A BASELINE SURVEY ON MANGO SUPPLY CHAIN IN SELECTED AREAS OF BANGLADESH

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A BASELINE SURVEY ON MANGO SUPPLY CHAINS IN SELECTED AREAS OF BANGLADESH

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Abstract

A lot of mangoes are spoiled every year due to the lack of proper pre- and postharvest measures and inefficient supply chain. Sufficient data and information on these issues are lacking in Bangladesh. Therefore, the study assessed the knowledge, attitude and practices (KAP) of key actors in mango supply chains and the status of market opportunities in Bangladesh. A total of 98 respondents taking 30 growers, 53 traders and 15 consumers were interviewed from Chapai Nawabganj and Dhaka districts. The results revealed that all growers (100%) and traders (97-100%) showed positive attitudes towards crop maturity, safe mango, and role of good packaging, and took various pre- and postharvest measures for keeping mangoes safe for the consumers. The estimated average postharvest losses were 14.11% and 9.61% at farm and traders' level respectively. At farm level, these losses occurred during harvesting, sorting & grading, and transportation. Harvesting losses were due to cracking, bruising, compression, and disease and insect damage. The highest loss was recorded at retail level (4.64%) followed by *Bepari* (3.95%). This study identified eight supply chains for mango marketing. The longest and prominent channel was *Farmer>Bepari>Urban Arathdar>Urban Retailer>Urban Consumer*. Farmers and *Farias* used different local carriers, whereas trucks and pick up van were used by *Bepari* to transport mango from assemble markets to urban wholesale markets. *Faria* received the highest net margin (Tk.8,068/ton) due to lower marketing cost and spoilage followed by retailer (Tk. 6,601/ton) and *Bepari* (Tk.5,394/ton). Major marketing problems in the supply chain are delayed sale and lack of buyers. Both farmers and traders suggested various measures to reduce postharvest losses and keep mangoes safe for the consumers.

Key words: Mango, supply chain, postharvest loss, food safety, food quality, postharvest handling

1. INTRODUCTION

Fruits have been recognized as good source of vitamins (vitamin C and A), minerals, and many nutrients. The fruit nutrients are vital for maintaining good health. They are naturally low in calories, fat, sodium, and cholesterol. Fruits are rich in fiber, which is essential for the smooth movement of food in the body's digestive system. It can reduce the risk of many illnesses, including heart disease and stroke (www.healthyeating.org/Healthy-Eating). The per capita consumption of fruits in Bangladesh is 44.8 gm. However, sharp increase (58.02%) was taken place in the per capita consumption of fruits in the country over the period from 2000 to 2010 (HIES, 2010).

Mango (*Mangifera indica*) is one of the important fruits of Bangladesh. It occupies a total area of land 30.80 thousand hectares with a total production of 956.87 thousand tons having an average yield of 31.07 ton/ha (BBS, 2013). In the last couple of years, mango production is increasing due to the introduction of improved varieties and production techniques as well as increased market demand (Fig 1). The area and production of mango are increasing at the rate of 1.5% and 5.3% respectively.

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Fig 1. Area, production and yield of mango, 2005-2014
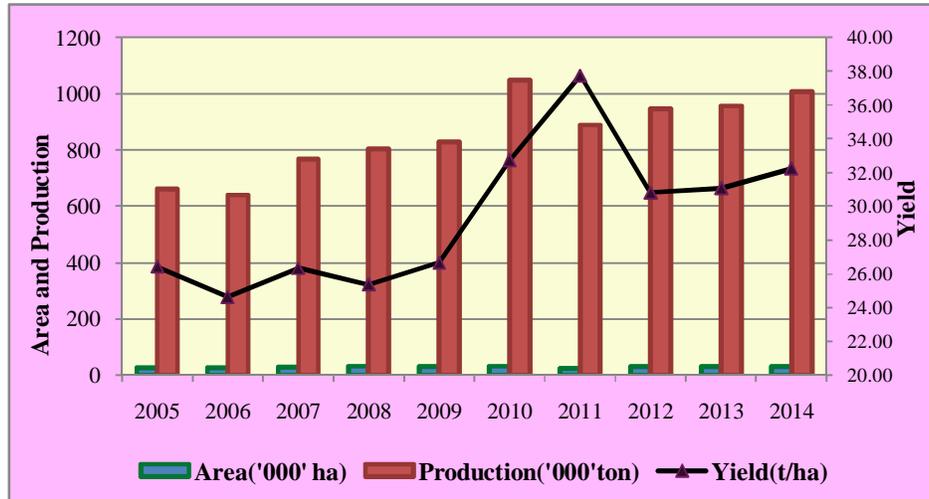
There are some intensive mango growing districts in Bangladesh, where mangoes are produced commercially and marketed in other areas of the country. Therefore, mango needs to be transported to a long distance to reach the ultimate consumers under the prevailing marketing system. Mangoes are bulky and perishable in nature and maintaining cool chain is not always possible due to higher cost involvement. In the peak season, there is an excess supply creating a glut in the market and causing a fall in the price and affecting the incomes of the farmers. However, both pre-harvest and postharvest factors are responsible for the postharvest losses of mango. A huge amount of mangoes are damaged every year due to their perishability, seasonality, bulkiness, poor infrastructure, and poor pre- and postharvest practices in Bangladesh that need to be taken into consideration. Due to absence of efficient marketing facilities, farmers are forced to sell their mangoes at lower price. Besides, improper use of pesticides by the producers and application of various chemical agents for force ripening of mango are causing problems for human health and the environment. Therefore, the knowledge of postharvest management of fruits is very much important at producers' and various stakeholders' levels in reducing postharvest losses and ensuring food safety for the consumers.

Efficient marketing plays a crucial role not only in stimulating production, but also in accelerating the pace of economic development. Efficient marketing system usually ensures higher producer's share, reducing the number of middlemen in the supply chain, and restricting the marketing charges and mal-practices during marketing of farm products (Matin et al., 2008). It is, therefore, essential to study the existing supply chain of mango in order to suggest suitable channel for the producers, appropriate technology for postharvest handling, and proper safety measures for the key stakeholders of the supply chain to ensure food quality and safety for the consumers.

The study was conducted with the view to develop capacity to Reduce Postharvest Losses in Horticultural Chains in SAARC countries to promote, support and implement good practices in order to minimize postharvest losses and improve quality and safety in horticultural supply chains. Therefore, the study was conducted with the following objectives:

1. To assess the knowledge, attitude and practices (KAP) of key stakeholders (producers, traders and consumers) toward food safety, food quality, postharvest handling, and postharvest losses in mango supply chains.

2. To assess the status of market opportunities through analysing supply chain for mango in Bangladesh.

2. REVIEW OF LITERATURE

Postharvest management knowledge for mango is very important at producers' and various stakeholders' levels for reducing postharvest losses and ensuring food safety for the consumers. But, there have been very few systematic attempts to assess the knowledge, attitude and practices (KAP) of key stakeholders (producers, traders and consumers) toward food safety, food quality, postharvest handling, and postharvest losses in mango supply chains. In the past, a number of studies were conducted on mango marketing, but did not reflect the real situation. Some of the related studies conducted at home and abroad have been reviewed and shown in the sub-sequent paragraphs.

The highest postharvest losses were occurred in mango because of its high perishability and climacteric pattern of respiration. There are several types of fungi like *Colletotrium gloeosporoides* and *Botryodiplodia theobromae* attack mango fruits at immature stage and remains quiescence until ripening. These fungi cause infection during storage and transportation, and the losses due to infections are quite heavy (Hasan et al., 2010).

Postharvest losses of mangoes can vary by country, by season, and by the data collection method. Pre-harvest factors, such as insect infestation and rainfall, can have a major impact on postharvest losses. In Benin, Vayssieres et al., (2008) estimated postharvest loss of mango at 17% in early April, but in mid-June this loss was very high (70%) due to attack of fruit flies. Interviews conducted in Ethiopia reported postharvest loss of mango at 26.3% (Tadesse, 1991). In Brazil, Choudhury and Costa (2004) estimated postharvest loss of mango at the rate of 28% of the total production using survey method. In Pakistan, Mushtaq et al., (2005) estimated postharvest loss of mango at 31% using survey method, but this loss was little bit higher (36.1%) when it was measured by sampling technique in 2008 (Malik and Mazhar, 2008).

The WFLO (2010) Appropriate Postharvest Technologies Planning Project, undertaken for the Bill and Melinda Gates Foundation, measured postharvest physical and quality losses for different fruits and vegetables in four countries. It provided detailed measurements of percentage of physical losses, percentage of mechanical damage and percentage of decay losses at the farm, wholesale and retail levels. In India, the rates of physical losses (sorted and discarded) of mango were 6.5% at farm level, 7.9% at wholesale market, and 7.1% at retail market. In the case of quality losses (% of mechanical losses), the estimates were 10.5%, 7.5% and 16% at farm, wholesale and retail market levels respectively. Another type of quality losses (% of decay) were estimated at 5%, 7% and 8.5% at farm, wholesale and retail market levels respectively.

In India, Singh (1960) reported that the postharvest loss of fresh mango fruit due to microbial decay varied from 20-33%. Srinivas *et al.* (1996) estimated postharvest losses of two mango varieties 'Totapuri' and 'Alphonso' in India, where the losses were 17.9% (3.5% in orchard, 4.9% during transportation, 4.1% in storage, and 5.4% in retail level) and 14.4% (1.9% in orchard, 3.7% during transportation, 3.7% in storage and 5.3% in retail level), respectively.

Hasan et al., (2014) estimated postharvest losses of fruits and vegetables in Bangladesh ranged from 23.6 to 43.5% of total production. The total loss of mango was estimated to be 27.4% (at growers' level 4.4%, *Bepari* 8%, wholesaler 8% and retailer level 7%). This was probably due to conventional harvesting methods, ignorance of the pickers, and most importantly due to the carelessness of the pickers. Damages of mango fruits included bruises, cuts, sap burn and fruit cracking. Bruises were the major cause of mango postharvest damage at the growers (51-88%) and *Bepari* (28-100%). 24-88% *Bepari* used straw in the bamboo basket to reduce postharvest loss during transport from one place to another, whereas 12-56% of the *Bepari* used paper

during packaging of mango. The losses are due mainly to the sub-standard postharvest practices, inadequate transport, lack of storage facility, and ignorance of the stakeholders.

In Tanzania, *Msogoya and Kimaro (2011)* assessed postharvest losses and the effect of shade at wholesale market and hot water treatments on storage of mango. The effect of heat stress during the wholesale market was evaluated by storing mangoes under the sun, woven polypropylene shade and black net shade. Again, mango fruits dipped in hot water at 60°C for 10 minutes were compared with untreated ones as control. Results showed that the total postharvest loss was 43.8% with the wholesale market, transportation, and during harvest accounting for 30.6 %, 10.6% and 2.6 % of the total losses respectively. The main causes of fruit deterioration during the wholesale market stage were softening and microbial decay. Microbial decays of 7.2% and mechanical injuries of 2.0% were the major features of mango fruit deterioration during the transport and harvest stages. Storing fruits for three days under the woven polypropylene and black net shades significantly reduced fruit postharvest losses by 52.7 and 38%, respectively in comparison with fruit storage under the sun. Hot water treatment reduced the incidence of microbial decay by 85% and improved fruit total soluble solids content by 15% in comparison to untreated fruits. However, hot water treatment reduced fruit firmness and shelf life by 56.0 and 71.4%, respectively.

Matin et al., (2008) estimated the marketing cost of mango at growers' level was Tk. 133 per quintal. Among the cost items, transportation incurred the major shares, which were about 45% of the total cost. Most *Beparis* (wholesaler) purchased mango from farmers through local *Arathdar* (commission agent) and sold it to retailers through urban *Arathdar*. Their average marketing cost was Tk. 446 per quintal. *Beparis* gross margin and net margin were Tk. 1,037 and Tk.591 respectively for transacting one quintal of mango. Retailers purchased mango from *Beparis* through urban *Arathdar* and sold it to the consumers. Their gross margin and net margin were about Tk. 498 and Tk. 261 per quintal respectively.

