

**MANGO VALUE CHAIN ANALYSIS AND DETECTION OF POST-HARVEST PROBLEMS AT FARMER AND TRADER LEVELS**

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***CERTIFICATE***

This is to certify that the thesis entitled “**MANGO VALUE CHAIN ANALYSIS AND DETECTION OF POST-HARVEST PROBLEMS AT FARMER AND TRADER LEVELS**” submitted to the Faculty of Agriculture, Sher-e- Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE IN PLANT PATHOLOGY**, embodies the results of a piece of *bona fide* research work carried out by **MD. MHAFUZUR RAHMAN**, Registration No. **12-04753**, under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

Dated:  
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**DEDICATED**

**TO**

**MY BELOVED PARENTS**

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## ABSTRACT

A survey study was conducted to analyse mango value chain and to determine post-harvest problem at farmer and trader levels. The survey was conducted during the periods of May to July, 2018 and March to May, 2019 in the Chapainawabganj district of Bangladesh. Three Upazillas namely Nachole, Shibganj and Bholahat were selected for collection of information on value chain in mango production and Kanshat of district Chapainawabganj, Baneshwar of Rajshahi and Mirpue-1 mango markets in Dhaka city were selected for value chain at marketing levels. The survey revealed that mango cultivation areas are being increased. Most of the farms were medium sized (60%) and farmers had 10-20 years' experience in mango cultivation. Harvesting by net with bamboo stick reported by the farmer were 73.33%. The trader mostly used plastic crates as packaging containers. The price of mango varied from Tk. 40 to 85 in the wholesale market. In the peak season maximum of 42.72% price was increased by the Bepari. Two significant fungi viz. *Colletotrichum gloeosporioides*, causal agent of anthracnose and *Botryodiplodia theobromae*, causal fungus of stem end rot were identified. The disease incidence of anthracnose and stem end rot were 16.00-33.00% and 9.00-21.00%, respectively. In value chain analysis some constraints like postharvest losses, storage problem, high transportation cost, high packaging cost, etc. were identified.

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## **CHAPTER I**

### **INTRODUCTION**

Mango (*Mangifera indica* L.) is a tropical as well as subtropical fruit belongs to the family Anacardiaceae. It is one of the most common and popular fruit of the world. Mango is often mentioned as the 'King of fruits' (Purseglove, 1972) because of its excellent flavor, attractive color, delicious taste and high nutritive value. Mango was originated in South-Asia-Malayan. Records suggested that it has been cultivated for more than 4000 years (Candolle, 1984). It is a juicy stone fruit. Mangoes are native to South-Asia from where the "common mango" or "Indian mango" has been spread worldwide to become one of the most widely cultivated fruits in the tropics. The fruit is native to India, Bangladesh, and Pakistan and it is the national tree of Bangladesh (Wikipedia, 2019). Mango is one of the most widely cultivated and globally traded fruit fruits in the world. It is produced in more than 85 countries in the world. The total amount of mango production in the world was around 35 million tons by the year 2009 (FAO, 2009). In 2010, mango covered an area of 4946 thousand hectares with a production of 37.12 million tons in the world. India occupies top position among mango growing countries of the world and produces 40.48% of the total world mango production. China and Thailand stood at second and third position among mango producing countries in the world with 4,366 and 2,551 thousand tons respectively. The other major mango producing countries in the world during 2010 were Thailand (2550 thousand tons), Pakistan (1784 thousand tones), Maxico (1633 thousand tones) and Indonesia (1314 thousand tones) respectively.

In 2010, Bangladesh was the top 8th country to produce mango cultivated in 170.8 thousand hectares of land, production was 1047.85 thousand metric tons and contributed 2.82% to world production (AgriXchange, 2019). Mango is a unique in its nutritional quality, taste, consumer's preference, etc., among the fifty kinds of fruits grown in Bangladesh (Ahmad, 1985). It occupies an area of 37,830 hectares of land with an annual production of about 116.2 million metric ton (BBS, 2016). Mango grows in almost all over Bangladesh but commercial and good quality mangoes are grown in the North-Western districts of the country. The leading mango growing districts of the country are Rajshahi, Chapainawabgonj and greater Dinajpur. Mango is seasonal cash crop of North-Western region of Bangladesh which dominates the economy of Rajshahi and Chapainawabgonj districts. More than 500 varieties of sweet edible mangoes are found in two districts. It is estimated that around 85% people of the mentioned districts are directly or indirectly dependent on mango cultivation and mango business. Chapainawabgonj is called the capital of the mango in Bangladesh. Most of the farmlands of this district are full of mango orchards where various kinds of mango are producing by farmers. Chapainawabgonj alone produces almost 275000 metric tons of mangoes from 22,000 hectares of land (DAE, 2019). The main parts of the mango production area are Shibgonj, Bholahat and Gomastapur upazillas (sub-district). Mango production provides more income to the farmers than any other crops. Mango production of the areas now on danger by different constraints like a high rate of pesticides, fertilizers, lack of fruit processing and preserving system, marketing facilities. There are ample scopes for expansion of mango cultivation in Bangladesh if we can be aware about these problems (Ajmary Sultana *et al.*, 2018).

Mango serves as a fundamental source of nutrition for rural populations (Vaysseres et al., 2012). It is an excellent source of dietary antioxidants, such as ascorbic acid, carotenoids and phenolic compounds (Ma et al., 2011). The fruit is popular due to its nutrients to health benefits, such as improved immunity, digestive health and eyesight, as well as a lower risk of certain cancers. Mango is low in calories but full of nutrients. One cup (165 g) of sliced mango provides: Calories: 99, Protein: 1.4 g, Carbs: 24.7 g, Fat: 0.6 g, Dietary fiber: 2.6 g, Vitamin C: 67% of the Reference Daily Intake (RDI), Copper: 20% of the RDI, Folate: 18% of the RDI, Vitamin B6: 11.6% of the RDI, Vitamin A: 10% of the RDI, Vitamin E: 9.7% of the RDI, Vitamin B5: 6.5% of the RDI, Vitamin K: 6% of the RDI, Niacin: 7% of the RDI, Potassium: 6% of the RDI, Riboflavin: 5% of the RDI, Manganese: 4.5% of the RDI, Thiamine: 4% of the RDI, Magnesium: 4% of the RDI, It also contains small amounts of phosphorus, pantothenic acid, calcium, selenium and iron (Elias, 2007; Healthline 2019). The mango fruit is susceptible to many postharvest diseases such as anthracnose (*Colletotrichum gloeosporioides*) and stem end rot (*Botrytis theobromae*) during storage under ambient conditions or even at low temperature. *Aspergillus* rot (*Aspergillus niger*) is another postharvest disease of mango (Vikaspedia, 2019). Proper post-harvest treatment packaging is required for maintaining better quality, extended shelf life, and having access to International markets (Anwar and Malik, 2007; Kumar, 2012). Good cultural practices can avoid the disease development and help in production of excellent fruits. Integrated disease management is considered as the most logical approach as preventive measures to minimize the disease severity (Alemu, 2014).

Anthrachnose and stem end rot are reduced by bagging mango fruits. Fruit bagging prevents pathogens from reaching the fruit, which protects them from several diseases that can cause major losses. Fruit bagging has been reported to reduce the incidence of anthracnose and stem-end rot in mango (Buganic et al., 1997; Hofman et al., 1997; Senghor et al., 2007; Chonhenchob et al., 2011). Thus, fruit bagging can be a beneficial practice for producing higher quality fruit, without or with less use of chemicals to control diseases. Pre-harvest application of Scholar fungicide (0.8 ml/liter), two weeks before harvest, significantly reduced disease development during storage of mango fruits. Post-harvest fungicide application gave better disease control and fruit color development, and resulted lower post-harvest disease incidence (Amin et al. 2015).

Value chain describes the activities which are required to bring a product or service from conception, through the different phases of production, delivery to final consumers, and final disposal after use. It is thus a conceptual tool that enhances an understanding of the factors that impact on the long-term profitability of a business. Mango is one of potential fruit crop produced in Bangladesh which has a significant contribution to the livelihood of small-scale farmers in the area thereby contributing to the income of the majority of smallholder producers as well as ensuring of food security. Moreover, mango is playing a crucial role in creation of business and employment opportunities for the many firms and commercial agents in the country. One of the most valuable tools is the value chain analysis, which provides businesses an advantage over their competition. Value chain analysis can help organizations to gain better understanding of key capabilities and identify areas for improvement.



It can help them to understand how competitors create value; and help organizations to decide whether to extend or outsource particular activities." A value chain is the full range of activities – including design, production, marketing and distribution – businesses conduct to bring a product or service from conception to delivery. For companies that produce goods, the value chain starts with the raw materials used to make their products, and consists of everything added before the product is sold to consumers. Value chain management is the process of organizing these activities in order to properly analyze them. The goal is to establish communication between the leaders of each stage to ensure the product is placed in the customers' hands as seamlessly as possible (Harrison, 2018). In Bangladesh, traditionally farmers are not organized and the supply chain is usually long, as it incorporates many middlemen in different stages from production to consumption. Getting the right agricultural inputs for production at the right time at a reasonable price is not easy for the individual farmer. On the other hand, there is a dominating role of the intermediaries (Collectors, Farias, and Commission Agents, etc.), hence farmers' bargaining power is very weak. As farmers do not have direct contact with the marketing companies or traders, and they usually do not add value to their produce before sending the produce to the market, ensuring fair price is uncertain. Therefore, farmers' income is usually low in the traditional supply chain of fruits (Alam, 2018). Efficient marketing system usually ensures higher producer's share, reducing the number of middlemen in the value chain, and restricting the marketing changes and mal-practices during marketing of farm products (Matin et al., 2008).

Considering the above facts, a survey was conducted with the following objectives:

1. To analyse mango value chain.
2. To determine post-harvest problem at farmer and trader levels.
3. To identify the pathogen that causes post-harvest diseases of mango in value chain.

## **CHAPTER II**

### **REVIEW OF LITERATURE**

Mango is the most important fruit crop in Bangladesh. Although mango is affected by large number of diseases, but some diseases are of great economic importance and are responsible for high loss in the mango production in our country. Even if we protect our crop and increase mango production, it is very essential to protect the fruits from post harvest rots as the post harvest losses are huge. To reduce the post harvest loss, it is essential to start protecting it in the field and then careful harvesting, hygienic handling, packaging and storage, temperature regulated transportation and finally intelligent marketing.

