Project ID #406

Competitive Research Grant

Sub-project Completion Report

on

Assessment of Postharvest Losses and Marketing Performances in Selected Vegetable Supply Chains in Bangladesh

Project Duration:

January 2017 to September 2018

Agricultural Economics Division
Bangladesh Agricultural Research Institute
Joydebpur, Gazipur-1701

Submitted to:
Project Implementation Unit-BARC, NATP 2
Bangladesh Agricultural Research Council
Farmgate, Dhaka-1215

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ABBREVIATIONS

AED	=	Agricultural Economics Division
BARI	=	Bangladesh Agricultural Research Institute
BARC	=	Bangladesh Agricultural Research Council
BBS	=	Bangladesh Buraue of Statistics
CAB	=	Consumers Association of Bangladesh
CIP	=	Country Investment Plan
CRG	=	Competative Research Grant
DAE	=	Department of Agricultural Extension
FAO	=	Food and Agricultural Organization
GAP	=	Good Agricultural Practice
GoB	=	Government of Bangladesh
HIES	=	Household Income and Expenditure Survey
HSC	=	Higher Scondary Certificate
IPM	=	Integrated Pest Management
KAP	=	Knowledge, Attitude and Practice
MSc	=	Masters of Science
MT	=	Mettric ton
NATP	=	National Agricultural Technology Program
NGO	=	Non-Government Organization
ROC	=	Return on Operating Capital
SAAO	=	Sub-Assistant Agriculture Officer
SDG	=	Sustainable Development Goal
SSC	=	Secondary School Certificate
USAID	=	United States Agency for International Development

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Executive Summary

Both production and consumption of vegetables in Bangladesh has been increased manifolds. Farmers use huge amount of fertilizers to boost up their production in one hand and use plenty of pesticides to protect their crops on the other. These efforts make vegetable production costly and toxic. Again, the hegemony of middlemen (*Bepari*) exists in the primary markets. They create overall demand and control price of vegetables that affect both farmers and consumers. The retail market has low marketing efficiency, high postharvest losses and does not foster competitiveness among buyers and sellers. The changing demand in domestic markets for vegetables creates both challenges and opportunities. So, efficient marketing is important to reduce enormous postharvest losses, and risk and uncertainty in timely delivery of quality and safe vegetables at reasonable prices to the consumers. Data and information relating to the aforesaid issues are lacking in Bangladesh. Therefore, the study was conducted in six vegetable growing districts namely Jamalpur, Mymensingh, Jessore, Rajshahi, Bogura, and Rangpurto assess the knowledge, attitude and practice (KAP) of producers and traders on postharvest practices and losses, and investigate vegetable market chains in order to identify market opportunities for producing and marketing safe produces to the consumers. Four summer vegetables namely brinjal, bitter gourd, yardlong bean and teasel gourd were considered for this study. Data and information for this study were collected from 320 farmers, 440 traders and 60 consumers.

Vegetable farmers concern with poor technology and low quality inputs, produce unsafe vegetables, and adopt poor postharvest practices. They indiscriminately use of pesticides to protect their crops. Insects-pests infestation, infection of viral and fungal diseases, higher price of pesticides, stem rot disease, scarcity of labour, and higher price of fertilizers are the major problems of vegetables production.Most farmers claimed to have adequate knowledge on safe vegetable production and proper postharvest practices, but they don't practice it due to various reasons. Although most farmers (61%) sell their produce to *Bepari* at the local markets, a good portion of farmers also sold vegetables at the crop field (39%). Both pre- and post-harvests practices are responsible for postharvest losses of vegetables at farm level. The total postharvest losses of brinjal, bitter gourd, yardlong bean and teasel gourd are 3.13, 3.23, 3.70 and 1.9% at farm level respectively. Postharvest loss is due to odd size, insect-pest infestation, disease infection, over maturity, physical creak and injury, and ripeness of vegetables. Farmers experience a total financial loss of Tk.48,303/ha. Volume of production, price, selling place, mode of transport, farming experience, spraying, and region had significant effect on postharvest losses of vegetables at farm level.

Most intermediaries involved in the vegetable supply chain have adequate knowledge on different postharvest practices in relation to reduce postharvest as well as monetary loss and keep vegetables safe for the consumers, and in most cases they claimed to practice it. A huge amount of vegetables move from farmer to consumer through two major channels: (i) *Farmer-Faria-Bepari-Paiker- urban retailer- urban consumer*; and (ii) *Farmer-Faria-Bepari-local retailer-local consumer*. The total postharvest loss of brinjal, bitter gourd, yardlong bean, and teasel gourd are 13.32, 18.03, 16.47, and 6.40% respectively at traders' level. The annual financial losses incurred at national level are Tk.3433.05 million and Tk. 2596.40 million when vegetables move through the above two channels respectively. The trader's level postharvest lossesare taken place at various stages in the supply chain such as sorting, cleaning, loading & unloading, packaging, and transportation. The highest marketing cost of selected vegetables was for urban retailer (Tk.610/quintal) followed by*Bepari* (Tk.608/quintal).The highest net margin was received by urban retailers for different vegetables. It was assumed that different intermediaries received reasonable net margin (Tk.93.0-Tk. 889.0/quintal) from vegetable marketing. Different marketing performance indicators reveals that local marketing channel (Chain-II) performs much better than urban channel (Chain-I) since the producer's share and marketing efficiency are higher and price spread is lower in the local channel. Return on operating capital for different intermediaries are also higher in local channel. Delay in transportation, higher transportation cost, lack of infrastructure, delayed sale, price fluctuation, harassment of traffic police, higher market toll and bad weather were the major problems faced by vegetable traders.

Consumers generally consider those vegetables safe for consumption which are free from pesticides & diseases, physically clean & fresh, and washed with clean water. Most consumers (87%) presumed that using higher dose of pesticides and fertilizers is the main cause of making vegetablesunsafe. The premium price the customers agreed to pay over market price for safe vegetables ranged from Tk 4.0 to Tk 15.0 per kg for different vegetables.

The study suggests different stakeholders to adopt good agricultural practices in producing vegetables, certify available safe vegetables for developing consumers' confidence,and ensure premium price of the safe vegetables for encouraging farmers towards safe vegetable production. It also suggests government to construct different infrastructuressuch as pack house, concrete floor, drainage, water & sanitation facility, and rest room for the

distant traders at the market premises. Development of awareness among producers, traders and consumers toward safe vegetable production, marketing and consumption is equally emphasized in this study.

CRG SUB-PROJECT COMPLETION REPORT (PCR)

A. Sub-project Description

1. Title of the CRG sub-project

Assessment of postharvest losses and marketing performances in selected vegetable supply chains in Bangladesh

2. Implementing organization

Agricultural Economics Division, Bangladesh Agricultural Research Institute (BARI)

3. Name and full address with phone, cell and E-mail of PI/Co-PI (s)

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4. Sub-project budget (Tk.)

4.1 Total: Tk. 17,24,685(Seventeen lac twenty four thousand six hundred eighty five taka only)
4.1 Revised (if any): Tk. 11,24,555 (Refund amount Tk. 4,54,180)

5. Duration of the sub-project

5.1 Start date (based on LoA signed): April, 2017
5.2 End date: 30 September 2018

6. Justification of undertaking the sub-project

The production and consumption of vegetables in Bangladesh increased manifolds with the increase of population. Most farmers do not follow good agriculture practices. They use increasing amount of fertilizers to boost up their production in one hand and indiscriminately use a plenty of pesticides to protect their crops on the other. All these efforts understandably make vegetable production costlierand toxic leading to lower returns from vegetable farming. It is thus important to generate field level information that are lacking in Bangladesh towards making vegetable production profitable to the farmers as well as safe for the consumers.

The hegemony of middlemen traders (especially *Bepari*) exists in primary markets. They create overall demand and control price of vegetables that affect both farmers and consumers to a great extent. Besides, the retail markets of vegetables are dominated by unorganized

retailers. The retail market has low marketing efficiency, high postharvest losses and does not foster competitiveness among buyers and sellers. Only a modern innovative system can reduce the vested interests of a large intermediary chain, create competition, assure safe produce and modernize operations in handling of vegetables. Again, the changing demand in domestic markets for vegetables creates both challenges and opportunities. So, efficient marketing is very much important to reduce enormous postharvest losses, and risk and uncertainty in timely delivery of quality and safe vegetables at reasonable prices to the consumers. Data and information relating to the aforesaid issues are lacking in Bangladesh.

7. Sub-project goal

Raise farmers and traders income through reducing postharvest losses from different segments of vegetable supply chains and ensuring safe produce for the consumers.

8. Sub-project objectives

a. To assess the knowledge, attitude and practices (KAP) of different middlemen toward post-harvest handling, losses as well as safe produce in selected vegetable supply chains;
b. To estimate postharvest losses at different segments of selected vegetable supply chains and to identify factors affecting postharvest losses at farm level; and
c. To assess the status of market opportunities through analyzing market performance of selected vegetables supply chains in the study areas.

9. Implementing locations

Four summer vegetables namely brinjal, bitter gourd, yardlong bean and teasel gourd were considered for this study. Based on BBS information (2014-15) on the area and production of the selected vegetables, six districts namely Jamalpur, Mymensingh, Jashore, Rajshahi, Bogura, and Rangpur were selected for this study.The rationale of selecting these areas was that a huge volume of vegetables transported from the study areas to urban cities like Dhaka and Gazipur.

10. Methodology in brief

In Bangladesh, a plenty of different types of vegetables are grown both in the summer and winter. In the past, supply chain analysis and postharvest loss assessment on different winter vegetables were given more emphasis on several studies compared to summer vegetables. Therefore, foursummer vegetables namely brinjal, bitter gourd, yardlong bean, and teasel gourd were purposively selected for the study. The Multi-stages sampling technique was followed to select sample respondents. At first, a total of six districts taking two districts for each selected vegetables were carefully chosen based on the area and production. Besides, theselected areas are the important vegetable pockets of many urban cities including Dhaka and Gazipur. Again, two highest vegetable growing *Upazilas* and then two Agricultural Blocks (ABs) from each district were selected in consultation with DAE personnel and concerned scientists of BARI in order to select respondent farmers. Thus the total number of ABs for each vegetables were eight. Finally, a total of 80 farmers taking 10 farmers from each block were randomly selected for each vegetable for interview. Thus the total number of selected farmers was 320. Again, based on specific supply chain, a total of 283 traders (*Faria, Bepari, Paiker*, and retailer) were interviewed from primary, secondary and terminal markets for this study. In most cases the vegetable markets situated in Upazila, district, and Gazipur-Dhaka City areas were considered as primary, secondary and terminal market respectively.

*Paikers*were found performing their business in the terminal markets. Finally, a total of 177 different categories of consumers (farmers, service holders, businessmen, housewives, etc.) were interviewed for this study. Data and information were collected on traded volume, distance transported, various marketing costs, mode of sales, purchase and sale prices, price formation, and marketing constraints. Other related data and information were gathered from various published sources. The study analyzed the knowledge, attitude and practices of different stakeholders toward safe produce, postharvest handling and postharvest losses in selected vegetables supply chains. It also analyzed postharvest practices and losses both at farm and trader's level. Tobit regression model was used for identifying factors affecting postharvest losses of vegetables at farm level. Finally, the study assess marketing opportunities through analyzing market performance (price spread, producer's share to consumer's price, marketing efficiency, and returns on operating capital) of different selected vegetables.

11. Results and Discussion (*pl. see the Attachment-1*)

12. Research highlight/findings

- Most farmers and traders have claimed that they have knowledge on safe vegetable production and proper postharvest practices regarding the reduction of postharvest/monetary losses, and keeping vegetables safe for the consumers, but most farmers don't practice it due to various reasons. However, intermediaries in most cases claimed to practice it.
- The total postharvest losses (PHL) of brinjal, bitter gourd, yardlong bean and teasel gourd at farm level are 3.13, 3.23, 3.70 and 1.90% respectively. This loss is due to odd size, insect-pest infestation, disease infection, over maturity, physical creak and injury, and ripeness of vegetables. The average financial loss of a sample farmer was Tk.48,303/ha due PHL.
- Volume of production, price, selling place, mode of transport, farming experience, spraying, and region had significant effect on postharvest losses of vegetables at farm level.
- A huge amount of vegetables move from farmer to consumer through two major channels: (i) *Farmer-Faria-Bepari-urban Paiker- urban retailer- urban consumer*; and (ii) *Farmer-Faria-Bepari-local retailer-local consumer*.
- The total postharvest loss of brinjal, bitter gourd, yardlong bean, and teasel gourd at traders' level are 13.32, 18.03, 16.47, and 6.40%of purchased vegetables respectively. The average annual financial losses incurred at national level are Tk.3334.05 million and Tk. 2596.40 million when vegetables move through the above two channels respectively. Postharvest loss will not be zero, but it could be minimized.
- The highest marketing cost for selected vegetables was for urban retailer (Tk.610/quintal) followed by *Bepari* (Tk.608/quintal). The highest net margin was received by different intermediaries for different vegetables.
- Different marketing performance indicators reveals that local marketing channel performs much better than urban channel (mentioned earlier) since the producer's share and marketing efficiency are higher and price spread is lower in the local channel. Return on operating capital for different intermediaries are also higher in local channel.
- Consumers consider those vegetables safe for human consumption which are free from pesticides & diseases, physically clean & fresh, and washed with clean water. Most

consumers (87%) presumed that using higher dose of pesticides and fertilizers is the main cause of making vegetables unsafe.

- The per kilogram premium price the customers agreed to pay over market price for safe vegetables ranged from Tk 4.0 to Tk 15.0 for different vegetables.
- Traders in vegetable marketing face different problems such as delay in transportation, higher transportation cost, lack of infrastructure, delayed sale, price fluctuation, harassment of police, higher market toll and bad weather.
- Adoption ofGAPs in vegetable production, certification of safe vegetables for developing consumers' confidence, ensuring the premium price of safe vegetables for encouraging farmers towards safe vegetable production, construction of infrastructures like pack house, concrete floor, drainage, water & sanitation facility, and rest room for the distant traders at the market premises, and development of awareness among producers, traders and consumers toward safe vegetable production, marketing and consumption are suggested in this study.

B. Implementation Position

1. Procurement

Description of equipment and capital items	PP Target		Achievement		Remarks
	Phy (#)	Fin (Tk)	Phy (#)	Fin (Tk)	
1. Laptop computer	01	100000	01	100000	
2. UPS (Offline)	01	7000	01	7000	
3. Portable hard disk	01	7000	01	7000	
4. Steel Almirah	01	24000	01	24000	
5. Visiting chair	03	12000	03	12000	
6. Bicycle	01	10000	01	10000	

2. Establishment/renovation facilities

Description of facilities	Newly established		Upgraded/refurbished		Remarks
	PP Target	Achievement	PP Target	Achievement	
					NA
					NA

3. Training/study tour/ seminar/workshop/conference organized

Description	Number of participant			Duration (Days/weeks/ months)	Remarks
	Male	Female	Total		
(a) Training					NA
(b) Workshop					NA

C. Financial and Physical Progress

Fig in Tk

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
A. Contractual staff salary	2,39,685	180000	176190	3,810	97.9	
B. Field research/lab expenses and supplies	3,25,000	311000	266300	44,700	85.6	

C. Operating expenses	2,60,000	207835	115365	92,470	55.5	
D. Vehicle hire and fuel, oil & maintenance	4,30,000	430000	366800	63,200	85.3	
E. Training/workshop/seminar	1,25,000	1,24,400	--	1,24,400	0	
F. Publications and printing	1,35,000	1,15,500	--	1,15,500	0	
G. Miscellaneous	50,000	50000	39900	10,100	79.8	
H. Capital expenses	1,60,000	1,60,000	1,60,000	--	100	
Total	**17,24,685**	**15,78,735**	**11,24,555**	**4,54,180**	**71.2**	

D. Achievement of Sub-project by Objectives: (Tangible form)

Specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output (i.e. product obtained, visible, measurable)	Outcome (short term effect of the research)
1. To assess the knowledge, attitude and practices of different stakeholders toward post-harvest handling, losses as well as safe produce in selected vegetable supply chains.	• Literature review • Vegetable & study area selection for this study • Prepared &pre-testing of survey questionnaire • Collected primary data from farmers, traders and consumers of vegetables. • Data editing and enter into computer • Data analysis	• A good number of literature collected • Four summer vegetables selected. • Six study areas selected • Prepared 3 types of questionnaire (farmer, trader, consumer) prepared • Pre-testing of questionnaire at one site • Interviewed 320 farmers, 283 traders and 177consumers. • Corrected data were entered into computer • Data analysis	• Most farmers and traders have adequate knowledge on safe vegetable production and proper postharvest practices regarding the reduction of postharvest/monetary losses, and keeping vegetables safe for the consumers, but most farmers don't practice it due to various reasons. However, intermediaries in most cases claimed to practice it.
2. To estimate postharvest losses at different segments of selected vegetable supply chains and to identify factors affecting postharvest losses at farm and trader's level.	• Collected primary data from vegetable farmers and traders • Data editing and enter into computer • Analysis of collected data	• Total PHL of brinjal, bitter gourd, yardlong bean and teasel gourd at farm level are 3.13, 3.23, 3.70 and 1.90% respectively. • Total PHL of above vegetables at traders' level are 13.32, 18.03, 16.47, and 6.40% respectively. • Volume of production, price, selling place, mode of transport, farming experience, spraying, and region had significant effect on PHs of vegetables at farm level.	• The financial loss of a farmer is Tk.48,303/ha due PHL. • The annual financial loss incurred at national level are Tk.3433.05 million and Tk. 2596.40 million when vegetables move through the channels (i) *Farmer-Faria-Bepari-Paiker- urban retailer- urban consumer*; and (ii) *Farmer-Faria-Bepari-local retailer-local consumer*, respectively.
3. To assess the status of market opportunities through analyzing supply chains for selected vegetables in the study area.	• Analysis of collected data	• A number of constraints related to production, marketing and consumption of safe vegetables were identified. • A number of challenges to establish a good supply chain through which farmers can increase their income through producing safe vegetables, intermediaries can earn normal profit, and consumers can buy	• The premium price for safe vegetables ranged from Tk 4.0 to Tk 15.0. • The current challenges are stopping indiscriminate use of pesticides, dissemination and popularization of Bt variety, ensuring premium price for safe vegetables, stopping middlemen's domination, and introducing cost-effective packaging for high value produce.

		safe produce with lower price were identified. • Marketing performance indicators measured.	• Above marketing channel-II performs better in terms of producer's share, marketing efficiency, price spread, and higher rate of operating capital.

E. Materials Development/Publication Made under the Sub-project

Publication	Number of publication		Remarks (e.g. paper title, name of journal, conference name, etc)
	Under preparation	Completed and published	
Technology bulletin/ booklet/leaflet etc.			NA
Journal publication			NA
Information development			NA
Other publications, if any			NA

F. Technology/Knowledge Generation/Policy Support (as applied)

1. Generation of technology (information/knowledge/non-commodity)

- Information on current knowledge, attitudes, and practice of farmers and intermediaries towards safe vegetable production and marketing.
- Quantity and magnitude of postharvest losses of selected vegetables with detailed sources,and factors of postharvest losses.
- Detailed marketing system of selected vegetables.
- Detailedcosts and margins of selectedvegetables at different levels of supply chain.
- Measures marketing performance
- Information on consumer's behaviour toward safe vegetables consumption and their willingness to pay premium price for safe vegetables.
- Recommendation on the rationing of fertilizers and bio pesticides for benefiting small and marginal farmers.
- Recommendation on training need for encouraging farmers and traders regarding safe vegetable production, marketing, and postharvest practices.
- Recommendation for infrastructure development at market premises.

2. Generation of new knowledge that help in developing more technology in future

- Similar information/knowledge has been developed in this study as stated in the previous section.

3. Technology transferred that help increased agril. productivity and farmers' income

- Government agency will provide hand-on training to the vegetable farmers on Good Agricultural Practices (GAP) along with diseases resistant variety, *Bt* variety, IPM technologies, and bio pesticides.
- Farmers will be encouraged to produce more organic vegetables due to receive premium price of the produces.

- Farmers may be financially benefited through establishing cooperative marketing society.
- Small and marginal farmers can be benefited through getting the higher share of subsidy if government take appropriate distribution system of chemical fertilizers and bio pesticides.
- Future recommendations on efficient supply chains will be possible for vegetable marketing.
- Develop awareness among producers, traders and consumers toward safe vegetable production, marketing, and reduction of post-harvest loss as well as financial loss in each segment of supply chain.
- Right measure to be taken by the Government will promote cost effective and appropriate post-harvest technologies regarding handling, packaging, and transportation.
- Adoption of appropriate postharvest loss reduction technology will increase the income of both producers and traders.
- With the help of data and information of this report, policy makers can formulate appropriate plan for developing the existing vegetable marketing systems in order to produce safe vegetables, reduce postharvest losses in the supply chain, and ensure safe and quality produce for the consumers.

4. Policy Support

- Since farm level postharvest loss is mostly depended on various pre-harvest practices, good agricultural practices (i.e. use of improved variety, disease free seedlings, less use of pesticides, use of more organic and less chemical fertilizers, use of sex pheromone traps as well as bio-pesticides, use of clean container during harvest, etc.) must be encouraged among vegetable farmers providing hand-on training, diseases resistant variety, *Bt* variety, IPM technologies, bio pesticides, and premium price of organic vegetables. The Department of Extension (DAE) should play a key role in this regard.
- Government should develop right mechanism (may be rationing) for providing more subsidy on chemical fertilizers and bio pesticides so that small and marginal category farmers can use it properly.
- Construction and renovation of village roads is important for reducing postharvest losses of vegetables to some extent.
- Farmers have no or little bargaining power for ensuring fair price of their produces. In this situation, farmers should be organized through cooperative marketing society for selling their produces for ensuring higher income.
- Stakeholders in the supply chain should be motivated for packaging of vegetables after proper sorting and grading (i.e. separate spotted, injured, and semi-spoiled vegetables from good ones). In this regard, a short-term training on post-harvest packaging and handling of produces may be provided to the respective stakeholders.
- Loss reduction strategies must be introduced in the supply chain.Therefore, the donor agencies and the government would provide fund for undertaking pilot project in establishing pack house and cool chain management system.
- Appropriate measures (strengthening govt. monitoring system, impose fine, fixing premium price of safe vegetables, certifying safe vegetables, etc) should be adopted in

assembling, wholesale and retail markets in order to maintain quality and safe produces for the consumers.

- The concerned authorities (Market Development Committee, Department of Agricultural Marketing and Agriculture Information Services etc.) should take necessary steps for the development of awareness regarding safe produce, food quality and postharvest losses among stakeholders in the vegetable supply chains. In this regard, technical know-how and technology related to postharvest management and nutrition should be disseminated through TV, radio, billboard, video, meeting, brochure and mobile phone apps, which would have much impact on the reduction of postharvest losses.
- Some traders are using plastic crates as packaging materials at the early stage of harvesting of some high value vegetables (tomato, bitter gourd, teasel gourd, cucumber, etc). Therefore, intermediaries must be motivated to use insertable plastic crates for vegetable packaging. To achieve this goal government should provide subsidy to the manufacturing company, so that the user can afford with lower price.
- The status of physical infrastructure at market premises is very poor. Therefore, government should construct pack house, well drainage facility, water and sanitation facility, rest room for distant *Beparis*, and concrete market floor at market premises.
- Branding plays a key role in attracting consumers for safe produce. If safe produces can be certified, then the consumers will be much more likely to buy them. Therefore, the available safe vegetables should be certified by some authority for developing consumers' confidence on safe vegetables. There are some government and non-government authorities (e.g. CAB) who supposed to take care food safety issues. Government monitoring system should be strengthened for ensuring safe produce for the consumers.
- Continuous research is essential to mitigate diverse problems prevailing in the vegetable supply chain in Bangladesh. Therefore, BARI and Agricultural Universities in Bangladesh should strengthen their existing capacity in terms of postharvest research and development.

G. Information Regarding Desk and Field Monitoring

i) Desk monitoring [description & output of consultation meeting, monitoring workshops, etc.]:

ii) Field monitoring (time & No. of visit, Team visit and output):

Monitoring team	Major observations/objections raised,if any	Status at the sub-project end	Time of visit
BARCteam	Verified project activities and collected data.	Good	06/02/18
GoB audit team (Foreign aid)	Verified all bills and vouchers and give advice on enumerators bill	Good	20/10/18

H. Lessons Learned

- The study of vegetable supply chains in relation to postharvest loss, and safe & quality produces is a complex and dynamic issue. It encompasses various aspects of production, marketing, and consumer's behaviour towards safe vegetable production, marketing and consumption.

- Close monitoring of vegetable lots and institutional/government supports are essential for fruitfully studyingthis complex issue.
- A study on the value chain of other vegetables may be conducted for generating data and information for overall recommendations.
- Finally, awareness toward safe vegetable production, marketing and consumption should be developed among different stakeholders of the supply chain actors, and consumers for developing a real safe supply chain of vegetables in Bangladesh.

I. Challenges

1. Stopping indiscriminate use of pesticides in vegetable production.
2. Development, dissemination, and popularization of *Bt* variety for vegetables.
3. Ensuring competitive price of vegetables for producers.
4. Stopping the domination of middlemen in the vegetable supply chain.
5. Certification of available safe vegetables for growing trustiness of the consumers.
6. Ensuring the premium price of safe vegetables for encouraging farmers.
7. Introducing safe and cost-effective quick transportation system for vegetables from primary market to urban markets.
8. Introducing cost-effective packaging for the selected vegetables.
9. Stopping illegal tolls and tips throughout the supply chain.

Signature of the Principal Investigator

Date …….

Seal

Counter signature of the Head of the organization/authorizedrepresentative

Date ……..

Seal

Attachment-1

ASSESSMENT OF POSTHARVEST LOSSES AND MARKETING PERFORMANCES IN SELECTED VEGETABLE SUPPLY CHAINS IN BANGLADESH





Dr. Md. Abdul Monayem Miah
Mohammad Shamsul Hoq

Implemented by:

Agricultural Economics Division
Bangladesh Agricultural Research Institute
Joydebpur, Gazipur-1701

Submitted to:

Project Implementation Unit-BARC, NATP 2
Bangladesh Agricultural Research Council
Farmgate, Dhaka-1215

SEPTEMBER, 2018

Chapter I

INTRODUCTION

1.1 Background

The importance of vegetables in the human diet is universally recognized. Vegetables are the major sources of vitamins and minerals without which the human body cannot maintain proper health and develop resistance to diseases. It also contains pectin, cellulose and various energy giving substances (www.choosemyplate.gov/vegetables-nutrients-health).The average per capita per day intake of vegetables has increased to 167.30 grams in 2016 (19.1%) from 140.47 grams in 2000 at national level (HIES, 2016). However, the present per capita per day consumption of vegetables is below the FAO recommendation of 220g (BBS, 2017).According to another estimation the desirable per capita per day intake of vegetables is 300gms (Delta plan-2100, 2017).

Bangladesh is producinga substantial amount of vegetables every year. In 2018, Bangladesh produced a total of 15.95 million tons of vegetables (DAE, 2018). It also exports a good amount of vegetables every year after satisfying its domestic needs. In 2016-17, Bangladesh exported different types of vegetables valuing Tk. 164.29 million which was 16.06% higher than its previous year's exports (BBS, 2018). Although we are sufficient in vegetable production based on the current per capita intake (167.3gm), but we are deficit by about 2.0 million tons (12.5% of total demand) if we consider desirable per capita per day intake of 300gm (Delta plan-2100). Therefore, Bangladeshis trying to increase vegetable production to some extent to fulfill the gap between current production and future demand. Among different vegetables, potato ranked the first in terms of both area and production (10.32 million tons) followed by brinjal(561.01 thousand ton) (DAE, 2018, BBS, 2019).

In accordance with the objectives of the study, considerable amounts of secondary data on area, production and prices of selected vegetables (brinjal, bitter gourd, yardlong bean, and teasel gourd) were collected from different secondary sources including books, journals,reports and online resources. The collected secondary data were analyzed and required tables and graphs were prepared to present and discuss the results. Apart from secondary data, an extensive survey was also conducted to collect primary data on the selected vegetables from various market actors using structured and pre-tested interview schedules.

1.2 Trend of Area and Production of Vegetables in Bangladesh

In order to understand the status of area and production of aforesaid selected vegetables over the period, trendanalyses were donefor the selected vegetables using secondary data.Secondary data were collected from various issues of BBS publications (*Yearbook of Agricultural Statistics*). The findings are discussed in the following sections.

1.2.1 Trend of area and production of brinjal

Brinjal is found available in the markets round the yearin Bangladesh. Currently, Bangladesh produces substantial amounts of brinjal annually. In 2017-18, 516.01 thousand metric tons of brinjal (summer & winter) were produced in the country (BBS, 2019). The production of summer brinjal showed slightly increasing trend (1.934% growth rate) except 2013-14 (Fig 1.1). By contrast, the production of winter brinjal decreased by 1.501% annually (Fig

1.2&Table 1.1). Regarding area coverage both summer and winter brinjal showed decreasing trend (decreasing at the rate of 1.42% and 1.85%). The gradual decrease in production of winter brinjal from 2000 to 2011 could be attributed to the corresponding increase in *Boro*rice and maize areas over the last several years (Hassan and Raha, 2013).After that period the production of winter brinjal showed steady growth. Again, the yield of both summer and winter brinjal significantly increased by 3.35possibly due to the introduction of new high-yielding and hybrid varieties and also due to the use of improved production technology (Table 1.1). Its production would have been further increased but the prime threat is the havoc caused by shoot and fruit borer (*Leucinodes orbonalis*). Recently, Bt brinjal, resistant to shoot and fruit borer, has been disseminated throughout the country.

Fig 1.1 Trend of area, production and yield of brinjal (summer) during 1999/00- 2017/18

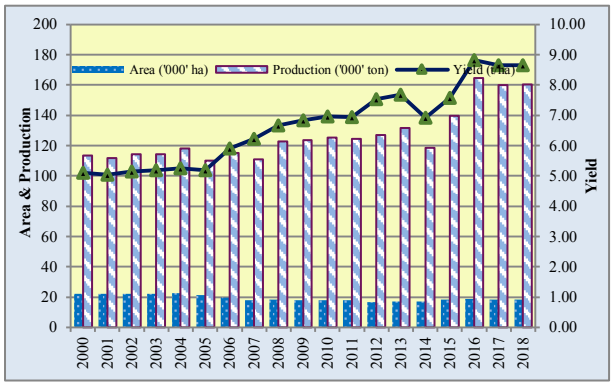
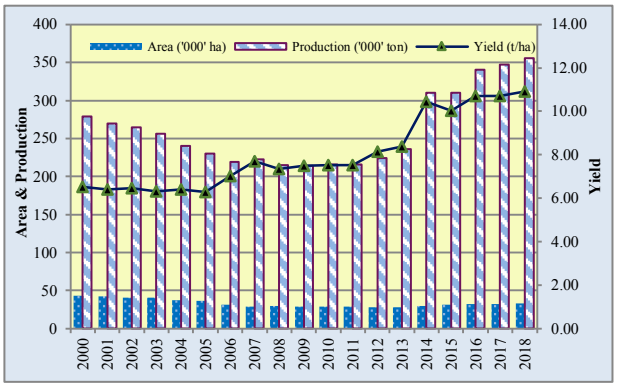


Fig 1.2 Trend of area, production and yield of brinjal (winter) during 1999/00-2017/18



Source: Various issues of BBS publications

Table 1.1 Annual growth rates of studied vegetables during 1999/00 to 2017/18

Vegetable	Area (ha)	Production (MT)	Yield (t/ha)
Brinjal (summer)	-1.415***	1.934***	3.349***
Brinjal (winter)	-1.845***	1.501**	3.345***
Bitter gourd	3.831***	6.280***	2.449***
Yardlong bean	3.749***	6.744***	2.995***
Teasel gourd	4.884***	6.844***	1.960***

Note: '***' and '**' represent significant at 1%, and 5% level.
Source: Author's calculation using various issues of BBS

1.2.2 Trend of area and production of bitter gourd

Bitter gourd is an important summer vegetable in Bangladesh. It is also somewhat found in the markets in the winter. Presently, Bangladesh produces substantial amounts of bitter gourd every year. In 2017-18, a total of 57.91thousand tons of bitter gourd were produced in the country (BBS, 2019). Figure 1.3 shows that the acreage and production of bitter gourd significantly increased by 3.83% and 6.28% respectively (Table 1.1). Besides, the yield of bitter gourd significantly increased by 2.45% might be due to the introduction of new high-yielding varieties and also due to the use of improved production technology such as proper fertilizer dose, irrigation, insect-pest control, etc.

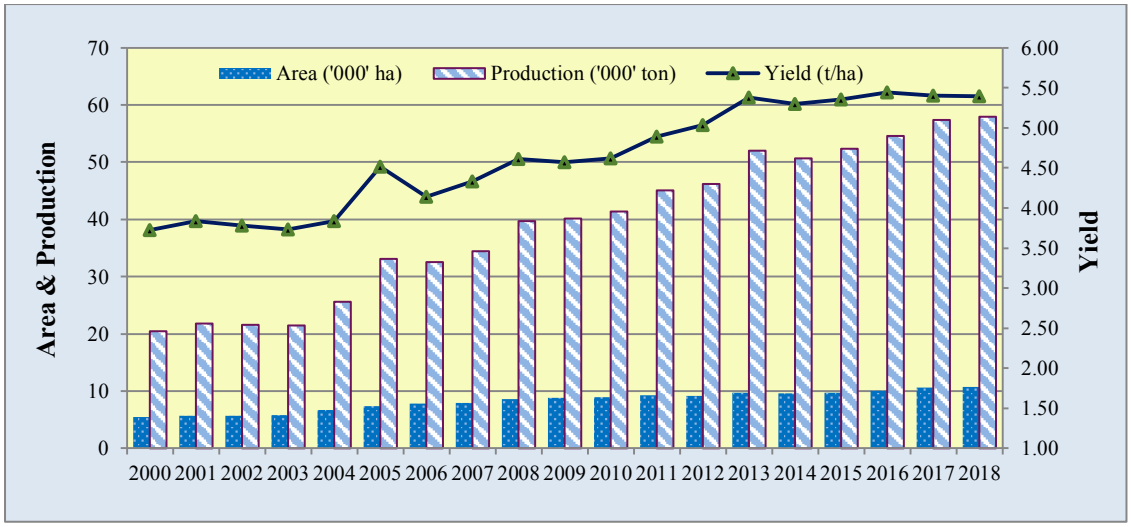


Fig1.3Trend of area, production and yield of bitter gourd during1999/00-2017/18

1.2.3 Trend of area and production of yardlong bean

Yardlong bean is one of the important summer vegetables in Bangladesh. Bangladesh produces a large amount of yardlong bean every year. In Bangladesh, a total of 25.65 thousand tons of yardlong bean were produced in an area of 6.59 thousand hectare of lands during 2017-18 (BBS, 2019). The area, production and yield of yardlong bean showed considerablyincreasing trend during the period from 2000 to 2018 (Fig 1.4). The perceived increase in the area, production and yield of yardlong bean was might be due to the introduction of new high-yielding varieties, use of improved production technologies, and overall increase in its demand. The annual growth rates of area, production and yield of yardlong bean were 3.75, 6.74, and 3.00% respectively (Table 1.1).