Malik and Mazhar (2008) estimated postharvest losses in two mango varieties namely 'Sindhri' and 'Chaunsa'. Although the postharvest losses increase gradually at every stage of the supply chains, however maximum fruit loss occurs at the stage of harvest and transportation from orchard to wholesaler. The estimated postharvest losses of *Sindhri* from harvest to the retailer were 68.56%.Only 3.62% fruit remained free from any disorder at the retail end, while 96.5% fruit were affected with any one of the detailed factors. The estimated postharvest losses of *Chaunsa* from harvest to the retailer were 75.36%. The most important factor causing fruit losses at the retail level was sap contamination (50.25%) followed by physically pressed fruits (15%), bruising (13.5%), physical damage (8.5%) and diseases or disorders (5.25%).

Haque and Hossain (2001) analyzed the marketing system of major fruits such as pineapple, banana, mango, guava, jackfruit and papaya both at farmers' and intermediaries' level. Four major channels were identified in fruits marketing system among which the channel-I (*Farmer-Faria-Bepari-Arathdar-Retailer-Consumer*) was ranked first. High price gap was found between farmers and consumers level at peak harvesting period. The postharvest losses of pineapple, banana, **mango**, guava, jackfruit and papaya were 13.8, 19.9, **18.7**, 6.4, 10.9 and 21.7% respectively of total fruit transaction.

Ahmed and Islam (1989) assessed the impact of weather and market price on the production of mango instability. The popular varieties of mango namely, Gopalvog, Fazli, Langra, Khirshapti and Arshina were taken into consideration. The average cost of production was Tk. 10,532/ha including "on year" and "off year" period. Econometric analysis showed that 80% of the inter district variations in instability in mango output were accounted by January-February, March–

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April, and May-June rainfall. Market price had no significant effect on output instability. Factors associated with instability in mango production were weather, unfavorable environmental condition, attack of insects and diseases, and increasing number of aged trees.

3. METHODOLOGY

3.1 Study Area Selection

Mango is an important fruit of Bangladesh. It grows more or less every parts of the country. However, Chapai Nawabganj, an extensive mango growing district, was purposively selected for conducting the baseline survey. Again, two suitable *Upazilas* in terms of the availability of data, ease of data collection, accessibility, and logistic support from each district were selected in consultation with DAE personnel and BARI scientists for administering market and KAP survey. The selected *Upazilas* were Shibgonj and Bholahat.

3.2 Sampling Procedure

For conducting baseline survey at household and market level, a complete list of farmers cultivating mango was prepared with the help of DAE personnel. At first, a total of 30 mango farmers (15 from each *Upazila*) were selected from the list for interview by applying simple random sampling technique to collect primary data. Secondly, it was planned that a total of 75 key actors in the mango supply chain (i.e. 15 each from *Faria*, *Bepari*, retailer, *Arathdar* and consumer) will be selected and interviewed, but due to the unavailability of some key actors the actual number of sample size was 68. All the actors were randomly selected and interviewed from different assemble, wholesale, and retail markets (i.e. *Upazila*/district/Dhaka City).

3.3 Period of Study

Primary data were collected by interviewing mango farmers and traders using a structured and pre-tested interview schedule during August-September, 2015. The researcher himself along with trained enumerators collected data and information for this study.

3.4 Analytical Technique

The collected data were edited, tabulated and analyzed applying simple descriptive methods. However, marketing margins of the key actors in the mango supply chain were calculated by the following equations.

$$GM_i = PR_i - PP_i \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \text{(1)}$$

Where,
GM_i= Gross margin (Tk/ton) for i^{th} intermediary
PR_i = Price received (Tk/ton) for i^{th} intermediary
PP_i = Price paid (Tk/ton) by i^{th} intermediary

$$NM_i = GM_i - MC_i - CPL_i \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \text{(2)}$$

Where,
NM_i = Net margin (Tk/ton) for i^{th} intermediary
MC_i = Marketing cost incurred (Tk/ton) by i^{th} intermediary
CPL_i = Cost of postharvest loss incurred (Tk/ton) by i^{th} intermediary

$$CPL = Q_{cd} \times P_p + Q_{pdu} \times P_p - Q_{pds} \times 0.5P_s \dots\dots\dots\dots\dots\dots\dots\dots \text{(3)}$$

Where,

CPL $\quad$ = Cost of postharvest loss (Tk/ton)

Q_{cd} $\quad$ = Quantity damaged completely (ton)

P_p $\quad$ = Average purchase price (Tk/ton)

Q_{pdu} $\quad$ = Quantity damaged partially that could not be sold (ton)

Q_{pds} $\quad$ = Quantity damaged partially that could be sold with less price (ton)

P_s $\quad$ = Average sell price (Tk/ton)

4. RESULTS AND DISCUSSION

4.1 Knowledge, Attitudes and Practices of Key Actors of Mango Supply Chain

The key stakeholders involved in the mango supply chain are mango grower, *Faria* (petty trader or collector)*, Bepari* (wholesale trader)*, Arathdar* (commission agent), retailer, and consumer (for details, pl. see the end note). They were asked questions related to their knowledge, attitudes and practices (KAP) usually done in the production and marketing of mango. The questions were related to postharvest handling and practices of mango at farmers' and traders' level, and their safety and quality issues.

4.1.1 Status of Pre-harvest Practices at Farm Level

The quality characteristics of mango are largely determined by pre-harvest production factors, which include production location, soil type, irrigation, rootstock, shading and nutrition (Hofman 1998). Some of the pre-harvest practices done by mango growers are discussed below.

*Use of pesticides and plant growth regulators***:** The major insects of mango were reported to be mango hopper, mango weevil, fruit fly, stem borer, and mango defoliator. Again, the major diseases of mango are dieback, gummosis, gall, anthracnose, and powdery mildew. All the respondent mango growers in the study areas used different types of insecticides and fungicides to control insect pests and diseases that cause great losses of their crop. They can't imagine the production of mangoes without use of pesticides. Respondent mango growers mentioned the names of 27 types of locally available and frequently used pesticides. They applied pesticides ranged from 16-20 times per year started before flowering to harvesting (Table 1).

In the study areas, plant growth regulators (PGR) are generally used by most of the mango growers in order to increase the size of fruits. They applied PGR from the stage of flowering to entire harvesting season. The names of commonly used PGR in the study area (Chapai Nawabganj) were reported to be Biogeem, Pencogeem, Ferti, and Yield. Hassan et al., (2010) also found to use the highest level of PGR by the mango growers in Chapai Nawabganj Sadar Upazila (92%) and the lowest in Bholahat Upazila (60%).

Fig 2: PGR Biogeem

Table 1. Frequency and stages of application of pesticides and PGR in mango cultivation

Name of pesticides and PGR	No. of application (No./season)	Dose	Stages of application
Pesticides: Desis, Hira, Diathen-M, Sumitheon, Lemra, Seven powder, Fighter, Rekit, Riva, Bavistin, Niyem, Theovit, Endrofil, Sapit, Niflex, Karate, Sekim, Endrokin, Thinseen S45, Alcojeb, Tilbes, Bisolt, Ripcot, Natibo, Secure, Acecap, Tilt, etc. **PGR**: Biogeem, Pencogeem, Ferti, Yield	16-20 times	1.0 ml or gm per 1.0 liter water	Before flowering to harvesting

Perception on crop maturity: Harvesting of crops at proper stage of maturity is of great importance for attaining desirable quality. The level of maturity actually helps in selecting storage methods, estimating postharvest shelf life, selecting processing operations for value addition (Dhatt and Mahajan, 2007). Proper knowledge on crop maturity is very much important to reduce postharvest losses as well. Key stakeholders in the mango supply chain were asked to response on crop maturity and its perceived characteristics. Mango growers and traders generally identify fruit maturity through observing physical outlook and experience. All the respondents know the symptom of fruit maturity and maturity characteristics of mango. Table 2 reveals that more than 94% respondents opined that some ripe mangoes drop from the tree when mangoes are full matured. Again, 79.4% respondents mentioned that when green colour becomes yellowish, mangoes are seemed to be matured. The other characteristics of mango maturity are radish colour spread over mango (72%), floating mature mango in water (31%), and mango becomes wide on upper side.

Table 2. Farmers' idea on crop maturity and perceived characteristics of mango maturity

Quality characters	% of responses				
	Farmer *(n=30)*	Faria *(n=15)*	Bepari *(n=10)*	Retailer *(n=13)*	All *(n=68)*
A. Idea on mango maturity					
Positive response	100	100	100	100	100
Negative response	--	--	--	--	--
B. Characteristics of mango maturity					
1. Dropping some ripe mangoes	93.3	100	100	84.6	94.1
2. Colour become yellowish from green	83.3	86.7	70.0	69.2	79.4
3. Radish colour spread over mango	70.0	73.3	100.0	53.8	72.0
4. Floating mature mango in water	43.3	13.3	30.0	23.1	30.9
5. Become wide on upper side of mango	16.7	6.7	20.0	30.8	17.7
6. Others	6.7	13.3	10.0	30.8	13.2

Stages of harvesting: Harvesting of fruit in proper time is an important task in fruit farming. Mango growers in the study areas harvest mango at both mature and immature stages. However, majority of the respondent growers (93.3%) harvested mangoes at mature period followed by at green stage (50%) and ripening stage (40%). Some mango growers harvest at immature stage for early marketing and receiving good price (Table 3).

Table 3. Stages of harvesting of mango in the study areas

Stages of harvest	No. of respondent *(n=30)*	% of responses
1. Matured stage	28	93.3
2. Green stage (not fully mature)	15	50.0
3. Ripening stage (starts ripening)	12	40.0
4. Immature stage	1	3.3

***Mode of harvesting*:** Harvesting of crop at the right time and in the right way maximizes crop yield and minimizes crop losses and quality deterioration. Mango growers in the study areas are very much cautious about mango harvesting. They know well that mango quality completely depends on the proper harvesting. However, all respondent farmers harvested mango with the help of *Tushi* (a bamboo pole with a net put in the end of mango harvester that shown in Fig 3) followed by hand picking (70%). Farmers generally harvest those mangoes by hand picking which are within reach. The time of harvesting did not vary much from farmer to farmer. It was reported that 100% farmers harvested mango during sunny morning. However, some of them also harvest mango in the afternoon and noon as well (Table 4).

Fig 3. Harvesting of mango using *Tushi*
(Source: http://fruit08.blogspot.com/p/mango)

Table 4. Mode and time of harvesting of mango in the study areas

Type of measures	No. of respondent *(n=30)*	% of responses
A. Means of harvesting		
By hand	21	70
Tushi	30	100
B. Time of harvesting		
1. Sunny morning	30	100
2. Afternoon	7	23.3
3. Noon	4	13.3

***Use of harvesting container*:** Harvesting containers should be made in such a way so that these should reduce mechanical damage to produce. Different types of containers were reported to use during harvesting of mangoes. Irrespective of mango variety, size and maturity, about 87% farmers placed harvested mangoes on rice straw. About 17% farmers each used bamboo basket and newspaper for placing mangoes immediate after harvest. Plastic crates are relatively expensive to purchase, but are reusable and easy to clean. It has good stacking strength, ventilation holes and long life. But, only 6.7% respondent farmers used it as harvesting container (Table 5).

Table 5. Placing container of mango immediate after harvest

Type of container	No. of respondent *(n=30)*	% of responses
1. Straw	26	86.7
2. Bamboo basket	5	16.7
3. On paper	5	16.7
4. Plastic crates	2	6.7
5. On ground	2	6.7

***Use of ripening chemicals*:** Uniformity in fruit colour, taste, and flavour is very important to the assurance of fruit quality. Therefore, the use of ripening chemicals is required for many fruits marketing in commercial purposes. A number of chemicals are available in the market and is approved for postharvest use on fruits for enhancing ripening. According to some

consumers views, "artificially ripened mangoes will have yellow outer skin, but the tissue/flesh inside will not be ripe".

Respondent mango growers strongly argued that they did not use of ripening chemicals. It is normally used at traders'/wholesale level. But, Hassan et al., (2010) reported that 4-16% of the growers were involved in mango ripening using chemicals. Calcium carbide was used (Fig-4) by 4-20% mango growers followed by Ripen 15 (0-12%). Their study also revealed that 4-32% growers used straw to accelerate ripening and 60-92% sold unripe mature mangoes.

