LOSSES OF SELECTED FRUITS AND VEGETABLES AT CONSUMERS' LEVEL

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CERTIFICATE

This is to certify that the thesis entitled **"LOSSES OF SELECTED FRUITS AND VEGETABLES AT CONSUMERS' LEVEL"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **Master of Science** in **Agricultural Extension and Information System**, embodies the result of a piece of bona fide research work carried out by **Muhaymen Anas Khalid**, Registration No. 06-02085 under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Dated:
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DEDICATED

TO

MY BELOVED PARENTS

AND TEACHERS

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ABSTRACT

The study was conducted to assess the losses of selected fruits (Mango, Jackfruit and Papaya) and vegetables (Tomato, Brinjal, Cabbage and Cucumber) at consumers' level; and to explore the association and relationship between income of the consumers and their losses of selected fruits and vegetables. Data were collected from 384 consumers of 10 locations of Dhaka city with the help of a pre-tested interview schedule during the period from July to December, 2012. Findings revealed that the average losses of the selected seven fruits and vegetables of the consumers was 6.95%. Among 3 selected fruits, the losses were 8.69%, 7.59% and 7.08% for mango, jackfruit and papaya respectively, while among four selected vegetables losses were 7.51%, 9.94%, 4.18%, 3.64% for tomato, brinjal, cabbage and cucumber respectively. Chi-square test revealed that average losses of consumers of these selected seven crops had significant association with their income. Out of seven crops, losses of six crops (mango, jackfruit, papaya, tomato, brinjal and cabbage) of the consumers individually had significant association with their income. Spearman rank correlation test revealed that average losses of consumers of these selected seven crops had significant negative relationship with their income. Out of seven crops, losses of six crops (mango, jackfruit, tomato, brinjal, cabbage and cucumber) of the consumers individually had significant negative relationship with their income.

CHAPTER I

INTRODUCTION

CHAPTER 1

INTRODUCTION

1.1 General Background

Fruits and vegetables are widely grown in Bangladesh. The leading fruits and vegetables producing districts of Bangladesh are Rajshahi, Capainawabganj, Natore, Dinajpur, Thakurgoan, Bogra, Rangpur, Pabna, Jessore, Mymensingh, Narshingdi, Gazipur, Manikganj and Chittagong. At present, the area under fruit cultivation is 1,681 hectares and production is 40,195 metric tonnes (BBS, 2012). A considerable amount of fruits and vegetables losses occur every year during harvesting, sorting, grading, wrapping, lining, packaging, loading, transporting, unloading, storing, selling and consuming due to perishability. The perishability of these fruits and vegetables is attributed to immense physiological changes after harvest (Momen *et.al.*, 1993). Amiruzzaman (1990) reported that the magnitude of postharvest losses in fresh fruits in Bangladesh is 25-50%, while it is only 5-25% in developed countries (Khader, 1992). It is necessary to know the actual causes of postharvest losses at poverty-stricken farmers, wholesalers, and retailers' level for developing an effective postharvest handling and packaging technique to minimize the postharvest losses. Postharvest handling, packaging and storage of fruits are important because they affect the postharvest quality and quantity of produce. Postharvest losses are started from harvesting at growers' level and continued to consume at consumers' level. There are several levels of marketing chains between growers and consumers such as collectors, wholesalers, retailers, etc. Postharvest losses are occurred in every level of marketing chains. For better understanding, some examples postharvest losses may be seen in Fig. 1.1 to Fig. 1.7

Fig. 1.1. Postharvest losses of Mango

Fig. 1.2. Postharvest losses of Jackfruit

Fig. 1.3. Postharvest losses of Papaya

Fig. 1.4. Postharvest losses of Tomato

Fig. 1.5. Postharvest losses of Brinjal

Fig. 1.6. Postharvest losses of Cabbage

Fig. 1.7. Postharvest losses of Cucumber

Only a little information on the postharvest practices and losses of fruits and vegetables at growers, collectors, wholesalers, retailers and consumers level are available.

Consumers are the end users of the fruits and vegetables carried through a number of handling steps. The perception of the consumers is important in considering the introduction of improved interventions in the present marketing systems (Hasan, 2010). Hasan (2010) also reported that 84% of the consumers of both Dhaka and Mymensingh regions are conscious about the deleterious effects of chemicals on human health. Hundred percent of the consumers were interested in purchasing safe fruits and vegetables. More than half (56-64%) of the consumers were willing to pay more for obtaining safe and chemical-free fruits and vegetables. Results also revealed that 64.8% and 33.8% of the consumers possessed refrigerator to store fruits and vegetables in surveyed areas of Dhaka and Mymensingh, respectively.

With these views in mind, the present study was conducted to explore the existing postharvest losses of fruits and vegetables at consumers' levels, which will help for developing appropriate postharvest practices to reduce losses.

1.2 Statement of the Problem

Bangladesh is a densely populated country and Dhaka is one of the over populated cities in the world. Fruits and vegetables are grown well in this country. But every year a large amount of fruits and vegetables are lost due to improper handling at marketing chains like growers, collectors, wholesalers, retailers and consumers. Ali, *et. al.* (2013) conducted a study to find out the post-harvest losses of same fruits and vegetables at different levels (growers, collectors, wholesalers, retailers and consumers) and found highest post-harvest loses in papaya (43.42%) followed by jackfruit (29.62%) and mango (28.92%) among the selected fruits. Among the selected vegetables, he found highest post harvest losses from growers to consumers' level in brinjal (32.03%) followed by tomato (31.09%), cabbage (24.94%) and cucumber (24.28%). Losses of consumers' level depend on the activities done by the initial levels. Again, consumers are the end users of fruits and vegetables.

The main purpose of the study was to have an understanding to determine the losses of selected major fruits (mango, jackfruit and papaya) and vegetables (tomato, brinjal, cabbage and cucumber) at consumers' level of Dhaka city in Bangladesh. For conducting the research in a planned and appropriate way, the researcher put forwarded the following questions:

1. What are the extent of losses of selected fruits and vegetables at consumers' level?
2. What was the extent of association between the losses of selected fruits and vegetables as perceived by the consumers and their level of income?
3. What was the extent of relationship between the losses of selected fruits and vegetables as perceived by the consumers and their level of income?

1.3 Specific Objectives

In order to shape the research in a manageable and meaningful way, the following specific objectives were formulated:

1. To assess the losses of selected fruits (mango, jackfruit and papaya) and vegetables (tomato, brinjal, cabbage and cucumber) at consumers' level
2. To explore the association of the consumers' losses of selected fruits and vegetables with their income
3. To explore the relationship of the consumers' losses of selected fruits and vegetables with their income

1.4 Justification of the Study

Every year a large amount of fruits and vegetables are lost due to improper post-harvest practices in Bangladesh. Post-harvest practices are started from harvesting at growers' level to consume at consumers' level. There are several levels of marketing chains between this growers and consumers like collectors, wholesalers, retailers, etc. Post-harvest losses are occurred in every level of this marketing chain. However, very little information on the postharvest practices and losses of fruits and vegetables at growers, collectors, wholesalers, retailers and consumers level are available. Some studies tried to find out the post-harvest practices and their losses at growers to retailers level. But consumers are the end users of these fruits and vegetables. Increase of post-harvest losses of growers to retailers' level affects the loss of consumers' level. On these considerations, the researcher of this study felt necessity to conduct this piece of research work.

Findings of this study, would therefore, be helpful to the planners and extension personnel in planning and implementing programs for enhancing the best post-harvest practices from growers to consumers' level to reduce post harvest losses.

1.5. Assumptions of the study

An assumption is the supposition that an apparent fact or principles is true in light of the available evidence (Goode and Hatt, 1952). An assumption is taken as a fact or belief to be true without proof. In this study, the researcher had the following assumptions in mind while carrying out this study:

1. The fruit and vegetable consumers of Dhaka city included in the sample were competent to furnish proper responses to the items included in the interview schedule.
2. The researcher who also acted as the interviewer was well adjusted to the socio-cultural environment of the study area.
3. The researcher collected data with utmost care and can be treated as reliable.
4. The responses furnished by the respondent consumers were reliable and they truly expressed their opinion regarding losses of selected fruits and vegetables from purchasing to consuming.
5. The sample size was representative of the whole consumers of the study area.
6. The measurement of the losses of selected fruits and vegetables were valid and reliable.

1.6. Scope of the study

The findings of the study will particularly be applicable to consumers of Dhaka city. However, the findings may also be generally applicable to other cities, towns and rural areas of Bangladesh. Thus, the findings are expected to be useful to the planners for preparation of programmers for introducing best postharvest practices to the farmers, traders and consumers of fruits and vegetables. The findings may also be helpful to the extension workers of different national building departments/organizations to improve their technique to introduce best postharvest practices of fruits and vegetables to reduce post-harvest losses of these crops.

1.7. Limitations of the study

The present study was undertaken to have an understanding to determine the post-harvest losses of the consumers of selected fruits and vegetables. In order to manage and handle the research program proposal, it became necessary to impose some limitations on certain aspects of the study. Considering time, money and other necessary resources available to the researcher, the following limitations were observed in the study:

1. The study was confined to 10 selected areas of Dhaka city in Bangladesh.
2. Only seven crops including three fruits (mango, jackfruit and papaya) and four vegetables (tomato, brinjal, cabbage and cucumber) were selected to determine their losses at consumers' level.
3. There are several levels of supply chain of fruits and vegetable marketing, like growers, collectors, wholesalers, retailers, consumers. In this study only consumers were considered.

1.9. Definition of the Terms

In order to avoid confusion and misunderstanding, certain terms used throughout the study are defined as follows:

Consumer: The people, who buy fruits and vegetables for consumption are known as consumer. Usually consumers buy fruits and vegetables from retailers.

