of transport	District/Upazila			
	Chapai Nowabgonj (<i>n=25 in each location</i>)			Rajshahi (<i>n=25</i>)
	C. N Sadar (%)	Gomostapur (%)	Kansat (%)	Banashor Bazar (%)
Truck	84	92	100	88
Bus	16	8	4	12

Table 25. Buyers of mango from the 'Bepari'

Category	Chapai Nowabgonj (<i>n</i> =25 in each location)			Rajshahi (<i>n</i> =25)
	C. N Sadar (%)	Gomostapur (%)	Kansat (%)	Banashor Bazar (%)
Wholesalers	80	88	92	80
Retailers	20	68	52	20
Local assemble markets	24	0	0	8
Consumers	4	4	16	4

NB. Due to duplication and overlapping sources exceed 25

Wholesalers

Age: The age of the wholesalers ranged from 15 to above 50 years. Based on the age of the wholesalers were classified into four categories. Around 30-44% of the wholesaler was of 35-50 years of age (Table 26).

Education: The mango wholesalers were classified into five categories. It was found that 8-24% of the wholesalers of mango had primary to secondary education. On the other hand, 20-60% of the wholesalers were illiterate (Table 27). Results suggest that the wholesalers had a reasonable level of education. Around one-third of the wholesalers were illiterate.

Sources of mango: Maximum wholesalers (80-96%) purchase mango from the 'Bepari'; 12-20% from the growers (Table 28).

Mode of transport to the storehouse: 56-72% of wholesalers used trucks for transport. Some wholesalers also used van 40-56%. There were no refrigerated transport facilities (Table 29).

Table 26. Age of mango wholesalers

Category	Dhaka (<i>n</i> =25 in each location)		Rajshahi (<i>n</i> =25 in each location)
	Badamtoli (%)	Karwan Bazar (%)	Charghat (%)
15 to <25	20	0	8
25 to <35	20	28	32
35-50	40	30	44
>50	20	12	8
Total	100	100	100

NB. Due to duplication and overlapping sources exceed 25

Table 27. Level of education of mango wholesalers

Wholesale market	Level of education					Total	
	Illiterate	Can sign only	Class I to <V	Class V to <SSC	S.S.C to <Graduation		
Dhaka							
Badamtoli (<i>n</i> =25)	%	20	20	12	24	24	100
Karwan Bazar (<i>n</i> =50)	%	60	24	16	0	0	100
Rajshahi							
Charghat (<i>n</i> =25)	%	28	16	40	8	8	100

Table 28. Sources of getting mango

Category	Dhaka (<i>n</i> =25 in each location)		Rajshahi (<i>n</i> =25 in each location)
	Badamtoli (%)	Karwan Bazar (%)	Charghat (%)
'Bepari'	88	80	96
Grower	12	16	20
'Faria'	8	10	12

NB. Due to duplication and overlapping sources exit 25

Use of ripening chemicals by the wholesalers: 92-100% wholesalers were not involved with mango ripening. Only a negligible percentage of wholesalers used ripening chemicals (Table 30).

Table 29. Mode of transport to storehouse

Category	Dhaka (n=25 in each location)		Rajshahi (n=25 in each location)
	Badamtoli (%)	Karwan Bazar (%)	Charghat (%)
Truck	64	72	56
Bus	8	8	24
Boat	4	0	0
Van	40	56	40
Pushcart	8	16	4

NB. Due to duplication and overlapping sources exceed 25

Table 30. Use of ripening chemicals by the wholesalers

Category	Dhaka (n=25 in each location)		Rajshahi (n=25 in each location)
	Badamtoli (%)	Karwan Bazar (%)	Charghat (%)
None	100	94	92
Ethylene	0	2	4
Calcium carbide	0	4	4

Buyer of mango from the wholesalers: 94-96% retailers and 12-24% consumers are the buyer of mango from the wholesalers (Table 31).

Table 31. Buyer of mango from the wholesalers

Category	Dhaka (n=25 in each location)		Rajshahi (n=25 in each location)
	Badamtoli (%)	Karwan Bazar (%)	Charghat (%)
Retailers	96	94	96
Consumers	12	24	12

NB. Due to duplication and overlapping sources exceed 25

Retailers

Age: The age of the mango retailers was ranged from 15 to above 50 years among the four retail markets of mango. Based on the age of the retailers were classified into four categories. 32-48% of retailers were 25-35 years and 12-36% of retailers were 35 to 50 years old (Table 32).

Table 32. Age of the retailers

Category of age (years)	C. N Sadar	Mymensingh Sadar	Dhaka	Rajshahi Sadar
	%	%	%	%
15 to <25	12	16	8	12
25 to <35	32	48	40	36
35-50	36	28	32	12
>50	20	8	20	8
Total	100	100	100	100

n=25 for each location

Education: 16-60% of the mango retailers had an education level of class V to < S.S.C. On the other hand, a considerable proportion (12-28%) of the retailers was illiterate (Table 33). It was also found that no graduate retailers' presence in the surveyed retail markets.