Fig 4. A man sprays carbide on mangoes at a wholesale centre, Baneshwar, Rajshahi (*Source: The daily star, June 12, 2014*)

4.1.2 KAP of Key Actors on Safe Mango

Product safety standard is a set of regulations to the design and production of consumer products to makes sure of the safety of consumer and to not represent any hazard (http://thelawdictionary.org). The respondent stakeholders in the mango supply chain were asked about the perceptions of safe mango and its related factors. All the respondents provided positive response on it. Majority of the respondents (88-89%) considered those mangoes safe for human consumption which is free from diseases and formalin. More than 71% respondent stakeholders thought that the appearance of safe mangoes must be physically neat and clean. A good percentage (12-41%) of respondents thought that safe mangos must be graded and washed with clean water (Table 6).

Table 6. Related knowledge of farmers and traders and factors associated with safe mango

Reason	% of responses by farmers and traders						
	Farmer *(n=30)*	Faria *(n=15)*	Bepari *(n=10)*	Retailer *(n=13)*	Arathdar *(n=15)*	Consumer *(n=15)*	All *(n=98)*
A. Idea on safe mango							
Positive response	100	100	100	100	100	100	100
Unknown/ignorant	--	--	--	--	--	--	--
B. Factors of safe mango							
1. Disease free	100	100	90.0	92.3	73.3	66.7	88.8
2. Formalin free	100	93.3	100	100	100	26.7	87.8
3. Neat & clean	76.7	80.0	90.0	76.9	86.7	20.0	71.4
4. Graded mango	33.3	60.0	90.0	84.6	6.7	--	40.8
5. Wash with fresh water	16.7	--	--	15.4	20.0	13.3	12.3
6. Others	3.3	--	--	--	--	53.3	9.2

Note: Others include bright colour, big size, good packaging, etc

The key contributing factors that make mangoes unsafe for human consumption were reported to be the use of pesticides (89.8%) unwisely, infestation of insects-pests (75.5%), use of ripening chemicals (73.5%), and bird dropping (22.4%). Some of the respondents also opined that mangoes are considered to be unsafe for human consumption when it is contaminated with unsafe water and chemical fertilizers (Table 7).

Table 7. Factors contributing to make mango unsafe for the consumers

Reason	% of responses by farmers and traders						
	Farmer *(n=30)*	Faria *(n=15)*	Bepari *(n=10)*	Retailer *(n=13)*	Arathdar *(n=15)*	Consumer *(n=15)*	All *(n=98)*
1. Use pesticides	100	93.3	90.0	69.2	73.3	100	89.8
2. Insect-pest infestation	73.3	86.7	80.0	69.2	66.7	80.0	75.5
3. Use ripening chemicals	63.3	66.7	60.0	76.9	80.0	100	73.5
4. Bird dropping	33.3	33.3	30.0	7.7	6.7	13.3	22.4
5. Use chemical fertilizers	--	6.7	10.0	15.4	6.7	6.7	6.1
6. Others	3.3	13.3	30.0	38.5	20.0	53.3	22.4

Note: Others include faulty irrigation water, harvest just after pesticides use, etc

All the stakeholders in the mango supply chain believed that adequate measures should be taken to keep mangoes toxic free for the consumers. They suggested a number of measures that will ensure mangoes toxic free for the consumers. The highest reported measures were ripe mango without chemicals (39.7%), harvest mature mango (38.6%), using recommended pesticide dose (38.5%), do not use formalin (34.9%), use clean container (22.9%), keep mango neat & clean (18.1%), and harvest mangoes after 7 days of applying pesticides (13.3%), and separate damage or semi-damage mangoes from good ones during packaging (12%). Besides, some respondents also considered some measures that keep mangoes toxic free for the consumers. The measures were using sex pheromone trap, bagging mangoes during growth stage, and use recommended dose of plant growth regulator to increase fruit size (Table 8).

Table 8. Measures could make mango toxic free (safe) for the consumers

Type of measures	% of responses					
	Farmer *(n=30)*	Faria *(n=15)*	Bepari *(n=10)*	Retailer *(n=13)*	Arathdar *(n=15)*	All *(n=83)*
A. Should mango keep toxic free?						
Positive response	100	100	100	100	100	100
Negative response	--	--	--	--	--	--
B. Measures to keep mango toxic free						
1. Should not use ripening chemicals	53.3	20.0	40.0	38.5	33.3	39.7
2. Harvest mature mango	16.7	66.7	30.0	46.2	53.3	38.6
3. Use recommended dose of pesticides	53.3	53.3	30.0	15.4	20.0	38.5
4. Should not use formalin	33.3	33.3	70.0	30.8	20.0	34.9
5. Use clean container	--	33.3	40.0	30.8	40.0	22.9
6. Keep mango neat and clean	3.3	26.7	50.0	38.5	--	18.1
7. Harvest after 7 days of applying pesticides	26.7	--	--	--	20.0	13.3
8. Separate rotten mangoes from good ones	3.3	20.0	--	30.8	13.3	12.0
9. Use sex pheromone trap	16.7	--	--	--	--	6.0
10. Use bagging for safe mango	10.0	--	--	--	13.3	6.0
11. Recommended dose of hormone/PGR	--	--	20.0	7.7	--	3.6
12. Others	--	20.0	20.0	--	13.3	8.4

Note: Other included financial benefit for safe mango selling traders, do not sale imported adulterate mango; harvest with *Tushi*, keep in cold storage, and use limited hormone/PGR.

Many farmers in practice took different measures to make mangoes safe and toxic free for the consumers. The highest percentage of farmers (26.7%) did not use any ripening chemical and formalin, used recommended dose of pesticides (23.3%), harvested mangoes at mature stage (16.7%), used clean container during harvest (10%), harvested mangoes after 7 days of applying pesticides (10%), and separated rotten mangoes from good ones. A small parentage of farmers also followed IPM technology and used sex pheromone traps to control fruit fly attack instead of applying pesticides (Table 9).

Market intermediaries also reported to take some practical measures to make mangoes safe and toxic free for the consumers. A good percentage (7-50%) of intermediaries claimed that they did not use any ripening chemicals and formalin to mangoes. Separation of damaged mangoes from good ones to avoid contamination was also done by intermediaries. Some *Arathdars* reported to supply mangoes to distant wholesale markets with good packaging (Table 9).

Table 9. Practices done at farmers and traders levels to make mango toxic free for the consumers

Type of practice	% of responses					
	Farmer *(n=30)*	Faria *(n=15)*	Bepari *(n=10)*	Retailer *(n=13)*	Arathdar *(n=15)*	All *(n=83)*
1. Do not use ripening chemicals	26.7	46.7	50.0	46.2	20.0	35.0
2. Do not use formalin	26.7	6.7	50.0	30.8	26.7	26.5
3. Use clean and safe container	10.0	33.3	40.0	30.8	33.3	25.3
6. Separate rotten mangoes from good ones	6.7	6.7	--	30.8	26.7	13.3
4. Use recommended pesticides dose	23.3	--	--	--	--	8.4
5. Harvest mature mango	16.7	--	--	--	--	6.0
8. Harvest after 7 days of applying pesticides	10.0	--	--	--	--	3.6
7. Use sex pheromone trap	6.7	--	--	--	--	2.4
9. Supply mango in good packaging	--	--	--	--	13.3	2.4
10. Others	--	--	20.0	7.7	26.7	8.4

Note: Others include develop farmers' awareness, use recommended dose of hormone, etc

4.1.3 KAP of Key Actors on Disease Free mango

The respondent mango growers were asked about the importance of keeping mangoes disease free for the consumers. All the respondent farmers suggested taking adequate measures to keep mangoes disease free and healthy for the consumers. In order to keep mango disease free depends mostly on pre-harvest measures to be adopted at farm level. More than 43% farmers suggested on keeping land weed free and 20% put emphasis on timely use of irrigation and fertilizer. Root zone should be kept dry and weed free was advocated by 13.3% mango farmers. Some mango farmers (6.7%) also suggested using limited fungicides, bagging of mango at immature stage, and using good quality and disease free sapling (Table 10).

In practice, many growers adopted a number of measures to make mangoes safe and disease free for the consumers. More than 93% of the grower curried soil in the root zone of the mango trees followed by 60% growers used limited pesticides/fungicides. Good quality and disease free saplings were used by 13.3% growers to make mango disease free. Uprooting disease infested saplings and the use of organic fertilizers were the two practices done by some of the respondent growers in the study areas (Table 11).

Table 10. Farmers' attitudes and measures towards keeping mango disease free

Particulars	No. of respondent (n=30)	% of responses
A. Should mango keep disease free?		
Positive response	30	100
Negative response	--	--
B. Measures needed to keep mango disease free		
1. Keeping land weed free	13	43.3
2. Timely use of irrigation and fertilizer	6	20.0
3. Root zone should be kept dry and weed free	4	13.3
4. Limited use of fungicides	2	6.7
5. Use bagging	2	6.7
6. Use good quality and disease free sapling	2	6.7
7. Use plant growth regulators or hormone	1	3.3

Table 11. Practices usually done by farmers to make mango disease free

Type of practices	No. of respondent (n=30)	% of responses
1. Curing soil	28	93.3
2. Limited use of pesticides/fungicides	18	60.0
3. Use good quality and disease free sapling	4	13.3
4. Uproot disease infested sapling	2	6.7
5. Use organic fertilizers	2	6.7
6. Others	3	10.0

Note: Others include keep land weed free; irrigate proper time, use vitamin/PGR

4.1.4 KAP of Key Actors on Clean Mango

Keeping surfaces clean and free of soil not only helps reduce the opportunities for spreading of germs, but helps extend the life of our personal possessions (http://www.about cleaning products.com). The mango growers in the study areas were asked about the significance of keeping mangoes clean for the consumers. All the growers reported that proper measures should be taken to make mangoes clean for the consumers. More than 86% growers thought that mangos should be placed on clean straw or paper immediately after harvest to keep it clean. Forty percent growers considered that dirty mangoes should be cleaned by dry and clean clothes, but 6.7% growers suggested cleaning mangoes through washing. About 26.7% growers seemed to be used clean container as a prerequisite for clean mangoes, whereas 6.7% growers suggested separating damaged mangoes from good ones (Table 12).

In practice, majority of the mango growers performed different actions to make mangoes clean for the consumers. Eighty percentage of the respondent growers placed mangoes on clean straw or paper just after harvest, whereas 43% used clean container for keeping mangos clean. Forty percent growers cleaned dirty mangoes with dry and clean clothes, and only 3.3% farmers separated rotten/damaged/spotted mangoes from good ones (Table 13).

Table 12. Farmers' attitudes and measures towards keeping mango clean

Particulars	No. of respondent *(n=30)*	% of responses
A. Should mango keep clean?		
Positive response	30	100
Negative response	--	--
B. Measures needed to keep mango clean		
1. Put mango on clean straw or paper just after harvest	26	86.7
2. Clean dirty mango by dry and clean clothes	12	40.0
3. Use clean container	8	26.7
4. Separate rotten/spotted/damage mangoes from good ones	2	6.7
5. Wash dirty mango with clean water	2	6.7
6. Others	2	6.7

Table 13. Practices usually done by farmers to make mango clean for the consumers

Type of practices	No. of respondent *(n=30)*	% of responses
1. Put mango on clean straw or paper just after harvest	24	80.0
2. Use clean container	13	43.3
3. Clean dirty mango by dry and clean clothes	12	40.0
4. Separate rotten/spotted mangoes from good ones	1	3.3

4.1.5 Perceptions of Key Actors on Good Quality Mango

The respondent farmers, consumers and intermediaries in the supply chain were asked to point out some important characteristics of a good quality mango. In this respect, the important characteristics of a good quality mango varied from person to person. In the case of farmer, large size, mature, neat & clean, yellow coloured, and sweetness are the important characteristics of a good quality mango. But, 100% consumers considered toxic and disease freeness as one of the most important characteristics of a good quality mango. Besides, clean, large size and yellow colour were also the important quality characters of a good mango as mentioned by the consumers. Intermediaries in the supply chain considered firmness, sweetness, clean and yellow colour as the characteristics of a good quality mango. Details can be seen in Table 14.