Ahmad (1985) stated that mango is a unique fruit in its nutritional quality, taste, consumer's preference etc., among the fifty kinds of fruits grown in Bangladesh. Bangladesh produces a large number of superior varieties of mangoes and these have wide demand in the market and are commercially important. Different varieties of mangoes are being produced in the country. Farmers have also been showing greater interest in commercial farming of sweet mangoes like Gopalbhog, Lengra, Fazlee, Khirsapati, and Amrapali owing to their high demand. The current consumption of fresh mango is almost one million tons and is growing with the growth of GDP and population.

FAO (2018) reported that the total amount of mango production in the world was around 47.13 million tons by the year 2017. More than 85 countries in the world cultivate mango. The number one mango producing country in the world is India. Production here reaches over 18 million tons, which is approximately 39% of the

global mango supply. The second largest mango producer is China with 4.77 million tons of mango. Thailand is the third largest mango producer in the world, with 3.4 million tons. Bangladesh holds the 8th position on the list among mango producing country in the world as it produces about 3.9 percent of the world's total mango production.

BBS (2016) reported that in Bangladesh, it occupies an area of 37,830 hectares of land with an annual production of 116,1685 metric ton (MT). In the summer, mango businesses lead the economy of this district. Most of the farmlands of this district are full of mango orchards where various kinds of mango are producing by farmers. Chapainawabgonj alone produces almost 152,285 MT of mangoes on 22000 hectares of land.

Dhaka Tribune (2018a) reported that mango grows in almost all of Bangladesh, but commercial and good quality mangoes grown in the North-Western districts of the country. The leading mango growing districts of the country are Rajshahi, Chapainawabgonj and greater Dinajpur. Mango is seasonal cash crop of North-Western region of Bangladesh which dominates the economy of Rajshahi and Chapainawabgonj district. More than 50 varieties of sweet edible mangoes can be found in Rajshahi and Chapainawabgonj district. It is estimated that around 85% people of these districts are directly or indirectly dependent on mango cultivation.

Malik *et al.*, (2010) indicated that international and domestic mango market is facing different issues regarding management of fruit at postharvest stage. Fruit quality losses cause significant economic losses. Preharvest climatic conditions and cultural practices affect the ultimate fruit quality.

HIES (2010) reported that Chapainawabgonj is called the capital of the mango in Bangladesh. In the summer, mango businesses lead the economy of this district. Most of the farmlands of this district are full of mango orchards where various kinds of mango are producing by farmers. The main parts of the mango production area are Shibgonj, Bholahat and Gomastapur upazilla (sub-district). 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.

Hussain (2010) stated that mango consumption in the domestic market is not only increasing, but also the demand of better-quality fruit at premium price has been reported. High incidence of disease, green-ripe fruit and poor cosmetic appearance of fruits results in loss of fruit quality and confidence of the consumers and reduces the profits of everyone from the grower to the retailer.

Vayssières *et al.*, (2012) stated that mango serves as a fruit crop and as a subsistence crop for family farms. As it ripens at the end of the dry season and at the start of the rainy season, the mango is a fundamental source of nutrition for rural populations. It is a highly seasonal tropical fruit, very popular among millions of people in the tropics. It also occupies a prominent place among the best fruits of the world. However, it is in constant demand, there is a pre-harvest scarcity and at times a post-harvest glut for this fruit. To increase the availability of this fruit throughout the year, the surplus production must be processed into a variety of value-added products.

Ma *et al.*, (2011) stated that mango fruit is an excellent source of dietary antioxidants, such as ascorbic acid, carotenoids, and especially phenolic compounds. Approximately 50% of all tropical fruits produced worldwide are mangos. As there has been increasing demand for mangos throughout the world, especially in the United States of America and in Europe, production has been increasing as well over the past decade. Dozens of Indigenous Fruit Tree Species (IFTs), although relatively unknown in global markets, are locally of large importance for food/nutrition security and income generation.

Ajila and Prasada (2008) reported that mango contains essential vitamins and dietary minerals. The antioxidant vitamins A, C and E compose of 25%, 76% and 9% of the Dietary Reference Intake (DRI) in a 165-gram (5.8-oz) serving. Vitamin B6 (pyridoxine, 11% DRI), vitamin K (9% DRI), other B vitamins and essential nutrients, such as potassium, copper and 17 amino acids are at good levels. Mango peel and pulp contain other phytonutrients, such as the pigment antioxidants carotenoids and polyphenols – and omega-3 and -6 polyunsaturated fatty acids, lignin, pectin and cellulose.

NFP (1989) reported that mango is nutritionally rich and provides energy to the extent of 74 Kcal/100 g. The fruit contains nearly 81 percent moisture, 0.4 percent fat and 0.6 percent protein. It contains nearly 17 percent carbohydrates and 0.4 percent minerals.

Elias (2007) stated that mango is a delicious fruit among all other fruits. They are also an excellent source of dietary fiber and vitamin C. A fruit with many properties has naturally found application for processing into several products.

Porter (1985) in his article on value chains and competitive advantage, showed that the competitive advantage of a firm stems from many discrete activities that the firm performs in designing, producing, marketing, delivery and support to its product as key components of the value chains. These activities contribute to the relative cost-effective position of the firm.

Rich *et al.*, (2009) stated that value chain analysis is conducted through a combination of qualitative and quantitative methods. Primary survey focusses group discussions, participatory rapid appraisals (PRAs), informal interviews, and secondary data sourcing all form the basis for the analysis. The information helps understand the linkages and structure of the value chain and serves as the basis for identifying many of the key constraints and policy issues that require further exposition.

Hasan (2010) reported, since ethylene is considered the only gaseous hormone to trigger fruit ripening, emphasis must be given on the inhibition of ethylene production to ensure safe and long postharvest life of climacteric fruits. Anti-ethylene compounds have been used for a long time in the extension of the postharvest life of horticultural commodities. He also reported that 4-16% of the growers were involved in ripening of mango using chemicals. Calcium carbide was used by 4-20% mango growers followed by Ripen-15 (0-12%). Results also showed that 4-32% growers used straw for enhancing ripening, and they (60-92%) mainly sold unripe mature-hard mangoes. It was found that 8- 20% of the 'Beparies' were involved in chemical fruit ripening, whereas the value was 6-8% in case of the wholesalers.

Hasan (2010) reported, in Bangladesh mangoes are transported from the growers' field to the local assemble markets by rickshaw, van and bicycle and to the distant markets by truck. The truck is found to be the main transport vehicle to carry mango from the place of purchase to the distant markets. No '*Bepari*' is found to use a refrigerated vehicle to carry perishables despite the fact that refrigerated vehicle is used to carry perishables in developed countries as part of cool chain management. The retailers mainly use vans to carry mangoes from the wholesale to retail markets. A large proportion of the retailers also use trucks to carry mango from the wholesale to the distant retail markets. The destination markets of the mangoes produced in Chapai Nawabgonj and Rajshahi districts are spread all over Bangladesh. However, most of the produced mango from Chapai Nawbganj and Rajshahi is delivered to different wholesale markets of Dhaka. Storage is essential for extending the shelf life of mangoes, regulating their supply to the market and for transportation to long distances. But modern storage of fruits and vegetables is virtually absent in Bangladesh.

Hewett *et. al.*, (1995) stated that production technology and climatic factors affect the fruit growth, as well as the postharvest storage behavior and fruit quality, including Physical weight loss, skin weight, seed weight, dry matter contents, Juice percentage, seed length, cosmetic appearance (colour, firmness, size, shape, blemishes and disease).

Lechaudel and Joas (2007) stated that preharvest factors affect fruit growth during development and fruit quality attributes during its storage by changing the concentration of water, dry matter and biochemical compounds.



Kader (2002) observed that mature green mangoes should be stored at 13°C, while the partially ripened mango should be stored at 10°C. Though low temperature storage significantly extended storage life of mangoes, temperatures as low as 8°C caused considerable damage due to chilling injury, which is characterized by uneven ripening, poor colour and flavour, surface pitting, grey scald-like skin discolouration, and increased susceptibility to decay and flesh browning. Cold storage facility is only available for potato, except a very few multi-chambered and privately-owned low temperature storage facilities in Bangladesh, where the wholesalers keep high-value fruits, particularly the imported apples, orange, dates, pears and grapes. Very few growers and intermediaries adopt any technologies to prolong shelf life of fruits.

Anwar and Malik (2007) stated that in the present communication some of the post harvest diseases of mango are responsible for high loss in the mango production in our country. Anthracnose and stem end rot are two major post harvest diseases which cause great loss in the mango production in Bangladesh. Proper postharvest treatments and packaging are required for maintaining better quality, extended shelf life and having access to international markets.

Anwar *et al.*, (2006) indicated that the local mango industry is constrained with some postharvest challenges. Most of our mangoes are packed in wooden crates; which apart from causing physical injuries and bruises to fruit during transit are being restricted in international markets on account of quarantine concerns and special disinfestation treatments necessary for international trade.

Bally *et al.*, (2009) stated that anthracnose and stem end rots are considered as the major constraint to increase the shelf life of mango fruit and have significant impact

on lowering price in domestic as well as international market. They also confirmed that the disease development of mango during postharvest life is associated with application of fertilizer during fruit growth and development stage.

Kabir (2002) showed that 30°C was the optimum temperature for the fungal growth of *Colletotrichum gloeosporoides* and pH- 5.6 was the optimum pH at which the crude extract of the fungal metabolite showed antimicrobial activity on the organism. Previously it had also been found that the maximum amount of antibiotic active compound was produced at pH 5.6 from *Colletotrichum gloeosporiodes* on PDA media.

Coates & Johnson (1993) indicated that stem end rot is caused by several fungi that infect before and after harvest. Stem end rot is caused by *Botryodiplodia theobromae* that can be controlled by dip in solution of mancozeb and iprodione.

Adeniyi *et al.*, (2011) stated that the optimum temperatures for the growth of *Botryodiplodia theobromae* were 200C, 250C and 300C, while light intensity has no effect on growth. Among several carbon sources, glucose and sucrose were found superior for growth. The potato dextrose agar with pH 6.0 was recorded the most suitable medium for the production of conidia of *B. theobroma*.

Alemu (2014) reported that integrated disease management is considered as most logical approach as preventive measure to minimize the disease severity. He also reported that the disease incidence and chilling injury disorder during mango storage were associated with the production locality. Stem end rots and body rots were the significant diseases. The disease severity of stem end rots was significantly higher in fruit harvested from subtropical site as compared to fruit of tropical sites.