Losses at consumers' level: Losses at consumers' level of fruits and vegetables refers the damaged percentage of fruits and vegetables at this level. It is determined by the deduction consumed part of crops from the purchased amount of crops and expressed in percentage.

Annual family income of the consumers: Annual family income of the consumers refers to the total earnings in taka of the respondent consumers and all his/her family members from service, business, and other sources during the previous year and it was expressed in Bangladeshi Taka (BDT.).

CHAPTER II

REVIEW OF LITERATURE

CHAPTER 2

REVIEW OF LITERATURE

The purpose of this Chapter is to review of literature having relevance to the present study. The researcher made an elaborate search of available literatures for the above purpose. But there were very little studies related to the present study. Therefore, the findings of such studies related to the present study have been reviewed in the following two sections:

First section: Literatures related to post-harvest losses of crops
Second section: Conceptual frame work of the study

2.1. Literatures related to post-harvest losses of crops

Amiruzzaman (1990) reported that the magnitude of postharvest losses in fresh fruits in Bangladesh is 25-50%, while it is only 5-25% in developed countries as reported by Khader (1992).

Momen *et.al.*(1993) reported that a considerable amount of fruits and vegetables losses occur every year during harvesting, sorting, grading, wrapping, lining, packaging, loading, transporting, unloading, storing, selling and consuming due to its perishability. The perishability of these fruits and vegetables is attributed to immense physiological changes after harvest.

Hasan's study (2010) also revealed that 84% of the consumers of both Dhaka and Mymensingh regions are conscious about the deleterious effects of chemicals on human health. Hundred percent of the consumers were interested in purchasing safe fruits and vegetables. More than half (56-64%) of the consumers were willing to pay more for obtaining safe and chemical-free fruits and vegetables. Results also revealed that 64.8% and 33.8% of the consumers possessed refrigerator to store fruits and vegetables in surveyed areas of Dhaka and Mymensingh, respectively.

Molla *et al.* (2010) reported that the postharvest loss of litchi at consumers' level was 7.5% after buying from retailers to consumption by them.

Buzby *et al.* (2011) reported that food loss at the retail and consumer levels in the United States includes 14.8 billion pounds of fruit and 23.4 billion pounds of vegetables, valued at $15.1 billion and $27.7 billion, respectively, in 2008 retail market prices. The total value of these losses is $42.8 billion per year, or roughly $141 per capita. To most efficiently reduce the annual food loss, it may be beneficial to focus efforts on the four fruits (fresh apples, grapes, peaches and strawberries) and four vegetables (fresh and canned tomatoes and fresh and frozen potatoes) that have the greatest amount of loss.

Molla *et al.* (2012) reported that the gross postharvest losses of banana were 26.63% at different levels from harvesting to consumption out of which 2.6% was at consumer level after buying to consumption.

Ali *et. al.* (2013) conducted a study to determine the post harvest losses of selected fruits and vegetables. The findings of this study revealed that among the selected fruits, highest postharvest losses from growers to consumers level was occurred for papaya (43.42%) followed by jackfruit (29.62%) and mango (28.92%). Among the selected vegetables, highest postharvest losses from growers to consumers level was observed for brinjal (32.03%) followed by tomato (31.09%), cabbage (24.94%) and cucumber (24.28%).

2.2 Conceptual Framework of the study

In scientific research, selection and measurement of variables constitute an important task. The hypothesis of a research is constructed properly to verify the relationship/association between the variables under consideration. Losses of selected fruits (mango, jackfruit and papaya) and vegetables (tomato, brinjal, cabbage and cucumber) of the consumers was the main focus of the study. These losses may be associated or related with the income level of the consumers.

Losses may be categorized as no, low, medium and high levels. There may be some causes of losses. Considering theses issues and in view of prime findings of review literatures, the researcher constructed a conceptual framework of the study, which is self-explanatory and is presented in Fig. 2.1.

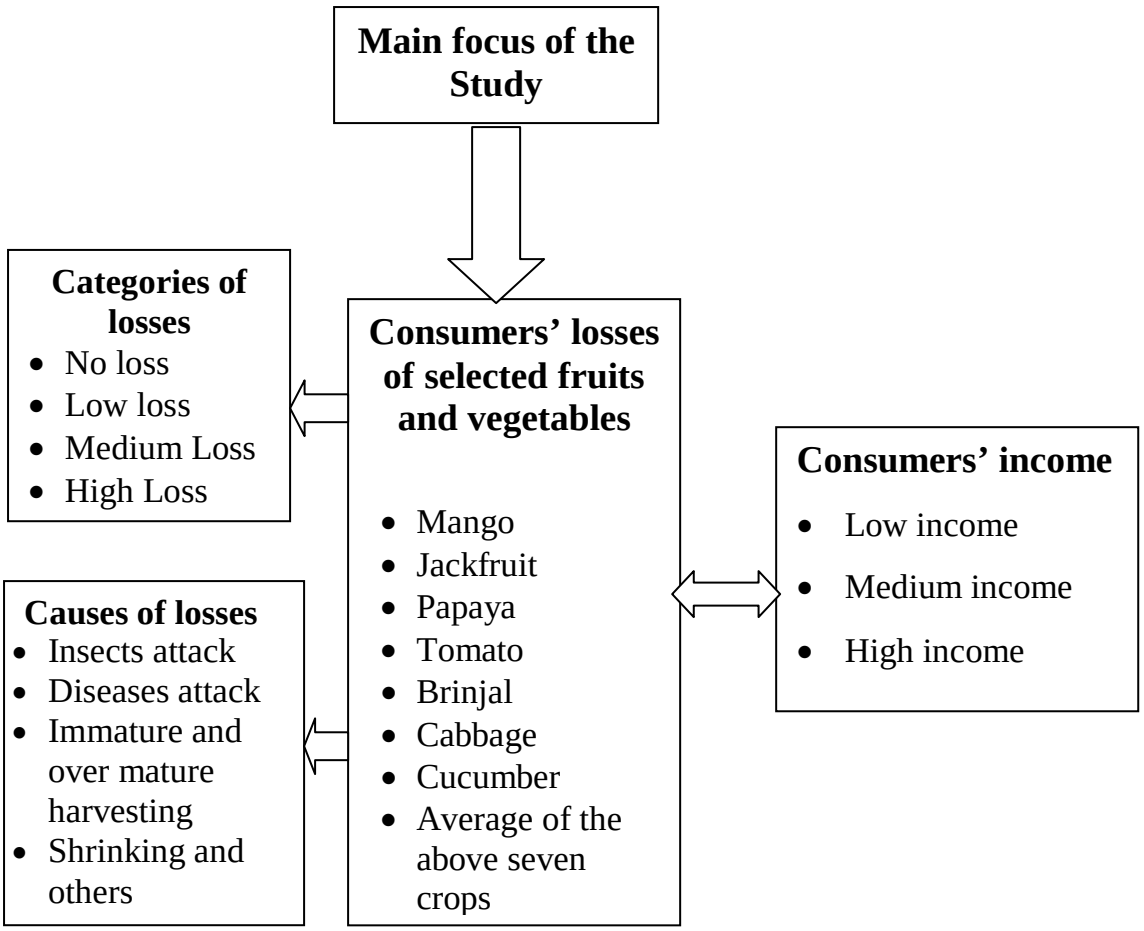

Fig. 2.1 Conceptual Framework of the study

CHAPTER III

METHODOLOGY

CHAPTER 3

METHODOLOGY

The methodology used in conducting any research plays a critically important role and deserves careful consideration by the researcher while formulating methods and procedure. It enables the researcher to collect valid and reliable information in terms of hypothesis or research instrument and to analyze the information properly to arrive at correct and valid results. The methods and procedures followed in this study are described in this chapter.

3.1 Locale of the Study

Dhaka is the capital city of Bangladesh. There are so many retailing markets of fruits and vegetables in this. Ten (10) retailing markets surrounding to Sher-e-Bangla Agricultural University (SAU) viz. as Kazipara market, Shawrapara market, Taltola market, Agargoan market, BNP market, SAU market, Farmgate market, Townhall market, Krishi market and Bihari market were purposively selected as the locale of the study.

3.2 Population and Sample

According to GeoNames geographical database (2012), the population of Dhaka city is 1,03,56,500. This statistics varies in different reports. The fruit and vegetable consumers of surrounding the selected markets were considered as the population of the study. The number of consumers of these areas was too large. So, it was not possible to make lists of consumers of the selected areas. According to ‘Sample Size Calculator’ of ‘Creative Research Systems’, the sample size is 384 for unknown population at confidence level of 95% and confidence interval of 5 (CRS, 1982). Under this consideration, 384 consumers from 10 selected locations of Dhaka city were selected by using accidental sampling method by taking 128 consumers from low, medium and high income group as the sample consumer of fruits and vegetables by using sample size

calculator developed by Creative Research System (1982). The distributions of the sample are presented in Table 3.1.

Table 3.1 Distribution of sample fruit and vegetable consumers of selected areas of Dhaka city

Sl. No.	Selected Locations	Sample size			
		Low income group	Medium income group	High income group	Total
1	Kazipara market	13	13	13	39
2	Shawrapara market	13	13	13	39
3	Taltola market	13	13	13	39
4	Agargoan market	13	13	13	39
5	BNP market	13	13	13	39
6	SAU market	13	13	13	39
7	Farmgate market	13	13	13	39
8	Townhall market	13	13	13	39
9	Krishi market	12	12	12	36
10	Bihari market	12	12	12	36
Total		**128**	**128**	**128**	**384**

3.3 Data Collecting Instruments

For the purpose of data collection, an interview schedule was prepared by keeping the objectives of the study in mind. The schedule contained both open and closed form questions. Direct and simple questions were included in the schedule to collect data from the sample respondent consumers.