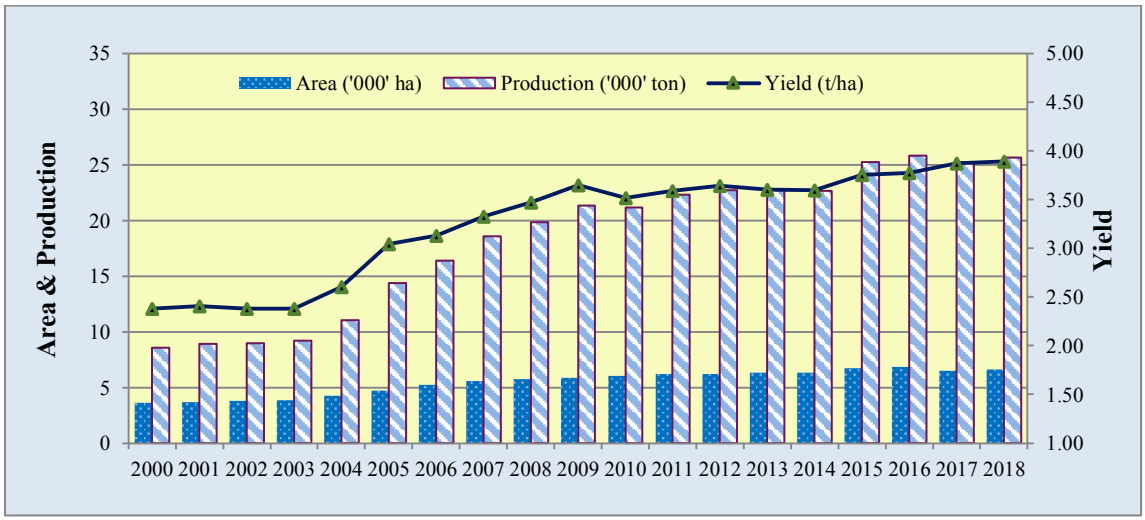


Fig1.4Trend of area, production and yield of yardlong bean during1999/00-2017/18

1.2.4 Trend of area and production of teasel gourd

Teasel gourd is also an important summer vegetable in Bangladesh. Bangladesh produces a substantial amount of teasel gourdannually. In 2017-18, a total of 28.65thousand tons of teaselgourd were produced in an area of 5.00 thousand hectare of lands in the country (BBS, 2019). The area, production and yield of teasel gourd showed increasing trends during the period from 2001 to 2018, except in 2014 and 2015 (Fig 1.5). The perceived increase in the

area, production and yield of teasel gourd was might be due to the introduction of new high-yielding varieties, use of improved production technology, and overall increase in its demand. The annual growth rates of area, production and yield of teasel gourd were 4.88, 6.84 and 1.96% respectively (Table 1.1).

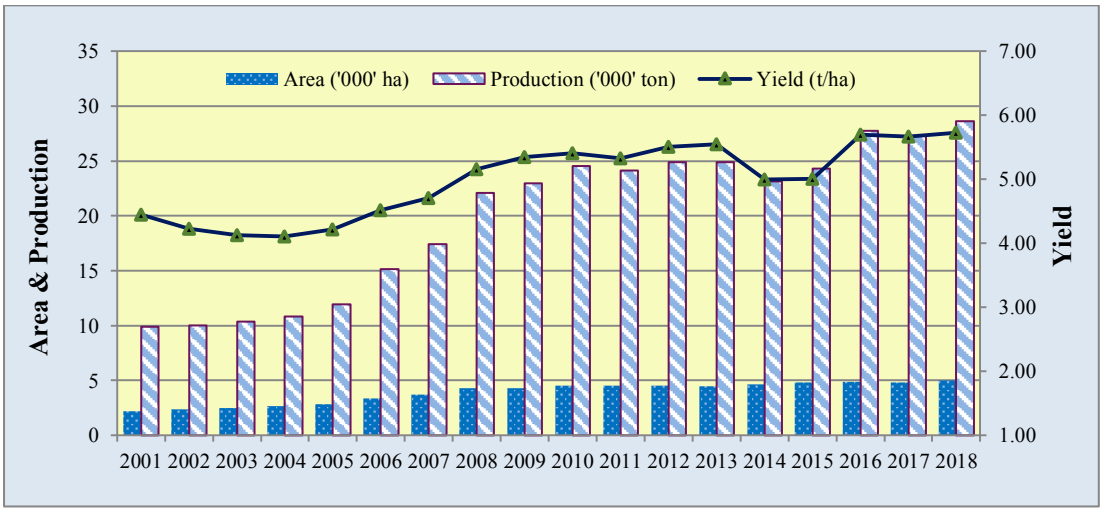


Fig1.5Trend of area, production and yield of teasel gourd during2000/01-2017/18

1.3 Rationale of the Study

It is agreed from aforesaid discussion that asubstantial amount of selected vegetables are grown in Bangladesh every yearand the trends of area and production of these vegetables are increasing, except the trend of area of brinjal.This sector is plagued with huge level of postharvest losses due to their perishability and poor pre- and postharvest practices that need to be taken into consideration. Empirical evidences (Hassan et al., 2010; Kayser et al., 2014)showed that the postharvest loss of fruits and vegetables in Bangladesh ranged from 16.73 to 43.5%, which accounts for an annual loss of Tk.34420 Million. Another study conducted by Hossain et al. (2001) found that the postharvest losses of different vegetables varied from 12 to 35% in the total marketing chain. Kayser et al. (2016) estimated the total postharvest losses of brinjal to be 23.38%. The total postharvest loss of tomato is ranged from 15 to 25.4% in total marketing chain (Miah et al., 2016;Khatun et al., 2014). Therefore, improved postharvest handling and efficient marketing are important to reduce postharvest losses, and risk in timely supply of quality and safe produce at reasonable prices to the consumers.

Due to the absence of proper storage and marketing facilities, farmers are forced to sell their vegetables at throwaway prices. The quality and nutritional value of fresh vegetables are also affected by postharvest handling and storage condition (Sablani et al., 2006). Nevertheless, indiscriminate use of pesticides by the producers is causing problems for human health and the environment. This issue is now considered an enormous burden for the nation's public health system. Therefore, the knowledge of postharvest management for vegetables is very much important at producers' and various stakeholders' levels for reducing postharvest losses and ensuring quality and safe produce for the consumers.

Right marketing channels and market functionaries are important in the movement of products from producers to the consumers. Inefficient marketing system reduces demand from consumers and participation by producers, who face various challenges to participate in the growing markets for vegetables. The retail markets of vegetables are mainly dominated by unorganized retailers and the existing vegetable market structure does not adequately address

the complex problems of farmers (Islam, 1996, Hossain and Hossain, 2013). The retail market has low marketing efficiency, high postharvest losses and does not foster competitiveness among buyers and sellers. A modern innovative system can reduce the vested interests of a large intermediary chain, create competition, assure quality and modernize operations in handling of vegetables, is necessary to raise income of the farmers. Again, the changing demand in domestic markets for vegetables creates both challenges and opportunities.

The important problems in marketing vegetables include both high costs and risks. High marketing costs often stem from poor transportation networks, lack of market information, and sometimes from the lack of competitiveness in the market. If these constraints can be removed, producers would earn more by specializing in crops for which they have a comparative advantage. Currently, it is important to generate reliable and up-to-date data on the actual costs and margins of producers and intermediaries involved in vegetables supply chain. The present study will provide up-to-date data on costs and margins of market actors that will help identifying cost-effective options for improving the performance of marketing system and propose improved policies and better institutional supports throughout the marketing chain of vegetables.

The Sustainable Development Goal (SDG) as well as the Bangladesh Country Investment Plan (CIP) put emphasis on strengthening the food marketing system, improving value chains, and reducing postharvest losses as a measure for improving food security and increasing incomes. Empirical data and adequate information regarding the above issues are lacking in Bangladesh. Therefore, the study was conducted to generate market and field level data and information by which the research managers and policy makers can formulate appropriate guidelines to promote, support and implement good practices in every segment of the vegetable supply chains for minimizing postharvest losses and ensure the supply of quality and safe produce for the consumers.

1.4 Objectives of the Study

a. To assess the knowledge, attitude and practices (KAP) of different middlemen toward post-harvest handling, losses as well as safe produce in selected vegetable supply chains;
b. To estimate postharvest losses at different segments of selected vegetable supply chains and to identify factors affecting postharvest losses at farm level; and
c. To assess the status of market opportunities through analyzing market performance of selected vegetables supply chains in the study areas.

1.5 Organization of the report

The report contains a total of seven chapters, which have been organized in the following sequences. *Chapter I* introduces the overall trend of acreage and production of selected vegetable over the years. Significance and purpose of the study are also outlined in *Chapter I*. The review of literature relating to the postharvest losses, marketing of vegetables, and consumers' behaviour towards safe vegetables is presented in *Chapter II*. Methodology of the study is discussed in *Chapter III* in accordance with the study objectives. *Chapter IV* describes the knowledge, attitude and practice of farmers towards safe vegetable production and marketing at farm level. Postharvest losses, factors of postharvest losses and constraints to vegetable marketing at farm level are also discussed in *Chapter IV*.Detailed postharvest operations, marketing systems, postharvest losses, and KAP of key actors towards safe produce marketing at traders' level are discussed in *Chapter V*. Consumers' behavior towards safe vegetable consumption isdelineated in *Chapter VI*. Finally, *Chapter VII* presents the conclusionsand recommendations of the study and also contains some policy guidelines

forminimizing postharvest losses and ensure the supply of quality and safe produce for the consumers.

Chapter II

LITERATURE REVIEW

2.1 Background

Proper knowledge and reliable information regarding postharvest management of vegetables are very much important for producers and stakeholders in reducing postharvest losses and ensuring food quality for the consumers. But, there have been very few systematic attempts to assess the knowledge, attitudes and practices towards safe and quality produce, postharvest handling, and postharvest losses in vegetable supply chains. Different studies were conducted on vegetables marketing based on small-scale survey and experiments, but it did not reflect the real situation. Some of the related studies conducted at home and abroad have been reviewed in the sub-sequent sections.

2.2 Related Studies Conducted in Bangladesh

Hossain et al. (2001) stated that the prices of vegetables in four districts, namely Gazipur, Dhaka, Comilla and Jessore were affected by improper handling and transportation. There were other causes like delay selling, more ripen and rotten that influenced the price of vegetable. It was observed that the prices of blemish vegetables were always found less than the blemish-free vegetables and both farmers and traders incurred some losses due to this reason. These losses varied from 12 to 35% for different vegetables.

Malakar (2006) in a study on "Agricultural Marketing Systems in Bangladesh" mentioned the problems regarding the improvement of marketing performance such as preponderance of various marketing acts, poor infrastructure. The author mentioned that only farmers could not increase the efficiency for which government support and private firms' investment were also required. He mentioned there were some agricultural markets in Bangladesh from which agricultural produces were traded such as rural wholesale markets, urban wholesale markets, urban wholesale cum retail markets and urban retail markets which had little connection with market information system. Finally the author recommended that the marketing system of farm products in Bangladesh needed to be based on modern and scientific lines. Modern techniques like contract farming, development and modernization of primary markets, retail outlets should be introduced.

Fazlur (2008) highlighted the lack of market information as one of the reasons for the low price received by the growers. The author mentioned that public sector market information systems like Directorate of Agricultural Marketing, Directorate General of Food and the Food Planning and Monitoring Unit are not updated so the existence of these systems is not much helpful for the farmers. The author also urged private enterprise to invest in this marketing system.

Matin et al. (2008) carried out a study on tomato marketing system in Bangladesh to identify the most efficient and suitable marketing channels of tomato in selected areas of Bangladesh. According to the volume of tomato handled and longevity or participation of the intermediaries in the channel, four major channels were identified as dominant in the study area. The channel *Farmer-Bepari-Arathdar (Dhaka)-Retailer (Dhaka)-Consumer* was ranked first. The results showed that *Farmer-Arathdar (Local)-Bepari-Arathdar (Dhaka)-Retailer (Dhaka)-Consumer* possesses the highest marketing efficiency. Establishment of tomato

processing plant in the intensive growing areas may be the remedy of the problem which will ensure fair prices for the farmer.

It is stated in the daily newspaper that the vegetable supply chain in our country is not effective where growers of vegetables are always deprived of profit. Growers in this chain face three challenges: financing crop production; poor yields; and losses due to the elements which reduce their bargaining power significantly (The Daily Star, 2009).

Islam and Ahsan (2009) investigated that the present market intelligence system in Bangladesh is not yet well organized. Communication system to link wholesale and retail markets in different areas has not been strengthened. Transportation is still poor. The study observed that only 37.5% Department of Agricultural Marketing officeshave telephone lines where market information are sent mostly by mails. Farm level prices are broadcasted over radio once a week. Farmers do not get good vegetable seeds at the right time at a reasonable price.

Saeed and Khan (2010) reported that the quality of tomatoes mainly depends on proper handling during postharvest processes like harvest, grading, packing and transportation. The study also focused on shelf life of tomato based on the systematic survey of the distribution of tomato crop. The deterioration of the produce due to packing material was 25%, transportation system was 10%, means of distribution was 5%, exceeding postharvest losses up to 30%, and sometimes the whole lot is lost. Time lag in transportation, bulky packing in the traditional wooden crates wrapped with papers cause high humidity making the microclimate favorable for mycoflora.

Hassan et al. (2010) found fruit's detachment from the stalk to be the major cause of postharvest damage of brinjal and about 48-60% of the growers reported this as one of the causes of damage. Nearly 56% retailers also opined that maximum damage in brinjal occurred due to fruit separation from the stalk. However, huge amount of losses were faced by *Bepari* every year due to lack of proper transport system. *Beparis* (52-64%) opined that maximum damage occurred due to bruises and vibrations in brinjal transport. They estimated 29.4% actual postharvest losses of brinjal which was due to the sub-standard postharvest handling, practices, inadequate transport, lack of storage facility, and ignorance of the stakeholders.

Hoq et al. (2012) estimated the per hectare production cost and value addition by farmers for bitter gourd were Tk.1,04,644 and Tk.2,37,356 respectively. The average estimated marketing cost and value addition by suppliers were Tk.2,906 and Tk.3,094 per ton. The value addition by different exporters for UK, Saudi Arabia, Kuwait, and Qatar (external markets) were Tk.55,778, Tk.16,661, Tk.16,902, and Tk. 23,754 per ton respectively. The study revealed that bitter gourd cultivation was more profitable than other vegetables and UK market was more profitable for vegetables export.

Hossain and Hossain (2013) described the existing vegetable supply chain system in Bangladesh which included number of markets, number of middlemen, and number of financing institutions. They showed various problems in the existing supply chain where the problems of the vegetable supply chain were discussed thoroughly. They also discussed the impacts of lack of effective supply chain linkages.

Khatun et al. (2014) found that the major postharvest activities practiced by the farmers and intermediaries of tomato were harvesting, grading, cleaning, storing, packaging and transporting. The average postharvest losses were estimated at 15.37% and 10% at the farmers' and intermediaries level, respectively. The harvesting loss was found the highest (6%) as compared to grading, packaging, storing and transporting. Besides, the losses of tomato were found the highest for *Beparis* (6.3%) followed by *Paikers* (2%) and retailers

(1.5%) due to transportation and selling. Monetary loss at farmers' level was Tk.78,540 per hectare and it was Tk.1,28,258 at traders level. At national level monetary loss was estimated at Tk.52.31 crore during 2009-10. Important factors leading harvesting losses were due to early and delayed harvesting and insect infestation. Product price, farming experience and suitable packaging materials had negative and total production and rainfall had positive and significant relationship with total postharvest losses.

Kayser et al. (2016) conducted a study in three districts namely Narshingdi, Jashore and Bogura to assess the postharvest losses of brinjal. They estimated total postharvest losses of brinjal (23.38%) considering total losses at farmer, *Arathdar, Bepari* and retail level. They estimated the highest loss (12.51%) at the grower level followed by retail level (5.96%), *Arathdar* level (2.35%), and *Bepari* level (2.65%). They found that farming experience, sale price, and transportation had negative and total production and foggy weather had positive and significant relationship with the total postharvest loss of brinjal. They identified poor postharvest treatments, low market price, lack of available storage facilities, and poor and costly transportation as the major marketing problems at farm and intermediaries level. Proper storage facilities, easy transportation, applied scientific method of harvesting and fair price policy suggested by the study to minimize the postharvest loss.

Miah et al. (2016*)* assessed the marketing status and estimated postharvest losses of winter tomato in selected areas of Bangladesh. Theyidentified seven marketing channels for tomato marketing. The prominent channel was *Farmer >Bepari>Urban Arathdar> Urban Retailer>Urban Consumer* since 71.5% products moved through this channel. Farmers and *Faria* used different local carriers like bicycle, rickshaw, van, and push cart to transport tomato. Trucks and pick up van were mostly used by *Bepari* transport tomato from assemble markets to wholesale markets. Retailer received the highest net profit (Tk.7,858/ton) due to higher sale price and lower marketing cost followed by *Faria* (Tk.2,444/ton) and *Bepari* (Tk.1,852/ton). The estimated postharvest losses were 4.57% and 11% at farm and traders' level respectively. At farm level,these losses occurred during sorting & grading (1.24%), transportation (1.15%), harvesting (0.94%), and storage (1.03%). *T*he highest loss was recorded for retailer (4.71%) and the lowest for *Faria* (1.82%).

2.3 Related Studies Conducted Abroad

Rehman et al. (2007) estimated postharvest loss of tomato to be 20% of the total production in Peshawar valley of Pakistan. The losses occurred during picking of the crop, during handling and transportation to the markets. In order to reduce these losses, farmers need to be trained about the latest techniques of packaging, processing of tomato crops, advanced techniques and methods of postharvest handling.

It was found in two different studies (Tatlidil et al., 2003; Demirci et al., 2005) conducted in Ayes and Mallihar districts of Ankara that the losses in tomato during the harvest period varied from 5.15% to 9.83%. It was pointed out that precautions taken by producers until the harvest maturity are not sufficient and necessary measures should also be taken during harvest and after harvest period, in order to decrease or eliminate the losses.

In Nigeria, Ayandiji et al. (2011) mentioned in his study the determinants of postharvest losses among tomato farmers in Imeko-afon local government area of Ogun statethat about 72% farmers use van/pick up in transporting their produce from the farm to the market. No storage facilities were used in the study area to preserve the tomatoes from rotten after harvesting as at the time of study. The average gross margin with postharvest losses is less than the average gross margin when no damage occurred in the fruits. The effect of all the independent variables (pre harvest working days, harvest working days, distance from the

farm to the market (km), days tomatospent on the farm (days), age of tomatoat harvest (months), area of land cultivated (ha), days tomatospent in the market before getting to the consumer (days), and no. of basket that was harvested) on the dependent variable (quantity of fruit loss) tested were significant at 5% probability level. The effects of postharvest losses lead to wastage of the products and tend to frustrate the efforts put into production and their income on the produce.

Sharma and Singh (2011) estimated the total postharvest loss of brinjal in Bhabhan farms was 16.81% of which growers' level loss was 11% and retailer's level loss was 5.81%. At grower's level, the highest postharvest loss was found during grading and packing (6%) followed by harvesting (4.50%).

Buntong et al. (2013) assessed and introduced possible handling improvements in traditional and modern supply chains for tomato. Traditional chain involved farmers and collectors in Kandal Province and wholesalers and retailers in wet markets in the capital of Phnom Penh, Cambodia. In the modern chain, only one intermediary between farmers and supermarkets was involved. Postharvest losses in the traditional and modern chains were 23% and 22.5%, respectively. The losses of farmer were mainly due to pre-harvest damage by insect-pests and diseases, and immaturity while losses during subsequent handling were due to physical damage, rotting, weight loss and/or over-ripening. Improved packaging, pre-cooling and sanitizing treatments as individual handling improvements were tried in the traditional chain. It was found that the use of 20kg capacity plastic crate with 50µm-thick low density polyethylene bagging and 20kg capacity bamboo basket lined with newsprint reduced tomato damage at the wholesale and retail stages relative to the conventional packaging of using 20kg capacity 50µm-thick high density polyethylene.

Utama and Kitinoja (2015) opined that the level of vegetable in small-scale agribusiness depends on the distribution channel. The loss of production on farm as rejected or non-harvested vegetables is about 5-10% due to the production size not being in accordance with market demand, and defects due to pest attack or diseases. The percentage of loss at the production stage can be greater depending on the level of pests and disease attack during the production process. The loss in the local traditional retail market located close to the production area occurs due to mechanical, physiological, and micro-biological damages during marketing. The farm level damage is lower than the damage that occurs in case of city for institutional customers it is set at no later than 9 a.m. However, the study identified five major agribusiness chains in vegetable marketing. The highest loss (23-42%) incurred in the longest channel *Farmer- subdistrict wholesale traditional market- City collectors- City traditional retail market*. The lowest loss (9.5-18%) incurred in the chain *Farmers-Suppliers of institutional consumers-Institutional consumers.*

Addol et al. (2015) analyzed the determinants of postharvest losses within the tomato supply chain, key players, their roles in the pre-harvest, harvest and postharvest handling of tomato at farmer's level. The quantitative losses during harvest across regions ranged between 4.6% and 10.85%, with the highest in Upper East region. Between 3.6% and 13.75% of tomato were lost during grading and parking time; 2.3% to 7.4%; and 2.6% to 3.3% during transporting and marketing respectively. Postharvest loss in the tomato value chain is very alarming. It demands that policy makers and other stakeholders redirect their focus towards reducing or eradicating these losses by offering training on postharvest handling of perishable products. It must be conducted with follow ups, feedback and adoption measurement to ensure sustainability.

In India, Sagar et al. (2015) estimated the per quintal postharvest losses of brinjal in three major supply chains. The chains were (1) Farmer-Commission agent1-Commission agent 2-Retailer-Consumer; (2) Farmer- Wholesaler- Retailer- Consumer; (3) Farmer- Retailers-Consumer. The per quintal losses in different supply chains were 21.62 kg in supply chain-I, 19.36 kg in supply chain-II and 16.24 kg in supply chain-III. In supply chain-I, losses were maximum at farm level (8.84 kg/q) followed by commission agent's level (5.29 kg/q) and at wholesaler's level (4.82 kg/q). In supply chain-II, the losses were found to be maximum at farm level (7.88 kg/q) followed by wholesaler's level (7.87 kg/q). In supply chain-III, the highest loss was found at farm level (8.76 kg/q). Among all agencies, it was found that postharvest losses at farm level were highest in all supply chains of brinjal.

They again estimated the total postharvest losses of beans which were 16.32 kg/q, 12.36 kg/q and 9.61 kg/q in supply chain I, II and III respectively. In supply chain-I, maximum loss was estimated at farm level (4.75 kg/q) followed by commission agent (6.02 kg/q) and wholesaler level (3.6 kg/q). In supply chain-II, the losses were found more at farm level (4.95 kg/q) and at wholesaler's level (4.58 kg/q). In supply chain-III, maximum loss was estimated at retailer's level (4.79 kg/q) followed by farm level (4.82 kg/q).

In Jordan, Kitinoja and Kader (2015) estimated the total postharvest loss of brinjal to be 19.4%. In Ghana through sampling method, they found physical losses of brinjal were 13.9% in farmer's level, 11.3% in wholesale market, and 16.2% in retail market.

2.4 Concluding Remarks

It is clear from the aforesaid literature that a number of studies regarding the assessment of postharvest losses of vegetables have been carried out in Bangladesh and elsewhere in the world based on field survey. The assessments of both quantitative and qualitative losses of selected vegetables are rare in Bangladesh. Therefore, a systematic approach to estimate postharvest losses in quantitative, qualitative (in terms of physical quality) and economic terms is the need of the time in Bangladesh. The intermediaries are very often blamed to take the lion share of marketing margins. But, reliable information on this matter is insufficient in the scientific literature. The crying need of this study is to generate reliable up-to-date data and information on the actual costs and margins of the market intermediaries, and other indicators of marketing performance for the selected vegetables. The outputs of this study would fill up the information gap, and indeed, contribute greatly to find out the most efficient marketing options for formulating a meaningful national policy to improve the current marketing systems of vegetables in Bangladesh.

Chapter III

METHODOLOGY OF THE STUDY

3.1 Selection of vegetables

A variety of vegetables are grown round the year in Bangladesh. The marketing systems of those vegetables are mostly traditional and more or less similar in nature, and associated with huge postharvest losses both at farmers and traders level. Different studies on marketing and postharvest lossesof several winter vegetables like brinjal, tomato, cauliflower, cabbage, etc.have been undertaken sporadically in Bangladesh, whereas summer vegetables have not been equally emphasized. Nevertheless, type and extent of post-harvest losses, pesticides use, status of food safety, retention of their shelf lives and other related issues have been discussed with vegetable scientists and traders before selecting summer vegetables for the present study. Considering the above issues, four summer vegetables, namely brinjal, bitter gourd, yardlong bean, and teasel gourd have been purposively selected for this study.

3.2 Selection of study area

Beforethe selection of study areas, different issues such as concentration of selected vegetable cultivation, distance of selected vegetables cultivation areas, volume of vegetable transactions and transportation, sources of vegetables for two urban cities namely Gazipur and Dhaka etc. were discussed with some traders (Bepari) and reviewed Yearbook of Agricultural Statistics (2014-15) of the Bangladesh Bureau of Statistics. Finally, the following six districts were purposively selected for collecting farm level as well as market level data and information for the project. The names of vegetables and study areas are given below (Table 3.1).

Table 3.1 Proposed vegetables and geographical coverage of the study areas

Vegetables	Study locations	
	Loation-1	*Location-2*
Brinjal (*Begun*)	Jamalpur	Rajshahi
Yardlong bean (*Borboti*)	Jashore	Mymensingh
Bitter gourd (*Korola*)	Bogura	Jashore
Teasel gourd (*Kakrol*)	Jashore	Rangpur

3.3 Selection of Sample Farmers and Traders

Multi-stages sampling technique was followed to select sample respondents. At the first stage of sampling, a total of six districts taking two districts for each selected vegetable were selected for this study.In the second and third stage, two highest vegetable growing *Upazilas*from each selected district and then two Agricultural Blocks (ABs) from each selected *Upazila*were respectively selected in consultation with DAE personnel and concerned scientists of BARI in order to select respondent farmers. Thus the total number of *Upazila* and ABs for each vegetables were four and eight respectively. In the final stage, a complete list of selected vegetable farmers was prepared with the help of DAE personnel for sampling. Finally, a total of 80 farmers taking 10 farmers from each block were randomly selected for each vegetable for interview. Thus the total number of selected farmers was 320 (Table 3.2).

Prior to the selection of vegetable traders, one important assembling or primary market from each Upazila and one secondary market from each district was selected purposively. Thus the

total numbers of selected primary and secondary markets for each vegetable were four and two respectively. Finally, two terminal markets namely Chowrasta Bypass Arath at Gazipur district and Kawran Bazar at Dhaka City were selected for the study after consultation with some *Arathdars* and *Beparis*. The selected vegetables mostly assembled in these two markets from different distant as well as selected districts.

It was opined that the presence of vegetable traders (distant *Bepari* and local *Faria*) in the selected markets vary from season to season due to the availability of vegetables. However, we plannedto take a total of 85 traders, taking 16 *Farias, 24 Beparis, 15 Paikers*, and 30 retailers to be selected randomly from different types of markets for a specific vegetable (for details, see Table 3.2). The length of experience, volume of trade, financial capability, societal membership, etc were not considered for selecting traders in this study. It considered only those *Beparis* who traded and transported vegetables from selected districts to selected terminal markets, and those retailers who have permanent vegetable shop in the primary and secondary markets. Accordingly, the total expected number of respondent traders for four vegetables was 340. But in reality (based on the availability of traders in the market), it could be possible to collect a total of 279 samples comprising 64*Farias*, 103 *Beparis*, 12 *Paikers*, and 100 retailers for the study.We also randomly selected and interviewed 160 different categories of vegetables consumers (due to response more than one vegetables by some consumers, the total sample was 177) from secondary and terminal markets.

Table 3.2 Number of respondents interviewed for a selected vegetable

Stakeholder	Location-1			Location-2			Terminal market (Gazipur, Dhaka)	All location
	Primary market (Upazila-1)	Primary market (Upazila-2)	Secondary market (District level)	Primary market (Upazila-1)	Primary market (Upazila-2)	Secondary market (District level)		
Farmer	20	20	-	20	20	-	-	80
Traders:								
Faria	4	4	-	4	4	-	-	16
Bepari	4	4	4	4	4	4	-	24
Paiker	-	-	--	-	-	--	15	15
Retailer	4	4	4	4	4	4	6	30
Consumer	--	--	10	--	--	10	20	40
Total	**32**	**32**	**14**	**32**	**32**	**14**	**41**	**205**

3.4Data and Information Collected

Data and information collected on knowledge, attitude and practices (KAP) of different stakeholders (i.e. farmers, traders and consumers) toward postharvest handling, postharvest losses, and food safety in selected vegetables supply chains. All these information were properly recordedusing KAP approach.

Data collected from farmers were on pesticides use, time and technique of harvesting, quantity loss during harvesting, quantity of postharvest losses, selling price, problems to vegetable production, and farmers' KAP for keeping vegetables safe and hygienic for the consumers. Again, data and information regarding vegetables marketing at traders' level were collected on traded volume, distance transported, mode of transportation, different type of losses, marketing costs, mode of sales, purchase and sale prices, and marketing problems. Other related data and information were gathered from various published sources such as BBS publications, FAO Stat, journals, research reports, thesis, etc.

3.5 Analytical Techniques

In order to measure the postharvest losses, factors influencing postharvest losses at farm and market levels, and market performances of selected vegetables, the following analytical techniques were considered in this study.

3.5.1 Assessment of quantitative and qualitative postharvest losses

A number of studies regarding quantitative loss of different vegetables were done in Bangladesh based on field survey (FAO, 2003; Khatun et al., 2014; Kayser el al., 2014; Hasan, 2010). The present study estimated both quantitative and qualitative losses (value term) of selected vegetables at farm level through survey method. Different types of physical damages occurred at farm level, traders' level and retail level were taken into consideration to estimate the total quantitative postharvest losses of vegetables. Usually, there is no practice of selling partially damaged vegetables with lower price at traders' (*Bepari, Paiker* and retailer) levels. Hence, the quantity of partially damaged vegetables were not considered at traders' level. Only partially physical damage of vegetables occurred at farm level were taken into consideration to estimate the total qualitative postharvest loss (market loss). In this case, different qualitative losses such as shape, colors, spots, crake, damage, and weight loss of vegetables were considered.

3.5.2 Assessment of financial loss

Financial loss incurred by farmers due to postharvest losses (including both damaged and partially damaged) of vegetables was estimated by the following equation (1):

$$F_L = Q_{cd} \times P_{cd} + Q_{pd} (P_{cd} - P_{pd}) \text{ ---------- (1)}$$

Where,

F_L = Financial loss (Tk/farm); Q_{cd} = Amount of completely damaged vegetable (kg/farm); P_{cd} = Price of good vegetable (Tk/kg); Q_{pd} = Amount of partially damaged vegetable (kg/farm); and P_{pd} = Price of partially damaged vegetable (Tk/kg)

It is noted that the financial loss at national level was also estimated applying the above mentioned equation (equ-1) using national level production data, and percent of postharvest loss and price information from the present study.

Again, financial loss incurred by middlemen traders due to postharvest losses was estimated by the following equation (2):

$$F_L = Q_{cd} \times P_{cd} \text{ ---------- (2)}$$

Where,

F_L = Financial loss (Tk/ton); Q_{cd} = Amount of discarded vegetables (kg/ton); P_{cd} = Price of good vegetables (Tk/kg)

3.5.3 Factors affecting post-harvest losses at farm level

Data and information on post-harvest losses were obtained from vegetable farmers during various operations, such as harvesting, sorting and grading, packaging, and transportation. A functional analysis was carried out to examine the factors affecting post-harvest losses at farm level. The following empirical censored Tobit model (3) was used for this study. Censoring occurs when the values of the dependent variable are restricted to a range of values i.e.; we observed both $Yi = 0$ and $Yi > 0$.

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + \text{--------} + b_9X_9 + e \quad \text{----------} \quad (3)$$

Where,

Y = Postharvest loss (%), X_1 = Total production (kg/farm), X_2 = Vegetable price (Tk/kg), X_3 = Market distance (km), X_4 = Selling place dummy (sale at market =1, sale at field=0), X_5= Education (year of schooling), X_6= Farming experience (year), X_7= Vehicle type dummy (Auto van=1, pulled van=0), X_8= Spraying (No./season), and X_9= Region (dummy). a = intercept, b_1. b_2------b_9 = Coefficients of the respective variables, and e = Random error

3.5.4 Measuring marketing margins

The net marketing margins of the intermediaries (after physical losses) were calculated by the following formula (Equations 4&5):

$$GMM_{ij} = SP_{ij} - PP_{ij} \quad \text{.....} \quad (4)$$

Where,

GMM_{ij}= Gross marketing margin (Tk/ton) for i^{th} trader of j^{th} vegetable

SP_{ij} = Sales price (Tk/ton) for i^{th} trader of j^{th} vegetable

PP_{ij} = Purchase price (Tk/ton) by i^{th} trader of j^{th} vegetable

$$NMM_{ij} = GM_{ij} - MC_{ij} \quad \text{.....} \quad (5)$$

Where,

NM_{ij} = Net margin (Tk/ton) for i^{th} trader of j^{th} vegetable

MC_{ij} = Marketing cost incurred (Tk/ton) by i^{th} trader of j^{th} vegetable

The marketing costs mainly include costs for various market operations like transportation, loading and unloading, market toll, shop rents, electricity, commission, wastage, depreciation, and other miscellaneous costs. The items of the marketing costs vary with the type of intermediaries.

3.5.5Measuring Marketing Performance

Marketing performance was evaluated using different measures of marketing efficiency as described by Hugar and Hireman (1984) and Acharya and Agarwal (2004). In the present study, the efficiency of marketing was investigated by examining price spread, producer's share to the consumer's price, Acharya and Agarwal's(2004) method for estimating efficiency, and return on operating capital (ROC). The aforesaid methods for studying these estimates are given below.