Johnson *et al.* (1992) reported another reason for better protection of fruits from anthracnose and stem end rot, especially in pruned trees, may be associated with rains (less precipitation retention). Pruning practice decrease the disease incidence percentage both of anthracnose and stem-end rot in ripe fruits stored at room temperature.

Azad (2001) stated that postharvest fungicides application gave better disease control and fruit colour development and resulted lower postharvest disease incidence. To attain the absolute fruit quality fruit maturity at the time of harvest is the most primitive factor that must be taken under consideration. Maturity is the key factor of storage life and postharvest quality of mango fruit.

Malik *et al.*, (2015) showed that preharvest application of scholar (0.8ml/L) fungicide, two weeks before harvest, significantly reduced disease development during storage of mangoes cultivar. Further, that preharvest and postharvest fungicide application showed no effect on biochemical attributes.

Matin *et al.*, (2008) stated that efficient marketing system usually ensures higher producer's share, reducing the number of middlemen in the value chain, and restricting the marketing charges and mal-practices during marketing of farm products. It is, therefore, essential to study the existing value 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 value chain to ensure food quality and safety for the consumers.

Alam *et al.*, (2017) stated that most of the farmers had medium-sized farm size. This was because mango farmers were more prosperous than other farmers in this area and the average land size of the mango farmers were higher than the national average.

Hassan *et al.*, (2014) reported that the number of Fazli and Ashwina orchard were increasing year after year since the growers receive more profit than other varieties that have more suppliers and market competition.

Matin *et al.*, (2008) reported that appropriate transporting system usually ensures higher quality of mango, reducing the amount of damage in the mango value chain, and fulfill the market demand with quality farm products.

Khan *et al.*, (2014) stated that the most significant problem in mango cultivation is lack of fruit processing industry, delayed sale and decay of mango for improper handling.

Akhtar *et al.*, (2009) stated that proper transportation was another constraint in the mango trade. Growers and exporters were deprived of an adequate supply chain, inland transport, cargo, processing and packing facilities.

Ann *et al.*, (2013) reported that use of integrated management practices in the field can also give better results in postharvest disease management. Different fungicides including carbendazim and mancozeb were recommended for postharvest diseases.

Jabbar *et al.*, (2011) reported that anthracnose was a serious postharvest disease of mango in Pakistan and stem end rot was emerging as another postharvest disease which also causes fruit spoilage in storage.

## **CHAPTER III MATERIALS AND METHODS**

### **3.1. Duration and location of survey**

A survey was conducted during 2018-19 mango production season to find out present status of cultivation practices, marketing and to analyze mango value chain. The location of the study was Chapainwabgonj district. Three upazillas, namely Nachole, Shibgonj and Bholahat under the district and 10 farmers (respondents) from each upazilla were randomly selected with the help of upazilla Agriculture Officer and Sub Assistant Agriculture Officer, Department of Agricultural Extension (DAE), the National Organization for Agricultural Extension Service. During survey, procedures of cultivation, inter cultural operations, harvesting, sorting, packing, packaging and transportation of mangoes were recorded. Data on those procedures were recorded from 30 growers.

### **3.2. Collection of information about mango production**

Two pre-tested questionnaires were used to collect information on mango production technologies from farmers (Appendix I) and loss due to post harvest diseases at traders' level (Appendix II). To collect information on production technologies, mango orchard was visited and farmers were interviewed. To collect data on post-harvest problems in marketing channels mango traders (Faria, Beparies, Retailers) were directly interviewed.

### **3.3. Categorization of mango growers**

On the basis of orchard size, the growers were classified into four categories viz. large farmer, medium farmer, small farmer and very small farmer, where the large farmers had more than 500 trees, medium farmers had 100-500, small farmers had 50 to 100 trees and very small farmer had less >50 trees.

### **3.4. Experience of growers in mango production**

Thirty mango growers were selected and interviewed for collection data on their experience about mango cultivation. On the basis of year of experience, the respondents were classified into three categories as below:

Low experience	Less than 10 years
Medium experience	10-20 years
High experience	More than 20 years

### **3.5. Survey on marketing of mangoes**

Three wholesale mango markets were selected viz, Kanshat of Chapai Nawabganj, Baneshwar of Rajshahi and Mirpur-1 of Dhaka were selected. Each market was visited three times during the harvesting month from May to July 2018 and March to May, 2019. The key traders involved in marketing chain (Farmer-Bairal-Bepari-Aratder-Retailer-consumer) were interviewed to collect data on various parameters.

### **3.6. Incidence of disease in market chain**

Disease incidence during marketing was recorded visiting the market chains and discussing with the traders. The disease was identified based on visible symptoms. If only one spot was found on a fruit it was considered a diseased. The disease incidence was calculated using the formula of Rai and Mamatha (2005) as shown below and expressed in percentage:

$$Disease\ Index\ (\%) = \frac{Number\ of\ infected\ mang\ X\ 100}{Total\ number\ of\ mango\ checked}$$

### **3.7. Identification and confirmation of mango diseases**

Mango diseases were identified based mainly visible symptoms (Champoiseau *et al.*, 2009). Confirmation of identification was done studying the causal fungi. Infected mangoes were collected from Beparies of Kanshat, Baneshwar and Mirpur-1 mango markets. The collected fruit samples were brought to the laboratory, Department of Plant Pathology, Sher-e-Bangla Agriculture University. Symptoms of the disease were recorded.

The causal fungi of anthracnose and stem end rot diseases were isolated following tissue planting methods on potato dextrose agar (PDA) medium (Tuite, 1969). To prepare PDA infusion of 200 g potato slices, 20 g Dextrose, 20 g Agar were mixed with 1000 ml water, boiled till melting of agar powder and autoclaved at 121°C for 15 min under 1.1 kg/cm<sup>2</sup>. Sterilized PDA was dispensed into sterile Petri dishes at 20-25 ml/dish.

The diseased samples were washed thoroughly under running tap water, cut into small pieces, surface sterilized with 4.0% NaOCl and rinsed thrice with distilled water. Three ply sterile moist blotting paper were placed in sterilized glass petridishes and surface sterilized pieces of mango fruits were placed on filter paper in petridishes. The inoculated petridishes were incubated in an incubator at 25°C. After 3-5 days of incubation a small portion of pure colony of fungi grew from the specimens were transferred to PDA plates. The pure cultures were allowed to grow on PDA plates for 8-12 days and the fungi were identified based on their morphology and morphometric using appropriate key book (Mordue, 1971).

## **CHAPTER IV RESULTS**

### **4.1. Survey on practices followed by growers during mango production and marketing.**

#### **4.1.1. Categories of mango growers**

The most of respondents were medium farmer (43.33% frequency) having 100-500 mango trees, 26.67% of farmers were small farmer having 50-100 mango trees and 16.67% were very small farmer having less than 10 mango trees. Only 13.33% were large farmers having more than 500 trees (Fig. 1).

#### **4.1.2. Experience of growers in mango production**

The experience in mango production of the respondent growers ranged from 4 to 30 years. The low and high experienced respondents were 16.7 and 23.3 % having less than 10 years and more than 20 years of experience, respectively. Significantly the highest frequency of 60.0% respondents were medium category having 10-20 years of experience (Fig. 2). The results indicate that age of most of the mango orchards are at least 10 years.

#### **4.1.3. Status of land area, number of trees and yield of mango**

A total of 30 farmers were interviewed to collect data on area, number of trees and mango fruit yield. Significantly ( $P=0.05$ ) the highest frequency of 53.3, 40.0 and 60.0% farmers (respondents) reported that their cultivation area, number of trees and fruit yield respectively of their orchards increased compared to previous years. The second highest frequency of farmers were 30.0, 33.3 and 33.3%, respectively and their cultivation area, number of trees and fruit yield decreased over previous years. On the other hand, the minimum frequency of 16.7, 26.7 and 6.7% farmers did not find any change in those three parameters (Fig. 2).



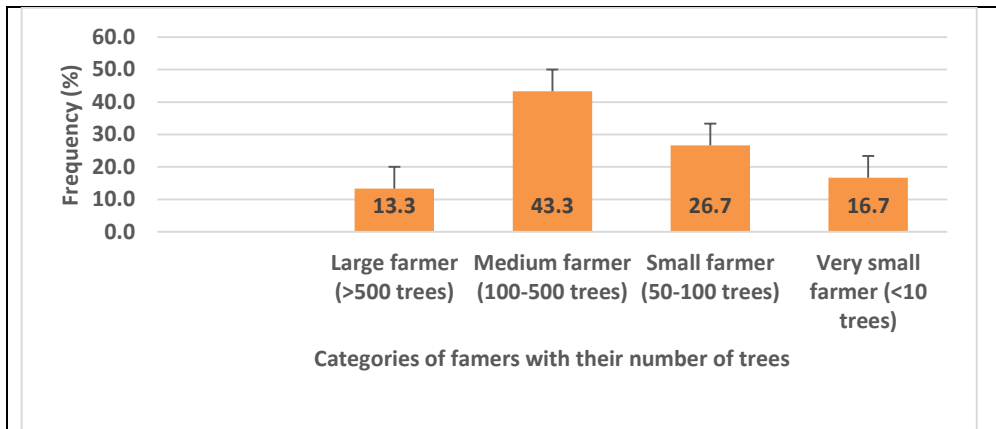


Figure 1. Frequency of farmers in four categories having less than 10 to more than 500 trees

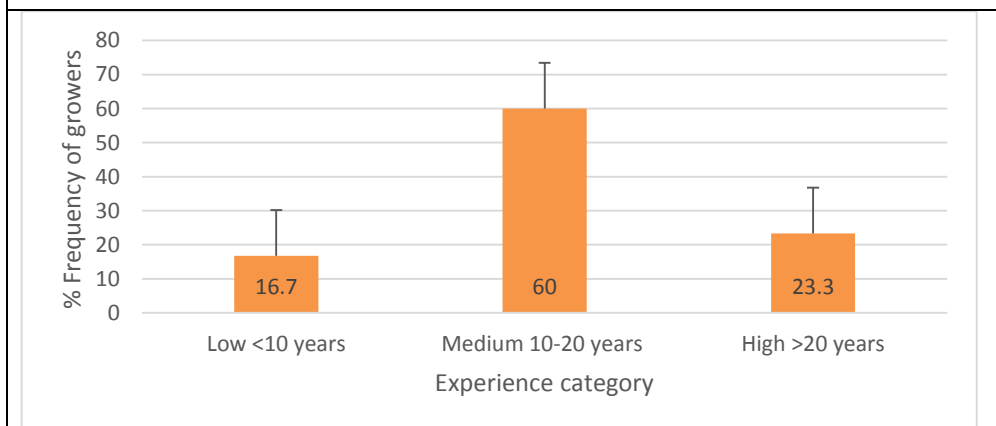


Figure 2. Frequency of mango growers under three categories having different years of experience