Sources of mango: 47-68.75% of retailers collect mango from a wholesaler and 25-30.77% was collect mango from 'Bepari' for their business (Table 34). Some retailers of Chapai Nowabgonj and Rajshahi collect mango from the growers' field as these two districts are the major mango growing area of Bangladesh. Thus, mango can be collected from the growers' field at a lower rate compared to the 'Bepari' and wholesalers.

Mode of transport from wholesalers to retail markets: 32-46% retailers used van for transport to their destination market. 13-34% of retailers use the truck to carry the mango to their desired destination (Table 35).

Table 33. Education level of mango retailers

Upazila		Illiterate	Signature	Class I to <V	Class V to <SSC	S.S.C to <Graduation	Total
C. N Sadar (New market)	%	12	20	4	60	4	100
Mymensingh Sadar (Notun, Machua Bazar and Charpara)	%	28	20	28	20	4	100
Dhaka (Sadarghat and sutrapur)	%	16	28	40	16	0	100
Rajshahi sadar (Shaheb Bazar)	%	20	12	40	28	0	100

Table 34. Sources of getting mango

Category	C. N Sadar	Mymensingh Sadar	Dhaka	Rajshahi Sadar
	%	%	%	%
Wholesaler	47	68.75	64.10	46.88
'Bepari'	28	25	30.77	28.13
Grower	19	6.25	2.56	25
Faria	3	0	2.56	0

NB. Due to duplication and overlapping sources exceed 25, n=25 in each location

Table 35. Mode of transport used by the retailers to carry mango

Category	C. N Sadar	Mymensingh Sadar	Dhaka	Rajshahi Sadar
	%	%	%	%
Truck	32	27	34	13
Head load	7	0	6	10
Bus	4	6	0	6
Pushcart	4	0	3	0
Van	46	36	43	32
Bicycle	7	0	0	19
Rickshaw	0	30	14	19

NB. Due to duplication and overlapping sources exceed 25, n=25 in each location

Buyers of mango of retailers: All retailers (100%) sold their mango to the consumers (Table 36).

Table 36. Buyers of mango of retailers

Category	C. N Sadar	Mymensingh Sadar	Dhaka	Rajshahi Sadar
	%	%	%	%
Consumers	100	100	100	100

n=25 in each location

Sale and purchase prices of mango at different levels of marketing: The sale and purchase prices of mangoes at different levels of mango supply chain are summarized in Table 37. The growers' sale price of Fazli, Langra, Gopalbhog, and Khirshapat were 43.91, 40.39, 40.44, and 40.15 Tk./Kg which sharply increased to 62.74, 57.37, 57.62, and 62.72 Tk./Kg, respectively at the retail level. The price increase of mango was 45.83% in the supply chain before reaching the consumers. The profit margin of 'Bepari', wholesaler, and retailer level was 7.51%, 12.84%, and 16.06%, respectively.

Table 37. Sale and purchase prices of mango at different levels of marketing

Respondent	Average purchase price (Tk/Kg)					Average sale price (Tk/Kg)				
	Fazli	Langra	Gopal bhog	Khirshapat	Mean	Fazli	Langra	Gopal bhog	Khirshapat	Mean
Grower	-	-	-	-	-	43.91	40.39	40.44	40.15	41.22
'Bepari'	45.23	42.35	41.43	41.13	42.53	47.13	48.56	43.78	43.55	45.75
Wholesaler	47.75	49.10	43.86	44.03	46.18	48.44	52.08	51.62	56.33	52.11
Retailer	50.29	51.80	52.19	52.88	51.79	62.74	57.37	57.62	62.72	60.11

IV. Conclusion

Preharvest and postharvest practices and procedures have a significant effect on the quality and postharvest loss (210158 metric tons) of mango (Hassan, 2010 d). The supply chain rarely follows the pre- and postharvest standard procedures in Bangladesh. According to (Shewfelt et al., 2000) the weakest link in the pre- and postharvest handling distribution chain of fresh fruits in the home handling system; the greatest potential for improvement includes the development of more sophisticated home handling equivalent and transfer of handling knowledge to the consumer. The stakeholders of the supply chain should make aware of the basic principles of fruit handling and storage. Besides that, the government should provide fundamental infrastructures like storage, handling, grading, packing, transport, marketing facilities and technical knowhow. Therefore, further research and development on pre- and postharvest handling of mango is required to reduce the huge amount of postharvest loss and ensure the quality of produce.

Conflict of interest

The authors declare that they have no conflict of interest.

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