3.5.5.1 Measuring price spread

The price spread refers to the difference between the price paid by the consumer and price received by the producer for an equivalent quantity of farm product. Total price spread is another measure of the marketing margin. Farmers' share is widely regarded as a measure of fairness of the farm price and the efficiency of the marketing system (Kohls and Uhl, 1980). The price spread in vegetable marketing was estimated by using the following equation (6).

$$Ps = Cp - Pp \quad \text{----------} \quad (6)$$

Where, Ps = Price spread
Cp = Price paid by consumer (Tk/ton)
Pp = Price received by producer (Tk/ton)

3.5.5.2 Measuring producers' share to consumers' price

The producers' share is derived by the ratio of net average price received by the producer to the weighted average price of selected vegetables. It was calculated with the following formula (7):

PS (%) = (Pp ÷ Cp) ×100 ---------- (7)

Where, PS = Producer's share
Cp = Price paid by consumer (Tk/ton)
Pp = Price received by producer (Tk/ton)

3.5.5.3 Measuring marketing efficiency

There are several types of measures that have some values and limitations in measuring marketing efficiency, but no single one can tell the whole story. However, the following formula (equation-8) was used to measure the marketing efficiency (Acharya and Agarwal, 2004) of a particular marketing chain. The higher value of marketing efficiency denotes higher level of efficiency and vice versa.

Marketing efficiency (ME) = $\frac{FP}{MC+MM}$ ---------- (8)

Where,

FP = Net price received by producer (Tk/ton)
MC= Total marketing cost incurred by intermediaries (Tk/ton)
MM = Total net marketing margin received by intermediaries (Tk/ton)

3.5.5.4 Return on operating capital

Return on operating capital (ROC) is a measure of performance used to assess the efficiency of an investment or to compare the efficiency of a number of different investments. It is one of the ways of considering profits in relation to capital invested. The objective of calculating ROC is to measure the rates of return on money invested in an economic entity for taking decision onfuture investment. Thecommonly used method of calculating ROC is to divide the net margin by total investment as given below (9):

Return on operating capital, ROC (%) = $\frac{Net\ Margin}{Operating\ capital} \times 100$ ---------- (9)

Where, operating capital = (Purchase price + Marketing cost)

3.5.6 Measurement of problem faced index (PFI)

Farmers faced various problems during vegetable production. But a specific problem may not be significant as same level to all the farmers. Therefore, an attempt was made to construct PFI for an individual problem along with percent responses. An overall problem score for

each respondent was computed by adding his problems scores in all five aspects. The PFI of each of the 5 problems was measured by using the following formulae (10).

$$CFI = 5\times fvhc + 4\times fhc + 3\times fmc + 2\times flc + 1\times fvlc + 0\times fnc \text{ --------- (10)}$$

Where,

fvhc = Number of respondents who faced very high problem (raked-1);
fhc = Number of respondents who faced high problem (raked-2);
fmc = Number of respondents who faced medium problem (raked-3);
flc = Number of respondents who faced low problem (raked-4);
fvlc = Number of respondents who faced very low problem (ranked-5); and
fnc = Number of respondents who faced no problem at all.

In order to make comparison among the problems, a rank order of problems (rank 5 to 1) were constructed in descending order. Problem score for a specific problem for a specific vegetable (n=40) ranged from 0 to 200, where 0 indicated no problem at all and 200 indicated very high problem faced.

Chapter IV

MARKETING AND POSTHARVEST LOSSES OF VEGETABLES AT FARMERS' LEVEL

One of the objectives of this study is to assess the knowledge, attitude and practices (KAP) of different stakeholders toward post-harvest handling, losses and safe produce in selected vegetable supply chains. Generating farm level data and information on the above issues are crucial for post-harvest handling of vegetables. Therefore, an attempt has been madeto discuss selectivepre-and postharvest practices at farm level, status of current knowledge, attitude and practice (KAP) of farmer on safe vegetable production and marketing, constraint to safe vegetable production, and status of postharvest losses.

4.1 Status of Pre-and Postharvest Practices at Farm Level

The postharvest loss and safe vegetables at farm level depends to a great extent on different pre-and postharvest activities of the farmers. The subsequent sections describe some pre-and postharvest practices usually done by the vegetable farmers in the study areas.

4.1.1 Pesticides use

The damaging insects of the selected vegetables were reported to be fruit fly, fruit and shoot borer, leaf hopper, aphid, stem borer, leaf roller, root-knot nematode, and epilachne beetle. Besides, brinjal is prone to massive attacks by several species of fungi and bacterial wilt that causes wilt, soft rot and root rot (Singh et al., 2014). High dependency on chemical pesticides in vegetable production was reported in the study areas. Respondent farmers applied a lot of pesticides to protect their crops from insects-pests infestation. Even those farmers who used *pheromone trap* and *Bistop* also used pesticides to some extent. They could not imagine the production of vegetables without the use of pesticides. Respondent vegetable farmers mentioned the names of different types of locally available and frequently used pesticides. They applied pesticides per season more than 54 times for brinjal, more than 13 times for bitter gourd and yardlong bean, and 23.1 times for teasel gourd which were started before flowering to harvesting (Table 4.1). It was reported that the current frequency of pesticides use was much lower compared to the previous years which was mainly due to adopt different IPM techniques (use of *pheromone trap,Bistop, bio pesticides, etc.)* in vegetable production.

Table 4.1 Frequency and stages of application of pesticides in vegetable cultivation

Name of vegetable	Crop duration (month)	Frequency of application (No./season)		
		Before flowering	After flowering	Total
Brinjal	6.5	12.86	41.46	54.32
Bitter gourd	4.5	2.88	10.64	13.52
Yardlong bean	4.5	3.45	10.21	13.66
Teasel gourd	8.5	4.35	18.75	23.10

4.1.2 Time and 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. Early morning harvesting isbest for

most vegetable crops. If harvesting green vegetables for salads or cooking, the best picking time of the morning is before 9:00AM. Pick greens while they are still cool and dew-covered from the night (https://homeguides.sfgate.com/pick-vegetables-morning-67408.html). Most farmers in the study areas harvested vegetables in the afternoon by hand picking (Figs 4.1 & 4.2). The assemble markets in the study areas usually sit early morning and ends by 1:00 PM. This is the main reason of harvesting vegetables in the afternoon of the previous day of selling. The farmers whose residences are closer to the assemble markets and having a small piece of vegetable land generally harvest vegetables in the morning. More than 80% brinjal, bitter gourd and teasel gourd farmers harvested vegetables in the afternoon of previous day. Except teasel gourd, nearly all farmers' respondent farmers harvested vegetables by hand picking. Only teasel gourd farmers harvest produce by the help of blade or sickle (Table 4.2).

4.1 Harvesting of brinjal by hands

Source: www.twitter.com/bdnews24/status/664087077663997953

4.2 Harvesting of teasel gourd by hands

Source: www.observerbd.com/2015/11/09/119814.php

Table 4.2 Time and mode harvesting of vegetables in the study areas

Particular	Brinjal		Bitter gourd		Yardlong bean		Teasel gourd	
A. Time of harvesting	N	%	N	%	N	%	N	%
Afternoon	68	85	64	80	61	76	70	88
Morning	12	15	16	20	19	24	10	12
B. Means of harvesting								
By hand	80	100	75	94	80	100	-	-
Blade/ sickle	-	-	5	6	-	-	80	100

4.1.3 Type of harvesting container

Harvesting containers should be made in such a way so that these should reduce mechanical damage to produce. It is also important to protect vegetables from contamination. Different types of containers were reported to use during harvesting of vegetables. Irrespective of vegetable types, about 63.4% farmers used bamboo basket shown in Fig 4.3 (contains about 4-5 kg), 17.8% used plastic crate (contains about 10-12 kg), and 10.9% used plastic or aluminum bowl (contains about 3-4 kg). Plastic crates are relatively expensive to purchase, but are reusable and easy to clean. Some farmers also used plastic or jute sac as harvesting container (Table 4.3). It is important to notice that the prices of selected vegetables are not affected at farmers' level by the types of harvesting containers.

Table 4.3 Harvesting containers and vegetable placement immediate after harvesting

(Value in %)

Type of container	Brinjal	Bitter gourd	Yardlong bean	Teasel gourd	All types
A. Harvesting container					
1. Bamboo basket	62.5	60.0	77.5	53.8	63.4
2. Plastic karate	12.5	15.0	12.5	31.3	17.8
3. Jute/plastic sac	18.8	6.3	--	6.3	7.8
4. Plastic/aluminum bowl	6.3	18.8	10.0	8.8	10.9
B. Veg. assembled on					
1. Open ground	11.3	3.8	5.0	2.5	5.6
2. Plastic sheet/mat	88.8	96.3	95.0	97.5	94.4

Farmers usually assemble harvested vegetables on plastic sheet, mat and sometimes on open ground (Fig 4.4) for sorting and packaging. Table 4.3 also showed that more than 90% of the respondent farmers assembled their vegetables on plastic sheet or mat immediate after harvest. A small percentage of farmers also assembled their harvested produces on ground covered by grasses or leaves.

Fig 4.3 Using bamboo basket as harvesting container
Source: www.thedailystar.net/backpage/news/the-unsung-tale-women-farming-1647100

Fig 4.4 Harvested brinjal placed on open ground
Source: www.icar.gov.in/files/ar0607/01-Crop%20Improvement.pdf

4.1.4 Sorting and grading

Sorting and grading play significant role in getting higher price of vegetables and reduce postharvest losses. No standard of grading of vegetables is available in the study areas. All the respondent farmers generally sort defect vegetables (i.e. insect infested, over mature, ripe, odd size, cut, broken, etc.) from good ones. In most cases, they sell these sorted vegetables to *Bepari* at lower price or use as cattle feed.

4.1.5 Washing and cleaning

It is also an important issue for keeping vegetables clean, fresh and safe for the consumers. It also helps getting higher price for the farmers. Most of the respondent farmers do not wash their vegetables after harvest. However, about 22% (see Table 4.12) of the respondent farmers in the study areas washed their dirty vegetables after harvest.

4.1.6 Packaging

Good packaging is very much important for maintaining product quality, transport to distant places, and reduce postharvest losses. Respondent farmers in the study areas used different types of containers as convenient to them for packaging and transporting their produces. The highest percentage (55-97.5%) of bitter gourd and yardlong bean farmers used bamboo basket

and 60% brinjal farmers used plastic/jute sac as packaging container. The highest 60% teasel gourd farmers used plastic crate for packaging and transporting their produces. However, bamboo basket was reported to be the highest used container for packaging vegetables in the study areas (Table 4.4). The prices of selected vegetables vary to some extent by its freshness, but not influenced widely due to the use of packaging containers.

Table 4.4 Packaging containers used by farmers in transporting vegetables from their farms

(Value in %)

Type of container	Brinjal	Bitter gourd	Yardlong bean	Teasel gourd	All types
1. Bamboo basket	38.8	97.5	55.0	30.0	55.3
2. Plastic/jute sac	60.0	10.0	25.0	13.8	27.2
3. Plastic crate	3.8	10.0	8.8	60.0	20.7
4. Others*	6.3	3.8	11.2	0.0	5.3

*paper carton andrapping with jute mat

4.1.7 Mode of transportation

Mode oftransportation is an important issue for incurring postharvest losses. Its use mostly depends on the type of vehicles available in the locality and costs charged for it. Farmers in the study areas transport their produces from farm/home to primary/assemble markets using different mode of transportations. About 43% respondent farmers used non-mechanized pulled van and 19.7% farmers used auto van for carrying their vegetables. A good percentage (37.8%) of farmers whose residences were closer to the primary/assemble markets or produce sold in the field transport vegetables on head or shoulder load (Table 4.5).

Table 4.5 Mode of transportation used by the farmers

(Value in %)

Vehicle type	Brinjal	Bitter gourd	Yardlong bean	Teasel gourd	All types
Pulled van	53.8	22.5	58.8	35.0	42.5
Auto van	16.2	37.5	21.2	3.8	19.7
Head-load	30.0	40.0	20.0	61.2	37.8

4.2 Knowledge, Attitude and Practice (KAP) of Farmer on Safe Vegetable Production

An attempt was made in this section to know the knowledge, attitude and practice (KAP) of farmers towards safe vegetable production.

4.2.1 Knowledge on safe vegetables

Respondent farmers were asked about the knowledge on safe vegetables and its related issues. Although they were not trained on these issues, they more or less gave positive response on it. Majority of them considered those vegetables safe for human consumption which are free from pesticides, disease free, physically clean and hygienic, and washed with clean water (Table 4.6).

Table 4.6 Knowledge and attributes of safe vegetables

Particulars	% of farmers' responses				
	Brinjal	Bitter gourd	Yardlong bean	Teaselgourd	All type
A. Idea on safe vegetables					
Positive response	100	100	97	100	100
Unknown/ignorant	--	--	3	--	--
B. Attributes of safe vegetables					
Poison free	96.3	98.8	100.0	91.3	96.6
Disease free	97.5	96.3	95.0	97.5	96.6
Clean and hygienic	75.0	83.8	81.3	83.8	80.9
Washed with clean water	22.5	12.5	12.5	18.8	16.6

4.2.2 KAP of farmers regarding safe vegetables

All the farmers believed that appropriate measures should be taken to keep vegetables toxic free for the consumers. They mentioned different measures that will ensure vegetables toxic free for the consumers. The use of various IPM methods (i.e. pheromone trap, *Bistop*, kill insects by hand, etc.), application of proper dose of pesticides in vegetable production, and wash properly with fresh water were the highest suggested measures for keeping vegetables toxic free. The other suggested measures for safe vegetable production were use of organic fertilizers, harvest vegetables after 7 days of applying pesticides, use organic pesticides, use *Bt* variety, and use no pesticides (Table 4.7).

Table 4.7 Farmers' attitudes and suggested measures for keeping vegetables toxic free

Particulars	% of farmers' responses				
	Brinjal	Bitter gourd	Yardlong bean	Teasel gourd	All type
A. Should vegetables keep toxic free?					
Positive response	100	100	100	100	100
Unknown/ignorant	--	--	--	--	--
B. Measures for toxic free vegetables					
1. Use IPM methods	90.0	100	100	100	97.5
2. Use minimum/proper dose of pesticides	85.0	71.3	83.8	77.5	79.4
3. Wash properly with fresh water	70.0	33.8	50.0	23.8	44.4
4. Use organic fertilizers	28.8	27.5	35.0	48.8	35.0
5. Harvest after 7 days of pesticides use	33.8	40.0	38.8	25.0	34.4
6. Use organic pesticides	23.8	18.8	23.8	26.3	23.1
7. Use *Bt* variety	7.5	16.3	5.0	5.0	8.4
8. Use no pesticides	10.0	8.8	8.8	2.5	7.5

Most of the farmers in real situation could not practice fully what they suggested for safe and toxic free vegetable production. It was found that 43.4% farmers adopted IPM techniques (use pheromone trap and *Bistop*) along with minimum use of pesticides to protect their crops, whereas 97.5% farmers suggested to adopt this technique. However, this IPM technique was largely adopted by brinjal farmers. Again, 44.4% farmers claimed that they used very small amount of pesticides although 79.4% farmers suggested this measure. On average, 41.6% farmers washed their vegetables with clean water. The other practiced measures were application of organic fertilizers (26%), and harvest vegetables 2-5 days after applying pesticides (18.1%)for keeping vegetables safe and toxic free for the consumers. About 23%

farmers did not adopt any measure to keep vegetables safe and toxic free meaning that they used pesticides as much as they feel (Table 4.8).

Table 4.8 Measures adopted by the farmers for making vegetables toxic free

Particulars	% of farmers' responses				
	Brinjal	Bitter gourd	Yardlong bean	Teasel gourd	All type
1. Use IPM methods	30.0	70.0	33.8	40.0	43.4
2. Use minimum/proper dose of pesticides	28.8	63.8	42.5	42.5	44.4
3. Use organic fertilizers	28.8	13.8	35.0	25.0	25.6
4. Harvest after 2-5 days of pesticides use	16.3	21.3	16.3	18.8	18.1
5. Wash properly with clean water	68.8	28.8	47.5	21.3	41.6
6. Use clean container	6.3	2.5	2.5	6.3	4.4
7. Use organic pesticides	2.5	8.8	--	2.5	3.4
8. Take no measures	31.3	6.3	28.8	23.8	22.5

4.2.3 KAP of farmers regarding disease free vegetables

The respondent farmers were asked about the importance of keeping vegetables disease free and healthy for the consumers. All the farmers opined that suitable measures should be adopted to make vegetables disease free and healthy for the consumers. Irrespective of vegetables, nearly 75% farmers advocated for keeping lands weed free and dry, and 53.4% put emphasis on using appropriate fungicides for keeping vegetables disease free and healthy. About 52% farmers pointed out about using good quality and disease free seed/seedlings for keeping vegetables disease free. The other suggested measures were treat seed (36.3%) and soil (30.3%) before sowing/transplanting, irrigate crop on a regular basis (20.6%), and uproot diseased seedlings and plants from the field. Some farmers also pointed out about changing crop rotation for producing disease free vegetables (Table 4.9). It is important to state here that the measures suggested by the respondent farmers are mostly true for keeping vegetables disease free as opined by the vegetable scientists of BARI.

Table 4.9 Farmers' attitudes and suggested measures for keeping vegetables disease free

Particulars	% of farmers' responses				
	Brinjal	Bitter gourd	Yardlong bean	Teasel gourd	All type
A. Should vegetables keep disease free?					
Positive response	100	100	100	100	100
Unknown/ignorant	--	--	--	--	--
B. Measures for disease free vegetables					
1. Keep land weed free and dry	70.0	67.5	76.3	85.0	74.7
2. Use appropriate fungicides	58.8	61.3	47.5	46.3	53.4
3. Use disease free seed/seedling	70.0	53.8	48.8	33.8	51.6
4. Treat seed before sowing	30.0	25.0	37.5	52.5	36.3
5. Treat soil before sowing	27.5	26.3	33.8	33.8	30.3
6. Irrigate crop field on regular basis	20.0	20.0	21.3	21.3	20.6
7. Uproot diseased plants	11.3	8.8	11.3	21.3	13.1
8. Change crop rotation	11.3	2.5	5.0	12.5	7.8
9. Others*	6.3	--	7.5	2.5	4.1

*Others include use of lime, ash, and application of balance fertilizer dose

In practice, many farmers carried out several actions to make vegetables disease free for the consumers. The highest percentage of farmers (64.7%) kept their lands free from weeds and

dry followed by 51.9% farmers used appropriate and recommended dose of fungicides, 29.1% used good quality and disease free seedlings, 20.6% farmers irrigated their crops on a regular basis, and 9.4% uprooted disease infested seedlings from the field to keep vegetables disease free. Some farmers (8.8%) also treated soil and seed before sowing (Table 4.10).

Table 4.10 Measures adopted by the farmers for keeping vegetables disease free

Particulars	% of farmers' responses				
	Brinjal	Bitter gourd	Yardlong bean	Teasel gourd	All type
1. Keep land weed free and dry	70.0	51.3	58.8	76.3	64.7
2. Use appropriate fungicides	53.8	61.3	50.0	45.0	51.9
3. Use disease free seed/seedling	30.0	31.3	31.3	23.8	29.1
4. Irrigate crop field on regular basis	20.0	20.0	21.3	21.3	20.6
5. Uproot diseased plants	10.0	3.8	11.3	12.5	9.4
6. Treat seed before sowing	12.5	7.5	11.3	3.8	8.8
7. Treat soil before sowing	6.3	12.5	6.3	10.0	8.8
8. Others	10.0	--	8.8	1.3	5.0

Note: Others include use of lime, ash, and application of organic fertilizer

4.2.4 KAP of farmers regarding vegetable cleaning

Cleaning products are used to help remove unwanted microbial contaminants from a surface. It plays a crucial role in our daily lives by providing important public health benefits to consumers. Respondent farmers were asked to response on the significance of keeping vegetables clean and hygienic for the consumers. More than 89% of the farmers reported that suitable measures should be taken to make vegetables clean and hygienic for the consumers. In order to keep vegetables clean and hygienic, 62.5% farmers suggested not to assemble vegetables on the ground immediately after harvesting. Sorting and grading of harvested vegetables should be done on a polythene sheet. Clean container plays important role in protecting contamination. Nearly 48.8% farmers put emphasis on clean harvest container for keeping vegetables clean and hygienic. A good percentage of farmers (44.4%) thought that dirty vegetables should be washed with fresh water or cleaned by cloths. Again, 29.4% farmers considered using clean container with leaves or paper lining for transport as a prerequisite for keeping vegetables clean and hygienic. About 28.1% farmers suggested to separate blemish and insect infested vegetables from good ones. Some farmers also opined that vegetables should not be harvested in wet condition in this regard (Table 4.11).

In practice, most of the farmers claimed taking different measures what they suggested earlier to make vegetables clean and hygienic for the consumers. About 62% farmers assembled harvested vegetables on polythene sheet to perform sorting and grading. A good number of farmers (41.6%) cleaned dirty vegetables with fresh water or swipe with cloth. Clean harvest container is important to protect contamination. More than 38.5% farmers claimed that they used clean container to collect harvested vegetables. Nearly 28% farmers separated blemish vegetables from good ones for keeping them clean and hygienic. Some farmers claimed that they transported vegetables with clean container with leaves lining (Table 4.12).

Table 4.11 Farmers' attitudes and suggested measures for keeping vegetables clean and hygienic

Particulars	% of farmers' responses				
	Brinjal	Bitter gourd	Yardlong bean	Teasel gourd	All type
A. Should vegetables need cleaning?					
Positive response	90.0	88.8	95.0	83.8	89.4
No need	10.0	11.3	5.0	16.3	10.6
B. Suggested measures for clean vegetables					
1. Sorting & grading activities on polythene sheet	65.0	60.0	60.0	65.0	62.5
5. Harvest container should be clean	30.0	60.0	65.0	40.0	48.8
2. Wash with fresh water/swipe with clean cloth	70.0	33.8	50.0	23.8	44.4
3. Transport with clean container with leaves or paper lining	38.8	21.3	22.5	35.0	29.4
4. Separate blemish vegetables from good ones	23.8	20.0	35.0	33.8	28.1
6. Wash hands before harvesting	17.5	5.0	3.8	13.8	10.0
7. Land should remain clean	1.3	8.8	8.8	3.8	5.6
8. Harvest should not be done in wet condition	0.0	3.8	5.0	2.5	2.8

Table 4.12 Measures adopted by the farmers for making vegetables clean and hygienic

Particulars	% of farmers' responses				
	Brinjal	Bitter gourd	Yardlong bean	Teasel gourd	All type
1. Sorting & grading on polythene sheet/jute sac	65.0	57.5	60.0	65.0	61.9
2. Wash with fresh water/swipe with cloth	68.8	28.8	47.5	21.3	41.6
3. Harvest with clean container	30.0	33.8	50.0	40.0	38.5
4. Separate blemish vegetables from good ones	23.8	20.0	28.8	31.3	26.2
5. Transport with clean container with leaves lining	23.8	10.0	10.0	22.5	16.6
6. Wash hands before harvesting	12.5	1.3	2.5	13.8	7.6

4.3 Problems of Vegetable Production

Respondent farmers in the study areas encountered various problems in vegetable cultivation. The most severe problem was insect-pest infestation. The studied vegetable crops are prone to massive attacks by fruit flies, fruit and shoot borer and many other insects. Attacks of several species of fungi and bacterial wilt also cause severe damage of crops. This insect-pest infestation problem was mentioned by 91.3% of brinjal farmers, 90% bitter gourd farmers, and 77.5% teasel gourd farmers. Again, the highest percentage of farmers reported viral and fungal disease infection as a serious problem in yardlong bean cultivation (Table 4.13).

Farmers indiscriminately applied huge amount of pesticides to protect their crops from these insect-pests infestation and disease infection. The other important problems for bitter gourd and teasel gourd production were higher price of pesticides, scarcity of labour, stem rot diseaseinfection, and higher price of fertilizers. Although the aforesaid problems were also faced by brinjal and yardlong bean farmers, these problems were not so severe like bitter gourd and teasel gourd farmer.

Usually, farmers have no or little bargaining power in vegetable price fixation. Vegetable price is mostly controlled by *Bepari* who come from different districts. Vegetable price, therefore, remains unstable throughout the season. Some vegetable farmers (5-14%) stated

that they become loser due to such price fluctuation. Flower dropping was stated by 13% farmers as an important problem in brinjal cultivation (Table 4.13).

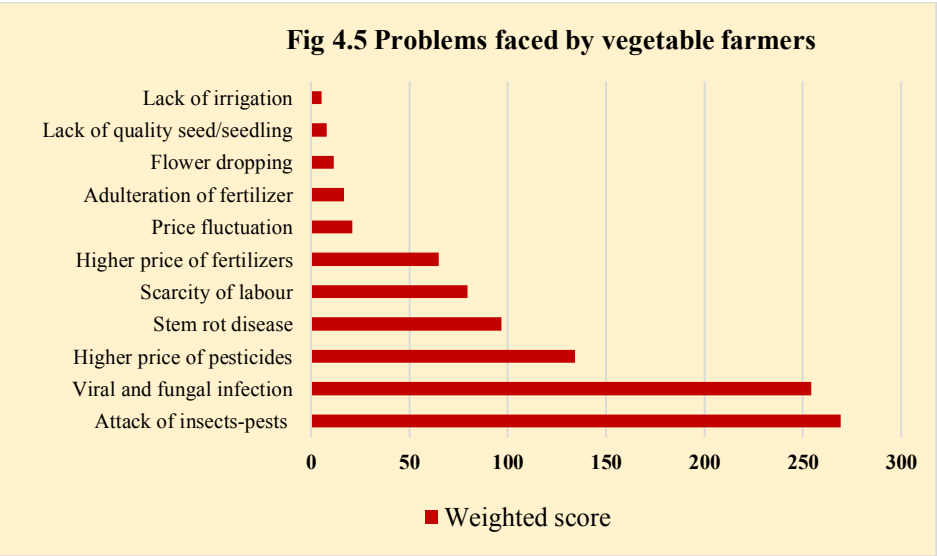
Table 4.13 Problems of vegetables production in the study area

Type of problems	Brinjal		Bitter gourd		Yardlong bean		Teasel gourd	
	%	Wt. score	%	Wt. score	%	Wt. score	%	Wt. score
1. Viral and fungal infection	92.5	333	46.3	150	100	372	46.3	162
2. Attack of insects-pests	91.3	306	90.0	242	98.8	331	77.5	198
3. Higher price of pesticides	31.3	83	65.0	201	26.3	58	62.5	195
4. Scarcity of labour	6.3	15	50.0	146	6.3	12	51.3	145
5. Stem rot disease	23.8	63	67.5	151	16.3	40	57.5	133
6. Higher price of fertilizers	8.8	26	42.5	108	3.8	10	46.3	116
7. Fluctuationof vegetable price	5.0	12	12.5	29	13.8	33	5.0	10
8. Lack of quality seed/seedling	2.5	6	--	--	5.0	13	3.8	12
9. Adulteration of fertilizer	8.8	21	5.0	14	11.3	24	3.8	8
10. Flower dropping	12.5	32	--	--	3.8	8	3.8	6
11. Lack of irrigation	3.8	10	2.5	6	--	--	1.3	5
12. Others*	20.0	46	2.5	2	15.0	33	28.8	80

*Others include higher toll, stolen by thief, higher bamboo price, lack of pheromone trap, attack by birds & squirrel, higher cost of lease land, and hand pollination in teasel gourd is laborious

If we consider the weighted score of individual problem, we can see that the insects-pests infestation was also reported to be the major problem of all vegetables followed by infection of viral and fungal diseases, higher price of pesticides, stem rot disease, scarcity of labour, and higher price of fertilizers (Fig 4.5).

Fig 4.5 Problems faced by vegetable farmers



4.4 Vegetable Marketing at Farm Level

The respondent farmers in the study areas generally sell their vegetables at nearby primary markets. Due to higher demand of some high value vegetables and good road communication, many middlemen traders (i.e. distant *Bepari, Faria*) come from different districts to the farmers for buying their produces. This creates opportunities for farmers to sell produce directly from the field that reduces farmers' transportation costs and valuable time as well.

Table 4.14 Selling place of vegetables and market distance in the study area

Vegetable name	Sell to *Faria* (%)		Sell to *Bepari* (%)		All traders (%)		Market distance (km)
	Field	Market	Field	Market	Field	Market	
Brinjal	13.7	18.8	16.3	51.2	30.0	70.0	1.9
Bitter gourd	3.8	11.2	37.5	47.5	41.3	58.7	4.6
Yardlong bean	--	10.0	25.0	65.0	25.0	75.0	1.8
Teasel gourd	12.5	7.5	47.5	32.5	60.0	40.0	1.4
All vegetables	7.5	11.9	31.5	49.1	39.0	61.0	2.4

Irrespective of vegetable types, 39% farmers sold their vegetables in the field and the rest 61% in the nearby primary markets. Field level marketing is prominent for teasel gourd (60%) in Rangpur district followed by bitter gourd (41.3%) in Bogura and Jashore districts (Table 4.14).

Respondent farmers sold vegetables mostly to distant *Beparis* who come from different districts. A small segment of farmers also sold vegetables to *Faria*. In many cases, *Farias* purchase vegetables on behalf of *Bepari* in lieu of small margin. Fig. 4.6 shows that different vegetable farmers ranged from 67.5 to 90% sold vegetables to *Bepari* and the rest 10 to 32.5% farmers sold to *Farias*. This difference tends to suggest that small category farmers perhaps sell to *Faria* as they have small slots and they might receive lower price of their produce.

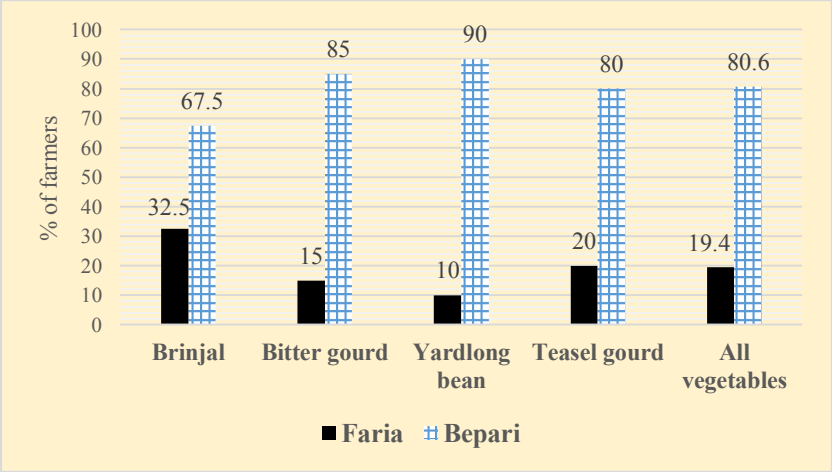


Fig 4.6 Selling vegetables to middlemen traders

The average selling price of good brinjal, bitter gourd, yardlong bean and teasel gourd were estimated at Tk 26.5, Tk 25.5, Tk 22.0 and Tk 26.0 respectively (Fig 4.7). Farmers could sell semi-damaged vegetables with lower price to *Bepari* (Table 4.15).

Table 4.15 Price received by farmers from different market actors

Vegetable	Price (Tk./quintal) received from *Bepari*		Price received from *Faria*
	Good vegetables	Semi-wastage vegetables	Good vegetables (Tk./quintal)
Brinjal	2667	735	2626
Bitter gourd	2571	1400	2532
Yardlong bean	2205	770	2195
Teasel gourd	2660	928	2533

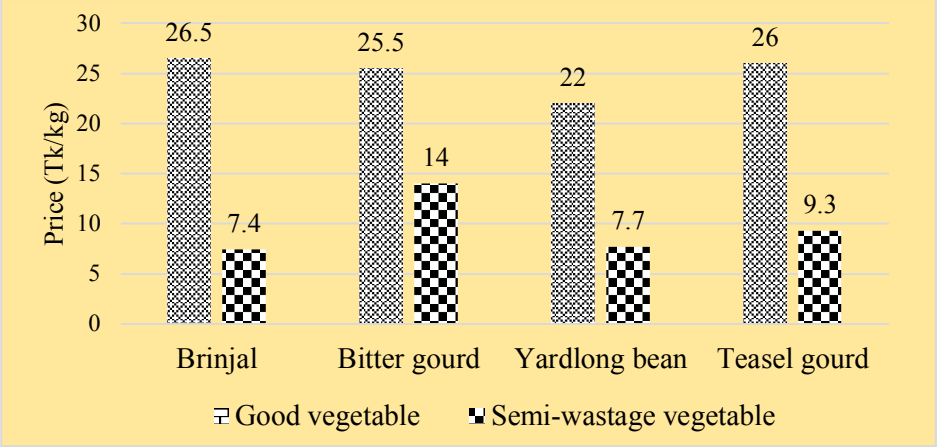


Fig 4.7 Average selling price of vegetables at farm level

4.5 Postharvest Loss of Vegetables at Farm Level

Generally three types of postharvest losses such as biological, chemical, and mechanical postharvest losses are found at farm level. Infestation of pest and diseases are biological postharvest losses. Visible external contamination of vegetables with pesticides, toxics and unpleasant flavor produces by pathogens are chemical postharvest losses. Different types of injuries and bruises occurred during harvesting are mechanical postharvest losses.

Completely discarded vegetables are treated as complete wastage and market loss is estimated from semi-wastage or blemished vegetables in this study. Detailed postharvest loss has been shown in Table 4.16. The total postharvest losses of brinjal, bitter gourd, yardlong bean, and teasel gourd were 3.13, 3.23, 3.70 and 1.94% respectively (Fig 4.8). Again, the shares of semi-wastage vegetables were 4.95, 1.45, 1.88 and 4.86% for brinjal, bitter gourd, yardlong bean, and teasel gourd respectively. The major share of postharvest losses at farm level was mainly for sorting and grading of vegetables. Very negligible losses were occurred during harvest and transportation (Table 4.16 & Fig 4.9).

Table 4.16 Postharvest loss of vegetables at farm level

Particulars	Brinjal		Bitter gourd		Yardlong bean		Teasel gourd	
	Quantity (kg/farm)	%	Quantity (kg/farm)	%	Quantity (kg/farm)	%	Quantity (kg/farm)	%
Total production								
Total sale	4831.5	100	3805.8	100	1614.6	100	3226.5	100
Cultivated area (dec)	28.84		34.27		16.11		22.56	
A. Complete wastage								
Harvest loss	--	--	3.5	0.08	--	--	--	--
Sorting & grading loss	140.3	3.13	128.7	2.99	62.6	3.64	61.8	1.94
Transport loss	--	--	6.0	0.16	1.1	0.05	--	--
Total	140.3	3.13	138.2	3.23	63.7	3.70	61.8	1.94
B. Semi-wastage								
Harvest loss	6.2	0.14	1.3	0.06	0.6	0.04	--	--
Sorting & grading loss	222.4	4.81	29.7	1.33	21.4	1.79	157.5	4.86
Transport loss	--	--	1.2	0.06	0.7	0.05	--	--
Total	228.6	4.95	32.2	1.45	22.7	1.88	157.5	4.86

The nature of postharvest losses of vegetables were odd size, insect-pest infested, disease infected, over mature, creak, injured and ripe. These types of losses mainly occurred in the field. Farmers usually separated these defective vegetables during sorting and grading before marketing.