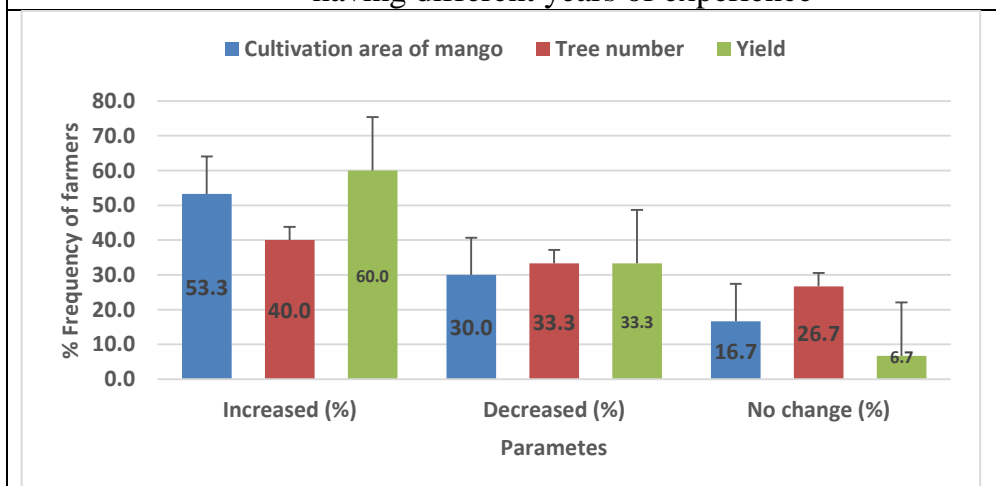


Figure 3. Frequency of responding mango farmers about their cultivation area, tree number and yield of mangoes.

#### **4.1.4. Varietal status of mango**

During the survey, the respondents reported that the most popular mango varieties in Chapainwabgonj are Fazli, Ashwina, Gopalvog, Langra and Khirsapati. Significantly the highest percentage of farmers grew the variety Fazli followed by Ashwina and Gopalvog. The least growing variety was Khirsapati followed by Langra. The frequency of farmers growing those varieties were 33.34, 26.65, 23.41, 10 and 6.60%, respectively (Fig. 4)

#### **4.1.5. Use of fertilizer**

During interviewing, all of the responding mango growers (100%) reported that they applied compost and cow dung every year. The second highest frequency of 93.3% growers used Urea and TSP, regularly. Frequency of MOP and Gypsum users were 83.3 and 53.3%, respectively (Fig. 5).

#### **4.1.6. Use of pesticide**

Mancozeb, Carbendazim and Cypermethrin with Chlorpyrifos applied by 76.7, 90.0 and 60.0% of the respondents, respectively for disease and insect control (Fig. 6).

#### **4.1.7. Harvesting, sorting and packaging of fruits**

Information on harvesting, sorting and packaging were recorded from 30 growers. Farmers reported that mangoes are harvested at full mature stage in the morning. They used net bags fixed on the tip of long bamboo sticks to harvest mango fruits from the big trees. Growers harvested mangoes by hand picking when trees are man height (Plate I).

#### **4.1.8. Sorting of mango**

After harvesting, mangoes were heaped on the orchard floor under the tree for 2-3 hours. The farmers sorted and graded the mangoes manually in their orchards. Damaged, diseased and rotten fruits were separated. Fruits were graded based on size (Plate II).

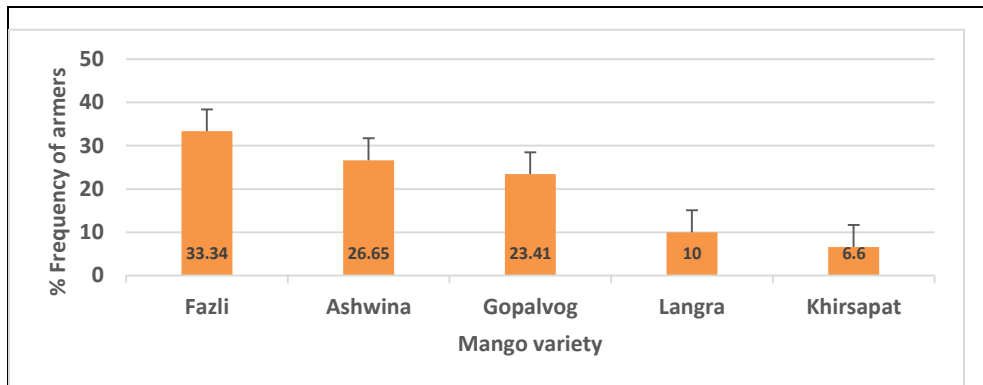


Figure 4. Frequency of farmers growing popular five varieties of mango in survey locations

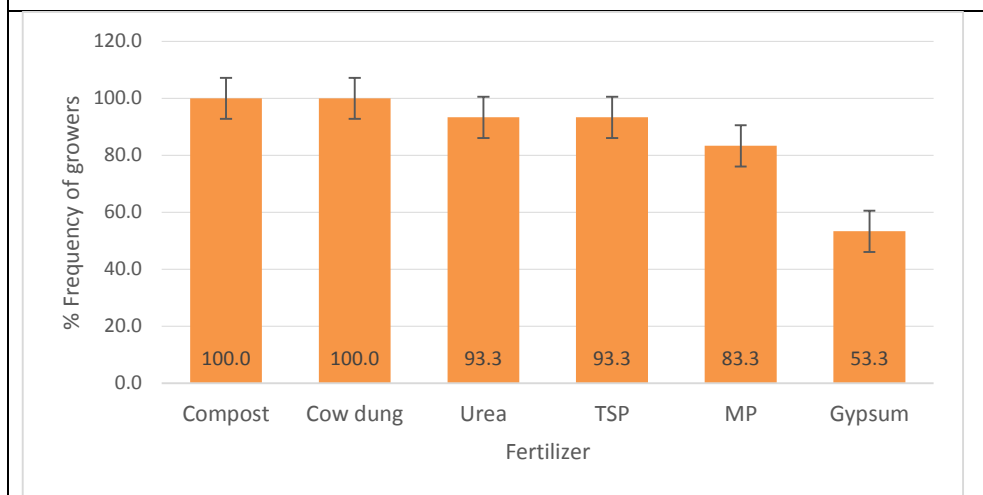


Figure 5. Frequency of mango growers used fertilizers

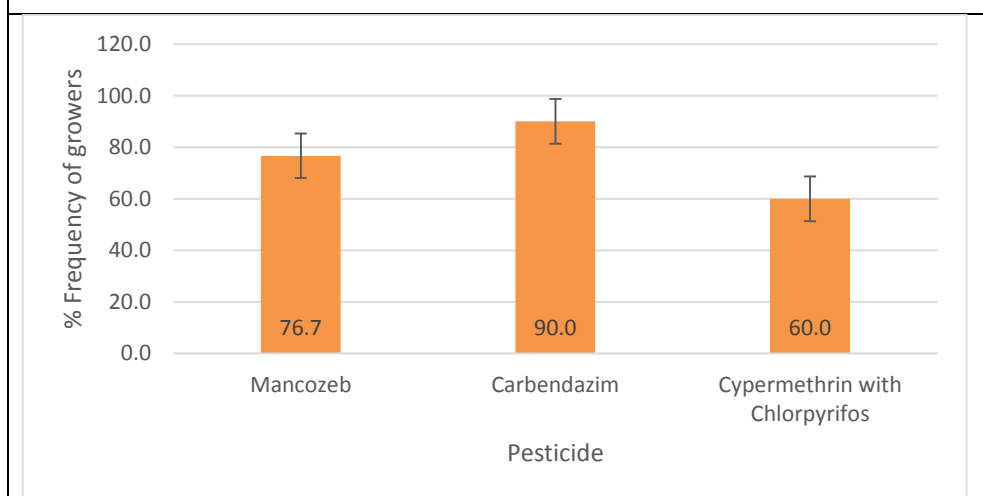


Figure 6. Frequency of mango growers used pesticides



Plate I: Photographs showing harvesting procedure of mango in orchards [(A). Picking mangoes from tree, (B)Collecting mangoes from net bag on baboo stick



Plate II : Photographs showing (A): heap of mango fruits for sorting and (B): procedure of sorting.

#### **4.1.9. Packing and Packaging of mango**

The mango farmers used old newspaper and/or rice straw for packing. Newspapers were used for packing mangoes and lining plastic crates and rice straw was used for packing and lining bamboo basket. After sorting different types of packaging materials were used. These included plastic crates, bamboo baskets and thick paper cartons (Plates III).

#### **4.1.10. Types of packaging container used**

During survey a mango grower was found to arrange mango fruits in thick paper cartoon lined with old newspaper (Plate IIIA). He also arranged mangoes in a plastic crate lined with same newspaper (Plate IIIB). The newspaper was also used as packing material in case both plastic crate and paper cartoon. In case of bamboo baskets, packing and lining material used was rice straw (Plates III and IV). After arranging the mangoes, top of plastic crate and paper cartoon were wrapped with newspaper, and that of bamboo basket with plastic net. All three types of packaging containers were tied with plastic rope (Plate IV). The most of the respondents (73.3%) used plastic crates with paper lining and paper packing. Bamboo basket lined and packed with rice straw were used by 20.0% respondents. The least 6.7% farmers used thick paper carton (Fig. 7).

#### **4.1.11. Mode of Transportation**

In the survey areas, the most important and widely used marketing channel of mango was found to be Farmer to Bepari to Aratdar in local markets and to Aratdar in Dhaka city wholesale market to Retailer to Consumer. All of the marketing actors used different types of vehicles depending on quantity of mangoes, distance of markets and type of traders. Farmers transported mango using different local low-cost carriers like bicycle, rickshaw and rickshaw van (Plate 5).

Trucks were mostly used for mango transportation by the *Beparies* (100%) from the assemble markets to the distant wholesale markets. Majority of the retailers (70%) used rickshaw/van and *Farias* (60%) used rickshaw/van and *Nosimon* (5 wheeler local vehicle) to transport their mangoes. The retailers (30%) and *Farias* (40%) used bicycle to transport their mangoes (Plate V and Fig. 8).