Table 14. Quality characters that are generally considered for a good quality mango

Quality characters	% of responses						
	Farmer *(n=30)*	Faria *(n=15)*	Bepari *(n=10)*	Retailer *(n=13)*	Arathdar *(n=15)*	Consumer *(n=15)*	All *(n=98)*
1. Firm	43.3	93.3	80.0	84.6	73.3	--	58.1
2. Neat and clean	70.0	--	10.0	7.7	93.3	86.7	51.0
3. Large size	86.7	--	--	--	73.3	66.7	48.0
4. Sweet	50.0	53.3	60.0	46.2	53.3	--	43.9
5. Yellow colour	60.0	13.3	20.0	--	60.0	60.0	40.8
6. Mature	70.0	26.7	10.0	30.8	13.3	--	32.7
7. Soft	--	60.0	70.0	61.5	6.7	--	25.5
8. Juicy	46.7	6.7	--	7.7	26.7	--	20.4
9. Red colour	43.3	--	--	--	33.3	--	18.4
10. Toxic & disease free	--	--	--	--	--	100.0	15.3
11. Others	3.3	13.3	10.0	7.7	--	20.0	8.1

Note: Others include good packaging, chemical fertilizer free, etc

The key actors in the mango supply chain were asked to give their opinions on the possible steps that should be practiced at assemble or primary markets for ensuring product quality and safety. They opined several views on this issues which are furnished in Table 15. On an average, more than 56% of the traders suggested that government (i.e. law enforcing authority) should take adequate steps to stop marketing of toxic mangoes. The highest percentage of *Arathdars* strongly suggested this step followed by retailer and *Bepari*. About 38% of the respondents opined that market committee should monitor market on a regular basis. The other suggestions come out from the respondents were mango growers and traders should be encouraged to sell safe mango (30.2%), establishment of cool or clean place in the market premises (26.4%), encouragement of traders to use limited ripening chemicals (24.5%), motivation of growers to use limited quantity of pesticides (17%), and ensure good quality packaging (11.3%). Some of the respondents suggested punishing those persons selling toxic mangoes, circulating poster or setting up billboard on toxic mangoes in order to develop awareness among stakeholders in the supply chain (Table 15).

Table 15. Practices needed at assembling market for ensuring product quality and safety

Possible steps	% of responses				
	Faria	Bepari	Retailer	Arathdar	All
1. Government initiatives to stop toxic mango	20.0	40.0	69.2	93.3	56.6
2. Market committee could monitor the market on a regular basis	33.3	70.0	38.5	20.0	37.7
3. Encourage farmers & traders for trading safe mango	26.7	50.0	46.2	6.7	30.2
4. Establish cool or clean place in the market premises	66.7	30.0	--	6.7	26.4
5. Encourage traders to use limited ripening chemicals	53.3	30.0	--	13.3	24.5
6. Motivate farmers to use limited quantity of pesticides	33.3	40.0	--	--	17.0
7. Ensure good quality packaging	13.3	10.0	15.4	6.7	11.3
8. Circulate poster, billboard regarding safe mango	20.0	--	7.7	13.3	11.3
9. Punishment for selling toxic mango	--	20.0	7.7	6.7	7.6
10. Develop improved marketing system	6.7	10.0	7.7	--	5.7
11. Consumer should avoid toxic mango	--	--	--	20.0	5.7

4.1.6 KAP of Key Actors on Good Packaging

Good packaging clearly communicates its product's features and allows the product to be displayed in the best possible way to highlight those features. It is also very much important for maintaining product quality, transport to distant places, and reduce postharvest losses (http://www.davison.com).

Majority of the respondent mango growers and traders agreed that good packaging has crucial role in maintaining product quality and attracting consumers. Most traders (80-100%) opined that plastic crate was the most important packaging instrument that could maintain product quality to a great extent during transportation and handling (Fig 6). Due to the lower cost of packaging, some *Faria* and retailers mentioned bamboo basket with straw lining as a good packaging instrument for mango transportation (Fig 5). However, 100% mango growers preferred thick/solid paper carton for good packaging (Table 16).

Fig 5: Conventional packing of mango using bamboo baskets & rice straw (Source: Hassan et al., 2010)

Fig 6: Improved packing of mango using plastic crates with paper lining (Source: Hassan et al., 2010)

Currently, the use of conventional packaging has reduced to a great extent. It was reported in the study areas that on an average 69.1% respondent key stakeholder in the mango supply chain used plastic crates with paper lining as packaging instrument. A good percentage of mango growers and local traders (*Faria*) used wooden box with tiny hole for packaging mango. It is important to state that growers and *Faria* do not require transport mangoes to the distant places or markets. Generally, *Beparis* need transport mangoes carefully from assemble market to distant wholesale markets. That's why most of the *Beparis* (90%) used plastic crates for packaging mangos. Except *Faria*, some growers and traders also used thick/solid paper carton for packaging mangoes (Table 16).

Table 16. Role of good packaging and type of packaging used for maintaining product quality

Particulars	% of responses by farmers and traders				
	Farmer *(n=30)*	Faria *(n=15)*	Bepari *(n=10)*	Retailer *(n=13)*	All *(n=68)*
A. Role of good packaging					
Positive response	100	100	100	85	97.1
Negative response	--	--	--	15	2.9
B. Type of packaging needed					
1. Plastic crates with paper lining	56.7	80.0	100	92.3	75.0
2. Thick/solid paper carton	100	--	--	--	44.1
3. Bamboo basket with straw lining	--	46.7	--	15.4	13.2
4. Wooden box with tiny hole	10.0	6.7	--	7.7	7.4
C. Type of packaging normally used					
1. Plastic crates with paper lining	76.7	20.0	90.0	92.3	69.1
2. Wooden box with tiny hole	56.7	53.3	--	15.4	39.7
3. Thick/solid paper carton	3.3	--	30.0	23.1	10.3

4.1.7 Perceptions of Key Actors on Consumers' Awareness

The perceptions of traders on consumers' awareness about food safety in the supply chain are very important in promoting any product in the market. Therefore, they were asked to respond on the consumers' awareness about food safety. The results presented in Table 17 revealed that most of the respondent traders more or less aware of the consumers' reactions on food safety. About 79% traders thought that consumers are concerned about getting sick from the food they eat. More that 68% traders seemed that consumers are also concerned about the use of formalin

on mango to prevent spoilage. Nearly 37% traders know that consumers are concerned about the residual effect of pesticides.

Table 17. Traders' perceptions on consumers' awareness about food safety

Particular	% of responses			
	Faria *(n=15)*	Bepari *(n=10)*	Retailer *(n=13)*	All trader *(n=38)*
1. Concerned about getting sick from the food they eat	66.7	90.0	84.6	79.0
2. Concerned about formalin use	73.3	50.0	76.9	68.4
3. Concerned about pesticide residue	26.7	40.0	46.2	36.9
4. Others	26.7	40.0	15.4	26.3

4.2 Study on Mango Supply Chain

The sequences of stages involved in supply of inputs to the farm and transferring produces from farm to consumers is generally referred to as a supply chain. The stages are pre-production, production, post-production and consumption. In this section, the analyses of pre-production activities are not considered in this study.

4.2.1 Socioeconomic Profile of Producer and Trader

The socioeconomic profile of mango producers and traders is presented in Table 18. All the respondent mango producers and traders included in the study were male. In fact, no female respondents were available for taking part in the interview. The highest percentage of farmers (57%) belonged to the age group of 31-40 years and the lowest was in the age group of 51-60 years. The level of education of the highest 33% mango producers was SSC to HSC. A good percentage of higher educated producers (20%) along with some illiterate producers (7%) were also included in this study. Almost all farmers sell mangoes in the primary or assemble market. The average landed area of mango orchard was estimated at 122.4 decimal (Table 18).

Table 18. Socioeconomic profile of mango producers and traders

Particular	% of responses			
	Producer *(n=30)*	Faria *(n=15)*	Bepari *(n=10)*	Retailer *(n=13)*
1. Gender				
Male	100	100	100	100
Female	--	--	--	--
2. Age range (years)				
20-30	--	27	--	38
31-40	57	46	40	23
41-50	40	27	50	31
51-60	3	--	10	8
3. Literacy level				
Illiterate	7	53	--	23
Class I-V	10	27	--	15
Class VI-X	30	13	50	46
SSC-HSC	33	--	20	8
Degree & above	20	7	30	8
4. Operate in the market				
Assemble market	100	100	100	--
Secondary market	--	--	100	100
5. Size of garden (decimal)	122.4	--	--	--

Table 18 also reveals that different types of traders with different ages were involved in the mango supply chain. The highest percentage of *Faria* (46%) belonged to the age group of 31-40 years, whereas in case of *Bepari* and retailer it was 41-50 years and 20-30 years respectively. Most of the respondent *Farias* were illiterate, but the level of education of half of the *Beparis* was reported to be class VI to class X. The level of education of the highest percentage of retailers (46%) was also reported to be class VI to class X. However, a good percentage of retailers were also illiterate. *Farias* usually operate in the primary/assemble market, whereas *Beparis* operate both in the primary and wholesale markets. Retailers operate only in the secondary market in the study areas.

4.2.2 Factors Influencing Mango Business

Different and more than one factors insisted key traders in the mango supply chain to undertake mango business. The highest percentage of traders (92.1%) performed mango business due to its higher profitability. Good quality products and good relations with suppliers were other two important reasons stated by 39.4% and 34.2% traders respectively for doing this business. Market information regarding mango business is available in the study areas which insisted 21.1% traders to undertake this business. Twenty one percent traders reported that they performed mango business due to its plenty supply and good quality (Table 19).

Table 19. Factors influencing traders to undertake mango business

Influencing factors	% of responses by traders			
	Faria *(n=15)*	Bepari *(n=10)*	Retailer *(n=13)*	All traders *(n=38)*
1. Profitable business	86.7	90.0	100	92.1
2. Availability of good quality products	33.3	30.0	53.8	39.4
3. Good relations with suppliers	46.7	50.0	7.7	34.2
4. Availability of market information	20.0	10.0	30.8	21.1
5. Plenty/regular supply	26.7	40.0	--	21.1

4.2.3 Disposal Pattern and Damages of Mango at Farm Level

The mango farmers in the study areas distribute their produces in different purposes. The main purpose was sale out to nearby market followed by consumption. However, disposal pattern of mango at farm level is shown in Table 20. The highest quantity of mango produced and sold in the peak season. The highest percentage (81.12%) of mango was sold by the growers at assemble market (Fig 7). About 2.74% of the total mangos were used for family consumption and 2.03% was gifted to their relatives or others.

Fig 7. One of the assemble markets in Chapai Nawabganj
Source: The daily star, July 18, 2013

Table 20. Disposal pattern and postharvest losses of mango at farmers' level

Key players	Peak season		Lean season		All season	
	Quantity (ton)	% of total	Quantity (ton)	% of total	Quantity (ton)	% of total
Sale	161.68	81.25	14.48	79.74	176.16	81.12
Consumption	5.20	2.61	0.76	4.19	5.96	2.74
Gift	3.80	1.91	0.60	3.30	4.40	2.03
Damage	28.32	14.23	2.32	12.78	30.64	14.11
Rotten	14.52	7.30	1.12	6.17	15.64	7.20
Blemish	13.80	6.93	1.20	6.61	15.00	6.91
Total	**199.00**	**100**	**18.16**	**100**	**217.16**	**100**

On an average, the total postharvest loss of mango at farm level was 14.11% of the total production. Among the losses, 7.2% was completely spoiled which had no market value at al, whereas 6.91% were blemished (semi-spoiled) that could sell half of the price. The main postharvest losses occurred at farm level due to cut, spotted, cracks, bruising, disease infected, and insect-pest damage found at harvest those were discarded from good ones during sorting and grading. Losses were also occurred due to improper packing and transportation system at farm level. Figure 9 reveals that the perceived damages during sorting & grading and transportation were estimated to be 6.16% and 1.04% respectively. Again, 6.75% of the total loss was semi-damaged during sorting & grading and 0.16% was due to improper transportation. However, the rate of damage in peak season was higher compared to lean season. The rate of damage for different causes can be seen in Fig 9.

Fig 8: Sorting & grading at farm level, Chapai Nawabganj   **Fig 9: Percent of postharvest losses of mango at farm level**
(*Source: http://photoghor.com/imageview.php?image*)

Different factors were responsible for postharvest losses of mango at farm level. The highest percentage of mango growers (90%) mentioned that most of the losses were due to heavy rainfall. Heavy rainfall usually cracks the mangoes to a great extent. The second important cause was fruit borer infestation. Nearly 67% farmers mentioned fruit borer infestation as the major contributing factors of postharvest losses. Foggy or bad weather also contribute to postharvest loss of mango that mentioned by 36.7% growers. Fungal infection, spotted and rotten due to transportation and crack during careless harvest were reported to be the important causes of postharvest losses of mango at farm level (Table 21).