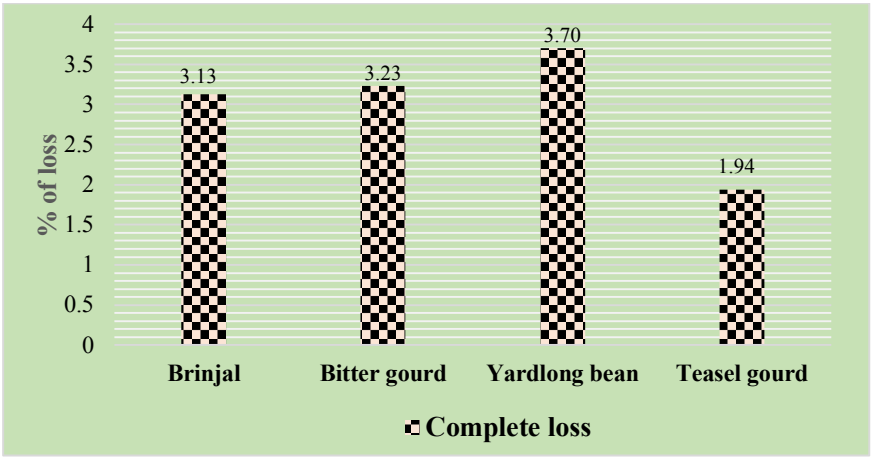


Fig 4.8 Farm level postharvest losses of vegetables

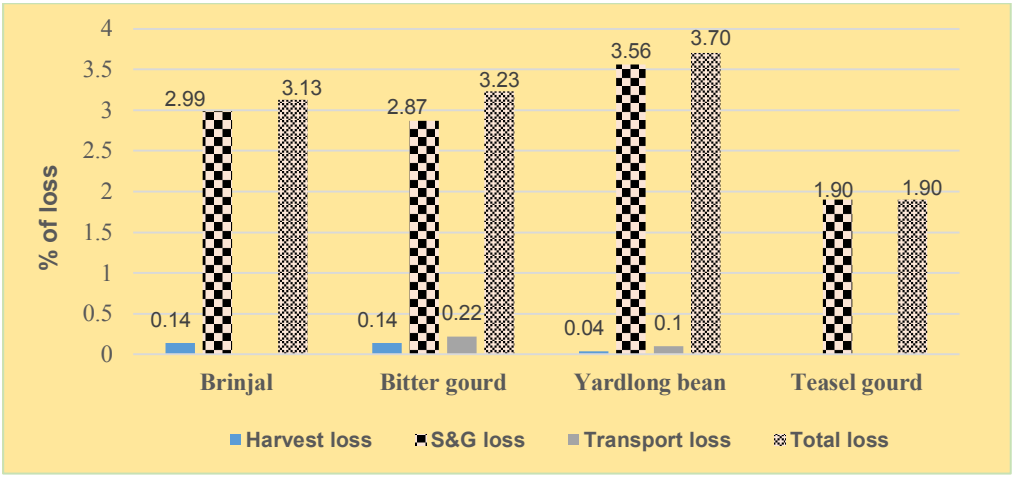


Fig 4.9 Causes of postharvest losses of vegetables at farm level

Respondent farmers experienced a substantial amount of financial loss due to wastage of vegetables. In all vegetables, the average financial loss was Tk 4976 per farm (Tk.48,303/ha) of which 58% was due to complete wastage of vegetables and 42% was for semi-wastage (Table 4.17). The financial losses were observed to be the highest for brinjal and teasel gourd compared to other two vegetables which was due to prolonged season and careless handling and packaging. In case of financial loss for completely wastage vegetables, the highest financial loss was for bitter gourd (88%) followed by yardlong bean (82%), brinjal (46%) and teasel gourd (37%). Again, financial loss due to semi-wastage vegetables, the highest financial loss was for teasel gourd (63%) followed by brinjal (54%) and yardlong bean (18%).

Table 4.17 Financial loss of farmers due to postharvest losses of vegetables

Vegetable	Loss due to wastage of vegetables (Tk/farm)	Loss due to semi-wastage of vegetables (Tk/farm)	Total loss	
			Tk/farm	Tk/ha
Brinjal	3788 (46)	4494 (54)	8282 (100)	70,930
Bitter gourd	4744 (88)	655 (12)	5399 (100)	38,913
Yardlong bean	1272 (82)	278 (18)	1550 (100)	23,765
Teasel gourd	1729 (37)	2945 (63)	4674 (100)	51,174
All vegetables	2883 (58)	2093 (42)	4976 (100)	48,303

Note: Figures in the parentheses are percentage of the total

4.6 Factors Affecting Postharvest Losses at Farmers' Level

The postharvest loss of vegetables is likely to be influenced by different socio-economic and environmental factors. Tobit model was used including nine variables to identify the factors influencing the postharvest losses at farm level. Among nine independent variables, seven variables namely total production, vegetable price, selling place (market=1, at field=0), mode of transport (auto van=1, pulled van=0) farming experience, no. of spraying, and district/region had significant effect on postharvest losses of different vegetables. The maximum likelihood estimates of variables determining postharvest losses at farm level and the marginal effects of those variables are shown in Tables 4.18 and 4.19 respectively.

4.6.1 Total production

It is expected that postharvest loss will be increased with the increase of total production. Except brinjal, positive relationships exist between dependent and independent variables of the rest three vegetables. However, the marginal negative effect estimate of brinjal indicated that if total production is increased by 1 unit, the probability of postharvest loss will be decreased by 0.453%, holding other factors constant. Brinjal is relatively big in size and hard skin. Its postharvest activities are easier then other three vegetables.These might be the reasons for appearing negative relationship between total production and postharvest loss. Again, if total production is increased by 1 unit, the probability of postharvest loss of yardlong bean will be increased by 0.711% holding other factors constant (Table 4.19).

4.6.2 Vegetable price

It is expected that postharvest loss will be decreased with the increase of vegetable price. The marginal negative estimates of bitter gourd indicated that if price is increased by 1 unit, the probability of postharvest loss will be decreased by 0.026%, keeping other factors remain constant. Signs of the marginal estimates for yardlong bean and teasel gourd are found to be negative. It indicated positive relationship between vegetable price and postharvest loss which is not desirable (Table 4.19).

4.6.3 Selling place

Due to higher demand of some vegetables, a good section of farmers sell their vegetables at field level that reduces their postharvest loss, transportation cost and valuable time as well. Therefore, it is expected that there should be a possibility of reducing postharvest loss in the case of selling vegetables at field level. Table 4.19 reveled that all the marginal estimates of selected vegetables hold negative sign implying that postharvest loss decrease to some extent when vegetable is sold at the field level. However, the postharvest loss reductions were significant at 10% level for brinjal and bitter gourd in the study areas.

4.6.4 Farming experience

It is a crucial factor that reduces postharvest loss to some extent. The marginal estimates of bitter gourd (-0.044*) and yardlong bean (-0.068*) are negative and significant at 10% level implying that an increase of farming experience by one unit, keeping other factors constant, the probability of postharvest losses of the aforesaid vegetables would decrease by 0.044% and 0.068% respectively in the aggregate situation.

4.6.5 Vehicle type (pulled van=1, auto van=0)

Farmers in the study areas used both mechanized (Auto) and non-mechanized (human pulled) van for carrying their produces to nearby markets. Auto van is much speedy than that of human pulled van. Due to rough surface of the village roads, trembling/jerking created from auto van is much higher than pulled van which causes physical injuries to the vegetables. Therefore, it is expected that the postharvest loss will be less in human pulled van compared to auto van. Table 4.19 reveals that the estimated coefficients of vehicle type (pulled van) for all vegetables are negative indicating that negative relationship exists between pulled van use and postharvest loss. In the case of yardlong bean, the estimated coefficient is negative and significant at 10% level implying that if farmers increase the use of pulled van by 1 unit, the probability of postharvest loss will be decreased by 1.354%, keeping other factors remain constant.

4.6.6 Pesticides spraying (No./season)

Farmers generally use huge amount of pesticides to protect crops from insect-pest infestation. They discarded infested vegetables from good ones which is treated later as postharvest loss at farm level. Therefore, the use of more pesticides will result in the reduction of insect-pest infestation meaning less postharvest loss. The marginal coefficients of spraying for brinjal and yardlong bean are negative and significant implying that if farmers increase the use of spraying by 1 unit, the probability of postharvest loss will be decreased by 0.022% and 0.051% respectively, keeping other factors remain constant. It is important to state here that for reducing postharvest loss increase use of pesticide should not be suggested as it is contradictory to safe vegetable production. However, in case of bitter gourd and teasel gourd, the estimated coefficient's sings are not expected.

Table 4.18 Estimated coefficients of variables affecting postharvest losses of vegetables at farmers' level using Tobit model

Variable	Brinjal		Bitter gourd		Yardlong bean		Teasel gourd	
	Coeff.	SE	Coeff.	SE	Coeff.	SE	Coeff.	SE
Constant	8.011***	2.143	3.170	2.198	-0.581	3.259	0.785	1.309
Total production (kg)	-0.455*	0.255	0.120	0.255	0.726**	0.346	0.072	0.147
Vegetable price (Tk/kg)	-0.017	0.046	-0.026*	0.016	0.128*	0.079	0.034*	0.023
Market distance (km)	-0.008	0.067	-0.065	0.063	-0.102	0.174	0.004	0.110
Selling place (dummy)	-0.756*	0.409	-0.741	0.530	-1.260	0.951	-0.034	0.233
Education (year)	-0.010	0.039	0.025	0.031	-0.007	0.055	-0.008	0.019
Experience (year)	-0.041	0.027	-0.044*	0.027	-0.069*	0.037	-0.0003	0.014
Vehicle type (dummy)	-0.475	0.398	-0.369	0.534	-1.383*	0.877	-0.053	0.458
Spraying (No.)	-0.022**	0.011	0.067*	0.038	-0.052*	0.032	0.003	0.008
Region (dummy)	3.363***	1.050	0.358	0.973	-2.37***	0.788	-0.75***	0.275
N	80		80		80		80	
LR chi2 (9)	33.72***		41.75***		19.91**		8.95	
Pseudo R2	0.1174		0.1341		0.0585		0.0482	
Log likelihood	-126.79		-134.82		-160.26		-88.485	

Note: ***, ** and * indicate significant at 1%, 5% and 10% probability level, respectively.

Table 4.19 Marginal effects of variables on postharvest losses of vegetables at farmers' level

Variable	Brinjal		Bitter gourd		Yardlong bean		Teasel gourd	
	dy/dx	SE	dy/dx	SE	dy/dx	SE	dy/dx	SE
Total production (kg)	-0.453*	0.255	0.119	0.254	0.711**	0.346	0.072	0.147
Vegetable price (Tk/kg)	-0.017	0.047	-0.026*	0.016	0.125*	0.079	0.034*	0.023
Market distance (km)	-0.008	0.067	-0.064	0.062	-0.100	0.174	0.004	0.110
Selling place (dummy)	-0.752*	0.407	-0.736*	0.527	-1.233	0.951	-0.034	0.233
Education (year)	-0.010	0.039	0.024	0.031	-0.007	0.055	-0.008	0.019
Experience (year)	-0.040	0.027	-0.044*	0.026	-0.068*	0.037	-0.0003	0.014
Vehicle type (dummy)	-0.473	0.396	-0.366	0.531	-1.354*	0.877	-0.053	0.458
Spraying (No.)	-0.022**	0.011	0.067*	0.038	-0.051*	0.032	0.003	0.008
Region (dummy)	3.349***	1.046	0.355	0.966	-2.32**	0.788	-0.75***	0.275

Note: ***, ** and * indicate significant at 1%, 5% and 10% probability level, respectively.

Chapter V

MARKETING AND POSTHARVEST LOSSES OF VEGETABLES AT TRADERS' LEVEL

The aim of this chapter is to investigate key players involved in the supply chain, knowledge, attitude and practice (KAP) of key players, detailed marketing system, postharvest losses, marketing costs and margins, and marketing performance at different traders' levels. The objectives of analyzing the above mentioned issues are to find out market opportunities for reducing postharvest losses and recommending proper guidelines for safe vegetables marketing. All these issues are discussed in a greater detail in the subsequent sections.

5.1 Key Actors Involved in Vegetables Supply Chain

Along with the farmers, a number of actors participated in the marketing of vegetables from the production point to the consumer point. The characteristics of various supply chain actors are different in function, business size, business premises, mode of operations, and place of business. Therefore, the main actors involved in the vegetables supply chains, their roles and inter relationships are discussed below.

5.1.1 Producers

Farmers are the primary and most valued actor in the vegetable supply chain. Two categories of farmers have been reported in producing selected vegetables: subsistence farmers and commercial farmers. Farmers decide, what input to use, when to seed and harvest, how much to consume, and how much to sell, considering the available resources. They perform most of the value chain functions right from farm inputs preparation to postharvest handling and marketing. They are producing vegetables for market. Due to perishableproducts, most farmers sell the majority of vegetables at harvest time, keeping only small amount for home consumption and for seed. They generally sell their products to the intermediaries either in the markets or at the farmyards, and thus formed a link in the marketing channel. The respondent farmers sold their vegetables to the middlemen traders such as *Faria* and*Bepari*.

5.1.2*Faria*(rural collectors)

Farias are petty traders independently operating at rural primary markets who assemble and transport vegetables from smallholder producers at the farm gate or local market. Generally, they sell their purchased products to the *Beparis* and partly to the retailers. Their volume of business is small in comparison to other intermediaries and possessed little capital. They do their business independently and are self-financed. Most of the *Faria*s are engaged in trading of different agricultural commodities. They have no permanent staff and do their petty business in cash. They usually do not store their vegetables even for a day.

5.1.3*Arathdars*

*Arathdar*s are simply commission agents. They have permanent establishment in the market premises. They help *Beparis* to store and sell their produces in lieu of commission at varying

ratesranged from 6-8% from both *Bepari* and retailer. It is not possible for *Bepari* to sell his produces without the help of *Arathdar*s.

5.1.4*Bepari*

Beparis are relatively big and non-licensed traders who purchase vegetables at the local primary markets from both farmers and *Faria,* and sell them to the *Paikers* (wholesalers) and retailers through *Arathdars*. They are the major buyers of vegetables as they buy at least a truck load of vegetables at a time from farmers and *Faria*. Their volume of business is larger than that of *Faria* and possessed large volume of capital. They have no fixed business premises. They have better transport and communication access than other traders. The majority of *Beparis* are located outside the studied districts (except Dhaka). They mostly purchase in bulk from the studied districts, transport and sell the produce to the urban markets like Khulna, Dhaka, Sylhet, Chattogram, Mymensingh, Gazipur, and other urban markets.

5.1.5 *Paiker*

Theyare also non-licensed wholesaletraders who purchase vegetables at the terminal markets (i.e. Dhaka, Gazipur) from *Bepari* through *Arathdars*. They buy 500-1000 kg of vegetables at a time and sell them to the retail tradersimmediately or sometimes after purchase. They have no fixed business premises in the market. Their purchased vegetables do not need any transportation for carrying them from one place to another.

5.1.6 Retailers

Retailers are key actors in vegetables supply chain within and outside the study area. They are known for their limited capacity of purchasing and handling products and low financial and information capacity. They are the last link between producers and consumers. Retailers are the small traders and perform their business independently. Most of them have permanent shops usually situated at crowded areas adjacent to the market places.

There are two types of retailers in the study areas: Upazila/district retailers and urban retailers. Upazila/district retailers buy vegetables from farmers, *Faria*, and *Bepari.* But urban retailers usually buy vegetables from *Paiker* and *Beparis* through *Arathdars*, and finally sell them to the ultimate consumers. The supermarket and chain shops are mainly in the major cities and commonly buy vegetables from suppliers (*Bepari*). Consumers usually buy the product from retailers as they offer according to requirement and purchasing power of the buyers.

5.1.7 Consumers

Consumers are the final purchasers of vegetables or vegetable products mostly from retailers for consumption purpose. Vegetable consumers are individual households (rural and urban dwellers), hotels, and institutions. Restaurants and hotels preferred larger size, fresh and undamaged vegetables. Almost all sampled consumers preferred fresh vegetables while a small proportion of consumers preferred packed vegetables.

5.2Socio-demographic Profile of the Key Actors

5.2.1 Age

The average ages of respondent traders like *Faria, Bepari, Paiker* and retailer were 40.2, 39.6, 43.0 and 40.1 years respectively. Except *Paiker*, the ages of the highest proportion of traders were in the age group of 31-40 years followed by the age group of 41-50 years (Table 5.1).

Table 5.1 Percent distribution of respondenttraders according to their age group

Age group (years)	*Faria* (n=68)	*Bepari* (n=103)	*Paiker* (n=12)	Retailer (n=100)
20-30	17.6	19.4	--	27.0
31-40	44.1	38.8	41.7	31.0
41-50	25.0	28.2	58.3	21.0
51-60	7.4	13.6	--	17.0
61-70	5.9	--	--	4.0
Average	40.2	39.6	43.0	40.1

5.2.2 Education

The respondent key actors in the vegetable supply chains were mostly low educated. The percent of higher educated traders were less in this sector. However, most of the key actors had primary level of education (class I-V) followed by secondary level of education (Class VI-X). A small percentage of *Farias, Beparis* and retailers had higher secondary level of education (Table 5.2).

Table 5.2 Percent distribution of respondenttraders according to their education

Education level	*Faria* (n=68)	*Bepari* (n=103)	*Paiker* (n=12)	Retailer (n=100)
Can sigh only	29.4	17.5	8.3	23.0
Class I-V	27.9	29.1	50.0	30.0
Class VI-X	25.0	27.2	41.7	27.0
SSC	10.3	14.6	--	15.0
HSC	7.4	8.7	--	4.0
Degree & above	--	2.9	--	1.0

5.2.3 Business experience

Average experience of the respondent traders in different levels of vegetable trading was 15.2 years for *Faria*, 16.4 years for *Bepari*, 16.8 years for *Paiker*, and 17 years for retailers in the study areas. Majority of the traders' experiences were ranged from 11 years to 20 years.However, the experience of a good number of market actors ranged from 21 years to 30 years (Table 5.3).

Table 5.3 Percent distribution of traders according to their business experience

Experience level (year)	*Faria* (n=68)	*Bepari* (n=103)	*Paiker* (n=12)	Retailer (n=100)
05-10	41.2	35.0	25.0	37.0
11-20	42.6	35.9	58.3	39.0
21-30	11.8	24.3	8.3	13.0
31-40	4.4	4.9	8.3	11.0
Average	15.2	16.4	16.8	17.0

5.2.4 Concentration of traders in the market

The nature of competition exists in the vegetable markets can be somewhat estimated through the presence of traders in the market. Some vegetable farmers and *Farias*reported that they

can receive good price of their produces when the presence of traders especially *Beparis*is high in the market. However, on an average the presence of *Faria, Bepari, Paiker* and retailers were reported to be 28, 27, 41 and 43 persons per market (Table 5.4).

Table 5.4 Concentration of respondenttraders in the studied vegetable markets

Vegetable traders	No. of traders per market			Std. deviation
	Minimum	Maximum	Average	
Faria	5	60	28	13.5
Bepari	10	60	27	10.5
Paiker	25	50	41	11.5
Retailer	10	150	43	33.5

5.3Postharvest Handling in Relation to Lossand Safe Produce

The performance of vegetable marketing notably depends on the status of different postharvest handlings. Again, the enhancement of market performance is directly linked with the improvement of postharvest management forvegetables.Information on different postharvest handlings such as assembling, washing and cleaning, sorting and grading, packaging, storage,and transportationhave been collectedduring market surveyand briefly discussed below.

5.3.1 Assembling

There are high possibilities of contamination due to assembling vegetables at unhygienic place. However, it was observed that assembling of vegetables at market premises before packaging and transportation is largely done by *Beparis* and occasionally by *Farias*. They assembled their vegetables on plastic sheet or mat immediate after purchase (Fig 5.1). Sometimesthey also assembled vegetables on ground covered by grasses or leaves (Fig 5.2).

Fig 5.1 Heap of purchased bitter gourd on plastic sheet, Shahjahanpur, Bogura

Fig 5.2Heap of purchased brinjal on open ground, Islampur, Jamalpur

5.3.2 Sorting and grading

Sorting is generally practiced for most vegetables to discard spoiled items. Majority of the traders sorted defect vegetables (i.e. insect infested, over matured, ripe, odd size, cut, broken, etc.) from good ones (Figures 5.3 and 5.4).In Bangladesh, still no grade standard has been developed for vegetables but is urgently needed for both domestic and export markets for getting higher price. In the study areas, grading is seldom practiced other than some limited scale size grading.

Fig 5.3Sorting purchased yardlong bean before packing, Shahjahanpur, Bogura

Fig 5.4Sorting purchased bitter gourd before packing, Shahjahanpur, Bogura

5.3.3 Washing/cleaning

Generallyselected vegetables are not washed at farm level for marketing. *Beparis* usually wash and clean particular dirty vegetables when neededbefore packing and transportation (Fig 5.5). Most retailers wash and clean their purchased vegetables, especially to fetch apparent higher price (Fig 5.6). It was also reported that washing of vegetables help reducing weight loss for the traders. Normally they use tube well water for washing vegetables.

Fig 5.5Washing brinjal by *Bepari*before packing, Islampur, Jamalpur

Fig 5.6Washing bitter gourd by retailer, Gazipur Sadar, Gazipur

5.3.4 Packaging

Adequate packaging is necessary for facilitating handling, transporting, and marketing of vegetables. Results of primary survey showed that packaging is practiced in all the selected vegetables (i.e. brinjal, bitter gourd, yardlong bean, and teasel gourd) marketing. Generally, gunny sacks of 80-84 kg capacity, plastic sacks of 40-45 kg capacity and poly bags of 25-30 kg capacity(Fig 5.7) are used in packaging brinjal,bitter gourd, and teasel gourd. For brinjal, still voluminous packages (400-500 kg capacity) made up of bamboo baskets and gunny sacks (like Fig 5.8) are used for long distance transportation.This type of packaging system is very cost effective to them although it involves higher postharvest lossdue to vibration, impacts and internal heat generation.Again, plastic karateis especially used in packaging bitter gourd and teasel gourd (Fig 5.9) when the prices are comparatively high at the early stage of harvesting of these vegetables.

Fig 5.7Packing brinjal in poly bag, Islampur, Jamalpur

Fig 5.8Packing bitter gourd in *Dhop,*Shahjahanpur, Bogura

Fig 5.9 Packing bitter gourd in plastic karate, Shahjahanpur, Bogura

5.3.5 Loading and unloading

Careful loading and unloading is very much important for reducing postharvest losses of vegetables. It was observed that the labourer involved in loading and unloading used hook for lifting vegetable packet/sacks/*Dhop*in the truck (Fig 5.10). Again, they unloaded vegetables very carelessly. These types of unhealthy activities are very much injurious for vegetables. Modern lifting device can be introduced for loading and unloading voluminous packages that will reduce spoilage of vegetables.

Fig 5.10Loading of brinjal, Sadar, Jashore

5.3.6 Transportation

The modes of transportation at the local level include head load, bi-cycle, pulled van, auto-rickshaw, motorized van, tractor, trolley, etc. Again, mini and large trucks of 7 and 10 tons capacities without any cooling facilities are usedfor long-distance transportation (Fig 5.11). So, any modifications to the present vehicle at least in pilot basis would greatly contribute to enhance marketing. For instance, Hortex Foundation of Bangladesh purchased few REEFER trucks with refrigeration facilities to carry horticultural produces.

Fig 5.11 Vegetable loaded truck for transportation, Islampur, Jamalpur

5.3.7 Storage

Storage is the most important function in agricultural marketing. Storage adds the time utility to the products. Low temperature storage facility for perishables is lacking in Bangladesh. No low temperature storage facilities were found in the study areas except potatoes. Pilot projects may be undertaken by the Government of Bangladesh and then private firms may come forward to improve the storage sector in Bangladesh.

5.4 Knowledge, Attitudes and Practice of Traders towards Safe Vegetable Marketing

The key traders involved in the selected vegetablesupply chain are *Faria, Bepari*, *Paiker*, and retailer. They were asked many questions related to their knowledge, attitudes and practices (KAP) towards postharvest practices and safe vegetable marketingand other related issues.

5.4.1 KAP of traders on safe vegetables

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 do not represent any hazard (http://thelawdictionary.org). The respondent traders in the vegetable supply chain were asked about safe vegetables and its related factors. All most all the respondents gave positive response on it. Majority of the respondents considered those vegetables safe for human consumption which is free from pesticides and diseases, and physical appearance is clean and bright. Some of them opined that safe vegetables must be washed with clean water (Table 5.5).

The key factors opined by the traders that make vegetables unsafe for consumption were discriminate use of pesticides, infection of diseases, and infestation of insects. Nevertheless, the excessive use of chemical fertilizers also makes vegetables unsafe. Some of the respondents also opined that vegetables are considered to be unsafe for human consumption when it is contaminated with birds' dropping and unsafe water (Table 5.5).

All the respondent traders in the vegetable supply chain believed that measures should be taken to keep vegetablessafe for the consumers. They mentioned different measures that will ensure vegetables safe for the consumers. The highest reported measure wasseparation of infested and diseased vegetablesfrom good ones so that good vegetables could not be contaminated with infested and diseased vegetables. A good number of respondents also suggested to wash dirty vegetables with clean water. The other suggested measures for keeping vegetables safe were good packaging, pesticides free vegetables production, clean container use, construction of pack house at market premises, and placing vegetables on clean and shadow place after purchase. (Table 5.6).

Table 5.5Percent response on the attributes of safe vegetables and causes for vegetables unsafe for consumers

Particulars	*Faria (n=68)*	*Bepari (n=103)*	*Paiker (n=12)*	Retailer *(n=100)*	All *(n=283)*
Idea on safe vegetables					
Yes	100	100	100	100	100
A. Attributes of safe vegetables					0
1. Disease free	100.0	88.3	100.0	96.0	94.3
2. Poison/pesticides free	98.5	98.1	66.7	85.0	92.2
3. Clean and bright	79.4	78.6	100.0	89.0	83.4
4. Washed with clean water	11.8	22.3	16.7	29.0	21.9
5. Less mature/soft	1.5	1.9	--	2.0	1.8
B. Causes for vegetables unsafe					
1. Use pesticides	98.5	98.1	100.0	100.0	98.9
2. Infested with insects-pests	89.7	87.4	75.0	84.0	86.2
3. Use chemical fertilizers	33.8	34.0	50.0	38.0	36.0
4. Bird's dropping	17.6	17.5	25.0	21.0	19.1

5. Contaminated irrigation water	1.5	3.9	16.7	2.0	3.2

Table 5.6 Suggested measures for keeping vegetables safe at traders' level

Particulars	*Faria (n=68)*	*Bepari (n=103)*	*Paiker (n=12)*	Retailer *(n=100)*	All *(n=283)*
Willingness to keep vegetables safe (%)					
Yes	100	100	100	100	100
Response on possible measures (%)					
1. Separate infested & diseased vegetables	48.5	56.3	91.7	47.0	52.7
2. Washed with clean water	26.5	25.2	8.3	50.0	33.6
3. Need good packaging	17.6	29.1	41.7	15.0	21.9
4. Produce pesticides free vegetables	14.7	19.4	0.0	31.0	21.6
5. Use clean container	14.7	25.2	33.3	16.0	19.8
6. Construct pack house at market premises	11.8	25.2	25.0	10.0	16.6
7. Place vegetables on clean and shadow place	20.6	12.6	16.7	11.0	14.1

Market intermediaries like *Faria, Bepari*, *Paiker* and retailer in practice took some practical measures to make vegetables safe for the consumers. The highest percentage of traders (46.3%) separated damaged vegetables from good ones to avoid contamination. Over twenty four percent *Bepari* and 42% retailers usually clean purchased vegetables with fresh tube well water before sale. A good portion of traders (11.8-25%) claimed that they used clean container to ensure vegetables safe for the consumers. Some *Farias, Beparis* and retailers reported that they sold poison free vegetables, although they were not sure about the sources and technique of production. After buying vegetables, about 14% traders placed them on clean and shadow place for the purpose of sorting, cleaning and packaging. More than 24% *Beparis* and 9% retailers used good packaging with plastic karate, paper carton, and bamboo basket with paper or leaves lining (Table 5.7).

Table 5.7Percent response on measures taken for keeping vegetables safe at traders' level

Measures taken for safe vegetables	*Faria (n=68)*	*Bepari (n=103)*	*Paiker (n=12)*	Retailer *(n=100)*	All *(n=283)*
1. Separated infested and diseased vegetables	30.9	53.4	83.3	45.0	46.3
2. Washed with clean water	13.2	24.3	8.3	42.0	27.2
3. Used clean container	11.8	21.4	25.0	16.0	17.3
4. Sell poison free vegetables	11.8	17.5	--	26.0	18.4
5. Placed vegetables on clean and shadow place	17.6	12.6	16.7	11.0	13.4
6. Use good packaging	--	24.3	--	9.0	12.0

5.4.2 KAP of traders on clean vegetables

Cleaning products are used to help remove unwanted microbial contaminants from a surface. So it plays a crucial role in our daily lives by providing important public health benefits to consumers. 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. The traders in the study areas were asked to response on the significance of keeping vegetables clean for the consumers. Most of the respondent traders reported that adequate measures should be taken to make vegetables clean for its end users. More than 42% traders thought that dirty vegetables should be cleaned by washing, but 43.1% traders suggested to separate defective vegetables from good ones. About29.3%traders considered using clean container as a prerequisite for clean vegetables, whereas more than 26% traders prohibited to perform sorting activities on

dirty polythene or places.Selling container is also an important factor for keeping vegetables clean. About half of the respondent traders mentioned this for this purpose. Some traders put emphasis on using clean cloths and hands for cleaning dirty vegetables (Table 5.8).

Table 5.8. Percent responses on cleaning vegetables at traders' level

Particulars	*Faria (n=68)*	*Bepari (n=103)*	*Paiker (n=12)*	Retailer *(n=100)*	All *(n=283)*
Response on cleaning vegetables					
Yes	98.5	96.1	100.0	100.0	98.2
No	1.5	3.9	--	--	1.8
Cleaning measures					
1. Separate defective vegetables from good ones	32.4	36.9	58.3	55.0	43.1
2. Wash with clean water	30.9	37.9	33.3	56.0	42.4
3. Transport with clean container	33.8	27.2	50.0	26.0	29.3
4. Sorting should be done on clean polythene	25.0	46.6	16.7	7.0	26.1
5. Placed vegetables on clean place	26.5	26.2	33.3	25.0	26.1
6. Selling container should be cleaned	16.2	9.7	41.7	45.0	25.1
7. Swipe with clean cloths	10.3	4.9	25.0	9.0	13.8
8. Handling with clean hands	4.4	6.8	16.7	15.0	9.5

In practice, majority of the traders performed different actions to make vegetables clean for the consumers and get higher price as well. About 39% of the respondent traders cleaned dirty vegetables with clean water and8.5% used clean cloths. Nearly 34% traders separated defective vegetables from good ones, 24% used clean containers, 22% sorted on clean polythene, and handled them with clean hands for keeping vegetables clean and fresh (Table 5.9).

Table 5.9Percent response on cleaning measures adopted for keeping vegetables clean at traders' level

Cleaning measures adopted	*Faria (n=68)*	*Bepari (n=103)*	*Paiker (n=12)*	Retailer *(n=100)*	All *(n=283)*
1. Wash with clean water	26.5	34.0	33.3	53.0	38.9
2. Separate defective vegetables from good ones	25.0	27.2	25.0	48.0	33.9
3. Selling container should be cleaned	14.7	8.7	33.3	45.0	24.0
4. Put on clean place	26.5	26.2	16.7	21.0	24.0
5. Transport with clean container	25.0	24.3	25.0	20.0	23.0
6. Sorting should be done on clean polythene	16.2	39.8	16.7	7.0	21.6
7. Swipe with clean cloths	11.8	10.7	25.0	17.0	8.5
8. Handling with clean hands	2.9	3.9	16.7	10.0	6.4

5.4.3 KAP of traders 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 important for maintaining product quality, transport to distant places, and reduce postharvest losses.

Majority of the respondents(92.6%) agreed that good packaging has vital role in maintaining product quality and attracting consumers. Nearly 86% retailers opined that plastic crate was the most important packaging tool that could maintain product quality during transportation and handling. Due to lower cost and availability, bamboo cage/basket with paper or leaves or straw lining was reported by majority of the traders (43.8%). More than 21% traders gave

emphasis on using poly bags for packaging brinjal and teasel gourd because this packaging system reduces weight loss of vegetables due to less evaporation. Paper cartoon is also a good material for packaging bitter gourd and teasel gourd (Table 5.10).

Table 5.10Percent response on the type of packaging needed for keeping vegetables safe at traders' level

Particulars	*Faria (n=68)*	*Bepari (n=103)*	*Paiker (n=12)*	Retailer *(n=100)*	All *(n=283)*
Role of packaging on vegetables safe					
Yes	83.8	95.1	83.3	97.0	92.6
No	16.2	4.9	16.7	3.0	1.8
Packaging type					
1. Plastic crates	73.5	90.3	91.7	88.0	85.5
2. Bamboo basket with leaves lining	30.9	38.8	41.7	42.0	43.8
3. Jute sac and poly bags	23.5	21.4	25.0	19.0	21.2
4. Paper cartoon	14.7	16.5	25.0	13.0	15.2
5. Aluminum or plastic bowl	--	--	--	10.0	3.5

In practice, on an average 42.8% traders in the vegetable supply chain used plastic crates as vegetables packaging instrument. The highest percentage of *Paiker*(83.3%) and the lowest percentage of *Faria* (22.1%) used plastic crates with paper lining as packaging instrument for vegetables. A good percentage (37.9-50.0%) of traders used plastic sac and poly bags for packaging and transporting vegetables in the study areas. Bamboo basket with leaves/jute sac or straw liningwas also used by 38.2% traders as packaging instrument. Some *Faria, Bepari* and retailers used paper carton for packaging and transporting high value vegetables in the study areas(Table 5.11).