The draft schedule was prepared in Bengali and pre-tested before using the same for collection of data. For pre-test purpose, 15 respondent consumers (by taking at 5 from each income group) were interviewed by using the draft interview schedule. Based on the pre-test experience, necessary corrections, additions, alternations and rearrangements were made in the schedule. Thus, the schedule was prepared for final use. The schedule was prepared both in Bengali and English version. The Bengali version of interview schedule was multiplied as per requirements to collect data from the respondent consumers. The English version of interview schedule is enclosed in Appendix-A.

3.4 Measurement of variables

In the present study, losses of selected fruits and vegetables at consumers' level were the main focus. Association of losses of selected fruits and vegetables of consumers with their income was determined. Measurement of losses of selected fruits and vegetables of consumers with their income are discussed below:

Measurement of consumers' losses of selected fruits and vegetables

For determining the losses of selected fruits and vegetables at consumers' level, a respondent consumer was asked to mention the amount (kg) of purchased selected fruits (mango, jackfruit and papaya) and vegetables (tomato, brinjal, cucumber and cabbage) and amount of consumed fruits and vegetables for last three times. Postharvest losses of selected crops (fruits and vegetables) of each time were determined by the following formula:

$$\%PHL = \frac{PC - CC}{PC}$$

Where, PHL = Postharvest loss at Consumers Level

HC = Amount of purchased crops (fruits and vegetables)

CC = Amount of consumed crops (fruits and vegetables)

By the average of postharvest losses of three times of a consumer, the actual loss of concerned crop of that consumer was calculated. Again, average post-harvest loss of all the selected seven crops at consumers' level was also determined by the average losses of all the selected crops of the individual consumer and it was expressed in percentage.

Measurement of annual family income of the consumers

The respondents were the citizens of Dhaka city. Their occupations were mainly service and business. There were other occupations also. Annual family income refers to the total earnings in taka of the respondent consumers and all his/her family members from service, business, and other sources during the previous

year. But, it was not possible to mention the exact annual family income by the respondents. As per Bangladesh Government rule (2012-13), the tax free annual income was upto BDT. 2,20,00.00. On these considerations, the respondents were asked to mention his/her annual family income by responding any one of the three alternative responses such as low annual income ($\leq$ 1 lac BDT.), medium annual income (> 1 lac to 2.2 lac BDT.) and high annual income (> 2.2 lac BDT.). Then, scores were assigned to this annual family income as 1, 2 and 3 for low, medium and high family annual income respectively.

3.5 Collection of Data

Data were collected personally through face-to-face interview of the selected fruits and vegetable consumers of the selected areas. All possible effort was made to explain the purpose of the study to the respondents. Rapport was established with the respondents prior to interview and the objectives were clearly explained to the extent possible. Excellent cooperation and co-ordination were obtained from all the respondent consumers. So, there was no hesitation to furnish proper responses to the questions and statements. Data were collected three times from each respondent, as all the selected crops were not available in the market round the year. As the sample consumers were selected by using accidental sampling, data were collected at market places for the first time of each respondent. Addresses and/or cell numbers of the consumers were collected for 2nd and 3rd time data collection. The 2nd and 3rd time data collection were done at the residence of the respondent consumers. The data collection was started on 1st July, 2012 and completed on 31 December, 2012.

3.6 Processing of Data

The collected raw data were examined thoroughly to find out the errors and omissions. For this, a careful scrutiny of the completed interview schedules was made to make sure that they were entered as complete as possible and well arranged to facilitate coding and tabulation. Very minor mistakes were detected by doing this, which were corrected promptly.

Having consulted with research supervisor, all the individual responses to the questions of the interview schedule were transferred to a master sheet to facilitate tabulation.

3.7 Statistical Procedures

The collected data were compiled, tabulated and analyzed in accordance with the objectives of the study. In order to explore the association of the annual family income of the respondents (fruit and vegetable consumers) with their losses of selected fruits and vegetables after buying to consuming, the Chi-square test was used. Again, In order to explore the relationship of the annual family income of the respondents with their losses of selected fruits and vegetables after buying to consuming, the Spearman rank correlation test was used as the measuring scale was in ordinal scale. Five percent (0.05) level of significance was used as the basis of rejecting/accepting any null hypothesis.

If the computed value of Chi-square was equal to or greater than the table value at designated level of significance for the relevant degrees of freedom, the null hypothesis was rejected and it was concluded that there was a significant association between the concerned variables. However, when the computed value of Chi-square was found to be smaller than the tabular value at the designated level of significance for the relevant degrees of freedom, it was concluded that the null hypothesis could not be rejected and hence, there was no significant association between the concerned variables.

If the computed value of Spearman rank correlation coefficient (ρ) was equal to or greater than the table value at designated level of significance for the relevant degrees of freedom, the null hypothesis was rejected and it was concluded that there was a significant relationship between the concerned variables. However, when the computed value of coefficient of Spearman rank correlation (ρ) was found to be smaller than the tabular value at the designated level of significance for the relevant degrees of freedom, it was concluded that the null hypothesis

could not be rejected and hence, there was no significant relationship between the concerned variables.

3.8 Statement of Hypothesis

Two types of null hypotheses were developed in this study to explore the i) association and ii) relationship between the consumers' losses of selected fruits and vegetables and their income.

Three fruits (mango, jackfruit and papaya) and four vegetables (tomato, brinjal, cabbage and cucumber) were considered for the study. The null hypotheses were formulated to explore the association between the consumers' losses of each of the crops and their income as follows:

- "There is no association between the consumers' loss of mango and their income".
- "There is no association between the consumers' loss of jackfruit and their income".
- "There is no association between the consumers' loss of papaya and their income".
- "There is no association between the consumers' loss of tomato and their income".
- "There is no association between the consumers' loss of brinjal and their income".
- "There is no association between the consumers' loss of cabbage and their income".
- "There is no association between the consumers' loss of cucumber and their income".

- "There is no association between the consumers' average losses of selected seven crops and their income".

The null hypotheses were again formulated to explore the relationship between consumers' losses of each of the selected crops and their income. Null hypotheses were developed regarding this issue in the following manner:

- "There is no relationship between the consumers' loss of mango and their income".
- "There is no relationship between the consumers' loss of jackfruit and their income".
- "There is no relationship between the consumers' loss of papaya and their income".
- "There is no relationship between the consumers' loss of tomato and their income".
- "There is no relationship between the consumers' loss of brinjal and their income".
- "There is no relationship between the consumers' loss of cabbage and their income".
- "There is no relationship between the consumers' loss of cucumber and their income".
- "There is no relationship between the consumers' average losses of selected seven crops and their income".

CHAPTER IV

FINDINGS AND DISCUSSION

CHAPTER 4

FINDINGS AND DISCUSSION

In this chapter findings of the study and interpretations of the results have been presented according to the objectives of the study. This chapter has been divided into three sections as follows:

First Section: Assessment of consumers' losses of selected fruits and vegetables

Second Section: Association of the consumers' losses of selected fruits and vegetables with their income

Third Section: Relationship of the consumers' losses of selected fruits and vegetables with their income

4.1 Assessment of consumers' losses of selected fruits and vegetables

Findings revealed that among the selected fruits, highest post harvest losses of consumers was occurred in mango (8.69%) followed by jackfruit (7.61%) and papaya (7.05%). Among the selected vegetables, highest post harvest losses of consumers was observed in brinjal (9.88%) followed by tomato (7.46%), cabbage (4.14%) and cucumber (3.65%). Average loss of these seven crops at consumers' level was 6.93%. Ali *et. al.* (2013) conducted a study to find out the postharvest losses of same fruits and vegetables at different levels (growers, collectors, wholesalers, retailers and consumers) and found highest postharvest loses in papaya (43.42%) followed by jackfruit (29.62%) and mango (28.92%) among the selected fruits. Among the selected vegetables, he found highest post harvest losses from growers to consumers' level in brinjal (32.03%) followed by tomato (31.09%), cabbage (24.94%) and cucumber (24.28%). Percentages of postharvest losses of selected fruits and vegetables at consumers' level with their causal percentages are presented in Table 4.1.

Table 4.1 Percentages of postharvest losses of selected fruits and vegetables at Consumers' level with their causal percentages

Crops	% Losses				
	Insect	Diseases	Immature/ Over mature	Shrinking & Others	Total
Mango	1.88	2.35	2.22	2.24	8.69
Jackfruit	1.66	1.95	2.60	1.40	7.61
Papaya	1.26	1.75	2.66	1.38	7.05
Tomato	1.81	2.12	1.86	1.67	7.46
Brinjal	3.25	3.13	0.75	2.75	9.88
Cabbage	1.25	1.13	0.25	1.51	4.14
Cucumber	1.13	1.00	0.25	1.27	3.65
Average	**1.75**	**1.92**	**1.51**	**1.75**	**6.93**

Causes of postharvest losses at consumers' level

Attempt has been made to identify the causes of postharvest losses of selected fruits and vegetables at consumers' level. It was found that causes were insects and diseases attack, immature and over mature harvesting, shrinking and others. The percentages of causes of postharvest losses of selected fruits and vegetables at consumers' level are presented in Table 4.1.

In case of mango, highest postharvest loses at consumers' level was found due to diseases attack (2.35%) followed by shrinking and others (2.24%), immature/over mature harvesting (2.22%) and insect attack (1.88%). Diseases may occur in mango after harvesting due to improper sorting, grading, washing, wrapping, lining, packaging, loading, transporting, unloading etc. These might be the causes of ultimate highest lose at consumers' level by diseases attack.