Plate III: Photographs showing packaging procedure of mango in the orchard (A): a farmer arranged mango inside the plastic crate and (B): arranged mango inside the plastic crate



Plate IV: Ptographs showing package of mango fruits in three types of containers: (A): plastic crates (B): bamboo basket and (C): thick paper carton

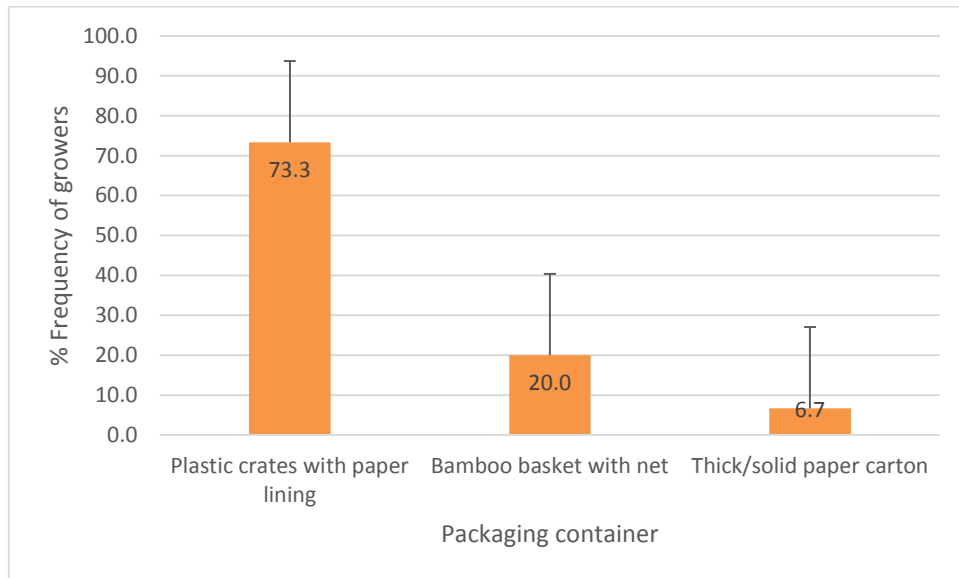


Figure 7. Frequency of mango growers used different types of packaging containers



Plate V: Photographs showing different types of transports used for mango transportation: (A): Truck loaded with plastic crates, (B): Nosimon loaded with plastic crates, (C): Rickshaw van with plastic crates and (D). Bicycle loaded with bamboo basket containing mangoes

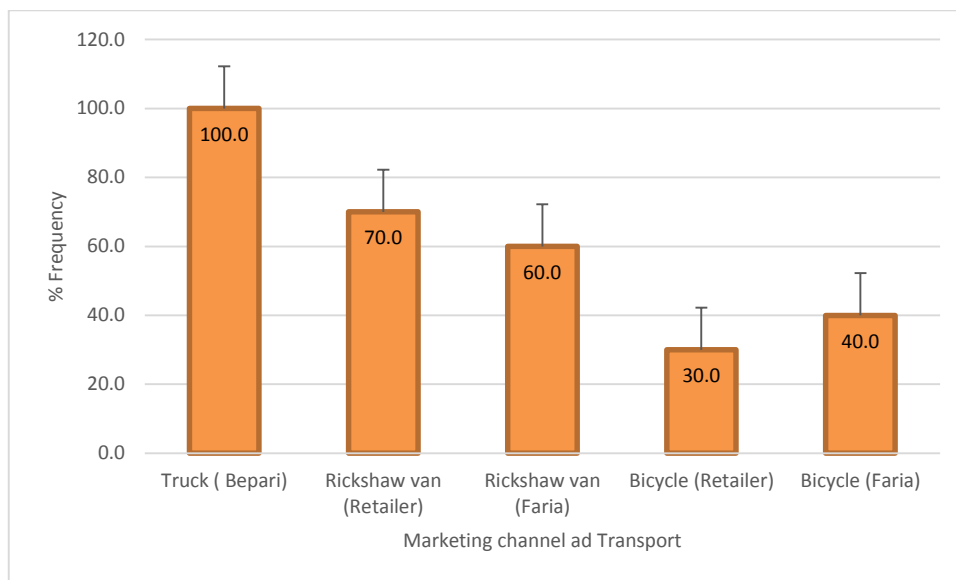


Figure 8. Frequency of actors in marketing channels of mango in Chapainawabganj district of Bangladesh

## 4.2. Mango marketing chain

### 4.2.1. Purchasing and selling price of mango

Only a few mango producers sold fruits directly to the consumers. Most of the producers sold to traders including Farias, Beparies, Aratders and Retailers worked in the marketing channel. At every stage of market channel, the middlemen obtained some profit. So, producers and consumers are deprived of fair price.

In peak period, the price of low-quality mango was increased by 28.9, 46.6 and 29.4%; and that of good quality mango was increased by 28.6, 38.9 and 20.0% at *Faria*, *Bepari*, and retailer levels, respectively. In lean period, the price of low-quality mango price was increased by 36.4, 33.3 and 30%, whereas the price of good quality mango was increased by 38.9, 36.0 and 17.7% at *Faria*, *Bepari*, and retailer levels, respectively (Fig. 9).

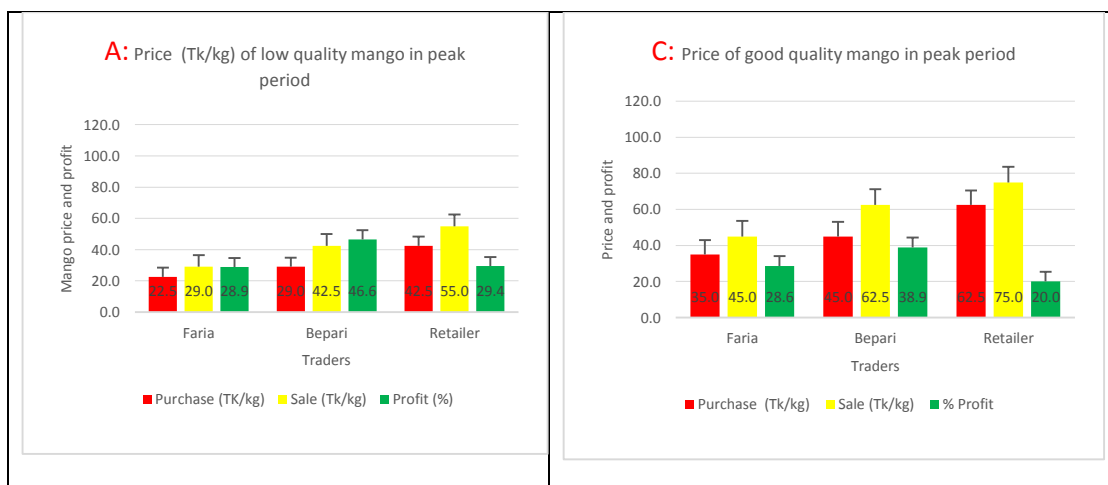


#### 4.2.2. Monthly price variation in four popular mango varieties

The mango variety, Gopalbhog was found available in the market in the months of May, June and July 2019, and the price was Tk. 55, 50 and 65/kg, respectively. The variety Langra was found in the market in June, July and August, and the price was Tk. 80, 55 and 75 /kg, respectively. The long duration variety Fazli remained available in the market in June, July, August and September, and the prices were Tk 45, 60, 85 and 70/kg. The late variety Ashwina was available during July, August and September and its price was Tk. 40, 50 and 65/kg (Table 1).

#### 4.2.3. Marketing costs and margin

Among different traders, Bepari spent the maximum average marketing cost of Tk. 8.63/kg followed by Faria at Tk. 3.92/kg and Retailer at Tk.2.85/kg. Beparis spent the highest costs due to higher cost of packaging (Tk.3.5/kg), transportation (Tk.3.0/kg) and Arathdar commission (Tk.1.5/kg) (Table 2). The highest gross margin was obtained by Bepari (Tk. 16.5/kg) followed by Retailer (Tk. 13.75/kg) and Faria (Tk. 11/kg). 7.87 Again, Retailer received the highest net profit of Tk. 10.09/kg followed by Bepari (Tk/kg) and Faria (Tk. 7.08/kg) (Table 3).



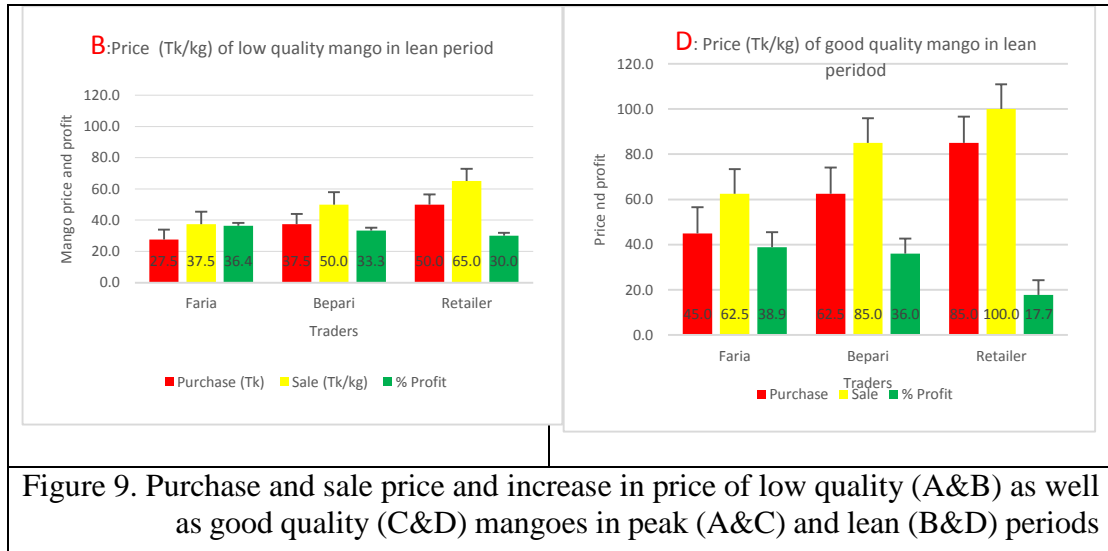


Table 1. Monthly price variation of four popular mango varieties

	Gopalbhog (Tk/kg)	Langra (Tk/kg)	Fazli (Tk/kg)	Ashwina (Tk/kg)
May	55		--	--
June	50	80	45	--
July	65	55	60	40
August	--	75	85	50
September	--	--	70	65

Table 2. Marketing cost of mango spent by the traders for different items

Trader	Item wise cost (Tk/kg)							Total (Tk/kg)
	Arathdar comission	Transportation	Cleaning & grading	Packaging	Sop rent	Market toll	Electricity	
Faria	--	1.30	0.05	2.50	--	0.07	--	3.92
Bepari	1.50	3.40	0.10	3.50	0.07	0.05	0.01	8.63
Retailer	--	1.20	--	--	1.50	0.05	0.10	2.85

Table 3. Marketing margin and net profit of different intermediaries

Traders	Average purchase price	Average sale price	Gross margin	Average marketing cost	Net profit
	Tk/kg				
	I	II	III=(II-I)	IV	V=(III-IV)
Faria	32.5	43.5	11.0	3.92	7.08
Bepari	43.5	60.0	16.5	8.63	7.87
Retailer	60.0	73.75	13.75	2.85	10.09

#### **4.2.4. Storage of mango in the market**

Beparies collected mangoes from Faria and stored in their storage in the market. Mangoes were found to keep in bamboo baskets which were placed on storage floor (Plate VIA) or directly heaped on the floor (Plate VIB). Sorting out of rotten mangoes was done in storage (Plate VIC). Beparies sold mangoes to whole sellers who sold to retailers or Beparies directly sold to Retailers.