Table 5.11Percent response on the type of packaging used for keeping vegetables safe at traders' level

Packaging type	*Faria (n=68)*	*Bepari (n=103)*	*Paiker (n=12)*	Retailer *(n=100)*	All *(n=283)*
1. Plastic crates	22.1	49.5	83.3	45.0	42.8
2. Jute sac and poly bags	38.2	37.9	50.0	40.0	39.2
3. Bamboo basket with leaves lining	33.8	41.7	66.7	50.0	38.2
4. Paper carton	4.4	7.8	--	5.0	5.7
5. Big size bag	1.5	2.9	8.3	3.0	2.8

5.5 Information and Communication

Sources of information regarding the availability, demand and price of vegetables depend mainly on the dependency relationship among traders. However, different tradersin the vegetable supply chains collected information from various sources such as farmer, *Faria, Bepari, Arathdars*, business partner and other fellow traders. Most of the *Farias* (68%) collected relevant information from *Bepari*followed by other traders and farmers. Majority of the *Beparis* and *Paikers* collected information from vegetable *Araths* followed by other fellow traders and business partners. Again, majority of the retailers (64%) collected relevant information from fellow traders and 33% from *Arathdars* (Table 5.12).

Table 5.12Sources of information and monthly frequency of contact with sources regarding vegetable trading

Information sources	*Faria (n=68)*		*Bepari (n=103)*		*Paiker (n=12)*		Retailer *(n=100)*		All *(n=283)*	
	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.
1. Vegetable farmer	24	9.4	16	6.7	--	--	26	10.8	20	9.3
2. *Faria*	15	19.6	0	--	--	--	3	14.7	5	18.5
3. *Bepari*	68	15.7	10	18.3	17	7.0	26	10.5	30	14.2
4. *Arathdar*	15	7.8	85	17.5	75	14.7	33	13.1	49	15.6
5. Other traders	38	15.9	39	14.3	67	19.4	64	17.7	49	16.5
6. Business partner	--	--	17	28.6	--	--	3	16.0	7	26.8

The key traders in the vegetable supply chains were asked about the necessity of information pertinent to safe produce,food quality and reducing postharvest losses. All respondent traders felt the necessity of information regarding the above purposes. They needed different types of information such as low-cost improved packaging and storage system, technique of short-time storage system, daily availability and price of vegetables, improved transportation system, and technique of reducing postharvest loss of vegetables (Table 5.13). If we look at the insides of the table we can find that the highest percentages of *Faria* and *Paiker* need information onlow-cost storage system,technique of short-time storage,and daily availability of vegetables because they don't have such type of facility at market level and sometimes these situations force them selling vegetables at lower price. Again, the information and related technology regarding low-cost packaging, improved transportation system, and techniques of reducing postharvestlosses are highly required for *Beparis* as they have to transport vegetables from long distances.

Table 5.13 Type of information needed for ensuring safety and quality of vegetables and reduce postharvest loss at traders' level

Particulars	*Faria (n=68)*	*Bepari (n=103)*	*Paiker (n=12)*	Retailer *(n=100)*	All *(n=283)*
Response on information need (%)					
Yes	100.0	100.0	100.0	100.0	100.0
Type of information needed (%)					
1. Low-cost improved packaging	26.5	79.6	41.7	78.0	64.7
2. Low-cost storage system	67.6	65.0	83.3	38.0	56.9
3. Technique of short-time storage	67.6	46.6	75.0	61.0	58.0
4. Daily availability of vegetables	64.7	17.5	75.0	53.0	43.8
5. Daily price of vegetables	50.0	9.7	25.0	58.0	37.1
6. Improved system of transportation	27.9	62.1	16.7	12.0	34.3
7. Postharvestloss reducing techniques	14.7	10.7	25.0	25.0	17.3

Vegetable traders were also asked about their preferred broadcast media though which they like to get their required information. In this regard they mentioned various broadcast media. The highest percentage of traders (77.4%) preferred television as the broadcast media because they enjoy it on a regular basis. The second most preferred broadcast media was reported to be billboard(59.7%). It will easily be visible to most of the traders in the market. These media required less cost and time. They could easily get correct information using these sources. The other favorite broadcast media were mobile massages and posters. Some traders also stated

radio and brochure as their preferred broadcast media for getting their required information (Table 5.14).

Table 5.14Percent response on traders' preferences on broadcast media for information and communication

Type of broadcast media	*Faria (n=68)*	*Bepari (n=103)*	*Paiker (n=12)*	Retailer *(n=100)*	All *(n=283)*
1. Television	75.0	78.6	83.3	77.0	77.4
2. Billboard	58.8	57.3	58.3	63.0	59.7
3. Mobile massage	30.9	44.7	41.7	43.0	40.6
4. Poster	39.7	39.8	25.0	43.0	40.3
5. Radio	10.3	12.6	--	13.0	11.7
6. Brochure	5.9	3.9	16.7	5.0	5.3

5.6 Type of Educational Activity Needed

The traders in the vegetable supply chain demanded some educational activities that will help promoting safe and quality vegetables and reducing postharvest losses during postharvest handling. Most of the traders (98.9%) wanted to take hand-on training on the techniques of low-cost packaging, short-time storage, careful handling and transportationof vegetables. More than half of the traders thought that regular meeting with farmers and fellow traders obviously enrich their current state of knowledge on safe and quality food which will help reducing postharvest losses. Some traders gave emphasis on the regular field visits of extension workers with farmers which will reduce postharvest loss at farm as well as traders level to a great extent (Table 5.15).

Table 5.15Percent responses on educational program needed for ensuring safety and quality of vegetables and reduce postharvest loss at traders' level

Type of educational program	*Faria (n=68)*	*Bepari (n=103)*	*Paiker (n=12)*	Retailer *(n=100)*	All *(n=283)*
1. Hand-on training	100.0	100.0	100.0	97.0	98.9
2. Consultation with fellow traders and farmers	51.5	52.4	66.7	60.0	55.5
3. Regular visit with extension agents	60.3	52.4	58.3	51.0	54.1

5.7 Actions Needed at Market Premises

The middlemen in the supply chain suggested different possible actions that should be practiced at assembling or primary market for ensuring product quality and safety. They opined different views in this regard which are shown in Table 5.16.

On an average, about 42% of the respondent traders suggested that both farmers and traders should be encouraged to sell organic vegetables or pesticides free vegetables. Market committee or any other govt. agency may identify organic vegetables at market premises and fix their reasonable premium prices to encourage the production and marketing of organic vegetables.

The role of pack house at market premises is very important. Vegetable traders especially *Beparis* have to perform different postharvest activities like assembling, sorting, washing,

cleaning and packaging of vegetables after buying from farmers and *Farias.*Due to lack of adequate places, these postharvest activities are being performed here and there. Nearly 37% traders suggested to construct pack house at each assembling market to perform different postharvest handlings efficiently. Government should create this facility in each vegetable assembling market.

Indiscriminate use of pesticides is currently an acute problem in vegetable cultivation. Most producers can't imagine growing vegetables without the use of pesticides. But they are not applying recommended practices regarding pesticides use and crop harvest. Therefore, about one-fourth of the respondent traders suggested to encourage farmers to harvest vegetables 7 days after applying pesticides and market authority should have pesticides detection instruments.

About 21% traders mentioned that motivational campaign against selling poisonous vegetables may be effective towards preventing its selling and discouraging its farm level production.More than 18% traders opined that market committee may impose fine for selling poisonous vegetables in the market.

In many events like political unrest, price fall, transporter's strike, short-time storage of vegetables at market premises is essential for many vegetable traders. Due to lack of storage facility respondent traders sometimes experienced a lot of postharvest losses of their produces. Hence, 18.4% vegetable traders suggested to establish low-cost cold storage at market premises.Government or private firm may come forward to establish low-cost cold storage at market premises.

Table 5.16Percent responses on possible actions/steps needed at market premises for keeping vegetables safe

Type of actions	*Faria (n=68)*	*Bepari (n=103)*	*Paiker (n=12)*	Retailer *(n=100)*	All *(n=283)*
1. Give incentives for selling organic or pesticides free vegetables	38.2	33.0	33.3	54.0	41.7
2. Construct pack house	33.8	45.6	50.0	27.0	36.4
3. Encourage farmers to harvest vegetables 7 days after applying pesticides	27.9	17.5	33.3	29.0	24.7
4. Need pesticides detection instruments	32.4	20.5	58.3	19.0	24.5
5. Motivational campaign against selling poisonous vegetables	25.0	26.2	8.3	13.0	20.5
6. Market committee may impose fine for selling poisonous vegetables	14.7	17.5	16.7	22.0	18.4
7. Establish low-cost cold storage	13.2	18.4	8.3	23.0	18.4

5.8 Brinjal Marketing at Traders' Level

5.8.1 Supply chain in brinjal marketing

Marketing channels are important in evaluating marketing system because they indicate how the various market participants are organized to accomplish the movement of a product from the producer to the ultimate consumers (Thomas, 2000). The process of brinjal marketing started with its producers and continued different actors through certain chains until the produce reached to the final consumers. The chain of brinjal marketing varied location to location. The following major chains were identified in the study areas (Jamalpur and Rajshahi) for brinjal marketing (Fig 5.12). The channel *Farmer>Bepari>Urban Retailer>Urban Consumer* was ranked first in terms of the volume of transaction (36.09%).

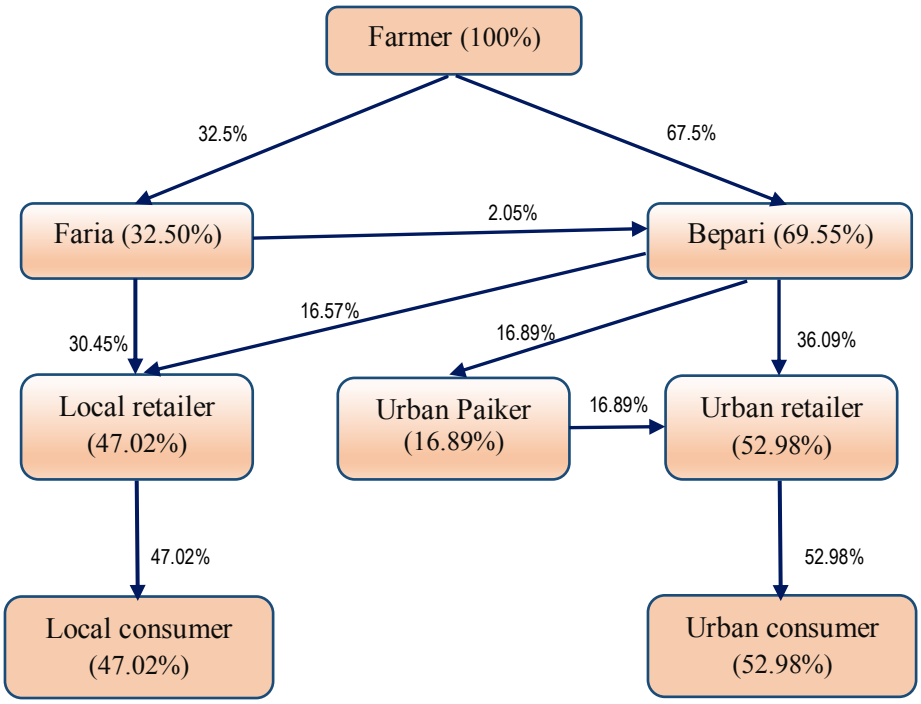


Fig 5.12 Flow diagram of brinjal supply chain

The following major chains were identified for brinjal marketing.

Marketing channel	% of product flow
Farmer >Bepari>Local retailer>Local consumer (local market)	16.57
Farmer >Bepari>Paiker>Urban retailer>Urban consumer	16.89
Farmer >Bepari>Urban retailer>Urban consumer (terminal market)	36.09
Farmer >Faria>Local retailer>Local consumer	30.45

5.8.2 Volumes of brinjal traded

It was observed in the study areas that the volume of brinjal traded by the sample traders varied from season to season, availability of product in the market, financial capacity of the traders, transportation facility, demand at wholesale markets, etc. The volumes of brinjal traded by different intermediaries are shown in Tables 5.17 and 5.18.

Faria is a petty trader in the brinjal supply chain. Theypurchased entire volume of brinjal(23.72 t/month) from farmer and sold them to *Bepari* andlocal retailers. They sold about 94% brinjal to *Bepari* immediately after purchase.*Bepari*is an important big trader in the brinjal supply chain. They purchase a lion share of brinjal from farmer and small share from *Faria*. The respondent *Bepari* bought 94.1% brinjal from farmers and the rest from *Faria* (Table 5.17). On the other side, they sold more than half of the brinjal to urban retailers through *Arathdars* followed by urban *Pikers* through *Arathdars* and local retailers. Local retailers purchase brinjal from different traders where they get good products with lower price. However, they purchased the highest volume of brinjal directly from farmers (54.8%) followed by *Bepari* (31.4%) and *Faria* (13.8%).Again, urban retailers directly purchased from *Paikers* and *Beparis* through *Arathdars*. Retailer sold their entire brinjal to the final consumers.

Table 5.17Volume of brinjal purchased from different sellers (kg/month)

Traders	n	Farmer		*Faria*		*Bepari*		*Paiker*		Total	
		Qty	%	Qty	%	Qty	%	Qty	%	Qty	%
Faria	23	23724	100	--	--	--	--	--	--	23724	100
Bepari	28	96650	94.1	6050	5.9	--	--	--	--	102700	100
Paiker	6	--	--	--	--	35567	100	--	--	35567	100
Retailer (local)	29	1284	54.8	322	13.8	736	31.4	--	--	2342	100
Retailer (urban)	6	--	--	--	--	393	47.6	433	52.4	826	100

Table 5.18Volume of brinjal soldto different buyers (kg/month)

Traders	Bepari		Paiker		Retailer (local)		Retailer (urban)		Consumer (local)		Consumer (urban)		Total	
	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%
Faria	22226	94	--	--	1498	6	--	--	--	--	--	--	23724	100
Bepari			23761	24	23300	24	50785	52	--	--	--	--	97845	100
Paiker	--	--	--	--	--	--	34560	100	--	--	--	--	34560	100
Retailer (local)	--	--	--	--	--	--	--	--	2247	100	--	--	2247	100
Retailer (urban)	--	--	--	--	--	--	--	--	--	--	779	100	779	100

5.8.3Price of brinjaland its seasonal variation

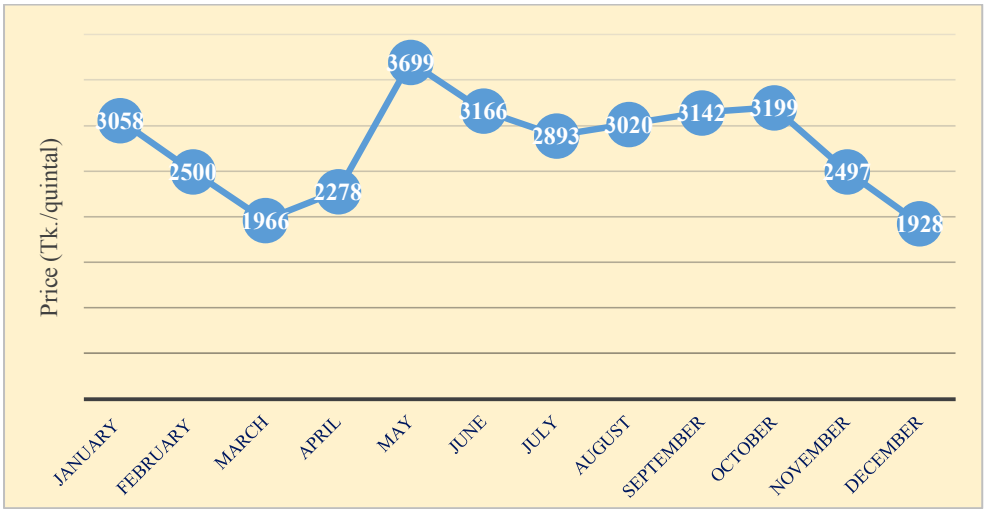
The price of brinjal depends mainly on different factors such as season, variety, size, colour, freshness, maturity, nature of supply in the market, etc. Irrespective of these factors, the average purchase prices of brinjal prevailed in the study areas were estimated at Tk.2626, Tk.2938, Tk.3691, Tk.3995, and Tk.3154per quintal respectively for *Faria,Bepari (local & urban)*, *Paiker*, urban retailer and local retailer. The selling price of brinjal for urban *Bepari* and urban retailer was much higher compared to local *Bepari* and local retailer in the study areas (Table 5.19).

Table 5.19 Buying and selling price of brinjal in the study areas

Traders	Buying price (Tk/quintal)	Selling price (Tk/quintal)	Gross margin(Tk/quintal)
Faria	2626	2938	312
Bepari (local)	2938	3154	216
Bepari (urban)	2938	3691	753
Paiker (urban)	3691	3995	304
Retailer (urban)	3995	4990	995
Retailer (local)	3154	3616	462

It has been stated in the earlier section that brinjal price is depended on many factors. Availability of brinjal in the market is one of the important factors that determine brinjal price. The pattern of changes of the average monthly wholesale prices of brinjal wasrecorded during 2018 (BBS, 2019). The recorded price data (Fig 5.13) reveals that the prices of brinjal were found very low in the month of December and March and high during May-October.

The highest price was might be due to lean period and new arrival of brinjal in the market. The prices of brinjal in the remaining months were more or less same with very lowvariation. It happened might be due to its stable supply in the market.



Source: BBS, 2019

Fig 5.13Monthly average wholesale price of brinjal, 2018

5.9 Bitter gourd Marketing at Traders' Level

5.9.1 Supply chain in bitter gourd marketing

The process of bitter gourd marketing started from its producers and continued different actors through certain chains until the produce reached to the final consumers. The chain of bitter gourd marketing varied location to location. Among different intermediaries,*Bepari*and retailer were the most important middlemen in the process of bitter gourd marketing. *Bepari* traded a large volume of bitter gourdthroughout production season.

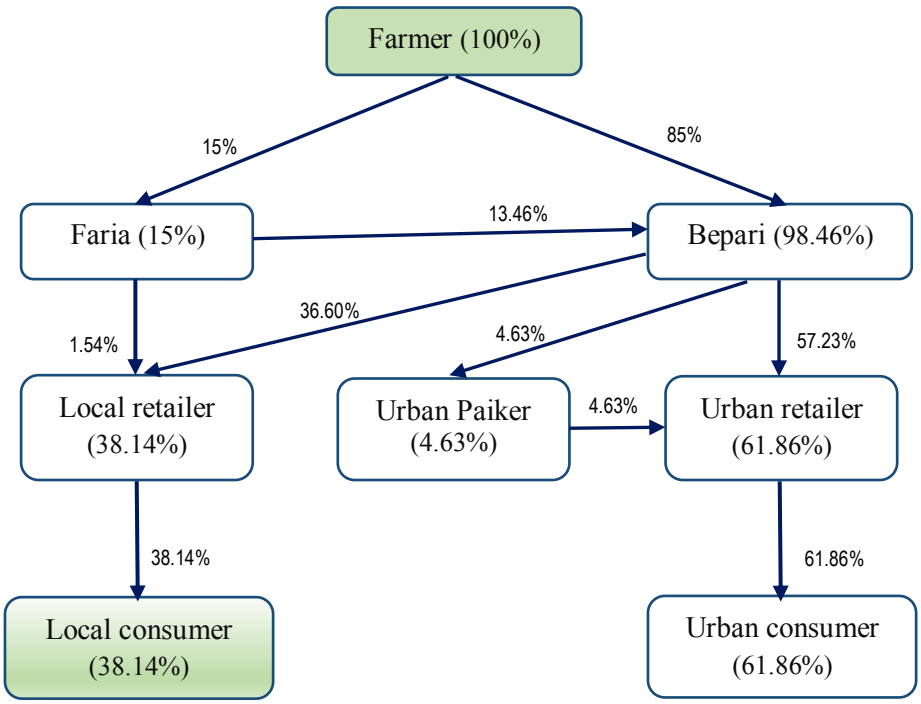


Fig5.14 Flow diagram of bitter gourd supply chain

The traded volume of *Faria*was much lower than *Bepari*. Like other vegetable traders, *Faria*do not store bitter gourd for even one night. The following major chains were identified in the study areas for bitter gourd marketing (Fig 5.14). The channel *Farmer >Bepari>Urban retailer>Urban consumer*(terminal market) was ranked first in terms of the volume of transaction (57.23%). The involvement of *Paiker* and *Faria* in bitter gourd marketing was reported to be very less, therefore the percent of product flow through the channels were very low.

The following major chains were identified for bitter gourd marketing.

Marketing channel	**% of product flow**
Farmer >Bepari>Urban retailer>Urban consumer (terminal market)	57.23
Farmer >Bepari>Paiker>Urban retailer>Urban consumer	4.63
Farmer >Bepari>Local retailer>Local consumer (local market)	36.60
Farmer >Faria>Local retailer>Local consumer	1.54

5.9.2 Volumes of bitter gourd traded

The volume of bitter gourd traded in the study areas varied from season to season, availability of product in the market, financial capacity of the traders, transportation facility, demand at wholesale markets, etc.

Like other vegetables, *Faria*purchase entire volume of bitter gourd (8.16 t/month) from farmers and sell them to *Bepari* and local retailers. Table 5.21 shows that *Faria*sold on an average 90% bitter gourd to *Bepari*and only 10% to local retailer immediately after purchase. *Bepari* is also an important non-licensed big trader in bitter gourd marketing. Usually, they purchase big amount of bitter gourd from farmers and small share from *Farias*. Table 5.20 reveals that *Bepari* bought 91.2% bitter gourd from farmers and the rest from *Farias*. On the other side, they sold 85% bitter gourd to urban retailers through *Arathdars* followed by 35% to local retailers. *Paiker* is a wholesale trader who generally performs business at urban areas (*Arath)*. They purchase entire volume of produces from *Bepari* and sell them to urban retailers. Local retailers purchase bitter gourd from different traders where they get good products with lower price. However, they purchased the highest volume of brinjal directly from farmers (48.9%) followed by *Bepari* (39.2%) and *Faria* (11.9%).Again, urban retailers directly purchased small amount from *Paikers*(15.3%) and *Beparis*(84.7%) through *Arathdars*. Retailers sold their entire bitter gourd to the final consumers.

Table 5.20Volume of bitter gourd purchased from different sellers (kg/month)

Traders	n	Farmer		*Faria*		*Bepari*		*Paiker*		Total	
		Qty	%	Qty	%	Qty	%	Qty	%	Qty	%
Faria	23	8158	100	--	--	--	--	--	--	8158	100
Bepari	28	30816	91.2	2982	8.8	--	--	--	--	33797	100
Paiker	6	--	--	--	--	24900	100	--	--	24900	100
Retailer (local)	29	201	48.9	49	11.9	161	39.2	--	--	411	100
Retailer (urban)	6	--	--	--	--	447	84.7	81	15.3	528	100

Table 5.21Volume of bitter gourd sold to different buyers (kg/month)

Traders	Bepari		Paiker		Retailer (local)		Retailer (urban)		Consumer (local)		Consumer (urban)		Total	
	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%
Faria	7320	90	--	--	838	10	--	--	--	--	--	--	8158	100
Bepari			1477	5	11676	37	18262	58	--	--	--	--	31414	100
Paiker	--	--	--	--	--	--	24053	100	--	--	--	--	24053	100
Retailer (local)	--	--	--	--	--	--	--	--	381	100	--	--	381	100
Retailer (urban)	--	--	--	--	--	--	--	--	--	--	488	100	488	100

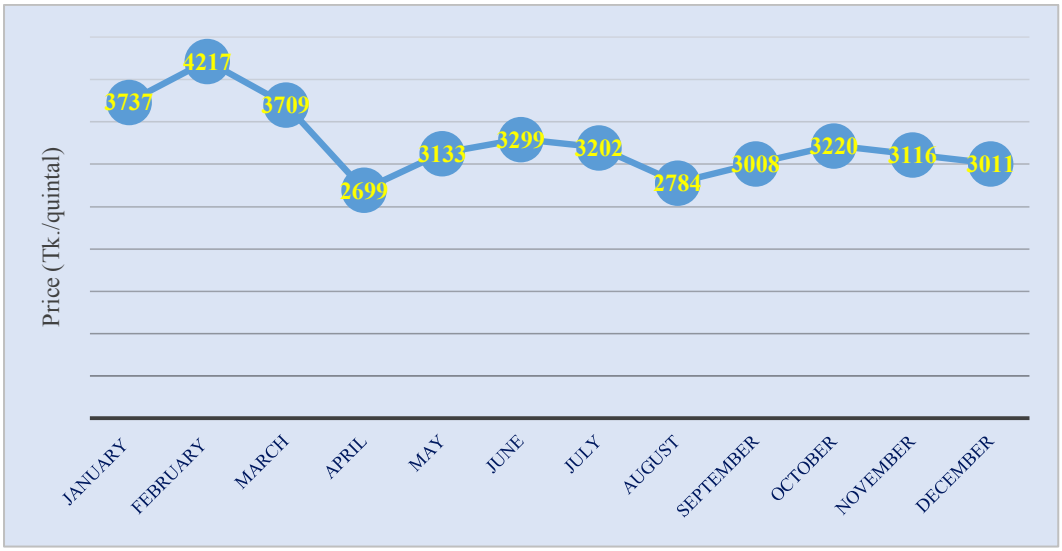
5.9.3 Price of bitter gourd and its seasonal variation

The price of bitter gourd influence by many factor. These factors are growing season, variety, size, colour, freshness, maturity, and nature of supply in the market. Irrespective of these factors, the average purchase prices of bitter gourd prevailed in the study areas were estimated at Tk.2532, Tk.2976, Tk.3709, Tk.3236 and Tk.4205 per quintal respectively for *Faria, Bepari (local & urban)*, *Paiker*, local retailer and urban retailer. Both local and urban *Beparis* purchased bitter gourd from farmers in the primary markets, so the purchase prices were same for them. The selling price of bitter gourd for urban *Bepari* and urban retailer was much higher compared to local *Bepari* and local retailer in the study areas (Table 5.22). The reasons behind these higher prices were transportation cost, postharvest loss and higher middlemen's margins.

Table 5.22 Buying and selling price of bitter gourd in the study areas

Traders	Buying price (Tk/quintal)	Selling price (Tk/quintal)	Gross margin(Tk/quintal)
Faria	2532	2976	444
Bepari (local)	2976	3236	260
Bepari (urban)	2976	3709	733
Paiker (urban)	3709	4205	496
Retailer (urban)	4205	5058	853
Retailer (local)	3236	3678	442

It has already been stated that the price of bitter gourd depends on many factors, but the availability of bitter gourd in the market is an important factor for determination of brinjal price. The pattern of changes of the average monthly wholesale prices of bitter gourd wasrecorded during 2018(BBS, 2019). The recorded price data (Fig 5.15) reveals that the prices of bitter gourd remained very low during April and August and high during January-March. The highest price was might be due to lean period and new arrival of bitter gourd in the market. The prices of bitter gourd in the remaining months were more or less same with very low fluctuation. It occurredmight be due to its stable supply in the market.



Source: BBS, 2019

Fig 5.15Monthly average wholesale price of bitter gourd, 2018

5.10 Yardlong bean Marketing at Traders' Level

5.10.1 Supply chain in yardlong bean marketing

The process of yardlong bean marketing started from its producers and continued up to the final consumersthrough certain chains. Sometimes, yardlong bean directly pass from producers to consumers and in that case there is a complete absence of middlemen or intermediaries. But it is only a very small proportion of the vegetables that moves directly from producers to consumers. The chain of yardlong bean marketing also varied location to location. A number of middlemen such as *Faria*, *Bepari, Paiker*and retailer are involved in the process of yardlong bean marketing. However, the involvement of *Paiker* and *Faria* in yardlong bean marketing was reported to be very less. The following marketing chains were identified in the study areas for yardlong bean (Fig 5.16). The channel *Farmer>Bepari>Local retailer>Local consumer*was ranked first in terms of the volume of transaction (49.08%). The percent of product flow through the channel-3 and -4 were very low.

The following major chains were identified for yardlong bean marketing.

Marketing channel	**% of product flow**
Farmer >Bepari>Local retailer>Local consumer	49.08
Farmer >Bepari>Urban retailer>Urban consumer	43.52
Farmer >Bepari>Paiker>Urban retailer>Urban consumer	6.04
Farmer >Faria>Local retailer>Local consumer	1.36

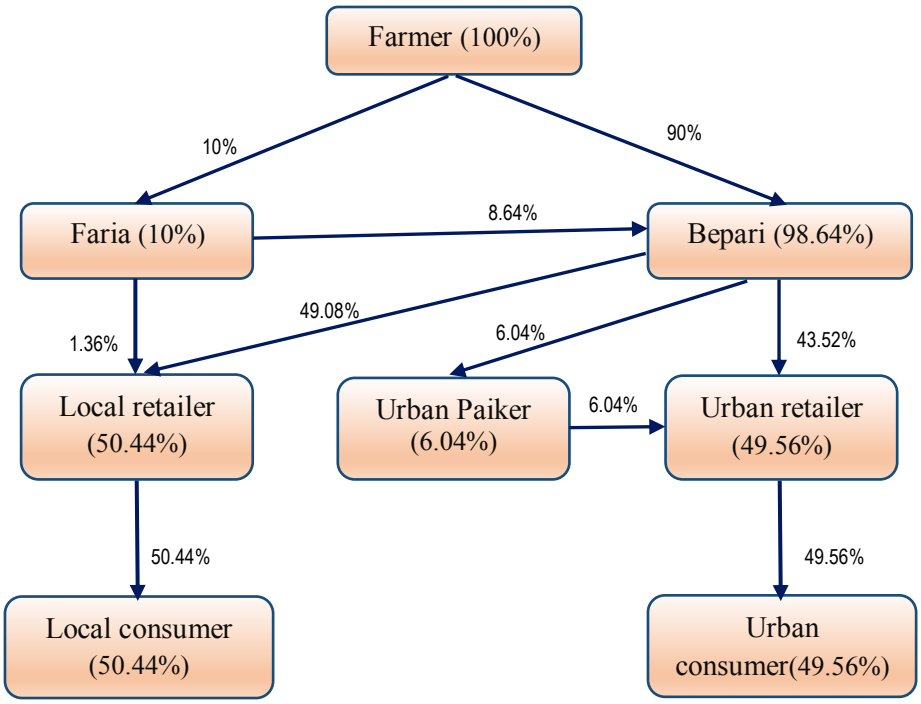


Fig5.16 Flow diagram of yardlong bean supply chain

5.10.2 Volumes of yardlong bean traded

The volume of yardlong bean traded in the study areas varied from season to season, availability of product in the market, financial capacity of the traders, transportation facility, demand at wholesale markets, etc.

Like other vegetables, *Faria*purchasedtheir entire volume of yardlong bean (8.35 t/month) from farmers and sold86% to *Bepari* and the rest 14% to local retailersimmediately after purchase. Usually, *Bepari*purchase big amount of yardlong bean from farmers and small share from *Faria*. Table 5.23 reveals that *Bepari* bought 93.1% yardlong bean from farmers and the rest from *Faria*. On the other side, they sold 44% yardlong bean tothe urban retailers through *Arathdar*and 44% to the local retailers (Table 5.24). *Paiker* is a wholesale trader who generally performs business at terminal markets (*Arath)*. They purchase entire volume of produces from *Bepari*through *Arathdar* and sell them to urban retailers. Local retailers purchase yardlong bean from different traders where they get good products with lower price. However, they purchased the highest volume of yardlong bean (53.1%) from *Bepari*and 44%directly from farmers and only 2-9% from *Faria*. Again, urban retailers purchased the highest volume of yardlong bean (66.8%) from *Paiker* and the rest amount (32.2%) from *Bepari* through *Arathdar*. Retailers sold their entire yardlong bean to the final consumers.

Table 5.23Volume of yardlong bean purchased from different sellers (kg/month)

Traders	n	Farmer		*Faria*		*Bepari*		*Paiker*		Total	
		Qty	%	Qty	%	Qty	%	Qty	%	Qty	%
Faria	19	8348	100	--	--	--	--	--	--	8348	100
Bepari	32	26580	93.1	1961	6.9	--	--	--	--	28542	100
Paiker	6	--	--	--	--	22400	100	--	--	22400	100
Retailer (local)	6	--	--	--	--	126	33.2	253	66.8	379	100

Retailer (urban)	30	196	44.0	13	2.9	237	53.1	--	--	446	100

Table 5.24Volume of yardlong bean sold to different buyers (kg/month)

Traders	Bepari		Paiker		Retailer (local)		Retailer (urban)		Consumer (local)		Consumer (urban)		Total	
	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%
Faria	7211	86	--	--	1137	14	--	--	--	--	--	--	8348	100
Bepari	--	--	1625	6	13222	50	11725	44	--	--	--	--	26572	100
Paiker	--	--	--	--	--	--	21663	100	--	--	--	--	21663	100
Retailer (local)	--	--	--	--	--	--	--	--	--	--	356	100	356	100
Retailer (urban)	--	--	--	--	--	--	--	--	418	100	--	--	418	100

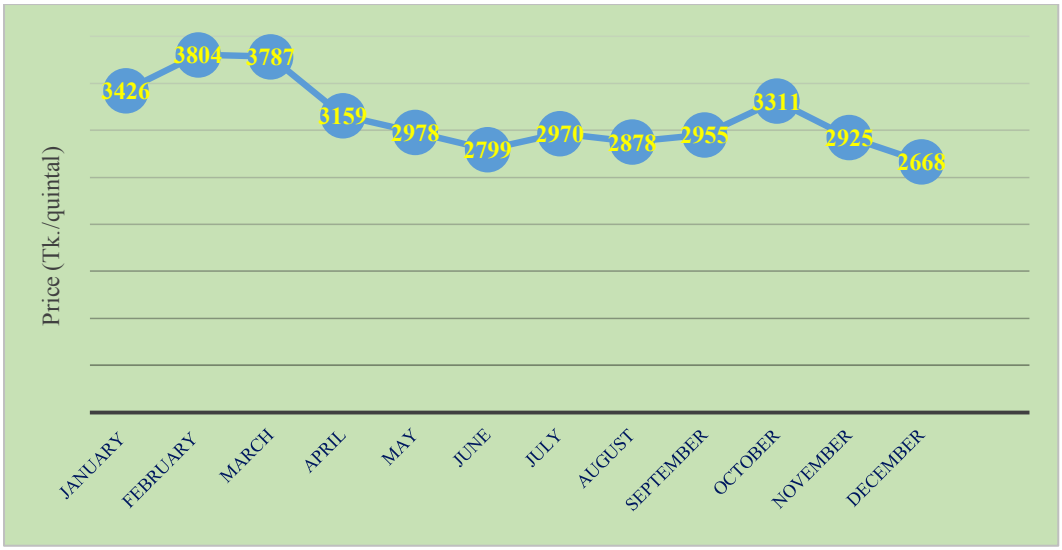
5.10.3 Price of yardlong bean and its seasonal variation

The price of yardlong beanis depended on many factors such as growing season, variety, size, colour, freshness, maturity, and nature of supply in the market. Irrespective of these factors, the average purchase prices of yardlong beanprevailed in the study areas were estimated at Tk.2195, Tk.2464, Tk.3074 and Tk.4224 and Tk. 2755 per quintal respectively for *Faria, Bepari* (local & urban)*Paiker*, urban retailer and local retailer. Again, the average selling prices were estimated at Tk. 2464, Tk. 3074, Tk. 4224, and Tk. 5008 per quintal respectively for *Faria, Bepari (urban)*, *Paiker*, and urban retailer. The selling price of local *Bepari* and local retailer was much lower than that of urban *Bepari* and retailer (Table 5.25).