Table 21. Factors contributing to postharvest loss (blemish) of mango at farm levels

Reason	No. of respondent (n=30)	% of responses
1. Crack due to heavy rain fall	27	90.0
2. Infested by fruit borer	20	66.7
3. Spotted and rotten due to foggy/bad weather	11	36.7
4. Fungal infection	6	20.0
5. Spotted and rotten due to transportation	4	13.3
6. Crack during harvest	3	10.0
7. Loss due to delayed sell (due to *Hortal* and strike)	2	6.7
8. Others	4	13.0

4.2.4 Marketing of Mango at Traders Level

4.2.4.1 Marketing channel in mango marketing

The process of mango marketing started with the producers and continued through certain channels until the produce reached the final consumers. Direct and indirect transactions between the producers and consumers were found in mango marketing system. The indirect transaction was found to be more prominent than the direct one. A number of intermediaries such as *Bepari, Faria, Arathdar*, and retailer were involved in the transaction (Fig 10). It was found that *Bepari* and *Faria* were the most important middlemen in the process of mango marketing in the study area. *Bepari* traded a large volume of mangoes in both peak and lean seasons. *Farias* traded volume was much lower than *Bepari*. Usually they do not store mangoes for even one night. *Arathdar* simply plays their role as a commission agent.
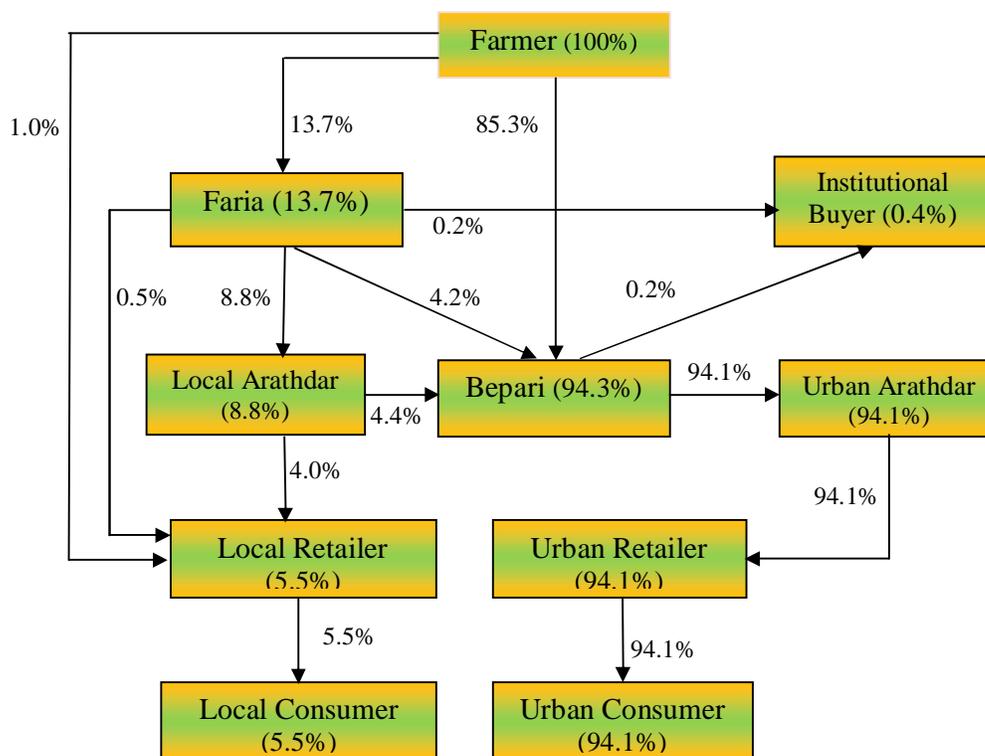
Fig 10: Flow diagram of mango supply chain

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The following channels were identified in the study areas for mango marketing:

Marketing channels	% product flows
1. Farmer >Bepari>Urban Arathdar>Urban Retailer>Urban Consumer	85.1
2. Farmer >Faria>Local Arathdar>Bepari>Urban Arathdar>Urban Retailer>Urban consumer	4.8
3. Farmer >Faria>Bepari>Urban Arathdar>Urban Retailer>Urban Consumer	4.2
4. Farmer >Faria>Local Arathdar>Local Retailer>Local consumer	4.0
5. Farmer >Local Retailer>Local consumer	1.0
6. Farmer >Faria>Local Retailer>Local consumer	0.5
7. Farmer >Faria>Institutional buyer	0.2
8. Farmer >Bepari >Institutional buyer	0.2

4.2.4.2 Volumes traded and seasonal variations

It was observed that the volume of mango traded by the sample traders varied according to seasons and due to many other reasons (Table 22 & 23). In the peak season[2] *Bepari, Faria* and retailers traded about four, three and five times higher quantities of mango compared to lean season respectively. On average, *Bepari* bought 62.1% mangoes from farmers and the rest from *Faria* (Table 22). On the other hand, they sold the lion share (99.8%) of mangoes to retailers through *Arathdar*. Some local *Beparis* also supplied a small percentage (0.2%) of mangoes to the local agent of the mango pulp factory situated in the study areas (Table 23). *Beparis* mainly supply sour variety of mango (*Ashina*) to the pulp factory in the lean season when the price and demand of mangoes both are low in the study areas.

Table 22. Total volume of mangoes bought from different sellers at intermediaries' level

Key players	Peak season		Off season		Total	
	Quantity (ton)	Percent	Quantity (ton)	Percent	Quantity (ton)	Percent
A. Bepari buys from:	*8633*	*100*	*2249*	*100*	*10882*	*100*
1. Farmer	5186	60.1	1576	70.1	6762	62.1
2. Faria	3447	39.9	673	29.9	4120	37.9
B. Faria buys from:	*832.36*	*100*	*258*	*100*	*1090.36*	*100*
1. Farmer	832.36	100	258	100	1090.36	100
C. Retailer buys from:	*121.44*	*100*	*14.92*	*100*	*136.36*	*100*
1. Farmer	70.20	57.8	6.32	42.4	76.52	56.1
2. Local Arathdar	45.52	37.5	8.60	57.6	54.12	39.7
3. Faria	5.72	4.7	--	--	5.72	4.2

Faria is an important trader in the mango supply chain. However, they purchased entire volume of mangoes from farmer and sold them to different buyers such as *Bepari*, local *Arathdar* and local agent of the mango pulp factory. *Faria* sold nearly 64.1% mangoes to local *Arathdar* followed by *Bepari* (30.5%) immediately after purchase. Retailer, an important trader in the mango supply chain, purchase mangoes from different types of traders where they get good products with lower price. However, retailer purchased the highest volume of mangoes (56.1%) directly from farmers followed by local *Arathdar* (39.7%) and *Faria* (4.2%). They sold their entire volume of mangoes to the final consumers (Table 22 &23).

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[2] The peak and lean seasons were ranged from Mid June-Mid August and Mid August to Mid September for Chapai Nawabganj district.

Table 23. Total volume of mangoes sold to different buyers at intermediaries' level

Key players	Peak season		Off season		Total	
	Quantity (ton)	Percent	Quantity (ton)	Percent	Quantity (ton)	Percent
A. Bepari sold to:	*8230.92*	*100*	*2302.24*	*100*	*10533.16*	*100*
1. Arathdar	8214.32	99.8	2293.24	99.6	10507.56	99.8
2. Local agent of pulp centre	16.60	0.2	9.00	0.4	25.60	0.2
B. Faria sold to:	*823.72*	*100*	*257.96*	*100*	*1081.68*	*100*
1. Bepari	159.00	19.3	171.00	66.3	330.00	30.5
2. Local Arathdar	609.46	74.0	83.26	32.3	692.72	64.1
3. Local retailer	38.90	4.7	2.50	0.9	41.40	3.8
4. Local agent of pulp centre	16.36	2.0	1.20	0.5	17.56	1.6
C. Retailer sold to:	*117.52*	*100*	*13.16*	*100*	*130.68*	*100*
1. Consumer	117.52	100	13.16	100	130.68	100

4.2.4.3 Postharvest loss at traders' level

The post harvest losses of mango at different intermediaries level in the supply chain is presented in Table 24. The total postharvest loss at trader's level was estimated at 9.61% which consisted of completely damaged mango (3.04%) and partial damaged mango (6.57%). Partial damaged mangoes could be sold at reduced price (e.g. in the study areas, it was sold at 50% of the selling price). Among intermediaries, the highest loss was recorded for retailer (4.64%) followed by *Bepari* (3.95%) and *Faria* (1.02%). The level of postharvest loss is dependent on various factors such as length of selling, type of transportation used, packaging system, etc. The volume of transaction of retailer is much lower, but the length of selling is higher compared to other intermediaries. Therefore, retailer's loss was reported to be the highest among intermediaries. Most of the *Beparis* currently used plastic crates to transport mango from assemble market to distant wholesale market that ensure lower transportation loss in the study areas.

Table 24. Total post harvest losses of mango at traders' level

Key players	Complete damage			Partial damage			Total damage		
	Total loss (ton)	Loss (kg/ton)	% of total purchase	Total loss (ton)	Loss (kg/ton)	% of total purchase	Total loss (ton)	Loss (kg/ton)	% of total purchase
Bepari	131.12	13.00	1.30	217.72	26.54	2.65	348.84	39.54	3.95
Faria	0.44	0.55	0.05	8.24	9.69	0.97	8.68	10.24	1.02
Retailer	2.12	16.87	1.69	3.56	29.48	2.95	5.68	46.35	4.64
Total	133.68	30.42	3.04	229.52	65.71	6.57	363.2	96.13	9.61

All the intermediaries stated that the loss incurred in the supply chain due to spoilage (not suitable for marketing) caused by short-time storage (1-2 days), improper handling during sorting & grading, transportation, and delayed sell. The percentage shares of postharvest losses at different stages in the supply chain are shown in Fig 11. It was revealed that *Faria* had no postharvest loss at storage level because they did not need storage at all. The highest loss at transportation level (2.91%) was incurred for *Bepari* due to unsuitable transportation. In the case of *Faria*, the highest loss (0.73%) incurred during sorting and grading due to inappropriate handling. The postharvest loss due to delayed sell (2.82%) was found to be the

highest for retailer. Irrespective of traders, the highest loss was due to transportation (3.19%) followed by delayed sell (3.12%) and sorting & grading (1.85%).
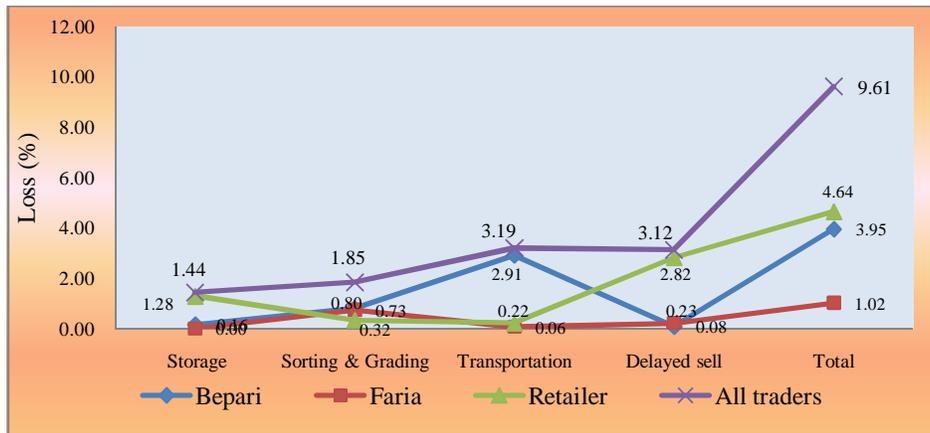
Fig 11. Postharvest losses at different stages of mango supply chain

4.2.4.4 Buying and selling price of mango

The price of mango depends mainly on different factors such as season, variety, size, colour, freshness, nature of supply, etc. Irrespective of these factors, the average purchase price of mango in the peak season was estimated at Tk. 37810, Tk. 37202 and Tk. 41538 per ton respectively for *Bepari, Faria,* and retailer. However, the price of mango estimated at the lean season was higher compared to peak season. In the lean season, the average purchase price of mango was estimated at Tk. 43256, Tk. 52224 and Tk. 65920 per ton respectively for *Bepari, Faria,* and retailer. There is an inverse relationship between demand and supply of mango (i.e. high demand vs low supply) exists in the lean season for which the price remained high. More or less similar trend was observed in the selling price of mango in the study areas (Table 25).