In case of jackfruit, highest postharvest loses at consumers' level was found due to immature/over mature harvesting (2.60%) followed by diseases attack (1.95%), insect attack (1.66%) and shrinking and others (1.40%). Harvesting at proper

maturity is very important for jackfruit. Immature or over mature harvesting of jackfruit might ultimately be increased the postharvest loses at consumers' level.

In case of papaya, highest postharvest loses at consumers' level was found due to immature/over mature harvesting (2.66%) followed by diseases attack (1.75%), shrinking and others (1.38%) and insect attack (1.26%). Like jackfruit, harvesting of papaya at proper maturity is very important. Immature or over mature harvesting of papaya might ultimately be increased the postharvest loses at consumers' level.

Highest postharvest loses of tomato at consumers' level was found due to diseases attack (2.12%) followed by immature/over mature harvesting (1.86%), insect attack (1.81%), and shrinking and others (1.67%). Diseases may occur in tomato after harvesting due to improper sorting, grading, washing, wrapping, lining, packaging, loading, transporting, unloading etc. These might be the causes of ultimate highest lose of tomato at consumers' level by diseases attack.

Highest postharvest loses of brinjal at consumers' level was found due to insect attack (3.25%) followed by diseases attack (3.13%), shrinking and others (2.75%) and immature/over mature harvesting (0.75%). Fruit and shoot borer insect attack in brinjal is very common in Bangladesh. Sometimes it is not seen on the brinjal, it is seen after cutting the brinjal. It is happened in the production stage and ultimately it might be the causes of highest lose at consumers' level.

Highest postharvest loses of cabbage at consumers' level was found due to shrinking and others (1.51%), followed by insect attack (1.25%), diseases attack (1.13%) and immature/over mature harvesting (0.25%). Traditionally, cabbages are transported without packaging in the open truck. This might be the cause for highest postharvest lose of cabbage at consumers' level due to shrinking and others.

In case of cucumber, highest postharvest loses at consumers' level was found due to shrinking and others (1.27%), followed by insect attack (1.13%), diseases attack (1.00%) and immature/over mature harvesting (0.25%). Traditionally, cucumbers are transported without lower packaging system in the open truck. This might be the cause for highest postharvest lose of cabbage due to shrinking and others at consumers' level.

In average of seven selected crops, highest postharvest loses at consumers' level was found due to diseases attack (1.92%) followed by insect attack (1.75%), shrinking and others (1.75%) and immature/over mature harvesting (1.51%).

4.2 Association of the consumers' losses of selected fruits and vegetables with their income

This section deals with the association of the consumers' losses of selected fruits and vegetables with their income. The associations have been described in eight sub-sections, each of first seven sub-sections dealt with the association of the consumers' losses of one crop with their income. The last section dealt with consumers' average losses of seven selected fruits and vegetables with their income.

The procedure followed in measuring the losses of selected fruits and vegetables at consumers' level and their income have already been discussed in Chapter 3.

For running chi-square test, it was necessary to categorize the respondent consumers according to their losses in selected crops and according to their income.

Categorization of consumers according to their losses in selected crops: After determining consumers' losses of selected seven crops consisting of three fruits (mango, jackfruit and papaya) and four vegetables (tomato, brinjal, cabbage and cucumber), consumers average (mean) loss of these selected seven crops was determined and it was 6.93 with a standard deviation (SD) of 3.74. By using this

mean and sd, the consumers were classified into following four categories according to their losses of selected fruits and vegetables:

Categories of the consumers according to their losses of selected fruits and vegetables	Basis of categorization (% of Loss)
No loss	0.00
Low loss	<Mean – 0.5sd, or <6.93 -0.5x3.74 i.e. <5.06
Medium loss	Mean $\pm$ 0.5sd, or 6.93 $\pm$0.5x3.74 i.e. 5.06 to 8.80
High loss	>Mean + 0.5sd, or >6.93 +0.5x3.74 i.e. >8.80

The above categories were used for individual crops. But, in case of average losses the consumers of the selected seven crops, the consumers were classified into three categories as low, medium and high loss as there was none faced no loss.

Categorization of consumers according to their income: As per Bangladesh government rule (2012-13), the tax free annual income was up to BDT. 2,20,000.00. Therefore, consumers having annual income above BDT. 2,20,000.00 was considered as high income consumer, consumers having annual income above BDT. 1,00,000.00 to BDT 2,20,000.00 was considered as medium income consumer and consumers having annual income upto BDT. 1,00,000.00 was considered as low income consumer.

Eight null hypotheses have been stated for testing the associations of the consumers' losses of selected fruits and vegetables with their income. For clarity of understanding relevant null hypothesis has been re-stated in course of discussion of each of the eight associations. Chi-square method was used by using SPSS software to test the associations of consumers' losses of all the seven selected crops including their average with the income of the consumers. Chi-square test was used because this gives the category wise information. The

category wise information is obviously helpful in formulating policies and programmes for special target groups. Throughout the study, five per cent (0.05) level of significance was used as the basis for rejection of any null hypothesis.

Moreover, as suggested by Cohen and Holliday (1982), contingency coefficient (C) was computed by using SPSS software to measure the strength of association of the consumers' losses of selected fruits and vegetables with their income. The value of C could range from zero to 1; the more the value of C approaches to 1, the greater was the strength of association. Number of distribution (observed frequencies) and expected frequencies (shown in parentheses in the Tables) were used for computation of χ^2.

For examining the association of the consumers' losses of each of the selected fruits and vegetables and their average with the income of the consumers, it was necessary to classify the respondent consumers into suitable categories according to their losses of selected fruits and vegetables and also according to their income. The respondent consumers were classified into four categories according to their losses in each of seven selected fruits and vegetables, namely, no loss, low loss, medium loss and high loss as shown in chapter 3. In case of average losses in seven selected fruits and vegetables, the respondent consumers were classified into three categories, namely, low loss, medium loss and high loss. These categories in respect of the consumers' losses have been used for conducting χ^2 test. Categories have been developed for chi-square test in respect of income of the respondent consumers as low income, medium income and high income as describe in methodology chapter (Chapter 3). In case of chi-square, some categories may need to merge when expected frequencies are less than 5 in more than 25 per cent cells. But, fortunately, no such case was happened in the study. For comparing the losses of selected fruits and vegetables and their average of different income categories of the respondent consumers, loss indices have been shown in the contingency table. Loss index of a category was computed by using the following formula:

Loss index (LI) = $L_n x0 + L_l x1 + L_m x2 + L_h x3$,

where,

L_n = Percentages of consumers faced no loss

L_l = Percentages of consumers faced low loss

L_m = Percentages of consumers faced medium loss

A_h = Percentages of consumers faced high loss

Loss index (AI) of any category of respondent consumers could range from 0 to 300, where '0' indicated no loss and '300' indicated highest loss.

4.2.1 Consumers' Loses of Mango with their Income

Data concerning the association of the consumers' loses of mango with their income has been presented in Table 4.2. The null hypothesis to be tested was:

"*There is no associations of the consumers' lose of mango with their income.*"

Analysis of data contained in Table 4.2 indicates the differences in loss of mango of the consumers according to their income. Percentage of consumers facing high loss was the highest (65.6 per cent) in the low income category and it decreased to 33.6 per cent in the middle income category and 24.2 per cent in the high income category. Proportion of consumers facing medium loss was the highest (32.0 per cent) in the middle income category as compared to 14.1 per cent in the low income and 29.7 per cent in the high income category. Thirty five point nine (35.9) per cent of the high income consumers faced low loss compared to 8.6 per cent low income category and 23.4 per cent middle income category.

Table 4.2 Distribution of Consumers according to their Lose in Mango and Income

Categories of Consumers according to Income	Number of Consumers according to their Lose in Mango					Loss Index
	Faced No Loss	Faced Low Loss	Faced Medium Loss	Faced High Loss	Total	
Low income	15 (11.7)	11 (8.6)	18 (14.1)	84 (65.6)	128 (100)	234
Medium income	14 (10.9)	30 (23.4)	41 (32.0)	43 (33.6)	128 (100)	188
High income	13 (10.2)	46 (35.9)	38 (29.7)	31 (24.2)	128 (100)	168
Total	**42 (10.9)**	**87 (22.7)**	**97 (25.3)**	**158 (41.1)**	**384 (100)**	**197**

$\chi^2 = 60.314$; df = 6; P=0.000; C = 0.368 ( ) indicates per cent

Chi-square was computed to determine whether the observed difference was statistically significant or not. Value of computed χ^2 was 60.314, which was higher than the table value of 16.812 with 6 degrees of freedom at 0.01 level of probability and hence the computed χ^2 was significant at this level. Therefore, the researcher was able to reject the null hypothesis and it was concluded that there was significant association between consumers' loss in mango and their income. Loss indices of the three income categories of the consumers indicated that loss was highest (LI=234) among the low income consumers and far lower among medium and high income consumers (LI = 188 and 168 respectively). Therefore, the association observed between the concerned variables was negative. The finding is also supported by Spearman rank correlation co-efficient (ρ = -0.283**) between the concerned variables (may be seen in next section). The value of C was found 0.368 indicating the strength of association.