Table 5.25 Buying and selling price of yardlong bean in the study areas

Traders	Buying price (Tk/quintal)	Selling price (Tk/quintal)	Gross margin(Tk/quintal)
Faria	2195	2464	269
Bepari (local)	2464	2755	291
Bepari (urban)	2464	3074	610
Paiker (urban)	3074	4224	1150
Retailer (urban)	4224	5008	784
Retailer (local)	2755	3616	861

Like other vegetables, the availability of yardlong beanin the market is an important factor for determination of yardlong bean price. The pattern of changes of the average monthly wholesale prices of yardlong beanwere collected from BBS (2019) for the year 2018. Figure 5.17 reveals that the prices of yardlong bean remained very low in the months of December and June and high during January-March. The highest price was might be due to lean period and new arrival of yardlong bean in the market. The prices of yardlong bean in the remaining months were more or less similar with very low variation. It occurredmight be due to its stable supply in the market.



Source: BBS, 2019

Fig 5.17Monthly average wholesale price of yardlong bean, 2018

5.11 Teasel gourd Marketing at Traders' Level

5.11.1 Supply chain in teasel gourd marketing

The process of teasel gourd marketing started from its producers and continued up to the final consumersthrough certain channels. The channels of teasel gourd marketing varied location to location. A number of middlemen such as *Faria*, *Bepari, Paiker* and retailer are involved in the process of teasel gourd marketing. However, the involvement of *Faria* in teasel gourd marketing was reported to be very less. *Faria* purchased their entire volume of teasel gourd from farmers and sell them to *Bepari.Bepari*traded a large volume of teasel gourdthroughout its production season. The traded volume of *Bepari* was higher than that of *Faria, Piker* and retailer. *Paiker* who usually performs their business at terminal market buys teasel gourd from Bepari through *Arathdar*. A total of four marketing channels were identified in the study areas for teasel gourd (Fig 5.18). The channel *Farmer>Bepari>Paiker>Urban retailer>Urban consumer*was ranked first in terms of the volume of transaction (80%) followed by channel *Farmer>Bepari>Local retailer>Local consumer*. The other two channels identified for teasel gourd marketing are shown below.

The following major chains were identified for teasel gourd marketing.

Marketing channel	**% of product flow**
Farmer >Bepari>Paiker>Urban retailer>Urban consumer	80.00
Farmer >Bepari>Local retailer>Local consumer	15.41
Farmer >Faria>Local retailer>Local consumer	0.15
Farmer >Faria>Bepari>Paiker>Urban retailer>Urban consumer	4.44

5.11.2 Volume of teasel gourd traded

Like other studied vegetables, the quantity of teasel gourd traded in the study areas varied from season to season, availability of product in the market, financial capacity of the traders, transportation facility, demand at wholesale markets, etc.

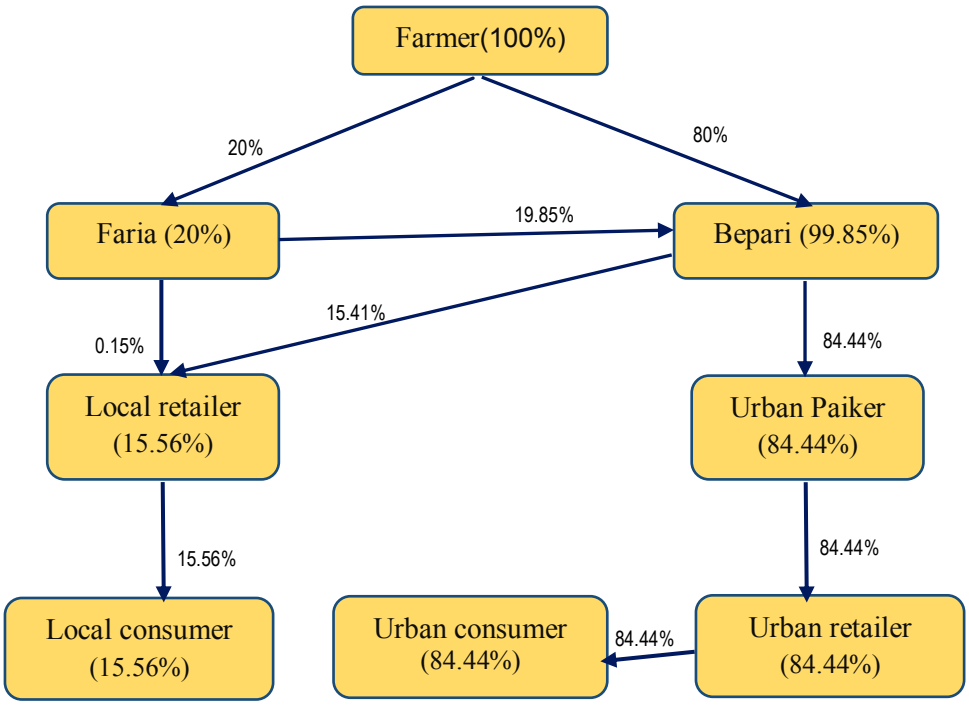


Fig5.18 Flow diagram of teasel gourd supply chain

*Faria*purchasedtheir total volume of teasel gourd (16.03 t/month) from farmers and sold99% to *Bepari* and the rest 1% to local retailersimmediately after purchase. Usually, *Bepari* purchase a big amount of teasel gourd from farmers and small share from *Faria*. *Bepari* bought 51.4% teasel gourd from *Faria* and the rest 48.6% from farmers.Again, they sold 85% teasel gourd to the local retailers and only 15% to the urban *Paiker*through *Arathdar*(Table 5.27). It is indicated that the majority of teasel gourd in the study areas are consumed by the local consumers (in the primary & secondary markets). *Paiker* purchased entire volume of produces from *Bepari* through *Arathdars* and sold them to urban retailers (based on Dhaka and Gazipur). Local retailers purchase teasel gourd from different traders where they get good products with lower price. However, they purchased the highest volume of teasel gourd (55%) from *Bepari*and 39%directly from farmers and only 6% from *Faria*. Again, urban retailers purchased the highest volume of teasel gourd (62.2%) from *Paiker* and the rest amount (33.8%) from *Beparis* through *Arathdar*(Table 5.26).Both types of retailers sold their entire teasel gourd to the final consumers.

Table 5.26Volume of teasel gourd purchased from different sellers (kg/month)

Traders	n	Farmer		*Faria*		*Bepari*		*Paiker*		Total	
		Qty	%	Qty	%	Qty	%	Qty	%	Qty	%
Faria	18	16031	100	--	--	--	--	--	--	16031	100
Bepari	34	25616	48.6	27078	51.4	--	--	--	--	52694	100
Paiker	6	--	--	--	--	32767	100	--	--	32767	100

Retailer (local)	6	--	--	--	--	143	33.8	280	66.2	423	100
Retailer (urban)	30	167	38.5	28	6.5	238	55.0	--	--	433	100

Table 5.27Volume of teasel gourd sold to different buyers (kg/month)

Traders	Bepari		Paiker		Retailer (local)		Retailer (urban)		Consumer (local)		Consumer (urban)		Total	
	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%	Qty	%
Faria	15907	99	--	--	124	1	--	--	--	--	--	--	16031	100
Bepari	--	--	7938	15	43506	85	--	--	--	--	--	--	51444	100
Paiker	--	--	--	--	--	--	32202	100	--	--	--	--	32202	100
Retailer (local)	--	--	--	--	--	--	--	--	--	--	415	100	415	100
Retailer (urban)	--	--	--	--	--	--	--	--	423	100	--	--	423	100

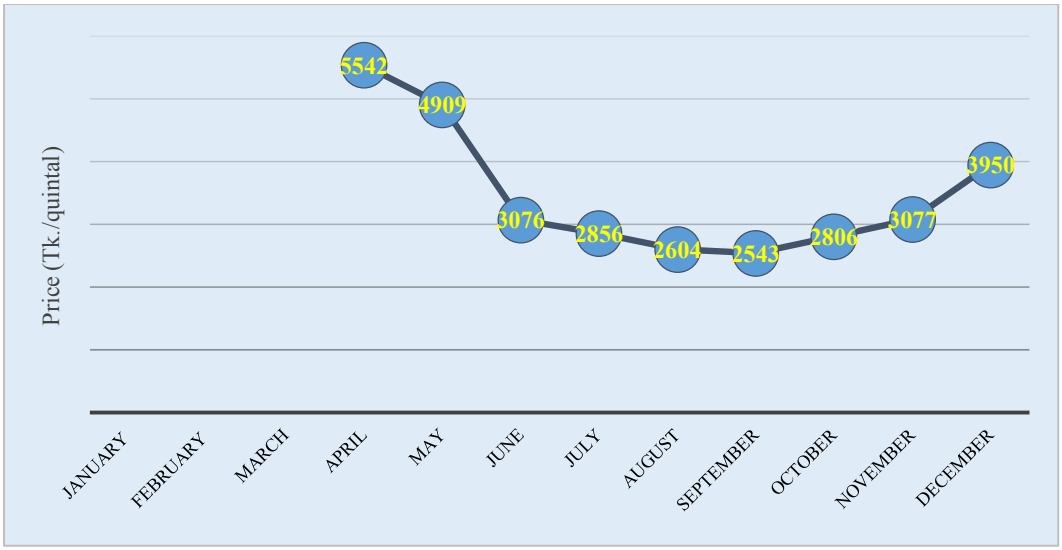
5.11.3 Price of teasel gourd and its seasonal variation

The price of teasel gourd is depended on many factors such as growing season, variety, size, colour, freshness, maturity, and nature of supply in the market. Irrespective of these factors, the average purchase prices of teasel gourdprevailed in the study areas were estimated at Tk.2533, Tk.2991, Tk.3699, Tk.4258, and Tk.3264per quintal respectively for *Faria, Bepari* (local & urban)*Paiker*, urban retailer and local retailer.Again, the average selling prices were estimated at Tk. 2991, Tk. 3699, Tk. 4258, and Tk. 5003 per quintal respectively for *Faria, Bepari (urban)*, *Paiker*, and urban retailer. The selling price of teasel gourd for local *Bepari* and local retailer was much lower than that of urban *Bepari* and retailer (Table 5.28).

Table 5.28 Buying and selling price of teasel gourdin the study areas

Traders	Buying price (Tk/quintal)	Selling price (Tk/quintal)	Gross margin(Tk/quintal)
Faria	2533	2991	458
Bepari (local)	2991	3264	273
Bepari (urban)	2991	3699	708
Paiker (urban)	3699	4258	559
Retailer (urban)	4258	5003	745
Retailer (local)	3264	3866	602

Like other vegetables, the availability of teasel gourdin the market is a crucial factor for determination of its price. The changing pattern of the average monthly wholesale prices of teasel gourdwascollected from BBS (2019) for the year 2018. Figure 5.19 reveals that the prices of teasel gourd remained very low during July to October and very high in the month of April-May and December. The highest price was might be due to lean period and new arrival of teasel gourd in the market. The prices of teasel gourd in the remaining months were more or less same with very low variation. It occurredmight be due to its stable supply in the market.



Source: BBS, 2019

Fig 5.19Monthly average wholesale price of teasel gourd, 2018

5.12 Postharvest Losses of Vegetables at Traders' Level

Mainly two types of postharvest losses such as mechanical and physical losses occurred in selected vegetable supply chains at traders' level. Different types of injuries, careless handling,causing internal bruising, splitting and skin breaks, etc. are regarded as mechanical postharvest losses, whereas shrinkage and loss of weight caused by water loss and discoloration are termed as physical postharvest losses.A number of factors were reported contributing to postharvest losses of vegetables at trader's level.The postharvest losses of vegetables at different intermediaries' level in the supply chain are presented in Table 5.29to Table 5.30.

5.12.1 Postharvest loss of brinjal at traders' level

The total postharvest loss of brinjal at trader's level in the longest channel (*Farmer-Faria-Bepari-Paiker-Urban retailer*) was estimated at 13.32%. Among intermediaries, the highest loss was estimated at urban retailer's level (5.76%) followed by *Bepari* (4.73%) and local retailer (4.03%) level (Table 5.29). Kayser et al. (2016) estimated total postharvest loss of brinjal to be 10.87% at trader's level of which retail level loss was 5.96%.Hassan et al. (2010) estimated postharvest loss of brinjal 22.4% at trader's level. The postharvest loss of brinjal at trader's level (5.81%) in India seemed to be lower than the loss occurred in Bangladesh (Sharma and Singh, 2011).No loss was reported at *Faria's* level in the study areas. Retailer sold small quantity and hold comparatively long time, therefore, retailer's loss was reported to be the highest among intermediaries.*Beparis* postharvest loss was also high because they have to transport brinjal from long distance (Rajshahi/Jamalpur to Dhaka/Gazipur).

Table 5.29Monthly postharvest loss of brinjal at traders' level

Traders	Total purchase (kg)	Total sale (kg)	Average loss (kg)	% loss
Faria	23724	23724	0	--
Bepari	102700	97845	4855	4.73
Paiker	35567	34560	1007	2.83
Retailer (local)	2342	2247	95	4.03
Retailer (urban)	827	779	48	5.76

Respondent traders stated some causes for the damage of brinjal at traders' level. The damage was realized in the brinjal supply chain due to spoilage (not suitable for marketing) caused by inappropriate handling during loading and unloading, sorting and grading, and transportation. Nevertheless, weight loss and wastage of produces also contribute to postharvest losses to a great extent (Table 5.30).

Table 5.30Monthly postharvest losses of brinjal at different stages of supply chain

Traders	Quantity loss (kg)						
	Loading & unloading	Sorting & grading	Transportation	Delayed sell	Weight loss	Rotten	Total loss
Bepari	425.89	422.43	1232.39	--	1355.22	1419.07	4855
Paiker	--	615.00	--	52.00	--	340.00	1007
Retailer (local)	--	12.14	1.12	--	48.71	33.03	95
Retailer (urban)	--	--	9.73	--	11.50	26.77	48

The percentage shares of postharvest losses at different stages of brinjal supply chain are shown in Figure 5.21. Irrespective of traders, the percentage share of the highest postharvest loss was occurred due to rotten (30% of total loss) and the share of wastage wasfound higher for urban retailers 56% followed by *Paiker* (34%) and *Bepari* (29%). The share of the second highest loss was due to weight loss (24%) of brinjal. This weight loss was happened at the highest level for local retailers followed by *Bepari* and urban retailers. The causes of weight loss at local retailers' level are unknown. The share of postharvest loss due to transportation (29%) was ranked first for *Bepari*due to inappropriate transportation facility, long distance, inappropriate packaging and over load of brinjal. Hassan et al. (2010) found that maximum damage occurred due to bruises and jerking or vibrations in brinjal transport. Another important postharvest loss was occurred due to sorting and grading of brinjal for packaging. Cuts, broken, spotted, disease infected, cracked and odd sized brinjals are usually discarded from good ones during sorting and grading (Fig 5.20). This activity was highly practiced at *Bepari, Paiker* and local retailers' levels. *Paiker* generally sells 5-20kg to different types of retailers and have little chance to sell bad quality produce to retailers. This might be the main cause of higher postharvest loss for *Paiker*.

Fig 5.20Discarded defective brinjal during packaging, Jamalpur

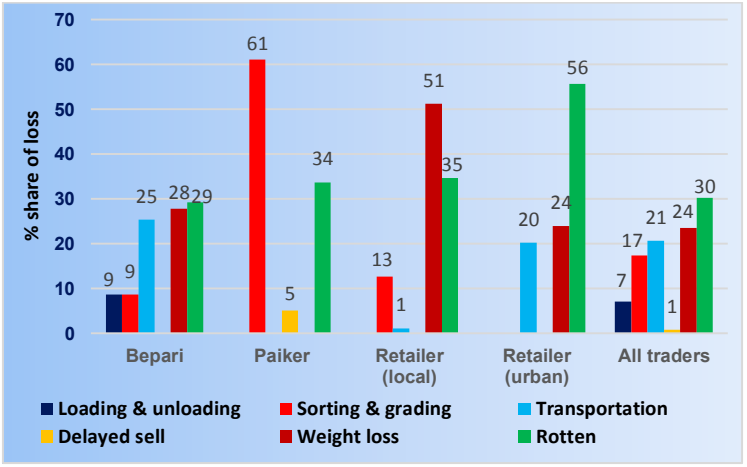


Fig 5.21 Postharvest losses of brinjal at different stages of marketing

5.12.2Postharvest loss of bitter gourd at traders' level

The total postharvest loss of bitter gourd at trader's level in the longest channel (*Farmer-Faria-Bepari-Paiker-Urban retailer*) was estimated at 18.03%. Among intermediaries, the highest loss was estimated at retaillevel (7.58%) in urban areas followed by *Bepari* (7.05%) and retail level (7.30%) in local study areas (Table 5.31). No loss was reported at *Faria's* level in the study areas. The highest or lowest loss is dependent on the length of selling. Retailer sold small quantity of bitter gourd and hold them comparatively longer time, therefore, their loss was highest among intermediaries.Beparis' postharvest loss was also high because they have to transport bitter gourd from long distance. Overloading of produces and vibration of inappropriate transport add fuel in increasing the postharvest losses for *Beparis*.

Table 5.31Monthly postharvest loss of bitter gourd at traders' level

Traders	Total purchase (kg)	Total sell (kg)	Average loss (kg)	% loss
Faria	8158	8158	0	--
Bepari	33797	31414	2383	7.05
Paiker	24900	24053	847	3.40
Retailer (local)	411	381	30	7.30
Retailer (urban)	528	488	40	7.58

Respondent traders stated some causes for the postharvest loss of bitter gourd at different stages of supply chains. The loss was realized mainly due to spoilage (not suitable for marketing) caused by inappropriate handling during loading and unloading, sorting and grading, and transportation. Nevertheless, weight loss and wastage of produces also contribute to postharvest losses to a great extent.The percentage shares of postharvest losses at different stages of bitter gourd marketing are shown in Figure 5.23. Irrespective of traders, the highest percentage share of postharvest loss was due to rotten of vegetables (48% of total loss) followed by wastage during sorting and grading (17%) and loss of weight (15%). Again, the highest percentage share of rotten bitter gourd was reported for *Bepari* (52%) followed by retailers (40-42%).

Table 5.32Monthly postharvest losses of bitter gourd at different stages of supply chain

Traders	Quantity loss (kg)						
	Loading & unloading	Sorting & grading	Transpor -tation	Delayed sell	Weight loss	Rotten	Total loss
Bepari	166.33	201.75	235.33	67.37	483.00	1229.22	2383
Paiker	--	336.00	--	194.60	--	316.40	847
Retailer (local)	--	4.40	--	6.18	6.73	12.69	30
Retailer (urban)	--	8.50	5.17	10.50	--	15.83	40

The share of the second highest postharvest loss was occurred duringsorting and grading of bitter gourd. Cuts, broken, spotted, disease infected, cracked and odd sized bitter gourds are usually discarded from good ones during sorting and grading (Fig 5.22). This loss was crucial for Paiker followed by urban retailers and local retailers. Delayed sell was also an important cause of postharvest losses at wholesale and retail levels. The share of postharvest loss due to transportation (10%) was ranked third for *Bepari* due to unsuitable transportation system, long distance, and inappropriate packaging of bitter gourd. This activity was highly practiced at *Paiker* and retailers' levels. *Paiker* generally sells 5-10kg to different types of retailers and

have little chance to sell bad quality produce to retailers. This might be the main cause of higher postharvest loss for *Paiker*.

Fig 5.22 Discarded defective bitter gourd during packaging, Bogura

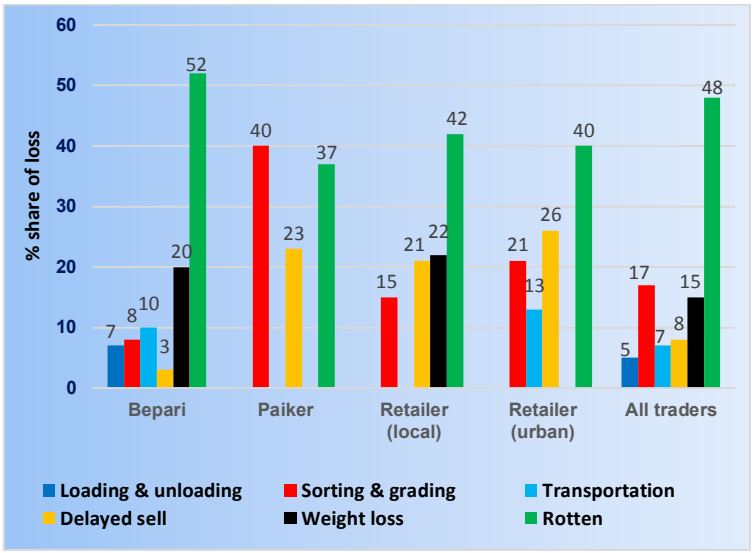


Fig 5.23 Postharvest losses of bitter gourd at different stages of marketing

5.12.3Postharvest loss of yardlong bean at traders' level

In the longest channel (*Farmer-Faria-Bepari-Paiker-Urban retailer*), the total postharvest loss of yardlong bean at trader's level was estimated at 16.47%. The highest loss was experienced by *Bepari*(6.90%) followed by urban retailers (6.28%) and *Paiker* (3.29%)in the study areas. *Faria* doesn't experience any loss during selling their purchased vegetables (Table 5.33). Beparis' postharvest loss was high because they have to transport yardlong bean from long distance.Retailers sell small quantity of yardlong bean to consumers and thus it takes long time to sell their entire produces. Therefore, retailer's loss was higher among intermediaries.

Table 5.33Monthly postharvest loss of yardlong bean at traders' level

Traders	Total purchase (kg)	Total sell (kg)	Average loss (kg)	% loss
Faria	8348	8348	0	--
Bepari	28542	26572	1970	6.90
Paiker	22400	21663	737	3.29
Retailer (local)	379	356	23	6.07
Retailer (urban)	446	418	28	6.28

Respondent traders stated some causes for the postharvest loss of yardlong bean at different stages of supply chains. The loss was realized mainly due to spoilage (not suitable for marketing) caused by inappropriate handling during loading and unloading, sorting and grading, and transportation. Nevertheless, weight loss and wastage of produces also contribute to the postharvest losses to a great extent (Table 5.34).

Table 5.34Monthly postharvest losses of yardlong bean at different stages of supply chain

Traders	Quantity loss (kg)						
	Loading & unloading	Sorting & grading	Transpor -tation	Delayed sell	Weight loss	Rotten/ wastage	Total loss
Bepari	181.54	221.60	380.58	346.30	386.84	453.14	1970
Paiker	--	206.25	--	242.30	149.25	139.20	737
Retailer (local)	--	5.32	--	5.20	6.73	5.75	23
Retailer (urban)	--	5.70	--	6.85	6.75	8.70	28

It is revealed from the bar diagram (Fig 5.25) that irrespective of traders, the highest percentage of postharvest loss was attributed to wastage/rotten and delayed sell of yardlong bean (22%each of total loss) followed by weight loss (20%) and sorting and grading (16%). Again, the highest percent share of postharvest loss was due to rotten/wastage for *Bepari* (23%) and urban retailer (31%), whereas delayed sell (33%) and weight loss (29%) shared the highest percentage of postharvest losses for *Paiker* and local retailer respectively. The percent share of the second highest postharvest loss was occurred during sorting and grading of yardlong bean. Cuts, broken, spotted, disease infected, cracked and odd sized yardlong beans are usually discarded from good ones during sorting and grading (Fig 5.24).

Fig 5.24 Discarded defective yardlong bean during sorting &packaging, Bogura

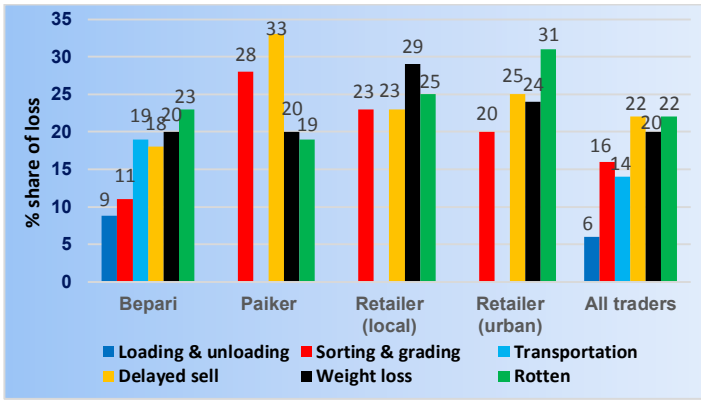


Fig 5.25 Postharvest losses of yardlong bean at different stages of marketing

This loss was crucial for *Paiker* followed by local and urban retailers. *Paiker* generally sells 5-10kg to different types of retailers and have little chance to sell bad quality produce to retailers. This might be the main cause of higher postharvest loss for *Paiker*. The percent share of postharvest loss due to transportation (19%) was ranked third for *Bepari* due to unsuitable transportation system, long distance, and inappropriate packaging system.

5.12.4 Postharvest loss of teasel gourd at traders' level

The total postharvest loss of teasel gourdin the longest channel (*Farmer-Faria-Bepari-Paiker-Urban retailer*)at trader's level was estimated at 6.40%. This loss is thelowest among other three studied vegetables. *Bepari* experienced the highest loss (2.37%) followed by urban retailers (2.31%) and local retailer (1.89%) in the study areas (Table 5.35). *Beparis'* postharvest loss was high because they have to transport teaselgourd from long distance. Retailers sell small quantity of teasel gourd to consumers and thus it takes long time to sell their entire produces. Therefore, retailer's loss was higher among intermediaries.

Table 5.35Monthly postharvest loss of teasel gourd at traders' level

Traders	Total purchase (kg)	Total sell (kg)	Average loss (kg)	% loss
Faria	16031	16031	0	--
Bepari	52694	51444	1250	2.37
Paiker	32767	32202	565	1.72
Retailer (local)	423	415	8	1.89
Retailer (urban)	433	423	10	2.31

Teasel gourd traders stated a number of causes for the postharvest losses at different stages of supply chains. The loss was attributed to the wastage/rotten (not suitable for marketing) of vegetables caused by inappropriate handling during loading and unloading, sorting and grading, and transportation. Nevertheless, weight loss and wastage of produces also contribute to the postharvest losses to a great extent (Table 5.36).

Table 5.36Monthly postharvest losses of teasel gourd at different stages of supply chain

Traders	Quantity loss (kg)						
	Loading & unloading	Sorting & grading	Transpor -tation	Delayed sell	Weight loss	Rotten/ wastage	Total loss
Bepari	65.5	99.35	332.73	121.27	487.45	143.7	1250
Paiker	--	353.2	--	147.3	64.5	--	565
Retailer (local)	--	0.33	--	2.07	3.52	2.08	8
Retailer (urban)	--	0.52	--	3.73	2.45	3.3	10

Irrespective of traders types, the highest percent of postharvest loss was occurred due to loss of weight(30% of total loss) followed by sorting and grading (25%) and transportation (18%). Cuts, broken, ripped, disease infected, cracked and odd sized teasel gourds are usually discarded from good ones during sorting and grading (Fig 5.26).The share of postharvest loss due to transportation was ranked second for *Bepari* due to unsuitable transportation system, long distance, and inappropriate packaging of teasel gourd. For *Bepari*, weight loss (39%) was the highest among other types of losses followed by transportation (27%) and wastage/rotten (10%) of vegetables. Again, the highest share of loss was due to sorting and grading (63%) for *Paiker,* whereas the share of weight loss (44%) to total postharvest loss was ranked first for the local retailers. *Paiker* generally sells 5-10kg to different types of retailers and have little chance to sell bad quality produce to retailers. This might be the main cause of higher postharvest loss for *Paiker*. In the case of urban retailers, the highest share of postharvest loss was delayed sell (37%) followed by wastage of vegetables (33%).

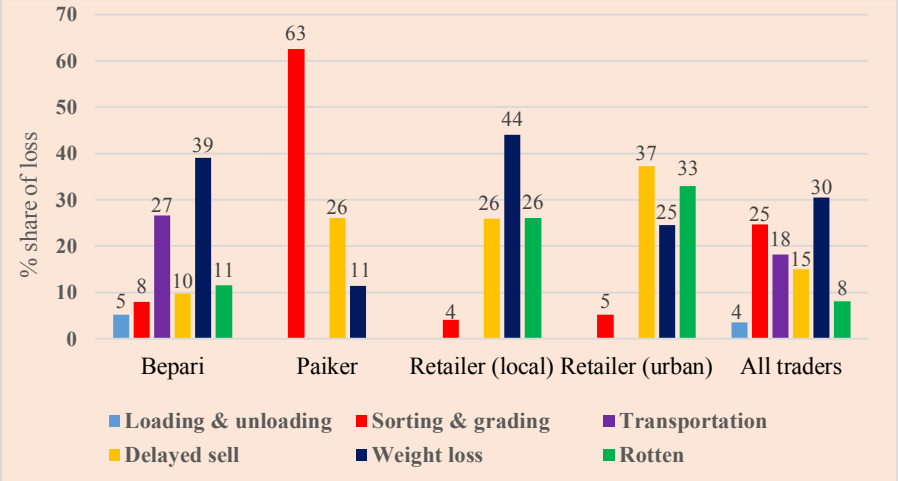


Fig 5.26 Postharvest losses of teasel gourd at different stages of marketing

5.13 Total physical loss and Financial Loss at National Level

Postharvest loss is a common phenomenon in the marketing of perishable horticultural crops especially fruits and vegetables. It is not possible to make postharvest loss zero, but it can be reduced to some extent. However, the total postharvest loss of a vegetable will vary depending on the length of its supply chain. Generally, a positive relationship is observed between the length of supply chain and postharvest loss. However, the total postharvest losses of brinjal, bitter gourd, yardlong bean, and teasel gourd in the longest channel (*Farmer-Faria-Bepari-Paiker-Urban retailer*) have been estimated at 16.45, 21.26, 20.17 and8.30% respectively (Fig 5.27).The postharvest loss of teasel gourd was opined to be low because its skin is comparatively hard than other three selected vegetables. The highest farm level loss was recorded foryardlong bean(3.70%) and the lowest forteasel gourd (1.90%). Again, the highest trader level loss was estimated for bitter gourd (18.03%) and the lowest for teasel gourd (6.4%).

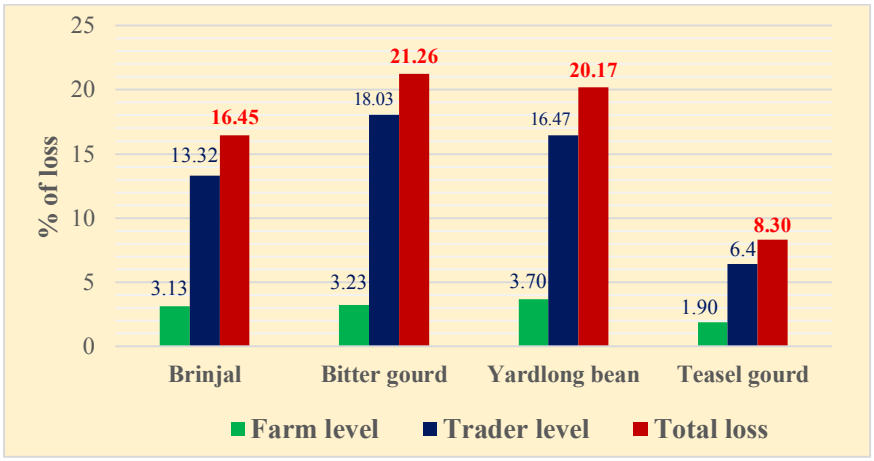


Fig 5.27Total postharvest losses in selected vegetable supply chains

An attempt has been made in this section for estimating the total financial loss at national level during 2017-18 using national level vegetable production data (BBS, 2019) as well as the current postharvest loss information (Table 5.37). Two main supply chains- long chain and short chain have been considered in this calculation. Total financial loss comprises financial

loss due to complete wastage of vegetables and market loss due to semi-wastage of vegetables at farm level. It is revealed that the total financial loss incurred for selected four vegetables is Tk.3433.05 million per year if these vegetables move from farmers to urban consumers through different middlemen (Scenario-1). However, this loss will be Tk.2596.40million per year when vegetables move from farmers to local consumers through different middlemen. The total financial loss is very high for brinjal compared to other vegetables. The length of growing period is much longer (year-round) for brinjal which might be the main reason for higher postharvest as well as financial loss at national level.

Table 5.37 Financial loss occurred at national level due to postharvest loss in 2017-18

Items	Brinjal	Bitter gourd	Yardlong bean	Teasel gourd	All area
1. Total production (MT)	504817	54539	25815	27757	612928
2. **Total postharvest loss (%)**					
Scenario 1 (long chain)	16.45	21.26	20.17	8.3	16.55
Scenario 2 (short chain)	11.89	17.58	16.67	6.16	13.08
3. **Total postharvest loss (ton)**					
Scenario 1	83042	11595	5207	2304	102148
Scenario 2	60023	9588	4303	1710	75624
4. Farm gate price of good veg (Tk./ton)	27780	32160	31380	34850	31543
5. Financial loss due to wastage (Million Tk./year)					
Scenario 1	2306.92	372.89	163.39	80.29	3222.06
Scenario 2	1667.43	308.35	135.04	59.59	2385.40
6. Market loss					
Semi-wastage veg. loss (%)	4.95	1.45	1.88	4.86	3.285
Semi-wastage veg price (Tk/ton)	7350	14000	7700	9280	9582.5
Quantity of semi-wastage veg (ton)	24988	791	485	1349	27614
7. Financial loss due to semi-wastage (Million Tk./year)	183.67	11.07	3.74	12.52	210.99
8. Total financial loss (Million Tk/year)					
Scenario 1	2490.58	383.97	167.13	92.81	3433.05
Scenario 2	1851.10	319.42	138.78	72.11	2596.40

Note: Long chain: *Farmer-Faria-Bepari-Paiker-Urban retailer*
Short chain: *Farmer-Faria-Bepari-Local retailer*

5.14 Causes of Postharvest Losses at Traders' Level

Middlemen in the vegetable supply chains stated different causes of postharvest losses from their practical experience, although the stated problems were not equally crucial to them. A problem sometimes very critical to a specific type of trader, but may not be a problem at all to other type of traders. However, the causes of postharvest losses of vegetables at traders' level are shown in Table 5.38 and have been discussed in details in the following sections.