Table 25. Buying and sell price of mango in the study areas

Cost headings	Purchase price (Tk/ton)			Sell price (Tk/ton)		
	Minimum	Maximum	Average	Minimum	Maximum	Average
A. Peak season						
Bepari	32234	48745	37810	44583	59772	51027
Faria	13435	51731	37202	34588	63654	46524
Retailer	19500	75000	41538	35000	85000	51043
B. Lean season						
Bepari	37281	50500	43256	52000	62519	58881
Faria	29688	75000	52224	37813	80833	59969
Retailer	27500	105700	65920	33750	112500	73093

4.2.4.5 Monthly price variation of mango

The pattern of changes of mango prices of different varieties were recorded during 2013 (BBS, 2013). The following Figure 10 reveals that the mango varieties Guti, Gopalbhog, Himsagar and Langra were found available in the market during May-July, and the price variation of these varieties ranged from 20.13-33.44 per kg. The variety Fazli remained available during June-September and its price ranged from Tk. 47.55-Tk.81.45 per kg. The last variety Ashina was found available during July in the market until September and its price ranged from Tk. 41.31-Tk.63.53 per kg. In the months of August and September, only two varieties namely

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Fazli and Ashina remained available in the market. The sale price of Ashina variety is significantly higher during these months only because of its late arrival in the market, although it is relatively poor quality mango (i.e. less sweetness, less taste, less nutrition, less customer appeal). This variety requires less care. Therefore, the number of Ashina orchard is increasing year after year since the growers receive more profit than other varieties that have more suppliers and market competition (Hassan et al., 2010).

Fig 12. Monthly price variation of different mango varieties, 2013

Month	Guti	Gopalbhog	Himsagar	Langra	Fazli	Ashina
May	52.84	58.69	70.85	81.58	--	--
June	33.97	50.28	52.55	54.1	47.55	--
July	44.81	66.75	56.86	78.25	63.99	41.31
August	--	--	--	--	81.45	49.94
September	--	--	--	--	71.56	63.53
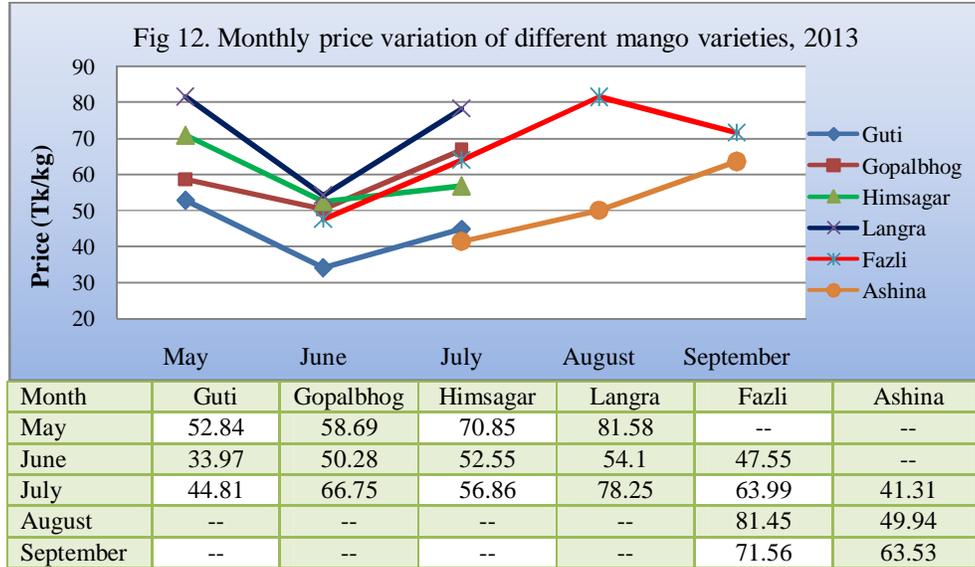
4.2.4.6 Factors influencing mango price

It has been stated earlier that mango price is depended on many factors. Mango size was one of the most important characters that highly influenced its price. On an average, about 87% traders mentioned this character that influence mango price. The second highest influencing factor was mango variety which was reported by 84.2% traders in the study areas. Most of the traders (71%) also mentioned that growing or harvesting season influenced mango price to some extent. The price remained very high during early season and late season when the supply of mango remained low, whereas the price remained low in the peak season. Product quality is also important to influence mango price. The other factors that influence price were reported to be bad weather and difficulties in transportation (Table 26).

Table 26. Factors influencing the price of mango

Influencing factors	% of responses by traders			
	Faria (n=15)	Bepari (n=10)	Retailer (n=13)	All trader (n=38)
1. Product size	93.3	70.0	92.3	86.8
2. Mango variety	86.7	80.0	84.6	84.2
3. Season	73.3	50.0	84.6	71.0
4. Product quality	26.7	40.0	53.8	39.5
5. Bad weather	13.3	40.0	--	15.8
6. Transportation defect	6.7	--	15.4	7.9

4.2.4.7 Marketing cost and margins at trader's level

The costs and margins in mango marketing for different traders are shown in Table 27 and 28 respectively. Mango traders spent on various activities during mango marketing. Among

different traders, *Bepari* incurred the highest average marketing cost of Tk. 7337.9 followed by retailer (Tk.1217.9) and *Faria* (Tk.738.2). *Beparis* incurred the highest costs due to higher *Arathdar* commission (Tk.4509.2/ton) and transportation (Tk.2083/ton). The table further reveals that transportation shared the highest cost to the total costs for retailer and *Faria* followed by personal expenses.

Table 27. Cost of mango marketing at traders level

Cost headings	Bepari		Faria		Retailer	
	Amount (Tk/ton)	Percent	Amount (Tk/ton)	Percent	Amount (Tk/ton)	Percent
1. Arathdar commission	4509.2	61.4	--	--	--	--
2. Transportation	2083.0*	28.4	431.3	58.3	738.7	60.7
3. Loading & unloading	401.4	5.5	5.6	0.8	--	--
4. Cleaning & grading	103.3	1.4	40.0	5.4	--	--
5. Basket/cartoon	65.2	0.9	16.3	2.2	--	--
6. Shop rent	76.1	1.0	--	--	181.0	14.8
7. Market toll	8.5	0.1	67.9	9.3	38.4	3.2
8. Electricity charge	7.6	0.1	--	--	62.4	5.1
9. Sweeping	5.1	0.1	1.7	0.2	9.5	0.8
10. Personal expenses	78.5	1.1	175.5	23.8	187.9	15.4
Total cost	**7337.9**	**100**	**738.2**	**100**	**1217.9**	**100**

* Transport mangos from Chapai Nawabganj to Dhaka for *Bepari*

The highest gross margin was estimated for *Bepari* (Tk. 13,549.23/ton) followed by retailer (Tk. 8,978.16/ton) and *Faria* (Tk. 8,961.49/ton). Again, *Faria* received the highest net margin (Tk. 8,067.76/ton) and *Bepari* received the lowest margin (Tk. 5,393.47/ton). The highest net margin for *Faria* was due to lower marketing cost and lower postharvest losses. Generally *Faria* performed both buying and selling activities in the same day and that's why their cost of transportation along with postharvest losses remained low. They purchase the entire volume of mango directly from farmers and sell it to *Bepari* and other customers immediately after purchase. On the contrary, the volume of transaction was the highest for *Beparis*, but their net margin was the lowest (Tk. 5,393.47/ton) due to higher marketing cost. Retailers received a reasonable net margin (Tk. 6,601.36/ton) from mango marketing (Table 28).

Table 28. Marketing margin and profit of different intermediaries

Trader type	Average purchase price (Tk/ton)	Average sale price (Tk/ton)	Gross margin (Tk/ton)	Average marketing cost (Tk/ton)	Average postharvest loss (Tk/ton)	Net profit (Tk/ton)
I	*II*	*III*	*IV=III-II*	*V*	*VI*	*VII=IV-V-VI*
Faria	37905.75	46867.24	8961.49	738.20	155.53	8067.76
Bepari	38303.92	51853.15	13549.23	7337.90	817.86	5393.47
Retailer	43146.83	52124.99	8978.16	1217.90	1158.90	6601.36

4.2.4.8 Mode of Transportation

The key actors in the supply chain used different types of vehicles to transport mango. The use of vehicles varied from traders to traders and the length of destination markets. Farmers transported mango by using different local carriers like bicycle, rickshaw, van, and push cart (Fig 13 &14). Trucks and vans were mostly used for mango transportation from the assemble markets to the destination wholesale markets. Majority of the *Farias* and retailers used rickshaw/van and *Nosimon* (5 wheeler local vehicle) to transport their mangoes.

Fig-13: Carrying mango on bicycle for selling at wholesale market, Chapai Nawabganj. Source: http://nijhoom.com/bangladesh-tour/

Fig-14: Carrying mango on van for selling at wholesale market, Chapai Nawabganj. *Source: Hassan el al., 2010*

The low-cost vehicles like rickshaw, van, tree wheelers, *Nosimon*, etc are very common in the study areas. Table 29 revealed that 60% of *Farias* used rickshaw/van and the rest of them used bicycle to carry mangoes from garden to assemble markets. All the *Beparies* used truck to transport mangoes from assembles market to distant wholesale markets. *Beparis* also used rickshaw or van to transport purchased mangoes from assembles place to local *Arath* or near to truck. The highest percentage of retailers used rickshaw or van followed by bicycle for transporting mangoes from purchase place to their permanent shops (Table 29).

Table 29. Mode of transportation of the traders

Mode of transport	% of responses by traders		
	Faria *(n=15)*	Bepari *(n=10)*	Retailer *(n=13)*
1. Truck/pick up	--	100.0	7.7
2. Rickshaw/van	60.0	--	76.9
3. Bicycle	40.0	--	15.4

Faria needed to transport mangoes on average 8.11km from assemble markets to destination markets, whereas this distance was 483km for *Bepari* and 4.5km for retailers. Some *Farias* and retailers did not need any transportation because their buying and selling markets are same. On an average, Bepari needed about 14 hours to reach assemble markets to the destination wholesale markets. Farias and retailers needed less than one hour to reach their destination markets (Table 30).

Table 30. Distance between purchasing and selling markets and time required for transportation

Particular	Faria *(n=15)*	Bepari *(n=10)*	Retailer *(n=13)*
1. Average distance (km)			
Minimum	0	350	0
Maximum	100	600	20
Average	8.11	483	4.5
2. Time required (hour)			
Minimum	0.16	10.0	0.16
Maximum	7.00	18.0	2.00
Average	0.89	13.8	0.63

4.2.4.9 Destination markets for buying and selling

All traders in the supply chain purchase mangoes from primary/assemble or retail markets in the study areas. Majority of the traders (80-100%) purchased mangoes from primary/assemble market. Some *Farias* and retailers also purchased mangoes from retail markets.

In the case of selling produces, 100% *Farias* and retailers sold mangoes in the local retail or assemble market. The study revealed that the numbers of destination wholesale markets are more than one for *Bepari*. Majority of them (40%) sold mangoes to Comilla wholesale market. The other destination markets of *Bepari* were Dhaka, Sylhet and Brahmonbaria (Table 31).

Table 31. Main destination market for buying and selling of mangoes

Type of market	% of responses by traders		
	Faria *(n=15)*	Bepari *(n=10)*	Retailer *(n=13)*
A. Purchasing market			
Assemble market	93.3	100	80
Retail market	6.7	--	20
B. Selling market			
Dhaka	--	20.0	--
Comilla	--	40.0	--
Sylhet	--	20.0	--
Brahmonbaria	--	20.0	--
Local assemble/retail market	100	--	100

Majority of the traders (60-100%) purchased mangoes daily during mango season. Only 40% *Bepari* and 30.8% retailer purchased mangoes twice per week. Only a few percentages (7.7%) of retailers purchased it once per week (Table 32).