4.2.2 Consumers' Loses of Jackfruit with their Income

Data concerning the association of the consumers' loses of jackfruit with their income has been presented in Table 4.3. The null hypothesis to be tested was:

"*There is no associations of the consumers' lose of jackfruit with their income.*"

Analysis of data contained in Table 4.3 indicates the differences in loss of jackfruit of the consumers according to their income. Percentage of consumers facing high loss was the highest (39.1per cent) in the low income category and it decreased to 21.1 and 24.2 per cent in the middle and high income categories respectively. Proportion of consumers facing medium loss was the highest (25.0 per cent) in the middle income category as compared to 22.7per cent in the low income and 18.8per cent in the high income category. Twenty seven point three (27.3) per cent of the high income consumers faced low loss compared to 9.4 per cent low income category and 23.4 per cent middle income category.

Table 4.3 Distribution of Consumers according to their Lose in Jackfruit and Income

Categories of Consumers according to Income	Number of Consumers according to their Lose in Jackfruit					Loss Index
	Faced No Loss	Faced Low Loss	Faced Medium Loss	Faced High Loss	Total	
Low income	37 (28.9)	12 (9.4)	29 (22.7)	50 (39.1)	128 (100)	172
Medium income	39 (30.5)	30 (23.4)	32 (25.0)	27 (21.1)	128 (100)	137
High income	38 (29.7)	35 (27.3)	24 (18.8)	31 (24.2)	128 (100)	138
Total	**114 (29.7)**	**77 (20.1)**	**85 (22.1)**	**108 (28.1)**	**384 (100)**	**149**

$\chi^2 = 20.997$; df = 6; P=0.002; C = 0.228 ( ) indicates per cent

Chi-square was computed to determine whether the observed difference was statistically significant or not. Value of computed χ^2 was 20.997, which was higher than the table value of 16.812 with 6 degrees of freedom at 0.01 level of probability and hence the computed χ^2 was significant at this level. Therefore, the researcher was able to reject the null hypothesis and it was concluded that there was significant association between consumers' loss in jackfruit and their income. Loss indices of the three income categories of the consumers indicated that loss was highest (LI=172) among the low income consumers and far lower among

medium and high income consumers (LI = 137 and 138 respectively). Therefore, the association observed between the concerned variables was negative. The finding is also supported by Spearman rank correlation co-efficient (ρ = -0.113*) between the concerned variables (may be seen in next section). The value of C was found 0.228 indicating the strength of association.

4.2.3 Consumers' Loses of Papaya with their Income

Data concerning the association of the consumers' loses of papaya with their income has been presented in Table 4.4. The null hypothesis to be tested was:

"*There is no associations of the consumers' lose of papaya with their income.*"

Analysis of data contained in Table 4.4 indicates the differences in loss of papaya of the consumers according to their income. Percentage of consumers facing high loss was the highest (41.4 per cent) in the low income category and it decreased to 32.8 and 31.3 per cent in the middle and high income categories respectively. Proportion of consumers facing medium loss was the highest (29.7 per cent) in the middle income category as compared to 13.3 per cent in the low income and 25.0 per cent in the high income category. Twenty two point seven (22.7) per cent of the consumers having high income faced low loss compared to 16.4 per cent low income category and 14.8 per cent middle income category.

Table 4.4 Distribution of Consumers according to their Lose in Papaya and Income

Categories of Consumers according to Income	Number of Consumers according to their Lose in Papaya					Loss Index
	Faced No Loss	Faced Low Loss	Faced Medium Loss	Faced High Loss	Total	
Low income	37 (28.9)	21 (16.4)	17 (13.3)	53 (41.4)	128 (100)	167
Medium income	29 (22.7)	19 (14.8)	38 (29.7)	42 (32.8)	128 (100)	173
High income	27 (21.1)	29 (22.7)	32 (25.0)	40 (31.3)	128 (100)	166
Total	**93 (24.2)**	**69 (18.0)**	**87 (22.7)**	**135 (35.2)**	**384 (100)**	**169**

χ^2 = 14.546; df = 6; P=0.024; C = 0.191 ( ) indicates per cent

Chi-square was computed to determine whether the observed difference was statistically significant or not. Value of computed χ^2 was 14.546, which was higher than the table value of 12.592 with 6 degrees of freedom at 0.05 level of probability and hence the computed χ^2 was significant at this level. Therefore, the researcher was able to reject the null hypothesis and it was concluded that there was significant association between consumers' loss in papaya and their income. Loss indices of the three income categories of the consumers indicated that losses were higher among the consumers having low (LI=167) and medium (LI=173) income than the consumers having higher (LI = 166) income. Therefore, the association observed between the concerned variables was negative. The value of C was found 0.191 indicating the strength of association. But Spearman rank correlation showed there was no significant relationship (ρ = -0.026) between the concerned variables though the relationship was in negative direction (may be seen in next section).

4.2.4 Consumers' Loses of Tomato with their Income

Data concerning the association of the consumers' loses of tomato with their income has been presented in Table 4.5. The null hypothesis to be tested was:

"*There is no associations of the consumers' lose of tomato with their income.*"

Analysis of data contained in Table 4.5 indicates the differences in loss of tomato of the consumers according to their income. Percentage of consumers facing high loss was the highest (50.8 per cent) in the low income category and it decreased to 28.1 and 20.3 per cent in the middle and high income categories respectively. Proportion of consumers facing no to low loss was the highest (45.3 per cent) in the consumers having high income category as compared to 42.9 per cent in the medium income and 34.4 per cent in the low income category.

Table 4.5 Distribution of Consumers according to their Lose in Tomato and Income

Categories of Consumers according to Income	Number of Consumers according to their Lose in Tomato					Loss Index
	Faced No Loss	Faced Low Loss	Faced Medium Loss	Faced High Loss	Total	
Low income	20 (15.6)	24 (18.8)	19 (14.8)	65 (50.8)	128 (100)	201
Medium income	35 (27.3)	20 (15.6)	37 (28.9)	36 (28.1)	128 (100)	158
High income	35 (27.3)	23 (18.0)	44 (34.4)	26 (20.3)	128 (100)	148
Total	**90 (23.4)**	**67 (17.4)**	**100 (26.0)**	**127 (33.1)**	**384 (100)**	**169**

χ^2 =34.754; df = 6; P=0.000; C = 0.288 ( ) indicates per cent

Chi-square was computed to determine whether the observed difference was statistically significant or not. Value of computed χ^2 was 34.754, which was higher than the table value of 16.812 with 6 degrees of freedom at 0.01 level of probability and hence the computed χ^2 was significant at this level. Therefore, the researcher was able to reject the null hypothesis and it was concluded that there was significant association between consumers' loss in tomato and their income. Loss indices of the three income categories of the consumers indicated that loss was highest (LI=201) among the consumers having low income compared to consumers having medium (LI = 158) and high (LI = 148) income categories. Therefore, the association observed between the concerned variables was negative. The value of C was found 0.288 indicating the strength of association. The finding is also supported by Spearman rank correlation co-efficient (ρ = -0.215**) between the concerned variables (may be seen in next section).

4.2.5 Consumers' Loses of Brinjal with their Income

Data concerning the association of the consumers' loses of brinjal with their income has been presented in Table 4.6. The null hypothesis to be tested was:

"*There is no associations of the consumers' lose of brinjal with their income.*"

Analysis of data contained in Table 4.6 indicates the differences in loss of brinjal of the consumers according to their income. Percentage of consumers facing high loss was the highest (63.3 per cent) in the low income category and it decreased to 39.1 and 35.9 per cent in the middle and high income categories respectively. Proportion of consumers facing no to low loss was the highest (38.3 per cent) in the consumers having high income category as compared to 34.4 per cent in the medium income and 25.0 per cent in the low income category.

Table 4.6 Distribution of Consumers according to their Lose in Brinjal and Income

Categories of Consumers according to Income	Number of Consumers according to their Lose in Brinjal					Loss Index
	Faced No Loss	Faced Low Loss	Faced Medium Loss	Faced High Loss	Total	
Low income	9 (7.0)	23 (18.0)	15 (11.7)	81 (63.3)	128 (100)	231
Medium income	28 (21.9)	16 (12.5)	34 (26.6)	50 (39.1)	128 (100)	183
High income	33 (25.8)	16 (12.5)	33 (25.8)	46 (35.9)	128 (100)	172
Total	**70 (18.2)**	**55 (14.3)**	**82 (21.4)**	**177 (46.1)**	**384 (100)**	**195**

χ^2 =36.331; df = 6; P=0.000; C = 0.294 ( ) indicates per cent

Chi-square was computed to determine whether the observed difference was statistically significant or not. Value of computed χ^2 was 36.331, which was higher than the table value of 16.812 with 6 degrees of freedom at 0.01 level of probability and hence the computed χ^2 was significant at this level. Therefore, the researcher was able to reject the null hypothesis and it was concluded that there was significant association between consumers' loss in brinjal and their income. Loss indices of the three income categories of the consumers indicated that loss was highest (LI=231) among the consumers having low income compared to consumers having medium (LI = 183) and high (LI = 172) income categories. Therefore, the association observed between the concerned variables was negative. The value of C was found 0.294 indicating the strength of association.

The finding is also supported by Spearman rank correlation co-efficient (ρ = -0.279**) between the concerned variables (may be seen in next section).

4.2.6 Consumers' Loses of Cabbage with their Income

Data concerning the association of the consumers' loses of cabbage with their income has been presented in Table 4.7. The null hypothesis to be tested was:

"*There is no associations of the consumers' lose of cabbage with their income.*"

Analysis of data contained in Table 4.7 indicates the differences in loss of cabbage of the consumers according to their income. Percentage of consumers facing high loss was the highest (32.8 per cent) in the low income category and it decreased to 18.8 and 17.2 per cent in the middle and high income categories respectively. Proportion of consumers facing no to low loss was the highest (70.7 per cent) in the consumers having high income category as compared to 67.1 per cent in the medium income and 47.7 per cent in the low income category.