Delayed sale: It is a common problem for vegetable traders, but its severity is different from trader to trader. Thirty three percent *Beparis* experienced huge amount of postharvest losses more than one times in their life due to delay (1.0-1.5 days) in selling their vegetables. It was happened mainly traffic jam, political hazard, and trouble in ferry service. *Paiker* generally sells 5-10kg of vegetables to retailers that increase their postharvest loss to some extent. Finally, retailer sells vegetables little by little to the consumer that influence postharvest loss to a great extent. Most of the retailers (85%) reported delayed sell as one of the causes of postharvest loss.

Sorting of vegetables: Sorting of vegetables after purchasing or before packaging or selling is a common practice by vegetable traders in the study areas. A good amount of defective vegetables are discarded from good ones during this activity. Cuts, broken, over matured, ripe, insect-pest infested, disease infected, cracked, discoloured and odd size vegetables are usually discarded from good ones. Irrespective of traders type, 45.1% traders mentioned sorting of vegetables as a cause of postharvest loss.

Delay in transportation: About 75% *Beparis* mentioned delay in transportation as an acute cause of postharvest losses of vegetables. It is happened due to traffic jam, delay in ferry, and police checking at different traffic points.This problem is not equally applicable for other traders like *Faria, Paiker* and retailer.

High pressure and jerking in the road: In orderto minimize the cost of transportation, most of the *Bepari's* commontendency is to over load vegetables (about 480-500 kg) in a five ton capacity truck in the study areas. It is opined that overload of vegetables create physiological loss of vegetables. On the other side, the road conditions in many areas are not good enough for heavy loaded transportation. It creates vibration/jerking that causes heavy loss in vegetables. Hence, nearly 52% *Beparis* stated this as one of the causes of postharvest losses of vegetables.

Table 5.38 Causes of postharvest losses of vegetables at traders' level

Causes	*Bepari (n=103)*	*Paiker (n=12)*	Retailer *(n=100)*	All *(n=215)*
1. Delayed sale/sell little by little	33.0	75.0	85.0	59.5
2. Discard defective vegetables during sorting	36.9	66.7	51.0	45.1
3. Delay in transportation (traffic jam/delay in ferry/police checking)	74.8	--	--	35.8
4. High pressure and jerking in the road	51.5	--	8.0	28.4
5. Frequent use of water	--	--	56.0	26.0
6. Improper loading and unloading	65.1	41.7	7.0	36.8
7. Improper/defective packaging	27.2	--	--	13.0
8. Excessive heat/high temperature	20.4	--	6.0	12.6

Frequent use of water: In order to reduce weight loss and show vegetables fresh to the customers, frequent use of water over vegetables is a common practice by each of the retailer. Spraying water over insect infested, crack and spore vegetables causes spoilage of those vegetables in case of delayed sell. Hence, more than half of the respondent retailers (56%) opined that the use of frequent water sometimes creates damage to the vegetables.

Improper loading and unloading: *Beparis* usually make bigger type of vegetables packet (locally known as *Dhop*) containing 0.20-0.48 MT for transportation. Due to lack of mechanical lifting device, *Beparis*hire human labour for lifting those giant vegetable packets on the track. Labourer use hookboth in loading and unloading the packets and the use of each hook spoils some vegetables in that time. After the completion of loading, all vegetable packets are bound tightly with synthetic/plastic ropes that again causes some losses of vegetables. The loss occurred due to improper loading and unloading was higher for *Bepari* compared to other middlemen traders. That's why more than 65% *Beparis* stated this as one of the causes of postharvest losses of vegetables.

Improper packaging: Proper packaging is very much important for keeping vegetables fresh and safe for the consumers. It also helps in reducing postharvest loss of vegetables to a great extent. Proper packaging practices for studied vegetables are almost absent in the study areas. In the early season of bitter gourd and teasel gourd when the price of these vegetables are high, some traders use plastic crates for its transportation to avoid unexpected loss. Otherwise, most *Beparis* and other traders usually make bigger type of packet containing 0.20-0.48 MT of vegetables for transportation. This improper system of packaging also causes loss for the traders mainly stated by 27.2% *Beparis* in the study areas.

Excessive heat/high temperature: More than 20% *Beparis* and 6% retailers opined that a large amount of vegetables sometimes become wastage only due to excessive heat or high temperature. Beside from high temperature in summer season, improper packaging or packaging with enormous volume of vegetables also generates huge amount of heat that add fuel to aggravate postharvest loss high.

5.15Possible Measures for Reducing Postharvest Losses

Responded middlemen traders suggested various measures for reducing the postharvest losses of vegetable in supply chains. The measures are briefly discussed below and shown in Table 5.39.

Quick transportation: Quick transportation is essential for transporting perishables in order to reduce postharvest losses and keep them safe for the consumers. More than half of the respondent traders suggested government to take necessary initiatives for making high way roads free from traffic jam and police checking. Besides, they also suggested government to construct another bridge over Padma River at Paturia-Faridpur route for avoiding congestion at ferry *Ghat*. Introducing special ferry services for vegetable loaded truck may be the alternate solution of this problem.

Careful sorting and grading: Sorting of vegetables after buying from sellers and before packaging is a common practice of middlemen traders in the study areas. Forty percent traders opined that for reducing postharvest losses and preventing contamination, defective vegetables should be carefully sorted from good ones before packaging and transportation.

Improve packaging: Good packaging of a vegetable increases its freshness, attract consumers' preference, increase product price, and finally reduce the possibility of its spoilage. Therefore, 27% traders suggested to avoid traditional packaging and adopt improved and low-cost packaging for high value vegetables. They also suggested concerned vegetable traders to use plastic crates and paper carton as packaging containers.

Table 5.39 Suggested measures for reducing postharvest losses of vegetables at traders' level

Suggested measures	*Bepari (n=103)*	*Paiker (n=12)*	Retailer *(n=100)*	All *(n=215)*
1. Need quick transportation	99.0	33.3	7.0	52.6
2. Careful sorting and wash before selling	29.1	33.3	52.0	40.0
3. Packaging with plastic crate/paper carton	46.6	16.7	8.0	27.0
4. Lifting device for loading and unloading	31.1	25.0	10.0	20.9
5. Need repair and maintenance of roads	34.0	--	--	16.3
6. Transport with refrigerated van	16.5	--	2.0	8.8
7. Establish cold storage at market premises	--	25.0	14.0	7.9

Lifting device for loading and unloading: Improper loading and unloading is a vital source of postharvest losses of vegetables. About 21% traders suggested that suitable mechanical device should be introduced at assembling and terminal markets for lifting bulky vegetable packets for reducing postharvest losses and make vegetables safe for the consumers.

Regular maintenance of roads: Unevenroad is a great source of vibration that causes postharvest losses of vegetable to some extent. That's why 34% *Beparis* suggested that government should allocate sufficient budget for regular maintenance of roads throughout the country.

Introduce refrigerated van: Transportation of the most vegetables with refrigerated van will not be cost-effective to the most vegetable traders. But it may be profitable for high value vegetables like bitter gourd and yardlong bean. Therefore, 16.5% *Beparis* suggested that refrigerated van may be introduced for transporting high value vegetables on pilot basis and should evaluate its cost-effectiveness of transportation.

Establish cold storage: Low-cost storage facility may be established at assembling and terminal markets for reducing postharvest losses of vegetables. For this purpose government should install low-cost cold storage at assembling and terminal markets on pilot basis.

5.16 Marketing Costs and Margins at Traders' Level

The costs and margins of market intermediaries for the selected vegetables were studied. Vegetable traders have to spend for performing various functions during marketing of vegetables. The types of marketing costs are transportation, loading & unloading, labour, weighing, cleaning, packaging, market toll, commission, rent, mobile bill, electricity, entertainment and miscellaneous costs. The postharvest loss of vegetables has been considered marketing cost in this analysis. The knowledge on marketing costs helps us to identify the reasons for high marketing costs and the possible ways of reducing them.

Marketing margins vary from commodity to commodity, place to place and time to time. The knowledge of marketing margins helps us to formulate and implement appropriate price and marketing policies. However, the marketing costs and margins of different intermediaries in vegetable marketing are discussed in the following sections.

5.16.1 Costs and margins at traders' level in brinjal marketing

The costs of brinjal marketing at different intermediaries' level are shown in Table 5.40. Among different traders, urban retailer incurred the highest marketing cost of Tk.610.2/quintal followed by *Bepari*(Tk.546.6/quintal) and *Paiker*(Tk. 211.4/quintal). The highest marketing cost incurred by urban retailer was due to postharvest loss of brinjal (Tk. 230.1/quintal).Again, *Beparis*have tocover a long distance to transport their vegetables and their volume of business is also high. Therefore, transportation shared the highest cost (Tk.156.8/quintal) to the total costs for *Bepari*.The marketing cost of brinjal for *Faria* was the lowest among other traders. It was stated earlier that the postharvest loss of brinjal was zero for *Farias* and they need very few transport to carry their vegetables. These are the reasons for lower marketing cost of *Faria*.

In brinjal marketing, the respondent urban retailers received the highest average gross margin of Tk.995 per quintal followed by *Bepari* (Tk.735/quintal), local retailer (Tk.462/quintal) and *Faria* (Tk.312/quintal). *Paiker* received the lowest gross margin in brinjal marketing.

However, the traded volume of urban retailers was found to be the lowest, but their net margins wasfound the highest (Tk.384.8./quintal) due to higher selling price and lower marketing cost. On the contrary, the traded quantity was reported to be the highest for *Beparis*, but their net margin was stand at the 4thposition (Tk.206.4/quintal) due to higher marketing cost. *Farias* received reasonable profit from brinjal marketing. *Paiker* received the lowest margin due to higher marketing cost (Table 5.41).

Table 5.40 Cost of brinjal marketing (Tk./quintal) at different intermediaries levels

Cost items	Faria	Bepari	Paiker	Retailer (local)	Retailer (urban)
Transportation	23.0	156.8	--	31.4	81.3
Loading	--	31.8	--	--	--
Unloading	--	32.2	--	--	--
Labour	8.6	30.4	--	--	51.6
Cleaning & packaging	--	53.6	--	--	--
Postharvest loss	--	139.0	104.5	127.1	230.1
Arathdar's commission	--	64.3	100.0	--	100.0
Market toll	13.0	24.2	--	17.7	--
Weighing	2.5	5.6	--	--	--
Shop rent	--	1.4	--	19.1	60.9
Sweeping	--	0.3	--	2.1	3.9
Telephone	3.6	2.3	2.2	2.8	22.3
Entertainment	7.1	3.1	3.3	3.5	43.9
Electricity	--	--	--	3.6	7.3
Miscellaneous	0.6	1.6	1.4	3.2	8.9
Total cost	**58.4**	**546.6**	**211.4**	**210.5**	**610.2**

Table 5.41 Gross margins and net margin of different intermediaries in brinjal marketing

Trader type	Gross margin (Tk/quintal)	Marketing cost (Tk/quintal)	Net Margin	
			Tk/quintal	Tk/kg
Faria	312	58.4	253.6	2.54
Bepari	753	546.6	206.4	2.06
Paiker	304	211.4	92.6	0.93
Retailer (urban)	995	610.2	384.8	3.85
Retailer (local)	462	210.5	251.5	2.52

5.16.2 Costs and margins at traders' level in bitter gourd marketing

The costs of bitter gourd marketing at different intermediaries' level are shown in Table 5.42. Among different traders, *Bepari*spent the highest marketing cost of Tk.608.4 per quintal followed by urban retailer (Tk.568.3/quintal),local retailer(Tk. 324.9/quintal), and *Paiker* (Tk.246.6/quintal). The highest marketing cost incurred by *Bepari* was due to higher postharvest loss (Tk.209.8/quintal) and transportation cost (Tk. 149.6/quintal). The second highest cost incurred byurban retailer was also due to postharvest loss (Tk. 318.7/quintal)of bitter gourd and commission (Tk.100/quintal). So, postharvest loss of vegetables is the main concern of all the stakeholders in the supply chain except *Faria*. The postharvest loss of bitter gourd is zero for *Farias* and they need very few transport to carry their vegetables. These are the major reasons for lower marketing cost of *Faria*.

Among the stakeholders in the bitter gourd marketing, urban retailers received the highest average gross margin of Tk.853 per quintal followed by *Bepari* (Tk. 733/quintal), *Paiker*

(Tk.496/quintal) and*Faria* (Tk.444/quintal). Local retailer received the lowest gross margin in bitter gourd marketing. However, the traded volume of urban retailers was found to be low, but their net margin(Tk.284.7/quintal) was the higher than that of *Bepari* and *Paiker*due to higher selling price and lower marketing cost (Table 5.43). *Farias*received the highest net margin (Tk.374.9/quintal) due to lower marketing cost. They purchase the entire volume of bitter gourd directly from farmers and sell it to *Bepari* immediately after purchase. So their marketing cost was minimum. The traded quantity was the highest for *Beparis* and their net marginwas in the 4thposition (Tk.124.6/quintal) due to higher marketing cost. *Paikers*and urban retailers received reasonable profit from bitter gourd marketing.

Table 5.42 Cost of bitter gourd marketing (Tk/quintal) at different intermediaries levels

Cost items	Faria	Bepari	Paiker	Retailer (local)	Retailer (urban)
Transportation	15.4	149.6	--	30.8	86.0
Loading	--	20.8	--	--	--
Unloading	--	20.2	--	--	--
Labour	12.5	28.5	--	--	9.7
Cleaning & packaging	--	64.6	--	--	--
Postharvest loss	--	209.8	126.1	236.2	318.7
Arathdars commission	--	71.4	100.0	--	100.0
Market toll	19.8	20.0	--	19.9	--
Weighing	3.0	3.0	--	--	--
Shop rent	--	1.3	--	22.9	25.0
Sweeping	--	0.6	--	2.7	5.9
Telephone	7.1	6.8	2.4	2.9	5.2
Entertainment	10.5	9.6	15.2	3.7	6.4
Electricity	--	--	--	4.6	6.9
Miscellaneous	0.8	2.2	2.9	2.2	4.5
Total cost	**69.1**	**608.4**	**246.6**	**324.9**	**568.3**

Table 5.43 Gross margins and net profit of different intermediaries in bitter gourd marketing

Trader type	Gross margin (Tk/quintal)	Marketing cost (Tk/quintal)	Net Margin	
			Tk/quintal	Tk/kg
Faria	444	69.1	374.9	3.75
Bepari	733	608.4	124.6	1.25
Paiker	496	246.6	249.4	2.49
Retailer (urban)	853	568.3	284.7	2.85
Retailer (local)	442	324.9	117.1	1.17

5.16.3 Costs and margins at traders' level in yardlong bean marketing

The cost of yardlong bean marketing wasnot same at different intermediaries' level. It depends on the number of activities performed by different intermediariesand their related cost. However, the estimated total cost of marketing was found highest (Tk.544.9/quintal) at urban retailer level and the lowest at *Faria* (Tk.82.3/quintal) level (Table 5.44). The highest marketing cost at urban retailer level was due to higher postharvest loss (Tk.265.3/quintal) and commission (Tk.100/quintal). The second highest cost of *Beparis* that was also due to higher postharvest loss(Tk.170.0/quintal) and higher cost of transportation (Tk.153.3/quintal). However, the postharvest loss of vegetable is the main concern of all the stakeholders in the

supply chain except *Faria*. The postharvest loss of yardlong beanwas zero for *Farias* and they hardly use transport to carry their vegetables. These were the major reasons for lower marketing cost of *Faria*.

Table 5.44 Cost of yardlong bean marketing (Tk./quintal) at different intermediaries levels

Cost items	Faria	Bepari	Paiker	Retailer (local)	Retailer (urban)
Transportation	30.0	153.3	--	56.6	63.3
Loading	--	10.8	--	8.6	0
Unloading	--	10.1	--	8.7	0
Labour	9.7	17.0	15.4	--	20.5
Cleaning & packaging	--	57.3	--	--	0
Postharvest loss	--	170.0	101.1	167.2	265.3
Arathdars commission	--	40.4	100.0	--	100
Market toll	22.7	14.0	--	13.7	0
Weighing	1.9	5.0	--	--	0
Shop rent	--	--	--	33.4	53.7
Sweeping	--	0.9	--	4.2	3.1
Telephone	6.6	5.3	18.9	10.6	12.9
Entertainment	10.9	5.8	18.5	15.9	13.9
Electricity	--	--	--	8.1	6.7
Miscellaneous	0.5	2.6	7.6	4.3	5.5
Total cost	**82.3**	**492.5**	**261.5**	**331.3**	**544.9**

In the yardlong bean marketing, *Paiker* received the highest gross margin of Tk.1150 per quintal followed by local retailer (Tk.861/quintal), urban retailer (Tk.784/quintal), and*Bepari* (Tk.610/quintal). The lowest gross margin was received by *Faria* (Table 5.45). However, the highest gross as well as net margin received by *Paiker*is confusing. The traded volume of retailers was found to be low, but their net marginwas found highest (Tk.239.1-529.7/quintal) due to higher selling price and lower marketing cost. The traded volume of yardlong bean was highest for *Beparis,* but their net margin(Tk.118/quintal) was low compared to other traders due to higher marketing cost. *Farias* received reasonable profit from yardlong bean marketing. *Farias* purchase the entire volume of yardlong bean directly from farmers and sell it to *Bepari* immediately after purchase. Therefore, *Farias* were found happy receiving low net marginfrom their business.

Table 5.45 Gross margins and net profit of different intermediaries in yardlong bean marketing

Trader type	Gross margin (Tk/quintal)	Marketing cost (Tk/quintal)	Net Margin	
			Tk/quintal	Tk/kg
Faria	269	82.3	186.7	1.87
Bepari	610	492.5	117.5	1.18
Paiker	1150	261.5	888.5	8.89
Retailer (urban)	784	544.9	239.1	2.39
Retailer (local)	861	331.3	529.7	5.30

5.16.4 Costs and margins at traders' level in teasel gourd marketing

The cost of teasel gourd marketing at different intermediaries' level isshown in Table 5.46. Among different intermediaries, the highest marketing cost (Tk.545.7/quintal)was incurred by

*Beparis*followed by urban retailers (Tk.387.5/quintal).The total marketing cost incurred by *Paiker* (Tk.190.5/quintal) and local retailer (Tk.185.8) were more or less same. The highest marketing cost incurred by *Bepari*was due to higher transportationcost (Tk. 216.1/quintal). *Beparis* have tocover a long distance to transport their vegetables and their volume of business is also high. Therefore, transportation shared (39.6%) the highest cost to the total costs for *Bepari*. The postharvest loss was not a great concern to the stakeholders of teasel gourd supply chain, because this loss was much lower compared to other vegetables. The marketing cost incurred by *Faria* was the lowest among teasel gourd traders. The postharvest loss is zero for *Farias* and they need very few transport to carry their vegetables. These were the major reasons for lower marketing cost for*Faria*.

Table 5.46 Cost of teasel gourd marketing (Tk./quintal) at different intermediaries levels

Cost items	Faria	Bepari	Paiker	Retailer (local)	Retailer (urban)
Transportation	35.9	216.1	--	48	75.3
Loading	--	25.5	--	20.2	--
Unloading	--	35.3	--	--	--
Labour	20.8	35.1	--	--	38.6
Cleaning & packaging	--	43.8	--	--	--
Postharvest loss	--	70.9	63.6	61.7	98.4
Arathdars commission	--	84.4	100.0	--	100.0
Market toll	18.0	16.3	--	--	--
Weighing	--	3.1	--	--	--
Shop rent	--	1.2	--	27.9	35.6
Sweeping	--	0.4	--	3.7	4.5
Telephone	--	5.3	8.6	4.1	8.4
Entertainment	10.6	7.1	12.6	10.1	12.6
Electricity	--	--	--	4.3	6.7
Miscellaneous	2.8	1.2	5.7	5.8	7.4
Total cost	**88.1**	**545.7**	**190.5**	**185.8**	**387.5**

In teasel gourd marketing, the respondent urban retailers received the higher gross margins(Tk. 745/quintal) compared to *Bepari* (Tk.708/quintal),local retailer (Tk.602/quintal), *Paiker* (Tk.559/quintal) and *Faria*(Table 5.47). However, the traded volume of local retailer was found to be the lowest, but their net margin wasfound highest (Tk. 416.2/quintal) due to higher selling price and lower marketing cost. Again, the gross margin of urban retailer was higher than local retailer, but his net margin was lower than local retailer which was due to higher marketing cost. The traded quantity was highest for *Beparis*, but their net margin (Tk.162.3/quintal) was stand at last position due to higher marketing cost. Both *Faria* and *Paiker* received impressive net marginfrom teasel gourd marketing. *Farias* purchase the entire volume of teasel gourd directly from farmers and sell it to *Beparis* immediately after purchase.

Table 5.47 Gross margins and net marginof different intermediaries in teasel gourd marketing

Trader type	Gross margin (Tk/quintal)	Marketing cost (Tk/quintal)	Net Margin	
			Tk/quintal	Tk/kg
Faria	458	88.1	369.9	3.70
Bepari	708	545.7	162.3	1.62
Paiker	559	190.5	368.5	3.69

Retailer (urban)	745	387.5	357.5	3.58
Retailer (local)	602	185.8	416.2	4.16

5.17 Marketing Performance in Vegetable Marketing

Marketing performance is marketing's results or output compared against the set objectives.Performance in vegetable marketing was evaluated using different measures of marketing efficiency as described by Shepherd (1972), Hugar and Hireman (1984), and Acharya and Agarwal (2004). In the present study, the efficiency of vegetable marketing was investigated by examining price spread, producer's share to the consumer's price, marketing efficiency using Acharya's method, and returns on operating capital. For these four indicators, required calculations have been done separately for each of the intermediaries considering two major marketing channelsof vegetables. The present study emphasized twomarketing channels that were originated from leading production districts and ended at Dhaka or Gazipur Cityareas, and two marketing channels that were originated from leading production districts and ended at the same district's consuming markets (local). Besides, the highest proportions of vegetables were moved from producers to consumers through these channels.

5.17.1Price Spread in Vegetable Marketing

Price spread is defined as the difference between the price paid by consumers and the net price received by the producer for an equivalent quantity of farm produce. It can also be expressed as percentage of consumer's price. Price spread is inversely proportional to the market efficiency.

Vegetables move from producers to urban or local consumers through different intermediaries such as *Faria, Bepari,Paiker*, and retailer. The price of vegetables increases in each intermediary's level due to their marketing cost and profit. Hence, longer the marketing channel, higher the product price and vice versa. Therefore, an attempt has been made in the following sections to estimate the total price spread in major marketing channels and its distribution through different intermediaries.

5.17.1.1 Price spread in brinjal marketing

In brinjal marketing, the estimated total price spreads or gross marginsper kilogram were Tk. 23.64, Tk. 17.48, Tk. 9.90 and Tk. 6.78 respectively in the supply chains-I, -II, -III and –IV (Table 4.48). These price spreads were distributed among different intermediaries. In supply chain-I and -II, urban retailers received the highest share of price spread and the lowest share of price spread (12.9%) was received by *Paiker*. The percent share of price spread was also high for urban *Bepari*. Again, local retailers in supply chain-IIIand –IV received the highest share of price spread followed by *Faria* (31.5%) and local *Bepari* (21.8%).

Table 5.48 Price spread among different intermediaries in brinjal marketing

Stakeholders	Supply chain-I				Supply chain-II			
	Selling price (Tk/kg)	Purchase price (Tk/kg)	Price spread		Selling price (Tk/kg)	Purchase price (Tk/kg)	Price spread	
			(Tk/kg)	Percent			(Tk/kg)	Percent
Farmer	26.26	--	--	--	26.26	--	--	--
Faria	29.38	26.26	3.12	13.2	29.38	26.26	3.12	15.1
Bepari (urban)	36.91	29.38	7.53	31.9	36.91	29.38	7.53	36.6

Paiker (urban)	39.95	36.91	3.04	12.9	--	--	--	--
Retailer (urban)	49.90	39.95	9.95	42.1	49.90	39.95	9.95	48.3
Total spread	--	--	23.64	100			20.60	100

Note: Chain-I: Farmer-Faria-Bepari (urban)-Paiker (urban)-Retailer (urban)-Consumer (urban)
Chain-II: Farmer-Faria-Bepari (urban)-Retailer (urban)-Consumer (urban)

Table 5.48 continued …….

Stakeholders	Supply chain-III				Supply chain-IV			
	Selling price (Tk/kg)	Purchase price (Tk/kg)	Price spread		Selling price (Tk/kg)	Purchase price (Tk/kg)	Price spread	
			(Tk/kg)	Percent			(Tk/kg)	Percent
Farmer	26.26	--	--	--	26.26	--	--	--
Faria	29.38	26.26	3.12	31.5	--	--	--	--
Bepari (local)	31.54	29.38	2.16	21.8	31.54	29.38	2.16	31.9
Retailer (local)	36.16	31.54	4.62	46.7	36.16	31.54	4.62	68.1
Total spread	--	--	9.90	100	--	--	6.78	100

Note: Chain-III: Farmer-Faria-Bepari (local)-Retailer (local)-Consumer (local)
Chain-IV: Farmer-Bepari (local)-Retailer (local)-Consumer (local)

5.17.1.2 Price spread in bitter gourd marketing

The estimated total price spread or gross margin in bitter gourd marketingwas Tk.25.26 and 20.30 per kg in the supply chain-I and -II respectively (Table 4.49). These price spreads were distributed among different intermediaries. The percent share of spread was highest for urban retailers followed by urban *Beparis* in both the channels. Again in supply chain-III and -IV, the total price spreads or gross margins were Tk.11.46 and Tk.7.02 per kilogram respectively. *Faria* in supply chain-III received the highest share of price spread (38.7%) followed by local retailers (38.6%). In channel-IV, the highest share of price spread (63%) was received by local retailers followed by local *Bepari* (37%).

Table 5.49 Price spread among different intermediaries in bitter gourd marketing

Stakeholders	Supply chain-I				Supply chain-II			
	Selling price (Tk/kg)	Purchase price (Tk/kg)	Price spread		Selling price (Tk/kg)	Purchase price (Tk/kg)	Price spread	
			(Tk/kg)	Percent			(Tk/kg)	Percent
Farmer	25.32	--	--	--	25.32	--	--	--
Faria	29.76	25.32	4.44	17.6	29.76	25.32	4.44	21.9
Bepari (urban)	37.09	29.76	7.33	29.0	37.09	29.76	7.33	36.1
Paiker (urban)	42.05	37.09	4.96	19.6	--	--	--	--
Retailer (urban)	50.58	42.05	8.53	33.8	50.58	42.05	8.53	42.0
Total spread	--	--	25.26	100			20.30	100

Note: Chain-I: Farmer-Faria-Bepari (urban)-Paiker (urban)-Retailer (urban)-Consumer (urban)
Chain-II: Farmer-Faria-Bepari (urban)-Retailer (urban)-Consumer (urban)

Table 5.49 continued …….

Stakeholders	Supply chain-III				Supply chain-IV			
	Selling price (Tk/kg)	Purchase price (Tk/kg)	Price spread		Selling price (Tk/kg)	Purchase price (Tk/kg)	Price spread	
			(Tk/kg)	Percent			(Tk/kg)	Percent
Farmer	25.32	--	--	--	25.32	--	--	--
Faria	29.76	25.32	4.44	38.7	--	--	--	--
Bepari (local)	32.36	29.76	2.60	22.7	32.36	29.76	2.60	37.0

Retailer (local)	36.78	32.36	4.42	38.6	36.78	32.36	4.42	63.0
Total spread	--	--	11.46	100	--	--	7.02	100

Note: Chain-III: Farmer-Faria-Bepari (local)-Retailer (local)-Consumer (local)
Chain-IV: Farmer-Bepari (local)-Retailer (local)-Consumer (local)

5.17.1.3 Price spread in yardlong bean marketing

The estimated total price spreads or gross margins were Tk.28.13 and Tk. 16.63 per kilogram in the supply chain-I and –II respectively. These price spreads were distributed among different intermediaries. In supply chain-I, *Paiker* received the highest share of price spread (40.9%) and the lowest share of price spread (9.5%) was received by *Faria*. But in channel-II, the percent share of price spread was highest for urban retailer (47.1%) followed by urban *Bepari* (36.7%). Again, local retailers in supply chain-III and IV received the highest share of price spread followed by local *Bepari*(Table 4.50).

Table 5.50 Price spread among different intermediaries in yardlong bean marketing

Stakeholders	Supply chain-I				Supply chain-II			
	Selling price (Tk/kg)	Purchase price (Tk/kg)	Price spread		Selling price (Tk/kg)	Purchase price (Tk/kg)	Price spread	
			(Tk/kg)	Percent			(Tk/kg)	Percent
Farmer	21.95	--	--	--	21.95	--	--	--
Faria	24.64	21.95	2.69	9.5	24.64	21.95	2.69	16.2
Bepari (urban)	30.74	24.64	6.10	21.7	30.74	24.64	6.10	36.7
Paiker (urban)	42.24	30.74	11.50	40.9	--	--	--	--
Retailer (urban)	50.08	42.24	7.84	27.9	50.08	42.24	7.84	47.1
Total spread	--	--	28.13	100	--	--	16.63	100

Note: Chain-I: Farmer-Faria-Bepari (urban)-Paiker (urban)-Retailer (urban)-Consumer (urban)
Chain-II: Farmer-Faria-Bepari (urban)-Retailer (urban)-Consumer (urban)

Table 5.50 continued ……

Stakeholders	Supply chain-III				Supply chain-IV			
	Selling price (Tk/kg)	Purchase price (Tk/kg)	Price spread		Selling price (Tk/kg)	Purchase price (Tk/kg)	Price spread	
			(Tk/kg)	Percent			(Tk/kg)	Percent
Farmer	21.95	--	--	--	21.95	--	--	--
Faria	24.64	21.95	2.69	18.9		--	--	--
Bepari (local)	27.55	24.64	2.91	20.5	27.55	24.64	2.91	25.3
Retailer (local)	36.16	27.55	8.61	60.6	36.16	27.55	8.61	74.7
Total spread	--	--	14.21	100	--	--	11.52	100

Note: Chain-III: Farmer-Faria-Bepari (local)-Retailer (local)-Consumer (local)
Chain-IV: Farmer-Bepari (local)-Retailer (local)-Consumer (local)

5.17.1.4 Price spreadin teasel gourd marketing

In teasel gourd marketing, the estimated total price spreads or gross margins were Tk.24.70 and Tk. 19.11 per kilogram in the supply chain-I and -II respectively. These price spreads were distributed among different intermediaries. Urban retailers received the highest share of price spread and Faria received the lowest share of price spread in both the channels. Again,

local retailers in supply chain-III and -IV received the highest share of price spread (Table 4.51).

Table 5.51 Price spread among different intermediaries in teasel gourd marketing

Stakeholders	Supply chain-I				Supply chain-II			
	Selling price (Tk/kg)	Purchase price (Tk/kg)	Price spread		Selling price (Tk/kg)	Purchase price (Tk/kg)	Price spread	
			(Tk/kg)	Percent			(Tk/kg)	Percent
Farmer	25.33	--	--	--	--	--	--	--
Faria	29.91	25.33	4.58	18.5	29.91	25.33	4.58	24.0
Bepari (urban)	36.99	29.91	7.08	28.7	36.99	29.91	7.08	37.0
Paiker (urban)	42.58	36.99	5.59	22.6	--	--	--	--
Retailer (urban)	50.03	42.58	7.45	30.2	50.03	42.58	7.45	39.0
Total spread	--	--	24.70	100	--	--	19.11	100

Note: Chain-I: Farmer-Faria-Bepari (urban)-Paiker (urban)-Retailer (urban)-Consumer (urban)
Chain-II: Farmer-Faria-Bepari (urban)-Retailer (urban)-Consumer (urban)

Table 5.51 continued …….

Stakeholders	Supply chain-III				Supply chain-IV			
	Selling price (Tk/kg)	Purchase price (Tk/kg)	Price spread		Selling price (Tk/kg)	Purchase price (Tk/kg)	Price spread	
			(Tk/kg)	Percent			(Tk/kg)	Percent
Farmer	25.33	--	--	--	25.33	--	--	--
Faria	29.91	25.33	4.58	34.4	--	--	--	--
Bepari (local)	32.64	29.91	2.73	20.5	32.64	29.91	2.73	31.2
Retailer (local)	38.66	32.64	6.02	45.1	38.66	32.64	6.02	68.8
Total spread	--	--	13.33	100	--	--	8.75	100

Note: Chain-III: Farmer-Faria-Bepari (local)-Retailer (local)-Consumer (local)
Chain-IV: Farmer-Bepari (local)-Retailer (local)-Consumer (local)

5.17.2 Producer's share to the consumer's price

Producer's share to the consumer's price is one of the criteria for evaluating market performance. There is a thumb rule that producer should get price spread of more than 50% for proper function of the market.It is revealed from Table 5.52 that the estimated most producer's shares except yardlong bean are ranged from 50.1% to 52.6% in supply chain-I indicate that the concerned vegetables markets function well to some extent. In supply chain-II, the producer's shares for all the vegetables are much higher than that of longer supply chain–I.

Table 5.52 Producer's share to the consumer's price in vegetable marketing

Particulars	Brinjal	Bitter gourd	Yardlong bean	Teasel gourd
Supply chain-I				
Consumer's price (Tk/kg)	49.90	50.58	50.08	50.03

Producer's price (Tk/kg)	26.26	25.32	21.95	25.33
Producer's share (%)	52.63	50.06	43.83	50.63
Supply chain-II				
Consumer's price (Tk/kg)	36.16	36.78	36.16	38.66
Producer's price (Tk/kg)	26.26	25.32	21.95	25.33
Producer's share (%)	72.62	68.84	60.70	65.52

Note: Chain-I: Farmer-Faria-Bepari (urban)-Paiker (urban)-Retailer (urban)-Consumer (urban)
Chain-II: Farmer-Faria-Bepari (local)-Retailer (local)-Consumer (local)

5.17.3 Marketing Efficiency in Vegetable Marketing

The concept of marketing efficiency is so broad and dynamic that no single definition comprises all of its theoretical and practical implications. The movement of goods from producers to consumers at the lowest possible cost, consistent with the provision of the services desired by the consumer, may be termed as efficient marketing. However, marketing efficiency is the degree of market performance. Generally, the higher value of marketing efficiency denotes the higher level of efficiency and vice versa.

In supply chain-I, the higher level of marketing efficiency was found in brinjal marketing and the lowest in yardlong bean marketing. The levels of efficiency found in bitter gourd and teasel gourd marketing are more or less same. In supply chain-II, the levels of marketing efficiency in all the studied vegetables are much higher compared to the levels of marketing efficiency found in supply chain-I which was due to the absence of *Paiker* in the chain which ensures lower marketing cost and higher consumer's satisfactiondue to lower price(Table 5.53).Results further revealed that the performance of marketing channel (chain-III & -IV) that reached to the local retail market of the study areas such as Jessore, Rajshahi, Rangpur and Bogura was betterthan those channels originated from aforesaid districts and reached to the urban markets of Dhaka and Gazipur. It was because of less number of middlemen involved in the chains. The overall results reveal that the longer channel possess lower marketing efficiency compared to shorter channel.