#### **4.2.5. Postharvest loss of mango**

Losses of mangoes after harvest at different levels were reported by respondents (growers and traders).

##### **4.2.5.1. Postharvest loss of mango at farm level**

The postharvest loss of mango at farm level in the peak season was 60.00 kg/ton (6%) and in the lean season was 20.00 kg/ton (2%). Among the losses, 43.75% were damaged and 31.25% were rotten which had no market value at all, whereas 25.00% were blemished (semi-spoiled) that could sell at half of the price (Table 4).

##### **4.2.5.2. Postharvest loss at marketing level**

According to respondents the postharvest losses at trader's level were estimated to 75.00 kg/ton (7.5%), which was consisted of 62.67% completely damaged and 37.33% partial damaged mangoes. Partial damaged mangoes were sold at 50% of the selling price of good mangoes. Among intermediaries, the highest loss was recorded in case of Beparies (66.67%) followed by Farias (20.0%) and Retailers (13.33%) (Table 5).

#### **4.2.6. Disease problems in mango production**

According to responding growers four common diseases attacked mango trees. The diseases were anthracnose, powdery mildew, sooty mold and stem end rot. Anthracnose and stem end rot are mostly responsible for post-harvest fruit rot. Among the respondents 43.3, 30.0, 16.7 and 10.0% reported incidence of anthracnose, powdery mildew, sooty mold and stem end rot, respectively (Fig. 10).



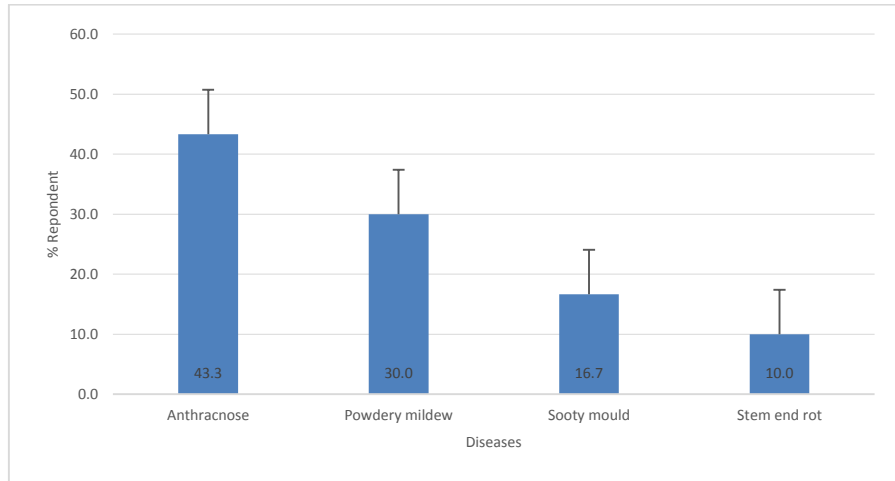
**Plate VI:** Storage of mango in the market (A). Collecting of mangoes from Farias (B). Stored mango in storage (C). Sorting mangoes by a wholesaler

Table 4. Postharvest losses of mango at farmers' level at peak and lean periods

Reasons	Peak season		Lean season		Total Loss	
	Quantity (kg/ton)	% of total	Quantity (kg/ton)	% of total	Quantity (kg/ton)	Percentage of total
Damage	25.00	41.67	10.00	50.00	35.00	43.75
Rotten	20.00	33.33	5.00	25.00	25.00	31.25
Blemish	15.00	25.00	5.00	25.00	20.00	25.00

Table 5. Total postharvest losses of mango at traders' level

Traders	Complete damage		Partial damage		Total damage	
	kg/ton	Loss %	kg/ton	Loss %	kg/ton	Loss %
Faria	10.00	21.28	5.00	17.86	15.00	20.00
Bepari	30.00	63.83	20.00	71.43	50.00	66.67
Retailer	7.00	14.89	3.00	10.71	10.00	13.33



**Figure 10. Frequency (%) of the respondents reported four diseases of mango**

#### **4.2.7. Problems in mango marketing**

The farmers and traders reported several problems in marketing of mangoes. Two problems were identified by the farmers, which were high cost of transportation and packaging materials. In case of traders, unstable price was the first problem followed by lack of capital and also high transport cost.

#### **4.2.8. Prevalence of postharvest diseases at market**

Incidence of anthracnose and stem end rot of mango varied appreciably from one month to another as well as one market to another. In case of anthracnose, the highest incidence was recorded in the month of July, 2018 in the Mirpur-1 market whereas the lowest incidence was recorded in the month of May, 2018 in the Kanshat market. In case of stem end rot, the highest incidence was recorded in the month of June, 2018 in the Baneshwar market whereas the lowest incidence was recorded in the month of June, 2018 in the Kanshat market (Fig. 11).

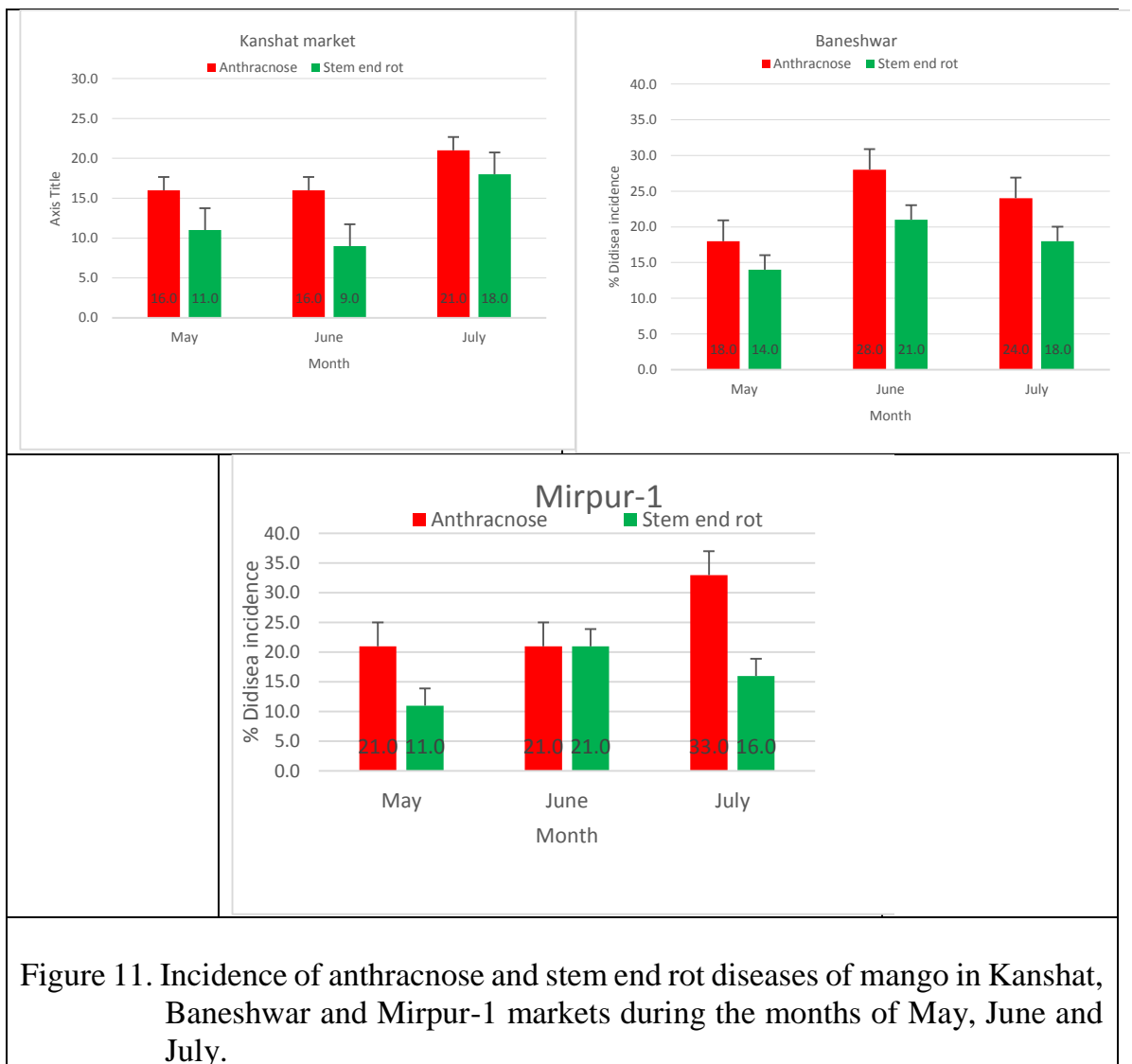


Figure 11. Incidence of anthracnose and stem end rot diseases of mango in Kanshat, Baneshwar and Mirpur-1 markets during the months of May, June and July.

#### 4.2.9. Identification of anthracnose and stem end rot disease and their causal fungi

##### 4.2.9.1. Symptoms on fruits and colony characters of causal fungus of anthracnose

Characteristics symptoms of anthracnose were observed on mango fruits (Plate VIIA&B). At 8 days of incubation colonies on PDA were grayish white to dark gray, acervulus was irregular in shape with setae, and conidia were hyaline unicellular and cylindrical (Plate VII C, D & E).