Table 4.7 Distribution of Consumers according to their Lose in Cabbage and Income

Categories of Consumers according to Income	Number of Consumers according to their Lose in Cabbage					Loss Index
	Faced No Loss	Faced Low Loss	Faced Medium Loss	Faced High Loss	Total	
Low income	43 (33.6)	18 (14.1)	25 (19.5)	42 (32.8)	128 (100)	152
Medium income	67 (52.3)	19 (14.8)	18 (14.1)	24 (18.8)	128 (100)	99
High income	76 (59.4)	14 (10.9)	16 (12.5)	22 (17.2)	128 (100)	88
Total	**186 (48.4)**	**51 (13.3)**	**59 (15.4)**	**88 (22.9)**	**384 (100)**	**113**

χ^2 =20.755; df = 6; P=0.002; C = 0.226 ( ) indicates per cent

Chi-square was computed to determine whether the observed difference was statistically significant or not. Value of computed χ^2 was 20.755, which was higher than the table value of 16.812 with 6 degrees of freedom at 0.01 level of

probability and hence the computed χ^2 was significant at this level. Therefore, the researcher was able to reject the null hypothesis and it was concluded that there was significant association between consumers' loss in cabbage and their income. Loss indices of the three income categories of the consumers indicated that loss was highest (LI=152) among the consumers having low income compared to consumers having medium (LI = 99) and high (LI = 88) income categories. Therefore, the association observed between the concerned variables was negative. The value of C was found 0.226 indicating the strength of association. The finding is also supported by Spearman rank correlation co-efficient (ρ = -0.195**) between the concerned variables (may be seen in next section).

4.2.7 Consumers' Loses of Cucumber with their Income

Data concerning the association of the consumers' loses of cucumber with their income has been presented in Table 4.8. The null hypothesis to be tested was:

"*There is no associations of the consumers' lose of cucumber with their income.*"

Analysis of data contained in Table 4.8 indicates the differences in loss of cucumber of the consumers according to their income. Percentage of consumers facing high loss was the highest (21.1 per cent) in the low income category and it decreased to 17.2 and 8.6 per cent in the middle and high income categories respectively. Proportion of consumers facing no to low loss was the highest (75.8 per cent) in the consumers having high income category as compared to 68.0 per cent in the medium income and 65.6 per cent in the low income category.

Table 4.8 Distribution of Consumers according to their Lose in Cucumber and Income

Categories of Consumers according to Income	Number of Consumers according to their Lose in Cucumber					Loss Index
	Faced No Loss	Faced Low Loss	Faced Medium Loss	Faced High Loss	Total	
Low income	64 (50.0)	20 (15.6)	17 (13.3)	27 (21.1)	128 (100)	105
Medium income	71 (55.5)	16 (12.5)	19 (14.8)	22 (17.2)	128 (100)	94
High income	79 (61.7)	18 (14.1)	20 (15.6)	11 (8.6)	128 (100)	71
Total	**214 (55.7)**	**54 (14.1)**	**56 (14.6)**	**60 (15.6)**	**384 (100)**	**90**

χ^2 =8.974; df = 6; P=0.175; C = 0.151 ( ) indicates per cent

Chi-square was computed to determine whether the observed difference was statistically significant or not. Value of computed χ^2 was 8.974, which was lower than the table value of 12.592 with 6 degrees of freedom at 0.05 level of probability and hence the computed χ^2 was not significant at this level. Therefore, the researcher was not able to reject the null hypothesis and it was concluded that no significant association was exist between consumers' loss in cucumber and their income. Loss indices of the three income categories of the consumers indicated that loss was highest (LI=105) among the consumers having low income compared to consumers having medium (LI = 94) and high (LI = 71) income categories. Therefore, the association observed between the concerned variables was negative. The value of C was found 0.151 indicating the strength of association. From Spearman rank correlation, it was found that there was significant negative correlation (ρ = -0.137**) between the concerned variables (may be seen in next section).

4.2.8 Consumers' Average Loses of Seven Selected fruits and vegetables with their Income

Data concerning the association of the consumers' average losses of seven selected fruits and vegetables with their income has been presented in Table 4.9. The null hypothesis to be tested was:

"*There is no associations of the consumers' average lose of selected fruits and vegetables with their income.*"

Analysis of data contained in Table 4.9 indicates the differences in average losses of seven selected fruits and vegetables of the consumers according to their income. Percentage of consumers facing high loss was the highest (51.6 per cent) in the low income category and it decreased to 14.1 and 15.6 per cent in the middle and high income categories respectively. Proportion of consumers facing low loss was the highest (58.6 per cent) in the consumers having high income category as compared to 39.1 per cent in the medium income and 12.5 per cent in the low income category.

Table 4.9 Distribution of Consumers according to their Average Loses in Seven Selected Crops and Income

Categories of Consumers according to Income	Number of Consumers according to their Average Loses in Seven Selected Crops				Loss Index
	Faced Low Loss	Faced Medium Loss	Faced High Loss	Total	
Low income	16 (12.5)	46 (35.9)	66 (51.6)	128 (100)	239
Medium income	50 (39.1)	60 (46.9)	18 (14.1)	128 (100)	175
High income	75 (58.6)	33 (25.8)	20 (15.6)	128 (100)	157
Total	**141 (36.7)**	**139 (36.2)**	**104 (27.1)**	**384 (100)**	**190**

χ^2 =87.728; df = 4; P=0.000; C = 0.431 ( ) indicates per cent

Chi-square was computed to determine whether the observed difference was statistically significant or not. Value of computed χ^2 was 87.728, which was higher than the table value of 13.277 with 4 degrees of freedom at 0.01 level of probability and hence the computed χ^2 was significant at this level. Therefore, the researcher was able to reject the null hypothesis and it was concluded that there was significant association between consumers' average losses in selected seven

crops and their income. Loss indices of the three income categories of the consumers indicated that loss was highest (LI = 239) among the consumers having low income compared to consumers having medium (LI = 175) and high (LI = 157) income categories. Therefore, the association observed between the concerned variables was negative. The value of C was found 0.431 indicating the strength of association. The finding is also supported by Spearman rank correlation co-efficient (ρ = -0.403**) between the concerned variables (may be seen in next section).

Chi-square test showed those consumers' losses of each of the selected fruits and vegetables except cucumber had significant negative association with their income. It also showed that consumers' average losses of these seven selected fruits (mango, jackfruit and papaya) and vegetables (tomato, brinjal, cabbage and cucumber) had significant negative association with their income. It means that consumers having higher income faced lower loss in consuming fruits and vegetables and vice-versa. More or less similar results were found in case of Spearman rank correlation test (May be seen in next section). Consumers having higher income might be purchased higher quality of fruits and vegetables with higher price, one the other hand, consumers having lower income might be purchased lower higher quality of fruits and vegetables with lower price. Theses might be the cause for these findings.

4.3 Relationship of the Consumers' Losses of Selected Fruits and Vegetables with their Income

This section deals with the relationship of consumers' losses of selected fruits and vegetables with their income. This was done to verify the results of chi-square test.

The scales developed for measuring consumers' losses of selected fruits and vegetables as well as their income were in ordinal scale. On this consideration,

Spearman rank correlation co-efficient (ρ) has been used to test the hypothesis concerning the relationships between two variables. Five percent level of significance was used as the basis for acceptance or rejection of any null hypothesis.

The summary of the results of the correlation co-efficient between the concerned variables is shown in Table 4.10.

Table 4.10 Co-efficient of Correlation of the Consumers' Losses of Selected Fruits and Vegetables with their Income

n=384

	Losses of Selected fruits and vegetables	**Computed value of 'ρ'**	**Level of significance at 382 degrees of freedom**
Income of the consumers	Mango	-0.283**	0.000
	Jackfruit	- 0.113*	0.027
	Papaya	-0.026NS	0.614
	Tomato	-0.215**	0.000
	Brinjal	-0.279**	0.000
	Cabbage	-0.195**	0.000
	Cucumber	-0.137**	0.007
	Average of seven crops	-0.403**	0.000

NSNon significant
*Significant at 0.05 level of probability
**Significant at 0.01 level of probability

4.3.1 Relationship of Consumers' Loss in Mango with their Income

The relationship between consumers' loss in mango with their income was examined by testing the following null hypothesis:

"There is no relationship of consumers' loss in mango with their income."

As shown in the Table 4.10 the co-efficient of correlation between the concerned variables was computed and found to be 'ρ' = -0.283 which led to the following observations:

- Firstly, the relationship showed a negative trend.
- The computed value of 'ρ' (-0.283) was greater than the table value of 'ρ' with 382 degrees of freedom at 0.01 level (P=0.000) of probability.
- Hence, the concerned null hypothesis was rejected.

The findings indicate that the consumers' loss in mango had a significant negative relationship with their income. Chi-square test also showed similar significant negative association between the concerned variables (May be seen in previous section).

4.3.2 Relationship of Consumers' Loss in Jackfruit with their Income

The relationship between consumers' loss in jackfruit with their income was examined by testing the following null hypothesis:

"There is no relationship of consumers' loss in jackfruit with their income."

As shown in the Table 4.10 the co-efficient of correlation between the concerned variables was computed and found to be 'ρ' = -0.113 which led to the following observations:

- Firstly, the relationship showed a negative trend.
- The computed value of 'ρ' (-0.113) was greater than the table value of 'ρ' with 382 degrees of freedom at 0.05 level (P=0.027) of probability.
- Hence, the concerned null hypothesis was rejected.

The findings indicate that the consumers' loss in jackfruit had a significant negative relationship with their income. Chi-square test also showed similar

significant negative association between the concerned variables (May be seen in previous section).