Table 5.53 Marketing efficiency in vegetable marketing

Particulars	Brinjal	Bitter gourd	Yardlong bean	Teasel gourd
Supply chain-I				
Producer's price (Tk/ton)	26260	25320	21950	25330
Total marketing cost (Tk/ton)	14266	15104	13812	12118
Total net margin (Tk/ton)	9374	10156	14318	12582
Marketing efficiency	1.11	1.00	0.78	1.03
Supply chain-II				
Producer's price (Tk/ton)	26260	25320	21950	25330
Total marketing cost (Tk/ton)	12152	12458	11197	10213
Total net margin (Tk/ton)	8448	7842	5433	8897
Marketing efficiency	1.27	1.25	1.32	1.33
Supply chain-III				
Producer's price (Tk/ton)	26260	25320	21950	25330
Total marketing cost (Tk/ton)	8155	10024	9061	8196
Total net margin (Tk/ton)	7115	6166	8339	9484
Marketing efficiency	1.72	1.56	1.26	1.43

Supply chain-IV				
Producer's price (Tk/ton)	26260	25320	21950	25330
Total marketing cost (Tk/ton)	7571	9333	8238	7315
Total net margin (Tk/ton)	4579	2417	6472	5785
Marketing efficiency	2.16	2.15	1.49	1.93

Note: Chain-I: Farmer-Faria-Bepari (urban)-Paiker (urban)-Retailer (urban)-Consumer (urban)
Chain-II : Farmer- Faria-Bepari (urban)-Retailer (urban)-Consumer (urban)
Chain-III: Farmer-Faria-Bepari (local)-Retailer (local)-Consumer (local)
Chain-IV: Farmer- Bepari (local)-Retailer (local)-Consumer (local)

5.17.4 Return on Operating Capital

The return on operating capital (ROC) is considered another way to understand the performance of marketing. It was calculated separately for each of the intermediaries in the marketing channelsof vegetables and presented in Table 5.54.

***Brinjal*:**The ROC of brinjal intermediaries ranged from 0.76-9.45%. Results also showed that the highest ROC was received by the *Faria* (9.45%) followed by urban retailer (8.36%), local retailer (7.48%) and*Bepari* (5.92%). In contrast, the lowest ROC was received by *Paiker* (0.76%). This result indicated that the income of *Faria*inbrinjalmarketing was observed to be the highest with corresponding low investment.

***Bitter gourd*:** The ROC of bitter gourd intermediaries ranged from 3.48-14.41%. The highest ROC was received by the *Faria* (14.41%) followed by *Paiker* (6.30%), urban retailer (5.59%), and *Bepari* (3.48%). The lowest ROC was received by local retailer (3.29%).This result also indicated that the income of *Faria*inbitter gourdmarketing was observed to be the highest with corresponding low investment. The ROC were more or less similar for *Paiker* and urban retailer although operating capital was higher for retailer than *Paiker*.

Table 5.54 Return on operating capital of various intermediaries in vegetable marketing

Intermediaries	Brinjal	Bitter gourd	Yardlong bean	Teasel gourd
Faria	9.45	14.41	8.20	14.11
Bepari	5.92	3.48	3.97	4.59
Paiker	0.76	6.30	20.64	9.47
Retailer (urban)	8.36	5.59	5.01	7.70
Retailer (local)	7.48	3.29	17.16	12.06

***Yardlong bean*:**The ROC of yardlong beanintermediaries ranged from 3.97-20.64%. *Paiker* received the highest ROC (20.64%) followed by local retailer (17.16%)and *Bepari* received the lowest (3.97%). The ROC of *Faria* (8.20%) was found to be reasonable. This result indicated that the income of *Paiker* inyardlong bean marketing was observed to be the highest with corresponding medium investment.

***Teasel gourd*:**The ROC of teasel gourd intermediaries ranged from 4.59-14.11%. The highest ROC was received by *Faria* (14.11%) followed by local retailer (12.06%). The ROC of *Paiker* (9.47%) and urban retailer (7.70%) seemed to be reasonable. The lowest ROC was received by *Bepari* (4.59%). This result indicated that the income of *Faria*inteasel gourd marketing was observed to be the highest with corresponding low investment.

5.18 Marketing Problems at Traders' Level

The intermediaries involved in the vegetable supply chainsfaced various problems during vegetable marketing. The type and magnitude of the problems varied from traders to traders, place to place and market to market. The marketing problems of,except the problem of postharvest losses that has been talked over in the earlier sections, different intermediaries are shown in Table 5.55 and discussed in the following sections.

Delay in transportation: About 97.1% *Beparis*and 14% retailers mentioned delay in transportation as a crucialproblem in vegetable marketing that is an acute causes of postharvest losses of vegetables. It is happened due to traffic jam, delay in ferry, and police checking at different traffic points.

Lack of infrastructure: Vegetable traders mentioned various problems related to infrastructure in the market premises. Majority of the assembling or primary vegetable markets are lacking of concrete (*Pacca*) floor, adequate drainage facility, water and sanitary facility, pack house, shed, and short time storage facility. More or less all category of traders faced these aforesaid problems during vegetable marketing.

Delayed sale: It is a common problem in vegetable marketing, but the severity of this problem is varied from trader to trader. It was opined that most respondent traders experienced this problem once or more than once in their life. It was happened mainly traffic jam, political hazard, and trouble in ferry service. This problem creates postharvest loss of vegetables to a great extent. *Paiker* generally sells 5-10kg of vegetables to retailers that increase their postharvest loss to some extent. Retailers sell vegetables little by little to the consumers that stimulates postharvest loss to a great extent. About 32.2% intermediaries mentioned delayed sale as a marketing problem.

Higher transportation cost: Higher transportation cost in the supply chain is one of the main causes of higher price of vegetables at retail market. Many vegetable traders opined that they could not take improved packaging measure (plastic crate) due to higher transportation cost. They transport vegetables with larger gunny bags (stitch with 3-4 bags)for minimizing transportation cost. Nearly 52% *Beparis*, 25% *Paikers* and 27% retailers mentioned this as a problem.

Table 5.55 Problems faced by different traders during vegetable marketing

Marketing Problems	*Faria (n=68)*	*Bepari (n=103)*	*Paiker (n=12)*	Retailer *(n=100)*	All *(n=283)*
1. Delay in transportation	--	97.1	--	14.0	40.3
2. Lack of infrastructure (i.e. storage, pack house, drainage, etc)	36.8	29.1	33.4	38.0	34.3
3. Delayed sell	--	24.3	25.0	63.0	32.2
4. Higher transportation cost	--	51.5	25.0	27.0	29.3
5. Lack of business capital	60.3	12.6	--	13.0	23.7
6. Price fluctuation	42.6	15.5	25.0	10.0	20.5
7. Harassment of police	--	45.6	--	5.0	18.4
8. Rough condition of roads	--	35.0	--	12.0	17.0
9. Higher market toll	13.2	11.7	--	22.0	15.2
10. Bad weather	8.8	12.6	41.7	12.0	12.7

11. Excessive heat/high temperature	--	24.3	--	6.0	11.0
12. Other problems	11.8	9.7	16.7	14.0	12.0

Lack of business capital: *Faria*, a petty trader in the primary market, possesses small cash money for running vegetable business. Therefore, lack of adequate business capital is a crucial problem of *Faria* compared to *Bepari* and retailer. More than 60% *Faria* mentioned that they had dearth of business capital.

Price fluctuation: Sometimes price fluctuation becomes loosing concern to the vegetable traders. It is happened due to unstable supply of vegetables in the market, political unrest, and strike in transportation sector. About 43% *Faria*, 15.5% *Bepari*, 25% *Paiker* and 10% retailers faced price fluctuation as a problem.

Harassment of police: Police harassment in the high ways is another problem of vegetable *Beparis*.They claimed illegal tolls and tips from traders and imposed restriction to the entry of vegetable loaded trucks into Dhaka city. About 46% *Beparis* and only 5% retailers faced this problem during vegetable marketing.

Bad condition of road: The road conditions in many study areas are not good enough for heavy loaded transportation. It creates vibration in the vegetable packets that causes heavy loss in vegetables. Hence, nearly 35% *Beparis*and 12% retailers stated this as one of the causes of postharvest losses of vegetables.

Higher market toll: About 15.2% middlemen traders complaint about unauthorized tolls and commissionthroughout the channels.

Bad weather: Bad weather sometimes create problem for vegetable traders. It hampers their buying and selling functions, creates scarcity of produces in the market, increases the price of vegetables, and finally reduces their profit margins. That's why 12.7% middlemen traders mentioned bad weather as a problem.

Excessive heat/high temperature: More than 24% *Beparis* and 6% retailers opined that a large amount of vegetables sometimes become wastage only due to excessive heat or high temperature. Beside from high temperature in summer season, improper packaging or packaging with enormous volume of vegetables also generates huge amount of heat that add fuel to aggravate postharvest loss high.

Other problems: The other important constraints were mainly related to existence of syndicate in price control, supremacy of *Bepari* in the supply chain, absence of modern marketing tools and equipment, lack of market information, lack of labour, and lack of knowledge and skills.

Chapter VI

CONSUMERS' BEHAVIOR TOWARDS SAFE VEGETABLES

6.1 Introduction

Consumers are the last but very essential link of the marketing chain of a product. Consumers' taste, preference, perceptions, and desire mostly regulate the behavior and activities of different stakeholders (farmers, traders, processor, etc.) of a particular product marketing chain. A consumer survey was conducted for exploring the consumers' perceptions on safe vegetables, their willingness to buy safe vegetables, and readiness to pay premium price for it. The findings of the study are discussed in the following subsequent sections.

6.1.1 Area coverage

The consumers whose intakes generally depend on purchase are mostly living in the urban areas. Therefore, the study was done at the urban areas of Upazila, district and City corporation levels. The study covered five City corporations namely Dhaka, Gazipur, Rajshahi, Rangpur, and Mymensingh. Again, it covered three districts namely Jashore, Bogura, and Jamalpur. Twelve Upazilas from above six districts (except Dhaka & Gazipur) were also considered for the consumer survey (Fig 6.1).

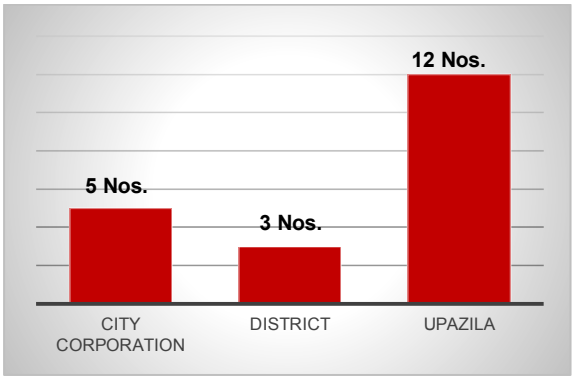


Fig 6.1 Area coverage of the study

6.2 Consumers' Profile

Occupation, age and educationof the consumers are considered important characteristics that regulate their behavior towards safe vegetables consumption to a large extent. However, a brief discussion on consumers' occupation, age and education is given below.

***Occupation*:** The work for which a man is engaged throughout the year is known as his main occupation of that person. The study put greater emphasis on collecting information from service holders and businessmen because they are the mainbuyers of vegetables from the market. Figure 6.2 shows that most of the respondent consumers (73%) belonged to different services followed by business (14%) and crop farming (10%). Only 3% of the respondents were housewife (Fig 5.2).

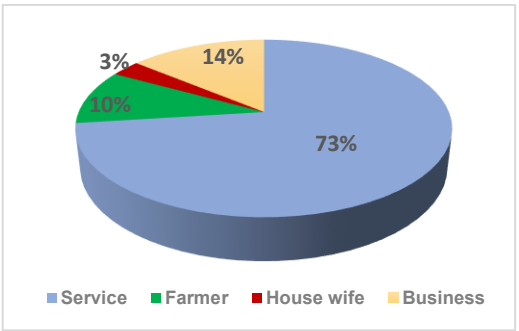


Fig 6.2 Consumers distribution by occupation

***Age*:** Consumer's age can play an important role in making rationale decision for buying safe foods. The age of the consumers was examined by classifying them into four groups: 21-30, 31-40, 41-50, and 51-60 years. Fig 6.3 reveals that most of the respondent consumers' (48%) belonged to the age group 21-30 and 31-40 years. This information imply that majority of the consumers were relatively younger in age. Again, 33% consumers were under middle age group and their ages ranged from 41-50 years. Nineteen percent consumers were belonged to the age group 51-60 years (Fig 6.3).

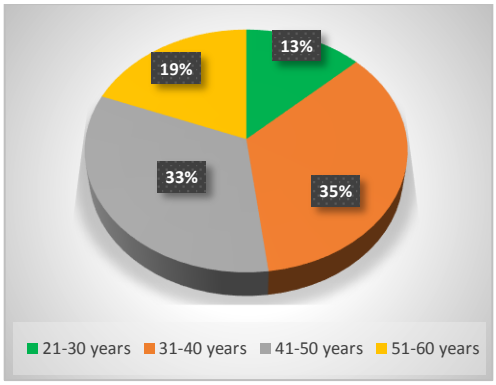


Fig 6.3 Consumers distribution by age group

Education: Education helps individuals to become conscious of their environment and develop rational insight into many matters of life. On the basis of education level, the literacy status of the consumers has been grouped into five categories. The categories are (1) Class V-SSC, (2) Higher secondary (HSC), (3) Degree, (4) MS/MSc, and (5) PhD. Of the educated respondents, the highest 36% consumers had HSC level of education followed by class V-SSC level. The share of degree and MSc level educated consumers were 31%. A few number of consumers had doctoral level of education (Fig 6.4).

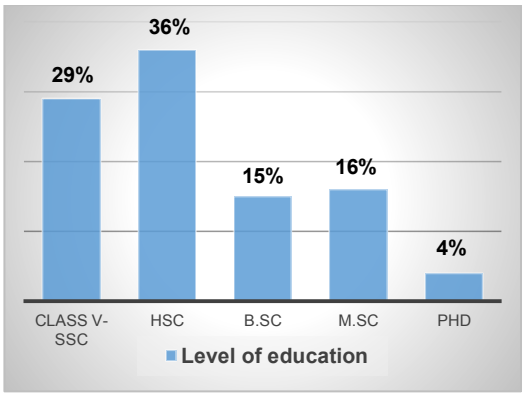


Fig 6.4 Consumers distribution by level of education

6.3 Consumers' Perceptions on Safe Vegetables

Safe food is defined as the food free of contamination occurring at any point in the growing, transporting, preparing, processing, storing, selling or serving of food. The respondent consumers in the present study generally consider those vegetables safe for consumption which are free from pesticides & diseases, physically clean & hygienic, and washed with clean water. The educated consumers of Bangladesh are becoming conscious day by day about safe food consumption. Sarker and Itohara (2008) showed that 51% consumers are highly conscious regarding their personal health and around 40% are moderately conscious, and 10% had low consciousness regarding the environmental hazards caused by agro-chemicals. But the supply of organic food items especially vegetables in the local market is not available.

In developed and developing countries, consumers are increasingly looking for quality food, and food healthier, safer, tastier and obtained with environmentally care (Gao et al., 2010). Most of the consumers are aware of the harmful effects of pesticides or chemical fertilizer on human body and environment, but due to the lack of knowledge about organic food, they have no option to normal food (Sarker, 2007). Therefore, the adoption of safe or organic foods is very low in Bangladesh due to many factors. Iqbal (2015) showed in her study that the main barriers to widespread adoption of organic foods are non-availability, higher price and lack of knowledge. The other major barriers of buying organic foods are its high price, limited availability, satisfaction with conventionally produced food, and the lack of trust in organic products (Tregear et al., 1994; Soil Association, 2012). Mukul et al., (2013) identifiedfive

predictors of consumer perceptions on organic foods which are food safety, price, nutrition, sensory attributes, and environmental friendliness.

The consumers of Bangladesh faced different problems regarding buying of organic produces. The problems were insufficient supply, lack of trust, produce not being certified, higher price, and limited number of shops in the market (Sarker and Itohara, 2008).

6.4 Consumers' Opinion on Unsafe Vegetables

The study attempted to gather the current state of knowledge of consumers on unsafe vegetables and possible sources of their contamination. They stated more than one answers in this regard (Fig 6.5). Most consumers (87%) presumed that using higher dose of pesticides is the main cause of making vegetables unsafe for human consumption. Thirty four percent consumers thought that using excess dose of fertilizers is responsible for vegetable contamination. A good percentage of consumers (24-27%) assumed that insect infestation & disease infection and mixture of good vegetables with rotten ones also make vegetables unsafe for consumption. It is found that farmers harvest vegetables immediately after using pesticides which is very much harmful to health. On the other side, most postharvest operations such as weighing, assembling, sorting and grading, packaging, loading, and unloading take place in unhygienic places due to adopt unhygienic techniques that makes vegetables unsafe for human consumption. Therefore, some consumers (18-23%) put emphasis on unhygienic harvest and postharvest activities for vegetable contamination. Lastly, transportation of vegetables with unhygienic containers is also a source of contamination as stated a small portion of consumers (4%) in the study areas.

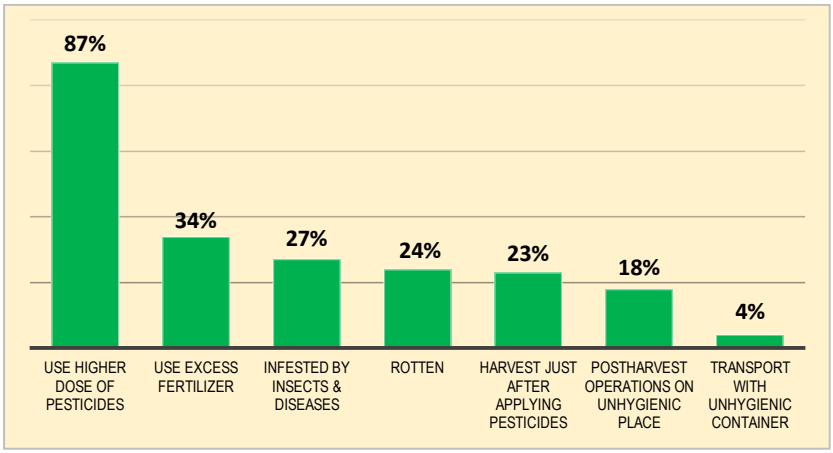


Fig 6.5 Consumers' perceptions on unsafe vegetables

6.5 Consumers' Perceptions on Good Quality Vegetables

Respondent consumers were requested to mention the characteristics of a good quality vegetable. They provided multiple answers on this issue which are furnished in Table 6.1. Fresh and unbroken spikes are so important for bitter gourd and teasel gourd, because many consumers consider these two vegetables good with this spike. More than half of the bitter gourd and about 22% teasel gourd consumers pointed out good condition of spike as an attribute of good vegetables. Green or greenish colour is one of the characters of a good vegetable. Except brinjal, most consumers try to ensure this character during purchase of the rest three vegetables. The highest 55% yearlong bean consumers followed by 44.4% bitter gourd and 37.8% teasel gourd consumers stated green colour as a quality character of vegetables. First impression is the last impression. Before buying vegetables, most consumers are attracted by the freshness of vegetables and later try to find out some defects on it.

Table 6.1 Consumers' perceptions on good quality vegetables

Quality characteristics	Brinjal (n=55)	Bitter gourd (n=45)	Teasel gourd (n=37)	Yardlong bean (n=40)	All veg. (n=177)
1. Looking fresh & attractive	67.3	42.2	48.6	50.0	53.1
2. Disease & insects free	49.1	33.3	37.8	50.0	42.9
3. Green/greenish colour	7.3	44.4	37.8	55.0	33.9
4. Medium size	47.3	24.4	24.3	10.0	28.2
5. Good condition of spike	--	51.1	21.6	--	17.5
6. Spotless & non-injured	18.2	4.4	13.5	10.0	11.9
7. Less matured	18.2	4.4	10.8	12.5	11.9

Therefore, freshness/attractiveness is the most important character of good vegetables that stated by 53.1% vegetable consumers of the study areas. Good quality vegetables must be free from insects' infestation and disease infection. Irrespective of price, majority of the consumers try to ensure these qualities in the time of buying vegetables. In all studied vegetables, about 43% consumers mentioned those vegetables as good which are free from insects' infestation and disease infection. The possibility is high to be over mature of large size vegetable. Hence many consumers try to avoid large sized vegetables and prefer medium size vegetables. The highest 47.3% brinjal consumers stated medium size as one of the characteristics of good vegetables. The other quality characteristics of a good vegetable are spotless & non-injured and less matured.

6.6 Amount of Vegetables Purchased

The quantity of vegetables purchase depends largely on consumer's preference& requirement, their financial capability, price of vegetables, and the availability of vegetables in the market. Table 6.2 shows that a consumer purchased on an average 2.02 kg of brinjal, 0.77 kg of bitter gourd, 0.97 kg of teasel gourd, and 0.95 kg of yardlong bean per week. These amounts seem to be very low. The causes of this low quantity purchase might be due to less availability (due to initial stage of harvesting) and higher price of the vegetables. The price of these vegetables were reported to be very high. The minimum and maximum prices of brinjal were Tk.30.0 and Tk.70.0 per kg. Bitter gourd prices ranged from Tk.35.0 to Tk.60.0 per kg. Again, the prices of teasel gourd and yardlong bean ranged from Tk.30.0 to Tk.60.0 per kg.

Table 6.2 Weekly purchase of vegetables and their prices

Vegetable	N	Quantity purchased (kg/week)			Purchased price (Tk/kg)		
		Minimum	Maximum	Average	Minimum	Maximum	Average
Brinjal	55	0.50	5.0	2.02	30.0	70.0	43.69
Bitter gourd	45	0.50	2.0	0.77	35.0	60.0	50.78
Teasel gourd	37	0.50	2.5	0.97	30.0	60.0	43.92
Yardlong bean	40	0.50	3.0	0.95	30.0	60.0	44.25

6.7 Buying Preference According to Type of Vegetable Shop

The respondent consumers generally purchase vegetables from permanent and temporary vegetable shops situated in the local *Katcha Baazar*. Temporary shops almost sit daily in the urban areas and twice in a week at the Upazila level. Some temporary shops also sit daily at Upazila level. As consumers are becoming busier day by day, they are shifting from temporary vegetable shops to permanent vegetable shops. Figure 6.6 shows that about 82% of the consumers purchased vegetables from permanent shop and 18.25% consumers from temporary shops. A negligible percentage of consumers lived in Dhaka City purchased vegetables from chain shops or supper market.

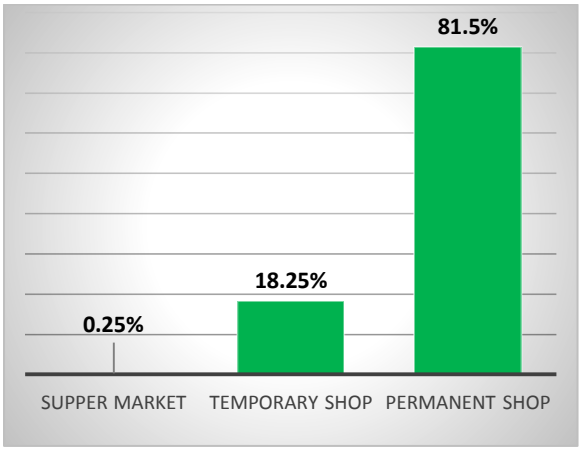


Fig 6.6 Buying preference according to type of vegetable shop

Recently, Agricultural Economics Division of BARI in association with CDCS conducted a consumer survey (AED, 2018) on fruits and vegetables in Dhaka City and found that 81% and 18% of the consumers purchased bitter gourd from permanent shops at local *Katcha bazar* and chain shops/super market respectively. Only 1% consumer purchased from roadside temporary shops.

6.8 Premium Price of Safe Vegetables

The educated consumers of Bangladesh are becoming conscious day by day about purchasing of safe vegetables. Sarker and Itohara (2008) reported that 91% consumers wanted to buy organic foods that are certified, since 63% were not confident that the available organic foods were really organic. But, the safe food or vegetables are scarce in the market. Irrespective of consumers' category, most of them agreed to pay premium price for safe vegetables. Therefore, an attempt was made to know the willingness to pay of the consumers for safe vegetables. The premium price the customers agreed to pay over market price for safe vegetables ranged from Tk 4.0 to Tk 15.0 for different vegetables (Table 6.3). The respondent customers wanted to pay the highest premium price for brinjal (21.4% higher over market price) followed by teasel gourd (20.8%) and yardlong bean (15.6%). The agreed premium prices seemed to be reasonable to attract consumers towards safe vegetables. A consumer study on organic foods conducted in Europe showed that 5-20% of consumers will buy organic food when premium prices are greater than 30%, while premium prices between 10-30% that attract 10-50% of the consumers (Wier and Carlverley, 2002).

Table 6.3 Premium price the customers agreed to pay over market price for safe vegetables

Vegetables	N	Premium price (Tk/kg)			% higher over market price
		Minimum	Maximum	Average	
Brinjal	30	5.0	15.0	9.37	21.4
Bitter gourd	15	5.0	10.0	7.00	13.8
Teasel gourd	15	4.0	15.0	9.13	20.8

Yardlong bean	25	5.0	10.0	6.92	15.6
All vegetables	85	4.0	15.0	8.19	17.9

6.9 Ways to Ensure Safe Vegetables

Every day we are consuming unsafe foods, which are triggering fatal diseases. The most of the foods irrespective of whether it is manufactured and processed foods or fruits, fish, meats, and vegetables are unsafe (Daily Star, 2018). Get rid of from this uncomfortable situation, the respondent vegetable consumers in the study areas were requested to provide some ways to ensure safe vegetables for the consumers. They put greater emphasis on controlling vegetable contamination by different chemicals in the various stages of production. Table 6.4 reveals that most of the consumers (59%) suggested to use organic fertilizers (i.e. compost, vermin-compost, etc) for producing vegetables. Many farmers have tendency of using higher dose of fertilizers for higher production of vegetable that has negative effect on safe food production and overall farm profitability. That's why some consumers (19%) emphasized on applying optimumdose of fertilizers in vegetable production. The higher level of contamination in vegetables is mostly occurred during crop protection due to non-judiciously applying chemical pesticides. In this issue, the highest level of consumers (74%) suggested to take appropriate vegetable cultivation techniques that will require no or less amount of pesticides. Forty three percent consumers gave importance on adopting IMP techniques (e.g. pheromone trap, bistop, destroy insects by hands, etc.) and 29% consumers put emphasis on using bio-pesticides for producing safe vegetables.

Table 6.4 Suggestions provided by vegetable consumers

Vegetables	No. of respondent (n =100)	% of responses
A. Fertilization		
1. Use organic fertilizers	59	59
2. Use balanced fertilizers	19	19
B. Crop protection		
1. Use no or low dose of pesticides	74	74
2. Use IPM technique	43	43
3. Use bio-pesticides	29	29
C. Harvesting		
1. Harvest after 5-7 days of applying pesticides	14	14
D. Packaging & transportation		
1. Need proper packaging	23	23
2. Reached vegetables as quick as possible	20	20
E. Others		
1. Need certification for safe vegetables	26	26
2. Need government monitoring	12	12

Most vegetables farmers in the study areas were found to harvest vegetables just after 3-4 hours of applying chemical pesticides. It is very harmful to health. Fourteen percent consumers suggested to harvest vegetables after 5-7 days of applying pesticides. Many consumers consider improper packaging and delay transportation as important factors that are responsible for vegetable contamination. Therefore, they suggested to pack vegetables before

transportation following proper technique of packaging and reached the same to the urban markets at the earliest for ensuring them safe for the consumers.

Branding plays a key role in attracting consumers for safe produce. If safe produces can be certified, then the consumers will be much more likely to buy them. The findings of the study demonstrate that some respondent consumers (26%) suggested that the available safe vegetables should be certified by some authority for developing consumers' confidence on safe vegetables. There are some government and non-government authorities (e.g. CAB) who supposed to take care food safety issues. Therefore, 12% respondents proposed that government monitoring system should be strengthened for ensuring safe produce for the consumers.

Chapter VII

CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

The study assessed the KAP of vegetable producers and traders on postharvest practices and losses, and investigated vegetable market chains in details for identifying market opportunities for producing and marketing safe vegetables to the consumers. The study reveals thatvegetable farmers concern with low quality inputs, produce unsafe vegetables, and adopt poor postharvest practices. Insects-pests infestation, infection of viral and fungal diseases, higher price of pesticides, stem rot disease, scarcity of labour, and higher price of fertilizers are the major problems of vegetables production. They indiscriminatelyuse plenty of pesticides to protect their vegetable crops. Most farmers claim to have adequate knowledgeon safe vegetable production and proper postharvest practices, but they don't practice it due to various reasons. Although most farmers sell their produce to *Bepari* at the local markets, a good portion of farmers also sell vegetables at the crop field. Both pre- and post-harvest practices are responsible for postharvest losses (2-4%) of vegetables at farm level. Postharvest loss is due to odd size, insect-pest infestation, disease infection, over maturity, physical creak and injury, and ripeness of vegetables. Farmers also experiencehuge financial loss as well. Volume of production, price, selling place, mode of transport, farming experience, pesticides spraying, and growing region have significant effect on postharvest losses of vegetables at farm level.

Most intermediaries involved in the vegetable supply chain claim to have adequate knowledge on different postharvest practices in relation to reduce postharvest as well as monetary loss and keep vegetables safe for the consumers, and in most cases they practice it. There are four major supply channels found for vegetable marketing in the study areas, but aplenty of vegetables move from producer to consumers through the two major channels such as (i) *Farmer-Faria-Bepari-Paiker- urban retailer- urban consumer*; and (ii) *Farmer-Faria-Bepari-local retailer-local consumer*. The total postharvest losses of selected vegetables at traders' level ranged from 8.3-21.3%. The annual financial losses incurred at national level during 2017-18 wereTk.3433.05 million and Tk. 2596.40 million when vegetables move through the above two channels respectively. The trader's level postharvest loss is taken place at various stage of practices such as sorting, cleaning, loading & unloading, packaging, and transportation. The highest marketing cost was for *Bepari* followed by urban retailer. The highest net margin was received by different intermediaries for different vegetables. Different marketing performance indicators reveal that local marketing channel (Chain-II) performs much better than urban channel (Chain-I) since the producer's share and marketing efficiency are higher and price spread is lower in the local channel. Return on operating capital for different intermediaries are also higher in local channel. However, delay in transportation, higher transportation cost, lack of infrastructure, delayed sale, price fluctuation, harassment of traffic police, and higher market toll are the major problems faced by vegetable traders.

Consumers generally consider those vegetables safe for human consumption which are free from pesticides & diseases, physically clean & fresh, and washed with clean water. Most consumers presumed that using higher dose of pesticides and fertilizers is the main cause of making vegetables unsafe. The premium price the customers agreed to pay over market price for safe vegetables ranged from Tk 4.0 to Tk 15.0 for selectedvegetables.

7.2 Recommendations

Based on the findings, a number of measures are needed at farm and market levels to reduce postharvest losses and supply safe and quality vegetables for the consumers.

1. Since farm level postharvest loss is mostly dependent on various pre-harvest practices, good agricultural practices (i.e. use of improved variety, disease free seedlings, less use of pesticides, use of more organic and less chemical fertilizers, use of sex pheromone traps as well as bio-pesticides, use of clean container during harvest, etc.) must be encouraged among vegetable farmers providing hand-on training, diseases resistant variety, *Bt* variety, IPM technologies, bio pesticides, and premium price of organic vegetables. The Department of Extension (DAE) should play a key role in this regard.

2. Farmers should be encouraged to harvest vegetables after 5-7 days of applying pesticides.

3. Government should develop right mechanism (may be rationing) for providing more subsidy on chemical fertilizers and bio pesticides so that small and marginal farmers can use it properly.

4. Functional analysis reveals that transportation on un-smooth road has significant positive impact on postharvest loss of vegetables at farm level. Therefore, construction and renovation of village roads is important for reducing postharvest losses of vegetables to some extent.

5. Selling vegetables with lower price is one of the problems of farmers. They have no or little bargaining power for ensuring fair price of their produces. In this situation, farmers may be organized through cooperative marketing society for selling their produces.

6. Supply chain stakeholders should be motivated for packaging of vegetables after proper sorting and grading (i.e. separate spotted, injured, and semi-spoiled vegetables from good ones). In this regard, a short-term training on post-harvest packaging and handling of produces may be provided to the respective stakeholders.

7. Loss reduction strategies must be introduced in the supply chain.Therefore, the donor agencies and the government would provide fund for undertaking pilot project in establishing pack house and cool chain management system.

8. Limited number of low temperature storage facilities should be established in major production hubs and assembling/wholesale markets for high-value crops like vegetables.

9. Appropriate measures (strengthening govt. monitoring system, impose fine, fixing premium price of safe vegetables, certifying safe vegetables, etc) should be adopted in assembling, wholesale and retail markets in order to maintain quality and safe produces

for the consumers. Safe vegetable producers will also be benefited from some of these measures.

10. The concerned authorities (Market Development Committee, Department of Agricultural Marketing and Agriculture Information Services etc.) should take necessary steps for the development of awareness regarding safe produce, food quality and postharvest losses among stakeholders in the vegetable supply chains. In this regard, technical know-how and technology related to postharvest management and nutrition should be disseminated through TV, radio, billboard, video, meeting, brochure and mobile phone apps, which would have much impact on the reduction of postharvest losses.
11. Some traders use plastic crates as packaging materials at the early stage of harvesting of some high value vegetables like tomato, bitter gourd, teasel gourd, cucumber, etc. They found it cost-effective and help reducing postharvest loss.Therefore, all intermediaries must be motivated to use insertable plastic crates for vegetable packaging. To achieve this goal government should provide subsidy to the manufacturing company, so that the user can afford with lower price.
12. The status of physical infrastructure at market premises is very poor. Therefore, government should construct pack house, well drainage facility, water and sanitation facility, rest room for distant *Beparis*, and concrete market floor at market premises.
13. Branding plays a key role in attracting consumers for safe produce. If safe produces can be certified, then the consumers will be much more likely to buy them. Therefore, the available safe vegetables should be certified by some authority for developing consumers' confidence on safe vegetables. There are some government and non-government authorities (e.g. CAB) who supposed to take care food safety issues. Government monitoring system should be strengthened for ensuring safe produce for the consumers.
14. Continuous research is essential to mitigate diverse problems prevailing in the vegetable supply chain in Bangladesh. Therefore, BARI and Agricultural Universities in Bangladesh should strengthen their existing capacity in terms of postharvest research and development.

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