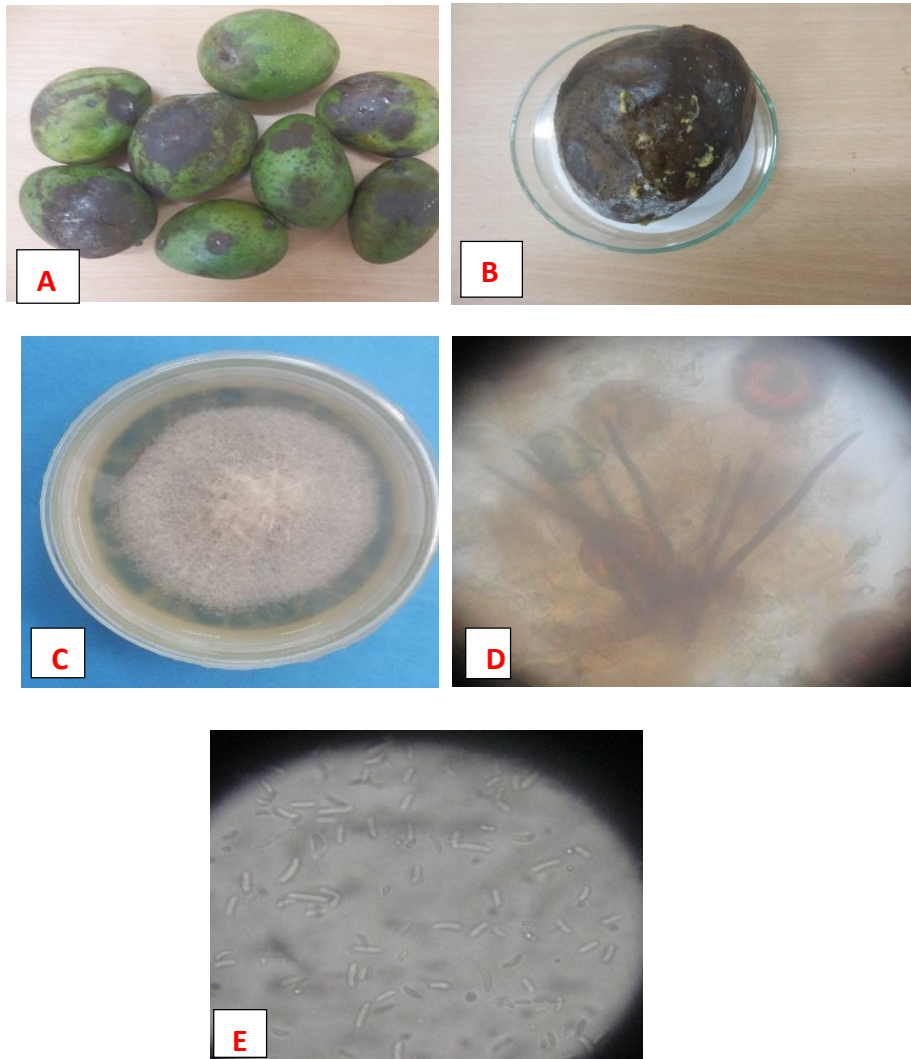


Plate VII. Symptoms of anthracnose in mango fruits and cultural characteristics of *Colletotrichum gloeosporioides* on PDA, A: infected fruit and B: mycelial growth on infected fruits, C: colony, D: acervulus with setae and E: conidia.

#### 4.2.9.2. Symptoms on fruits and colony characters of causal fungus of Stem end rot

Characteristics symptoms of stem end rot were found on mango fruits. After 12 days of growth on PDA, colony of *B. theobromae* grew rapidly showing characteristic colony character of the pathogen. Colonies on PDA were greyish black to blackish grey. Mycelia were hyaline. Conidia were dark walled, one septate (Plate VII A-D).

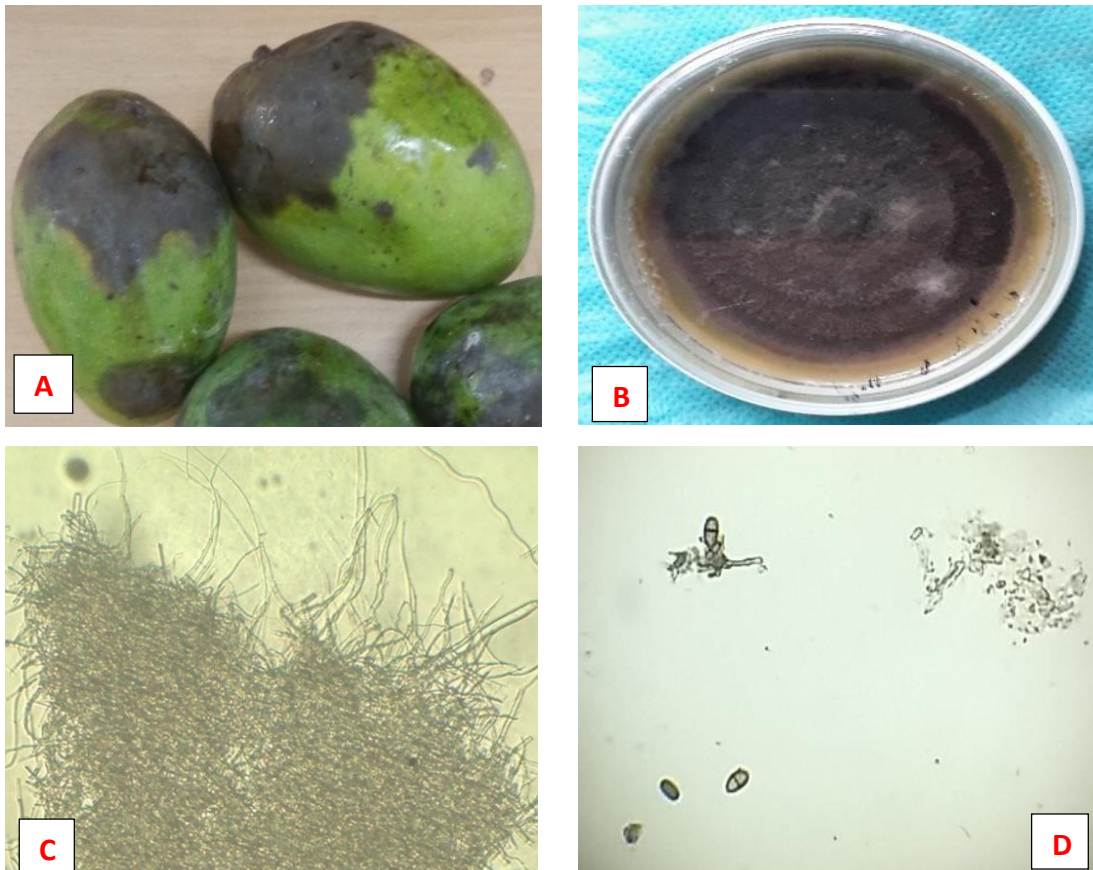


Plate VII. Cultural and morphological view of *B. theobromae* (A) Mango fruit showing stem end rot (B) Growth of *B. theobromae* on PDA media (C) Mycelia of *B. theobromae* (D). Conidia of *B. theobromae* isolated from mango fruit



## CHAPTER V

### DISCUSSION

A survey was conducted to analyse mango value chain and to determine post-harvest problem at farmer and trader levels. The survey was conducted during the periods of May to July, 2018 and March to May, 2019 in the Chapainawabganj district of Bangladesh. Three Upazillas namely Nachole, Shibganj and Bholahat were selected for collection of information on value chain in mango production and Kanshat of district Chapainawabganj, Baneshwar of Rajshahi and Mirpue-1 mango markets in Dhaka city were selected for value chain at marketing levels. The survey revealed that mango cultivation areas are being increased. Most of the farms were medium sized (60%) and farmers had 10-20 years' experience in mango cultivation. Harvesting by net with bamboo stick reported by the farmer were 73.33%. The trader mostly used plastic crates as packaging containers. The price of mango varied from Tk. 40 to 85 in the wholesale market. In the peak season maximum of 42.72% price was increased by the Bepari. Two significant fungi viz. *Colletotrichum gloeosporioides*, causal agent of anthracnose and *Botryodiplodia theobromae*, causal fungus of stem end rot was identified. The disease incidence of anthracnose and stem end rot were 16.00-33.00% and 9.00-21.00%, respectively. In value chain analysis some constraints like postharvest losses, storage problem, high transportation cost, high packaging cost, etc. were identified.

Survey study on mango cultivation practice and post-harvest value chain were conducted by many other workers around the world (Mandhar and Senthil, 1993; Joyce *et al.*, 1997; Matin *et al.*, 2008; Akhtar *et al.*, 2009; Hassan *et al.*, 2014; Sarkar *et al.*, 2014; Balyan *et al.*, 2015; Alam *et al.*, 2017; Jahangir *et al.*, 2017; Miah *et.*

*al.*, 2018). Sarkar *et al.*, (2014) reported that farmers (70%) are interested to increase their mango cultivation area because they had suitable mango land and favorable environment for mango cultivation. From India, Balyan *et al.* (2015) reported that total production increased mainly due to increase of mango cultivation area.

In present study it was found that most of the farmers (43.33%) had medium sized mango farm. Alam *et al.*, (2017) also observed that most of the farm were medium-sized farm in Bangladesh. They also observed that mango farmers were more prosperous than other farmers and the average land size of the mango farmers were higher than the national average. The number of Fazli variety (33.34 %) were increasing because these are the popular among different varieties. This result is supported by Hassan *et al.*, (2014) who observed that the number of Fazli and Ashwina orchard were increasing since the growers received more profit than other varieties and have more suppliers and market competition.

In the area of present survey, most of the farmers (60%) had medium (10-20 years) experience in mango production. This result is corroborated with Jahangir *et al.* (2017) who reported that 63.80% farmers had medium (10-20 years) experience in mango farming in Bangladesh. Sarkar *et al.* (2014) reported that 50% farmers had 10 to 15 years' experience in mango farming. Survey study revealed that 100% farmers used cow dung and compost to the mango trees while 93.33% used Urea and TSP. This result is also in agreement with Jahangir *et al.*, (2017) who reported that 95.20% farmers used Urea and TSP to their mango trees. Farmers used net with bamboo stick to harvest fruits at the matured stage from the big trees. Mandhar and Senthil (1993) reported that the damage to the fruit is found to be high in tree shaking method whereas use of net harvesters decreases the amount of damage.