4.3.3 Relationship of Consumers' Loss in Papaya with their Income

The relationship between consumers' loss in papaya with their income was examined by testing the following null hypothesis:

"There is no relationship of consumers' loss in papaya with their income."

As shown in the Table 4.10 the co-efficient of correlation between the concerned variables was computed and found to be 'ρ' = -0.026 which led to the following observations:

- Firstly, the relationship showed a negative trend.
- The computed value of 'ρ' (-0.026) was smaller than the table value of 'ρ' with 382 degrees of freedom at 0.05 level (P=0.614) of probability.
- Hence, the concerned null hypothesis was not rejected.

The findings indicate that the consumers' loss in papaya had no significant relationship with their income. But chi-square test showed significant negative association between the concerned variables (May be seen in previous section).

4.3.4 Relationship of Consumers' Loss in Tomato with their Income

The relationship between consumers' loss in tomato with their income was examined by testing the following null hypothesis:

"There is no relationship of consumers' loss in tomato with their income."

As shown in the Table 4.10 the co-efficient of correlation between the concerned variables was computed and found to be 'ρ' = -0.215 which led to the following observations:

- Firstly, the relationship showed a negative trend.
- The computed value of 'ρ' (-0.215) was greater than the table value of 'ρ' with 382 degrees of freedom at 0.01 level (P=0.000) of probability.
- Hence, the concerned null hypothesis was rejected.

The findings indicate that the consumers' loss in tomato had a significant negative relationship with their income. Chi-square test also showed similar significant negative association between the concerned variables (May be seen in previous section).

4.3.5 Relationship of Consumers' Loss in Brinjal with their Income

The relationship between consumers' loss in brinjal with their income was examined by testing the following null hypothesis:

"There is no relationship of consumers' loss in brinjal with their income."

As shown in the Table 4.10 the co-efficient of correlation between the concerned variables was computed and found to be 'ρ' = -0.279 which led to the following observations:

- Firstly, the relationship showed a negative trend.
- The computed value of 'ρ' (-0.279) was greater than the table value of 'ρ' with 382 degrees of freedom at 0.01 level (P=0.000) of probability.
- Hence, the concerned null hypothesis was rejected.

The findings indicate that the consumers' loss in brinjal had a significant negative relationship with their income. Chi-square test also showed similar significant negative association between the concerned variables (May be seen in previous section).

4.3.6 Relationship of Consumers' Loss in Cabbage with their Income

The relationship between consumers' loss in cabbage with their income was examined by testing the following null hypothesis:

"There is no relationship of consumers' loss in cabbage with their income."

As shown in the Table 4.10 the co-efficient of correlation between the concerned variables was computed and found to be 'ρ' = -0.195 which led to the following observations:

- Firstly, the relationship showed a negative trend.
- The computed value of 'ρ' (-0.195) was greater than the table value of 'ρ' with 382 degrees of freedom at 0.01 level (P=0.000) of probability.
- Hence, the concerned null hypothesis was rejected.

The findings indicate that the consumers' loss in cabbage had a significant negative relationship with their income. Chi-square test also showed similar significant negative association between the concerned variables (May be seen in previous section).

4.3.7 Relationship of Consumers' Loss in Cucumber with their Income

The relationship between consumers' loss in cucumber with their income was examined by testing the following null hypothesis:

"There is no relationship of consumers' loss in cucumber with their income."

As shown in the Table 4.10 the co-efficient of correlation between the concerned variables was computed and found to be 'ρ' = -0.137 which led to the following observations:

- Firstly, the relationship showed a negative trend.
- The computed value of 'ρ' (-0.135) was greater than the table value of 'ρ' with 382 degrees of freedom at 0.01 level (P=0.000) of probability.
- Hence, the concerned null hypothesis was rejected.

The findings indicate that the consumers' loss in cucumber had a significant negative relationship with their income. But Chi-square test did not show any significant association between the concerned variables (May be seen in previous section).

4.3.8 Relationship of Consumers' Average Losses in Selected Seven Crops with their Income

The relationship between consumers' average losses of selected seven crops (fruits and vegetables) with their income was examined by testing the following null hypothesis:

"There is no relationship of consumers' average losses of selected seven crops(fruits and vegetables) with their income."

As shown in the Table 4.10 the co-efficient of correlation between the concerned variables was computed and found to be 'ρ' = -0.403 which led to the following observations:

- Firstly, the relationship showed a negative trend.
- The computed value of 'ρ' (-0.403) was greater than the table value of 'ρ' with 382 degrees of freedom at 0.01 level (P=0.000) of probability.
- Hence, the concerned null hypothesis was rejected.

The findings indicate that the consumers' average losses of seven selected crops (fruits and vegetables) had a significant negative relationship with their income.

Chi-square test also showed similar significant negative association between the concerned variables (May be seen in previous section).

Spearman rank correlation results showed that consumers' losses of each of the selected fruits and vegetables except papaya had significant negative relationship with their income. It also showed that consumers' average losses of these seven selected fruits (mango, jackfruit and papaya) and vegetables (tomato, brinjal, cabbage and cucumber) had significant negative relationship with their income. It means that consumers having higher income faced lower loss in consuming fruits and vegetables and vice-versa. More or less similar results were found in case of chi-square test (May be seen in previous section). Consumers having higher income might be purchased higher quality of fruits and vegetables with higher price, one the other hand, consumers having lower income might be purchased lower higher quality of fruits and vegetables with lower price. Theses might be the cause for these findings.

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATIONS

CHAPTER 5

SUMMERY, CONCLUSION AND RECOMMENDATION

This chapter presents the summary, conclusion and recommendations of the study.

5.1 Summary

5.1.1 Introduction

Fruits and vegetables are grown almost all over Bangladesh. The leading fruits and vegetables producing districts of Bangladesh are Rajshahi, Capainawabganj, Natore, Dinajpur, Thakurgoan, Bogra, Rangpur, Pabna, Jessore, Mymensingh, Narshingdi, Gazipur, Manikganj and Chittagong. A considerable amount of fruits and vegetables losses occur every year during harvesting, sorting, grading, wrapping, lining, packaging, loading, transporting, unloading, storing, selling and consuming due to its perishability. For developing an effective postharvest handling and packaging technique to minimize the postharvest losses, it is necessary to know the actual causes of postharvest losses at poverty- stricken farmers, wholesalers, and retailers' level. Postharvest handling, packaging and storage of fruits are important because they affect the postharvest quality and quantity of produce. Post-harvest losses are started from harvesting at growers' level to consume at consumers' level. There are several levels of marketing chains between this growers and consumers like collectors, wholesalers, retailers, etc. Post-harvest losses are occurred in every level of marketing chains. However, very little information on the postharvest practices and losses of fruits and vegetables at growers, collectors, wholesalers, retailers and consumers level are available.

Consumers are the end users of the fruits and vegetables carried through a number of handling steps. The perception of the consumers is important in considering the introduction of improved interventions in the present marketing systems.

With these views in mind, the present study was conducted to find out the following objectives:

- To assess the losses of selected fruits (mango, jackfruit and papaya) and vegetables (tomato, brinjal, cabbage and cucumber) at consumers' level
- To explore the association of the consumers' losses of selected fruits and vegetables with their income
- To explore the relationship of the consumers' losses of selected fruits and vegetables with their income

5.1.2 Methodology

5.1.2.1 Location

Ten (10) retailing markets surrounding of Dhaka city viz. as Kajipara market, Shawrapara market, Taltola market, Agargoan market, BNP market, SAU market, Farmgate market, Townhall market, Krishi market and Bihari market were selected purposively as the locale of the study.

5.1.2.2 Population and sample

The fruit and vegetable consumers of surrounding the selected markets were considered as the population of the study. Three hundred eighty four (384) consumers from 10 selected locations of Dhaka city were selected by using accidental sampling method by taking 128 consumers from low, medium and high income group as the sample consumer of fruits and vegetables.

5.1.2.3 Measurement of variables

Measurement of consumers' losses of selected fruits and vegetables: For determining the losses of selected fruits and vegetables at consumers' level, a respondent consumer was asked to mention the amount (kg) of purchased crops (selected fruits such as mango, jackfruit and papaya and vegetables such as tomato, brinjal, cucumber and cabbage) and consumed crop for last three times.

Postharvest losses of selected crop of each time were determined by the following formula:

$$\%PHL = \frac{PC - CC}{PC}$$

Where, PHL = Postharvest loss at Consumers Level

HC = Amount of purchased crops (fruits and vegetables)

CC = Amount of consumed crops (fruits and vegetables)

By the average of postharvest losses of three times of a consumer, the actual loss of concerned crop of that consumer was calculated. Again, average post-harvest loss of all the selected seven crops at consumers' level was also determined by the average losses of all the selected crops of the individual consumer and it was expressed in percentage.

Measurement of annual family income of the consumers: Annual family income refers to the total earnings in taka of the respondent consumers and all his/her family members from service, business, and other sources during the previous year. The respondents were asked to mention his/her annual family income by responding any one of the three alternative responses as low, medium and high annual family income.

5.1.2.4 Data collecting instruments and collection of data

Data were collected personally through face-to-face interview of the selected fruits and vegetable consumers of the selected areas by using pre-tested interview schedule. Data were collected three times from each respondent, as all the selected crops were not available in the market round the year. As the sample consumers were selected by using accidental sampling, data were collected at market places for the first time of each respondent. Addresses and/or cell numbers of the consumers were collected for 2nd and 3rd time data collection. The 2nd and 3rd time

data collection were done at the residence of the respondent consumers. The data collection was started on 1st July, 2012 and completed on 31 December, 2012.