Table 32. Frequency of purchase of mango

Mode of purchase	% of responses by traders		
	Faria *(n=15)*	Bepari *(n=10)*	Retailer *(n=13)*
Daily	100	60.0	61.5
Twice per week	--	40.0	30.8
Once per week	--	--	7.7

4.2.4.10 Problems of mango marketing

The key intermediaries in the supply chain encountered various problems with the produce on arrival at the market. The highest reported problem was delayed sale (57.9%) and lack of buyers (47.3%) due to lack of adequate demand. *Beparis* and retailers faced these two problems to a great extent compared to *Faria*. All the traders experienced partial damage of produces to some extent. Only 10% *Beparis* encountered mostly damage problem with their produce on arrival at the market (Table 33).

Table 33. Main problems encountered with the produce on arrival at the market

Major reason	% of responses by traders			
	Faria *(n=15)*	Bepari *(n=10)*	Retailer *(n=13)*	All trader (n=38)
1. Delayed sale	40.0	70.0	69.2	57.9
2. Lack of buyer	33.3	50.0	61.5	47.3
3. Partial decay/rotten	6.7	30.0	15.4	15.8
4. Mostly damage	--	10.0	--	2.6

The traders in the supply chain sometimes have to reject some portion of their purchased mangoes after arrival in the market due to various reasons. The reasons were spoilage of mangoes, plenty supply, partial damage, low product quality, rotten of mangoes, small size, and bad weather (Table 34). Among these problems absence of buyer due to low demand was reported to be the major problem (42.1%) followed by plenty supply in the market (29%), partial damage (23.7%), and low quality product (18.4%).

Table 34. Main reasons for rejecting or not selling mangoes in the market

Major reason	% of responses by traders			
	Faria *(n=15)*	Bepari *(n=10)*	Retailer *(n=13)*	All trader *(n=38)*
1. Absence of buyer	60.0	20.0	38.5	42.1
2. Plenty supply	20.0	30.0	38.5	29.0
3. Partial damage	13.3	--	53.8	23.7
4. Low quality	13.3	--	38.5	18.4
5. Rotten/decay	--	--	38.5	13.2
6. Small size	--	--	30.8	10.5
7. Bad weather	6.7	10.0	--	5.3
8. Others	13.3	--	--	5.3

4.2.4.11 Steps for minimizing transportation damages

Mango traders suggested various measures for reducing damage to mango during transportation. Majority of the traders (31-100%) suggested using plastic crates or bamboo case with paper lining for packaging mango for minimizing damage. Some traders (18.4%) recommended avoiding transport large volume of mangoes at a time. Nearly 11% traders thought that bad quality, damaged, and rotten mangoes should be separated from good ones in order to avoid contamination and reduce transportation damage (Table 35).

Table 35. Probable steps needed during transportation for minimizing damage to mango

Possible steps	% of responses			
	Faria *(n=15)*	Bepari *(n=10)*	Retailer *(n=13)*	All trader *(n=38)*
1. Use plastic crates or bamboo cage for packaging	80.0	100	30.8	68.4
2. Avoid transporting large volume at a time	26.7	10.0	15.4	18.4
3. Sorting bad quality, damage, rotten mango from good ones	13.3	10.0	7.7	10.5
4. Avoid transporting chemical mixed mango	6.7	--	15.4	7.9
6. Others	6.7	20.0	7.7	10.5

Note: Others included use clean container, avoid adulterate mango, engage own person in transportation, etc

4.2.4.12 Steps for attracting consumers

The respondent traders in the supply chain mentioned various measures that should be taken during selling mango to attract customers. The highest percentage of traders (51%) suggested that mango should be made neat and clean before placing in the selling container. More than 45% traders thought that mangoes should be nicely decorated after washing with clean water and shampoo. Mature and large size ripe mango also attracts most of the consumers that's why 30.2% traders mentioned that mature and large size ripe mango should be marketed to attract consumers. Many traders expected that consumers might be attracted if they are confident about their produce safe. So, clean container should be used during transportation and placing mangoes in the shop which was reported by 17% traders. The other measures that attract

consumers were mango should be graded, using improved packaging, and mango with attractive colour (Table 36).

Table 36. Probable practices needed during selling mango to attract customers

Possible steps	% of responses				
	Faria *(n=15)*	Bepari *(n=10)*	Retailer *(n=13)*	Arathdar *(n=15)*	All trader *(n=53)*
1. Physical appearance should be neat and clean	46.7	50.0	46.2	60.0	51.0
2. Decorate mangoes after washing with shampoo	53.3	80.0	61.5	--	45.3
3. Market matured ripe mangoes	20.0	60.0	30.8	20.0	30.2
4. Market large size and good mangoes	20.0	30.0	23.1	46.7	30.2
5. Use clean container during transport	20.0	20.0	30.8	--	17.0
6. Mango should be sorted and graded	20.0	--	7.7	33.3	17.0
7. Use improved packaging	6.7	20.0	--	20.0	11.3
8. Collect mango with attractive colour	--	--	--	53.3	15.1

All traders want to maximize their profit by selling at a maximum level, but it could not always be possible for various reasons. Various factors are preventing traders from implementing required practices on a regular basis to attract the customers. More than 32% traders could not perform required practices due to lack of enough time. A good percentage of traders (13-17%) did not show interest doing required practices to attract consumers because the cost of labour was very high and they could not receive good price of their produce. About 8% traders did not show interest doing required practices because they got less profit from mango business. Some traders claimed that they could not implement required practices due to lack of sufficient mangoes for sale (Table 37).

Table 37. Factors preventing sellers from implementing required practices to attract customer on a regular basis

Factors	% of responses				
	Faria *(n=15)*	Bepari *(n=10)*	Retailer *(n=13)*	Arathdar *(n=15)*	All trader *(n=53)*
1. Lack of enough time	40.0	20.0	23.1	40.0	32.1
2. Higher cost of labour	13.3	20.0	15.4	20.0	17.0
3. Due to low price of mango	6.7	--	23.1	20.0	13.2
4. Unavailability of fresh mango	13.3	10.0	15.4	--	9.4
5. When business appeared to be unprofitable	6.7	20.0	7.7	--	7.6
6. Low supply in the market	6.7	10.0	7.7	--	5.7
7. Natural calamities	13.3	--	7.7	--	5.7

4.3 Consumers' Perceptions and Preferences

The respondent consumers in the study areas purchased mango from both growers and retailers during peak season and off-season, but most of them purchased from retailers. On an average, they purchased 143 kg and 15 kg of mango per month from growers in the peak and off season respectively. However, the quantity purchased during peak season was much higher compared to off-season (Table 38). Eighty percent consumers purchased mango once a week and the rest consumers purchased it twice a month (Table 39). More than half of the consumers reported that they also purchased imported mango during off-season (Table 40).

Table 38. Quantity of mango purchased per month during peak and off-season

Type of seller	Peak season		Off-season	
	Respondent (N= 15)	Quantity (kg)	Respondent (N= 15)	Quantity (kg)
Farmer	6	143	3	15
Retailer	15	82	12	28

Table 39. Frequency or type of purchase

Type of purchase	No. of respondent	% of responses
Once a week	12	80
Twice a month	3	20

Table 40. Purchasing of imported mango

Particulars	No. of respondent	% of responses
A. Do you buy imported mango?	*N=15*	
Yes	8	53
No	7	47
B. Time of buying	*N=8*	
1. Off-season	6	75
2. When the price of imports is lower than locally produced mangoes	2	25

The average purchase prices of mango per kilogram were Tk.52 and Tk. 120 during peak and off-season respectively. The overall price reported by the consumers of Chapai Nawabganj district was lower than that of Dhaka district because of mango growing area (Table 41).

Table 41. Average purchase price of mango per kilogram

Study area	No. of respondent	Peak season	Off-season
Chapai Nawabganj	10	49	115
Dhaka	5	59	130
All area	15	52	120

Different factors influenced consumers to take decision in purchasing mangos. The highest reported (87%) factor was the quality of mango. Availability (60%) and low price (60%) of mango were the next important factors that influence consumers greatly to purchase mango. Nevertheless, good relations with retailer and improved packaging were also reported to be the influencing factors of consumers' decision (Table 42).

Table 42. Factors influencing consumers' decision for mango purchase

Influencing factors	No. of respondent	% of responses
1. Good quality	13	87
2. Availability in the market	9	60
3. Good price or low price	9	60
4. Good relations with retailer	2	13
5. Improved packaging	2	13
6. Others (guests, special occasions, etc)	2	13

4.4 Preferences of Institutional Consumer: Some case studies

Some leading limited companies namely Pran Group of Industries, Sajeeb Group of Industries, Square Food and Beverage Ltd, Abul Khair Group, Partex Group and Akij Group are producing mango juice and marketing their products throughout the country. The researchers able to conduct two interviews with the *Square Food and Beverage Ltd* and *Hashem Agro Processing Ltd* to know the information about mango purchase and factors influence their purchase decision. It was reported that Square and Hashem Agro Company purchased 300 tons and 1481 tons of mango in the last year (2016) from selected vendors (main suppliers) and farmers respectively with the prices ranged from Tk.24000 to Tk.28000 per ton (Table 43). They purchased mangoes only in the peak period (May-July). In this period, the price of mango in the local market became low due to plenty of supply. However, the companies do not import any mango from foreign countries. The price of mango was reported to be a principal factor that influenced them to a great extent followed by mango quality.

Table 43. Information on mango purchased during peak season in 2016

Product name	Manufacturer	Quantity purchased (ton)	Purchase period	Purchase frequency	Type of supplier	Purchase price (Tk/ton)
Mango Juice	Square food & Beverage Ltd.	300	May-June	Daily	Selected vendor	24000-26000
Shezan Juice Pack	Hashem Agro Processing Ltd.	1481	June-July	Daily	Farmer	26000-28000

4.5 Information and Communication

Different traders collected information relevant to mango supply chain from various sources. Most of the traders (70-100%) collected relevant information from other mango growers or neighbours. About 24% and 18.4% traders collected relevant information from *Arathdars* and daily newspaper respectively. *Faria* and *Bepari* also gathered information from other traders (Table 44).

Table 44. Sources of information relevant to mango supply chain

Information sources	% of responses			
	Faria (n=15)	Bepari (n=10)	Retailer (n=13)	Al traders (n=38)
1. Other farmers/neighbour	86.7	70.0	100	86.9
2. Arathdar	20.0	40.0	15.4	23.7
3. Newspaper	20.0	10.0	23.1	18.4
4. Other traders	13.3	20.0	--	10.5
5. Pesticides dealers	--	--	23.1	7.9

Respondent mango traders were asked to answer the question how they assess collected information in terms of accuracy and reliability. They assessed the collected information in many ways. About 66% traders thought that the collected information was seemed to be accurate and reliable when they got benefit from the information. Again, 29% traders thought their collected information to be accurate and reliable when it was come from reliable persons. Some traders (21.1%) considered their collected information to be accurate and reliable, when it was true in practice. When mango traders (21.1%) collected information from their business partner, they considered it accurate and reliable. Sometimes they verified their collected information through consultation with fellow traders (Table 45).

Respondent traders considered some of their sources of information credible for various reasons. The best credible source of information to the traders was mobile phone which was reported by 79% traders. Using this device they can collect mango trade related information from different sources incurring low cost. Personal contact with other traders was the second most important credible source of information. Some traders also considered *Arathdar* and television to be the creditable sources of information to them.

Table 45. Assessment of collected information in terms of accuracy and reliability

Assessment criteria	% of responses			
	Faria *(n=15)*	Bepari *(n=10)*	Retailer *(n=13)*	All traders *(n=38)*
1. When we get benefit from the information	66.7	40.0	84.6	65.8
2. Collect information from reliable person	26.7	40.0	23.1	29.0
3. Collect information from business partner	20.0	30.0	15.4	21.1
4. When corrected information proved true in practice	20.0	20.0	23.1	21.1
5. Verify collected information with others	6.7	20.0	15.4	13.2

They mentioned various reasons for considering these sources to be credible. About 42-66% of the traders opined that these sources of information required less cost and time. They could easily get correct information using these sources. A good section of traders also mentioned that they used these sources because many traders use it and correct information could help reducing postharvest losses. Detailed can be seen in Table 46.