Farmers reported that they sorted damaged, diseased and rotten fruits by hand in the orchard as well as in storage. Bryan et al. (1980) reported that the mechanically assisted manual grading was effective for sorting mangoes that contained higher number of decayed fruits that could be removed by conventional grading procedure. Joyce *et al.* (1997) reported that packaging of mango fruit following suitable method was helpful for managing postharvest diseases like anthracnose, stem end rot and skin blemishes. In the present study it was observed that the use of vehicles varied from traders to traders and most of the traders used Rickshaw van and Nosimon. Miah *et al.* (2018) also reported that majority of the *Farias* and retailers used rickshaw van and *Nosimon* (5-wheeler local vehicle) to transport their mangoes. Matin *et al.*, (2008) observed that appropriate transport system usually ensures higher quality of mango, reduce the damage of mango value chain, and fulfill the market demand with quality farm products. Akhtar *et al.*, (2009) pointed that lack of proper transportation is another constraint in the mango trading. Growers and exporters were deprived of an adequate supply chain, inland transport, cargo, processing and packing facilities. Hasan (2010) reported that, in Bangladesh mangoes are transported from the growers' field to the local assemble markets by rickshaw, van and bicycle and to the distant markets by truck.

In the present study, it was found that the price of mango varied from Tk. 40 to 85 in the wholesale market. According to BBS, (2013) report, the monthly price variation was Tk.33.97 to 81.58/kg. The highest marketing cost Tk. 8.63/kg spent by Bepari followed by Tk. 3.92/kg by Faria, and at Tk. 2.85/kg spent by retailer. Matin *et al.* (2008) reported that the highest marketing cost spent by Bepari followed by Retailer and Bairal.

In present study it was found that the average post-harvest loss of mango at farm level was 6.00% and at traders' level the average loss was 7.50%. This result is corroborated with Kamrul, (2010) reported that the average post-harvest loss of mango at growers' level was 4.40% and at traders' level the average loss was 7.67%. The important problem was higher cost of transportation and unstable price for farmers and traders. Similar problems have also been reported by Matin *et al.* (2008). During the present survey mango plants were mostly found to be attacked by Anthracnose, Powdery mildew, Sooty mould and stem end rot. Same diseases were reported by Jahangir *et al.* (2017). During May to July 2018 and March to May 2019, two fungal *C. gloeosporioides* and *B. theobromae* were identified. The fungus *C. gloeosporioides* is the major causal agent of mango anthracnose in almost all the mango growing countries of the world (Sangchote, 1989; Dodd *et al.*, 1991; Johnson and Coates, 1993; Akem, 2006; Awa *et al.*, 2012; Naqvi *et al.*, 2014). Johnson (2008) stated that *B. theobromae* is a causal fungus of stem end rot. The disease is a serious threat for the mango industry because it was difficult to control (de Oliveira Costa *et al.*, 2010). The highest incidence of anthracnose of mango was recorded (33%) in May, 2018 and the lowest incidence of anthracnose was recorded (16%) in the Mirpur market and Kanshat market. Sarkar *et al.* (2011) reported 37% anthracnose and 24% of stem end rot at marketing levels.

In the present study, the prominent marketing channel was Grower > Faria > Bepari > Retailer > Consumer. If the farmers can sell their mango directly to the ultimate consumers then they will get more benefit, but it would not be possible because of intermediaries are engaged to transfer mango from the farmers' field to distant consumers.

## **CHAPTER VI SUMMARY AND CONCLUSION**

A survey was conducted to analyse mango value chain and to determine post-harvest problems at farmer and trader levels. The survey was conducted during the periods of May to July, 2018 and March to May, 2019 in the Chapainawabganj district of Bangladesh. Three Upazillas namely Nachole, Shibganj and Bholahat were selected for collection of information on value chain in mango production and Kanshat of district Chapainawabganj, Baneshwar of Rajshahi and Mirpue-1 mango markets in Dhaka city were selected for value chain at marketing levels.

Survey revealed that cultivation areas of mango are increased every year. Most of the farmers (43.33%) had medium sized mango orchard. They preferred to grow Fazli variety (33.34 % farmer) because this is the popular among the mango varieties. Most of the farmers (60%) had medium (10-20 years) experience in mango production. It was found that 100% farmers used cow dung and compost to the mango trees while 93.33% used Urea and TSP. Farmers used net with bamboo stick to harvest fruits at the matured stage from the big trees. Farmers reported that they sorted damaged, diseased and rotten fruits by hand in the orchard as well as storage. It was observed that most of the farmers (73.33%) used plastic crates as packaging materials. The use of vehicles varied from traders to traders and most of the traders used van and nosimon. The price of mango varied from Tk. 40 to Tk. 85 in the wholesale market. It was found that the highest marketing cost was spent by Bepari followed by Faria and Retailer. The average post- harvest loss of mango at farm level was 6% and at trader level the average loss was 7.5%. The highest reported problem was higher cost of transportation and unstable price for farmers and traders.

The mango plants were mostly (43.33%) attacked by Anthracnose which was followed by Powdery mildew, Sooty mold and stem end rot. Two fungi namely *Colletotrichum gloeosporioides* and *Botryodiplodia theobromae*, were identified as causal agents of anthracnose and stem end rot, respectively.

The survey revealed that mango cultivation areas are being increased. Most of the farms were medium sized (60%) and farmers had 10-20 years' experience in mango cultivation. Harvesting by net with bamboo stick reported by the farmer were 73.33%. The trader mostly used plastic crates as packaging containers. The price of mango varied from Tk. 40 to 85 in the wholesale market. In the peak season maximum of 42.72% price was increased by the Bepari. Two fungi viz. *Colletotrichum gloeosporioides* and *Botryodiplodia theobromae* were identified as causal agents anthracnose and stem end rot, respectively. The disease incidence of anthracnose and stem end rot were 16.00-33.00% and 9.00-21.00%, respectively. In value chain analysis some constraints like postharvest losses, storage problem, high transportation cost, high packaging cost, etc. were identified. Although mango is a profitable crop, due to some constraints such as diseases infestation, higher cost of packaging materials and transportation few farmers have showed negative attitudes toward its production.

Based on findings of the present survey the following conclusions may be drawn:

- (i) Value chain analysis clearly reveal that mango growing areas are increasing every year.

- (ii) The most of the orchards have 100-500 plants and the popular mango varieties grown in Chapainawabganj district are Fazli, Ashwina, Gopalvog, Langra and Khirsapati.
- (iii) Farmers regularly use manure and fertilizers in mango orchards.
- (iv) Most of the growers use net fixed on bamboo pole to harvest mangoes.
- (v) Rickshaw van is the most common transport for short distance carrying and Truck is used for long distant carrying.
- (vi) The common marketing channel is Grower > Faria > Bepari > Retailer > Consumer
- (vii) Price of mango is dependent on mango varieties and month of harvest.
- (viii) The most common diseases of mango plants in orchards are anthracnose, stem end rot, powdery mildew and sooty mold. Of them anthracnose and stem end rot are common disease in storage.
- (ix) Lack of modern storage and transport, processing industries, high margin of traders, high cost of packaging containers, transport and production inputs, and uncertainty of market price are also notable problem in value chain of mangoes.

## CHAPTER VI

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## CHAPTER VIII

### APPENDICES

#### Appendix I. English version questionnaire used for collection of data from mango farmers

Name:----- .

Address: - Vill----- Upazilla----- Dist.-----.

(Please help by answering the following questions to collect data about mango production in our country. Give tick (√) marks more than one place, if necessary.)

1. Mango orchard-

Own  Contract

2. Area/farm size-

a) Increased  b) Decreased  c) No change

3. How many mango plants in your orchard?

a) <10  b) 50-100  c) 100-500  d) >500

4. Which varieties of mango plants are in your orchards?

a. Fazli  d. Langra   
b. Gopalvog  e. Ashina   
c. Khirsapat  f. Any other  (specify)-----

5. Experience in Mango farming: - a) <10  b) 10-20  c) >20

6. What kind of pesticides and fertilizers do you use in production season?

i)-----  
ii)-----  
iii)-----  
iv)-----

7. How many days do you stop using pesticides before harvesting mango?  
----- (days).

8. What are the yield in growing season in your orchard?

----- (ton/ha)

9. Generally in which stage, do you pluck mango?

i) Pre-matured

ii) Matured

iii) Over matured

10. How do you pluck the mangoes from the plants?



i)



ii)



iii)

11. Which strategy do you follow for packaging Mangoes?

d) Plastic crates

e) Bamboo baskets

f) Tick paper boxes

g) Any other  (specify)-----

12. Did you grade the mangoes before packaging?

Yes

No

13. Which following diseases have you observed in your mango garden?



i) Anthracnose



ii) Stem end rot

iii) Any others

14. What is your opinion about cultivation of mango?

Date:

Name and signature  
Researcher

**Appendix II. English version questionnaire used for collection of data from mango traders**

Name: -----.

Market Address: - Upazilla----- Dist.----- --.

(Please help by answering the following questions to collect data about mango production in our country. Give tick (√) marks more than one place, if necessary.)

1. Which varieties of mango do you sell?

- |              |                          |              |  |
|--------------|--------------------------|--------------|--|
| a. Fazli     | <input type="checkbox"/> | d. Langra    | <input type="checkbox"/>                   |
| b. Gopalvog  | <input type="checkbox"/> | e. Ashina    | <input type="checkbox"/>                   |
| c. Khirsapat | <input type="checkbox"/> | f. Any other | (specify)-----<br><input type="checkbox"/> |

2. Experience in Mango business----- (years).

3. Write down the availability and price of different mango varieties according to following table:

Mango varieties	Times of availability (Months)	Buying Price (Per kg)	Selling Price (Per kg)
Fazli			
Gopalvog			
Khirsapat			
Langra			
Ashina			



5. Which mode of transportation do you use during transporting mangoes?

- a) Trucks
- b) Tempos
- c) Pickup
- d) Any other  (specify)-----

6. Did you grade the mangoes before sell?

Yes  No

7. What are the major Problems in Mango marketing?

- a)----- c)-----
- b)----- d)-----

7. Which following diseases have you observed in your mango storage?



i) Anthracnose



ii) Stem end rot

iii) Any others

8. What is your opinion about mango business?

Good Business  Medium  Not good

Date:

Name and signature  
Researcher