5.1.2.5 Processing of Data

The collected raw data were examined thoroughly to find out the errors and omissions. For this, a careful scrutiny of the complete interview schedule was made to make sure that they were entered as complete as possible and well arranged to facilitate coding and tabulation. Very minor mistakes were detected by doing this, which were corrected promptly. Having consulted with research supervisor, all the individual responses to the questions of the interview schedule were transferred to a master sheet to facilitate tabulation.

5.1.2.6 Statistical Procedures

The collected data were compiled, tabulated and analyzed in accordance with the objectives of the study. In order to explore the association of the annual family income of the respondent fruit and vegetable consumers with their losses of selected fruits and vegetables after buying to consuming, the Chi-square test was used. Again, In order to explore the relationship of the annual family income of the respondent fruit and vegetable consumers with their losses of selected fruits and vegetables after buying to consuming, the Spearman rank correlation test was used as the measuring scale was in ordinal scale. Five percent (0.05) level of significance was used as the basis of rejecting/accepting any null hypothesis.

5.1.2.7 Statement of Hypothesis

Two types of null hypotheses were developed in this study to explore the
i) Association and ii) relationship between the consumers' losses of selected fruits and vegetables and their income as follows:

- *"There is no association of the consumers' loss of selected fruits and vegetables with their income".*
- *"There is no relationship of the consumers' loss of selected fruits and vegetables with their income".*

5.1.3 Findings

5.1.3.1 Assessment of consumers' losses of selected fruits and vegetables

Findings revealed that among the selected fruits, highest post harvest losses of consumers was occurred in mango (8.69%) followed by jackfruit (7.61%) and papaya (7.05%). Among the selected vegetables, highest post harvest losses of consumers was observed in brinjal (9.88%) followed by tomato (7.46%), cabbage (4.14%) and cucumber (3.65%). Findings also revealed that the causes theses losses were due to insects and diseases attack, immature and over mature harvesting, shrinking and others.

5.1.3.2 Association of the consumers' losses of selected fruits and vegetables with their income

Chi-square test showed that among seven crops, consumers' losses of six crops such as mango, jackfruit, papaya, tomato, brinjal and cabbage had significant negative association with their income. But, consumers' losses of cabbage had no significant association with their income. But, it also showed that consumers' average losses of these seven selected fruits and vegetables had significant negative association with their income.

5.1.3.3 Relationship of the consumers' losses of selected fruits and vegetables with their income

Spearman rank correlation results showed that among seven crops, consumers' losses of six crops such as mango, jackfruit, tomato, brinjal, cabbage and cucumber had significant negative relationship with their income. But, consumers' losses of papaya had no significant relationship with their income. But, it also showed that consumers' average losses of these seven selected fruits and vegetables had significant negative relationship with their income

5.2 Conclusions

Findings of the study and the logical interpretations in the light of relevant facts prompted the researcher to draw the following conclusion:

Findings of the study revealed that the losses of selected fruits (mango, jackfruit and papaya) and vegetables (tomato, brinjal, cabbage and cucumber) were 3.65% to 9.88% at consumers' level. The causes of these losses were due to insects and diseases attack, immature and over mature harvesting, shrinking and others. Chi-square test showed that consumers' average losses of these seven selected fruits and vegetables had significant negative association with their income. Again, Spearman rank correlation results showed that consumers' average losses of these seven selected fruits and vegetables had significant negative relationship with their income. Therefore, it may be concluded that consumers having lower income faced higher losses in consuming fruits and vegetables and vice-versa.

5.3 Recommendations

Recommendations have been divided into two sub-section viz. Recommendation for policy implication and recommendations for further study.

5.3.1 Recommendations for policy implications

Based on the findings and conclusion of the study, the following recommendation was made:

The losses of selected fruits and vegetables were 3.65% to 9.88% at consumers' level. The causes of these losses include insects and diseases attack, immature and over mature harvesting, shrinking and others. Both Chi-square and Spearman rank correlation test showed those consumers' average losses of selected fruits and vegetables had significant negative association/relationship with their income. Therefore, it may be recommended that measures should be taken to reduce the losses of fruits and vegetables at consumers' level by taking the following steps:

- Care should be taken at growers' stage to harvest fruits and vegetables at proper maturity stage
- Attempts should be taken to reduce disease and insect attack at growers, collectors, wholesalers, retailers and consumers' level.
- Sorting and grading should be done in every stage of marketing chain growers, collectors, wholesalers, retailers and consumers to maintain quality of the fruits and vegetables and to reduce their losses.
- Steps should be taken for proper wrapping, lining, packaging, loading, transporting, unloading, handling etc. for reducing losses from shrinking and others causes.
- Wastage fruits and vegetables should be damaged properly to maintain the quality of rest fruits and vegetables, so that the sellers could not sell the low quality fruits and vegetables to the consumers having low income.

5.3.2 Recommendations for further study

On the basis of scope and limitations of the present study and the observations made by the researcher, the following recommendations have been made for further study:

1. Seven selected crops including three fruits (mango, jackfruit and papaya) and four vegetables (tomato, brinjal, cabbage and cucumber) were considered for the study. Similar research work may be conducted for other crops of Bangladesh.
2. Only Dhaka city was considered for this study. Similar research work may be conducted for other cities, town and rural areas of Bangladesh.
3. Losses of consumers were determined in this study. Similar research work may be conducted for other levels of supply chain like growers, collectors, wholesalers and retailers.

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APPENDICES

Appendix-A

Department of Agricultural Extension & Information System
Sher-e-Bangla Agricultural University, Dhaka

Interview Schedule for Collecting Data on Consumers' Losses of Selected Fruits and Vegetables

Sl. No. ……..

Name of the Consumer: ……....
Address: …….
Cell Phone No: ……

Please answer the following questions. Your answers will be kept secret and used only for research purpose.

1. Please mention your level of income by putting (√) mark.
   a) Low annual income (≤ 1 lac BDT.) ( )
   b) Medium annual income (> 1 lac to 2.2 lac BDT.) ( )
   c) High annual income (> 2.2 lac BDT.) ( )

2. Please provide the following information regarding losses of selected fruits and vegetables at consumers' level for last three times.

Mango:

Trip and date	Buying quantity (kg)	Consumed quantity (kg)	Loss (kg)	Loss (%)	Reasons of losses and their %					
					Disease infected	Pest infected	Injured by carrying	Im-maturity	Over-maturity	Others
Last trip Date: ……..										
Before last trip Date: ……..										
Previous trip Date: ……..										
Average										

Jackfruit:

Trip and date	Buying quantity (kg)	Consumed quantity (kg)	Loss (kg)	Loss (%)	Reasons of losses and their %					
					Disease infected	Pest infected	Injured by carrying	Im-maturity	Over-maturity	Others
Last trip Date: ……..										
Before last trip Date: ……..										
Previous trip Date: ……..										
Average										

Papaya:

Trip and date	Buying quantity (kg)	Consumed quantity (kg)	Loss (kg)	Loss (%)	Reasons of losses and their %					
					Disease infected	Pest infected	Injured by carrying	Im-maturity	Over-maturity	Others
Last trip Date: ……..										
Before last trip Date: ……..										
Previous trip Date: ……..										
Average										

Tomato:

Trip and date	Buying quantity (kg)	Consumed quantity (kg)	Loss (kg)	Loss (%)	Reasons of losses and their %					
					Disease infected	Pest infected	Injured by carrying	Im-maturity	Over-maturity	Others
Last trip Date: ……..										
Before last trip Date: ……..										
Previous trip Date: ……..										
Average										

Brinjal:

Trip and date	Buying quantity (kg)	Consumed quantity (kg)	Loss (kg)	Loss (%)	Reasons of losses and their %					
					Disease infected	Pest infected	Injured by carrying	Im-maturity	Over-maturity	Others
Last trip Date: ……..										
Before last trip Date: ……..										
Previous trip Date: ……..										
Average										

Cabbage:

Trip and date	Buying quantity (kg)	Consumed quantity (kg)	Loss (kg)	Loss (%)	Reasons of losses and their %					
					Disease infected	Pest infected	Injured by carrying	Im-maturity	Over-maturity	Others
Last trip Date: ……..										
Before last trip Date: ……..										
Previous trip Date: ……..										
Average										

Cucumber:

Trip and date	Buying quantity (kg)	Consumed quantity (kg)	Loss (kg)	Loss (%)	Reasons of losses and their %					
					Disease infected	Pest infected	Injured by carrying	Im-maturity	Over-maturity	Others
Last trip Date: ……..										
Before last trip Date: ……..										
Previous trip Date: ……..										
Average										

Thank you for providing information.

Signature of the Interviewer with Date:

Appendix-B (Correlation Matrix)

Characters	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	Y
X_1	-								
X_2	0.326**	-							
X_3	0.233**	-0.074	-						
X_4	0.229**	0.096	0.207**	-					
X_5	0.361**	0.171**	0.223**	0.425**	-				
X_6	0.141**	0.068	0.034	0.143**	0.263**	-			
X_7	0.093	0.166**	0.093	0.105*	0.135**	0.437**	-		
X_8	0.643**	0.526**	0.422**	0.589**	0.706**	-0.465**	0.455**	-	
Y	-0.302**	-0.137**	-0.054	-0.240**	-0.295**	-0.157**	-0.174**	-0.358**	-

X_1 = Losses of Mango
X_2 = Losses of Jackfruit
X_3 = Losses of Papaya
X_4 = Losses of Tomato
X_5 =Losses of Brinjal
X_6 =Losses of Cabbage
X_7 = Losses of Cucumber
X_8 =Average Losses of all the seven selected crops
Y = Income level of the Respondent Consumers