Table 46. Credible source of information and the reasons of its credibility

Particulars	% of responses			
	Faria *(n=15)*	Bepari *(n=10)*	Retailer *(n=13)*	All traders *(n=38)*
A. Credible source of information				
1. Mobile phone	66.7	90.0	84.6	79.0
2. Personal contact	26.7	10.0	23.1	21.1
3. Arathdar/trader	20.0	--	--	7.9
4. Television	13.3	--	--	5.3
B. Reasons for its credibility				
1. Required low cost	66.7	40.0	84.6	65.8
2. Required short time	26.7	50.0	53.8	42.1
3. Getting correct news	46.7	30.0	15.4	31.6
4. Many people can use	13.3	--	15.4	10.5
5. Correct news reduce postharvest losses	13.3	10.0	7.7	10.5
6. Reliability with the businessmen	6.7	10.0	15.4	10.5

Most of the traders (76.3%) usually share their collected information with other persons to confirm its reliability. Among traders the highest percentage of *Faria and Bepari* (80-93.3%) shared collected information with others. The sharing persons were reported to be other traders, *Arathdar,* and farmer. About 47.4% traders mentioned that they shared information with others in order to know the market price and product supply situation in the market. About 21.1% and 16% traders reported that they shared information with others for getting reliable information and searching loss reducing mango varieties respectively. Some traders shared information with others for verifying collected information and maintaining similar rate of mango purchasing (Table 47).

Table 47. Share collected information with others and the reasons of sharing

Particulars	% of responses			
	Faria (n=15)	Bepari (n=10)	Retailer (n=13)	All traders (n=38)
A. Share information with others				
Yes	93.3	80.0	53.8	76.3
No	6.7	20.0	46.2	23.7
A. Share information with:				
Other traders	66.7	80.0	53.8	65.8
Arathdar	40.0	--	7.7	18.4
Farmer	13.3	10.0	--	7.9
B. Reasons of sharing				
1. Ensuring correct market price & supply	66.7	50.0	23.1	47.4
2. For getting reliable information	20.0	10.0	30.8	21.1
3. To identify loss reducing variety	13.3	10.0	23.1	15.8
4. For verifying information	13.3	20.0	7.7	13.1
5. Maintaining same rate for purchasing	6.7	10.0	--	5.3

Most of the respondent traders (76.3%) told that other traders/persons also discussed information with them. Nearly 24% traders told that other traders/persons did not share information with them. The other persons who discussed information with them were reported to be other traders, farmers, buyers, neighbours and company agent. Among these persons, the highest percentage (71.1%) of other traders discussed information with them. They discussed on various issues such as daily market price, supply and demand situation, presence of mango traders (*Bepari*) in market, and quality & variety of mango. The highest percentage of other persons (73.7%) discussed about daily market price of the produces followed by supply and demand situation (50.0%). Detailed can be seen in Table 48.

Table 48. Other traders discuss information with you

Particulars	% of responses			
	Faria (n=15)	Bepari (n=10)	Retailer (n=13)	All trader (n=38)
A. Other discusses information with you?				
Yes	86.7	90.0	53.8	76.3
No	13.3	10.0	46.2	23.7
B. Persons discussed with them				
1. Other trader	86.7	80.0	46.2	71.1
2. Farmer	26.7	30.0	7.7	21.1
3. Buyer	6.7	--	7.7	5.3
4. Neighbour	6.7	--	7.7	5.3
5. Company agents	--	20.0	--	5.3
C. Subjects of discussion				
1. Daily market price of mango	80.0	90.0	53.8	73.7
2. Supply and demand situation	46.7	70.0	38.5	50.0
3. Concentration of mango traders in market	20.0	20.0	--	13.2
4. Quality and variety of mango	6.7	10.0	15.4	10.5
5. About mango supplying places	13.3	--	--	5.3

4.5.1 Type of Information Needed

The key traders in the mango supply chain were asked about the necessity of information pertinent to food safety, food quality and reducing postharvest losses of mango. Nearly 82% traders felt the necessity of information in these regards. They raised different types of information such as political program (i.e. *Hartal*, transport strike), product demand & supply situation in the destination wholesale market, low-cost storage, good quality packaging, daily market price, techniques of quality maintenance, presence of buyers in the market, safe mango, and exact dose of ripening chemicals. Detailed can be seen in Table 49.

Mango traders were also asked about their preferred broadcast media though which they want to get their required information. In this regard they mentioned various broadcast media. The highest percentage of traders (58%) preferred television as the broadcast media because they enjoy it on a regular basis. The second most preferred broadcast media (55.3%) was reported to be mobile phone. It is easy to use and cost effective. About 53% traders preferred billboard to be placed in the market. It will easily be visible to most of the traders in the market. The other favorite broadcast medias were participating training program, distributing brochure or pamphlets, and showing video (Table 49).

Table 49. Need of information pertinent to food safety and quality and reducing post harvest losses

Particulars	% of responses			
	Faria *(n=15)*	Bepari *(n=10)*	Retailer *(n=13)*	All trader *(n=38)*
A. Information Need:				
Yes	60.0	100	92.3	81.6
No	40.0	--	7.7	18.4
B. Type of information needed				
1. Political program (hortal, strike, etc) and transportation situation	26.7	40.0	23.1	29.0
2. Quantity of demand and supply	20.0	30.0	46.2	31.6
3. Low cost storage	26.7	20.0	23.1	23.7
4. Improved packaging system	26.7	20.0	15.4	21.1
5. Daily market price	6.7	30.0	30.8	21.1
6. Product quality maintenance	13.3	30.0	7.7	15.8
7. Variety of mango	6.7	30.0	7.7	13.2
8. Presence of buyer in the market	13.3	20.0	7.7	13.1
9. Technique regarding safe mango	20.0	--	7.7	10.5
10. Exact dose of ripening chemicals	6.7	10.0	7.7	7.9
C. Preferred broadcast media				
1. Television	66.7	50.0	53.8	57.9
2. Mobile phone	60.0	60.0	46.2	55.3
3. Billboard	46.7	90.0	30.8	52.7
4. Participating training	26.7	--	30.8	21.1
5. Brochure	13.3	20.0	--	10.5
6. Video	--	10.0	15.4	7.9

4.4.2 Type of Educational Activity Needed

The traders in the mango supply chain needed some educational activities that will help in promoting food safety and quality and reducing postharvest losses of mango. Majority of the traders (71.1%) wanted to take hand-on training on food safety and quality that will help in

reducing postharvest losses and ensure food safety and quality. More than 47% traders thought that regular meeting among mango farmers and traders certainly enrich their current state of knowledge on food safety and quality. Some traders put emphasis on the regular field visits of extension workers with farmers which will reduce postharvest loss at farm level to a great extent (Table 50).

Table 50. Traders needed educational activities to promote food safety & quality and reduce postharvest losses of mango

Educational activities	% of responses			
	Faria *(n=15)*	Bepari *(n=10)*	Retailer *(n=13)*	All trader *(n=38)*
2. Hand-on training	26.7	100	100	71.1
1. Meeting among farmers/traders	40.0	80.0	30.8	47.4
3. Study tour	6.7	--	--	2.6
4. Regular field visits of extension workers	6.7	--	--	2.6

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Mango is one of the popular fruits in Bangladesh. Due to the lack of appropriate pre- and postharvest measures and inefficient marketing system, a plenty of mangoes are blemished every year. Sufficient data and information on these areas are lacking in Bangladesh. Therefore, an attempt was taken to assess the knowledge, attitude and practices (KAP) of key stakeholders in mango supply chains and the status of market opportunities in Bangladesh.

The study reveals that most of the stakeholders in the supply chain show positive attitudes towards crop maturity, safe mango, clean and disease free mango, good packaging and consumers' awareness, and take various postharvest measures keeping mangoes safe for the consumers. In most cases mango growers harvest mangoes at mature stage and use rice straw for placing mangoes immediate after harvest. Most growers do not use ripening agent at farm level, but traders apply it on semi-mature mangoes for early market and good price. In order to reduce spoilage and keep mango safe, most *Beparis* use plastic crates to transport mango from assemble markets to urban wholesale markets.

The average postharvest losses are 14.11% and 9.61% at grower and traders' level respectively. These losses occurred due to cut, cracks, bruising, insect-pest infestation, which are discarded during sorting & grading after harvest. Transportation and delayed sale are the two main causes of losses at traders' level. The highest loss has been recorded for retailer (4.64%) followed by Bepari (3.95%). This study identifies eight supply chains for mango marketing. The longest and prominent channel is *Farmer>Bepari>Urban Arathdar> Urban Retailer>Urban Consumer*. Farmers and *Farias* use different local carriers like bicycle, rickshaw, and van (manual cart) to transport mango. Trucks and pick up van have been mostly used by *Bepari* to transport mango from assemble markets to urban wholesale markets. *Faria* receives the highest net margin due to lower marketing cost and spoilage followed by retailer and *Bepari*. Major marketing problems in the supply chain are delayed sale and lack of buyers.

Most of the consumers purchase mangoes in the peak season from retailers. They also occasionally purchase imported mango during off-season. Good quality and price are the two major factors that influence them to purchase mango.

5.2 Recommendations

Based on the findings of the study, a number of measures are required to reduce postharvest losses and supply safe and quality mangoes for the consumers.

1. Mango growers should adopt **Good Agricultural Practices (GAP)** during pre- and postharvest management activities (less use of pesticides, proper harvesting, harvest at mature stage, harvest at least 20 days after applying pesticides, use of clean container, hot water treatment etc.). The Horticulture Research Centre of BARI in collaboration with Department of Agriculture Extension (DAE) may arrange pre- and postharvest management training and demonstration for the stakeholders in the mango value chain.

2. The total postharvest loss of mango at farm and traders level is about 24%. A huge amount of monetary loss is occurred every year due to postharvest spoilage. Hence, loss reduction strategies need to be introduced in the value chain. Therefore, the donor agencies and the government would make arrangement for funding to perform the pilot project establishing packhouse and cool chain management system for fresh fruits and vegetables.

3. The concerned authorities (Market Development Committee, Agriculture Information Service and Department of Agricultural Marketing, etc.) should take necessary steps for creating awareness about postharvest losses among the stakeholders in the supply chain. In this regard, technical know-how and technology related to postharvest management and nutrition should be disseminated through TV, radio, billboard, video, brochure, and mobile phone apps etc., which would have much impact on the reduction of postharvest losses.

4. Government should render due importance on the establishment of low temperature storage facility both at assemble and wholesale levels. The concerned authority may undertake pilot projects to establish limited number of low temperature storage facilities in production catchment areas and wholesale markets for high-value crops including mango.

5. To minimize wastage of mango, more small-scale processing facilities should be established in the intensive growing areas. Employment generation and women's involvement will be enhanced through this initiative.

6. Proper safety measures should be adopted in the assembled, wholesale and retail markets in order to ensure the nutrition and food safety for the consumers. The dosages of the recommended ripening chemicals need to be ascertained by continuous monitoring of DAE and law enforcing authority. The government and donor agencies should take initiative to establish ethylene gas based ripening chamber at assembled/wholesale market levels.

7. Continuous research is essential to mitigate diverse problems prevailing in the mango supply chain in Bangladesh. Therefore, BARI and Agricultural Universities in Bangladesh should strengthen their existing capacity in terms of postharvest research and development.

End Note:

Faria: *Faria* is a petty trader or small scale businessman that purchases produces from the farmers at village or local assemble market, and offer the same to the *Bepari* or *Arathdar*. Sometimes, he sells his produces directly to the local retailers or consumers. Their volume of purchase is generally low and use small local vehicle for transporting produces from field to assemble market.

Bepari: *Bepari* is a professional wholesale trader who makes his purchase from producer or *Faria* at the local assemble market, bring their consignment to the urban wholesale market and sell them to *Paikar* and retailer through *Arathdar*. Their volume of purchase is generally high and use large vehicle for transporting produces from assemble market to distant wholesale markets.

Arathdar: *Arathdar* is a commission agent who has a fixed establishment and operates between *Bepari* and retailer, or between *Bepari* and *Paiker*, or between *Faria* and *Bepari*. They take commission from both of the parties but generally they do not follow any standard rule to take commission. The rate of commission in the study areas varied from 8-10% of the total sell.

Paiker: Wholesaler in the consuming area is known as *Paiker*, who purchase from *Bepari* through *Arathdar* and sell those to the retailer. In mango marketing, the researcher did not find any *Paiker* in the study areas.

Retailer: The retailer, the last link in the marketing channel, buys produces from *Arathdar* or wholesaler/*Paiker* and sells these to the consumers.

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