

POST-HARVEST PROBLEMS OF POTATO FARMERS IN JOYPURHAT DISTRICT

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**POST-HARVEST PROBLEMS OF POTATO FARMERS IN
JOYPURHAT DISTRICT**

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CERTIFICATE

This is to certify that the thesis entitled, “**POST-HARVEST PROBLEMS OF POTATO FARMERS IN JOYPURHAT DISTRICT**” 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 (MS) in Agricultural Extension**, embodies the result of a piece of bona fide research work carried out by **Md. Matior Rahman**, Registration No. 10-04086, under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.

I further certify that any help or sources of information, as has been availed of during the course of investigation have been duly acknowledged.

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DEDICATION

DEDICATED TO

THIS THESIS IS LOVINGLY DEDICATED TO MY PARENTS
AND RESPECTED TEACHERS FOR THEIR ENDLESS
SUPPORTS, ENCOURAGEMENT THROUGHOUT MY LIFE.

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ABBREVIATION AND GLOSSARY

Abbreviation	Acronyms
AAO	= Additional Agriculture Officer
Ag. Ext. and Info. Sys.	= Agricultural Extension and Information System
BARI	= Bangladesh Agriculture Research Institute
BBS	= Bangladesh Bureau of Statistics
CCWPU	= Columbus's contribution to world population and Urbanization
CMD	= Changed Mean Difference
CMS	= Changed Mean Score
DAE	= Department of Agriculture Extension
DAM	= Department of Agricultural Marketing
<i>et. al</i>	= All Others
FAO	= Food and Agriculture Organization
FAOSTAT	= Food and Agriculture Organization Statistics
MoA	= Ministry of Agriculture
OIA	= Office of International Affairs
POP	= Potatoes to Plastics
p.	= Page
SAAO	= Sub Assistant Agriculture Office
SD	= Standard deviation
UAO	= Upazilla Agriculture Officer

POST-HARVEST PROBLEMS OF POTATO FARMERS IN JOYPURHAT DISTRICT

ABSTRACT

Post-harvest problem is one of the major factors to cause a measurable quantitative and qualitative losses in potato cultivation. The purpose of this study was to investigate the extent of post-harvest problems of potato farmers. Data was collected from 94 potato farmers of Banihara, Hatior and Balait villages of Ahamedabad union at Kalai Upazila under Joypurhat district during the period from November 05 to December 04, 2016. Descriptive statistics, multiple regression (B) were used for analysis. Most of the potato farmers (72.3 percent) experienced medium post-harvest problems, while 14.8 and 12.9 percent of them had low and high post-harvest problems respectively. Education, distance to the market, distance to the cold storage and availability of market information were positively significant and provided 47.3 percent contribution on post-harvest problems. It was also found that as per Problem Faced Index (PFI), presence of middleman positioned the 1st and lack of technical knowledge was in the last. It is concluded that the policy makers consider the above mentioned significant factors of the post-harvest problems of potato farmers in Joypurhat for policy intervention to bring about improvements to potato farmers in the district.

CHAPTER I

INTRODUCTION

1.1. General background

Potato was introduced in this subcontinent in the sixteenth century. It was grown then in small plots as a vegetable. Potatoes have been grown in Bangladesh since at least the 19th century. By the 1920s, the first commercial production of the crop was established in the country (Islam, 1983). Potato is one of the main commercial crops grown all over the country. In Bangladesh, potato is mainly consumed as vegetable. Various other food items (Singara, Samucha, Chop, chips etc.) are also made from potato. Adequate supply of potato stabilizes the vegetable market all-round the year (Moazzem and Fujita, 2004). Appropriate and efficient post-harvest technology is critical to the entire production-consumption system of potato because of its bulkiness and perishability. After harvesting, a series of operations need to reach in the consumers' table termed as post-harvest operations. During these operations, some losses occur called post-harvest losses. In developing countries, post-harvest processing of potato is the major practice for adding value to this crop through traditional processing or modern technology. Most of the processing is done on a commercial basis as a business. Recently many potato chips industries have established in Bangladesh. There are other indigenous postharvest practices used for processing of potato in rural and peri-urban areas.

Potato is a living entity that is capable of respiring, transpiring (release water) and reproducing. Major causes of postharvest losses of potato are water loss, mechanical damage, physiological damage, diseases damage and insect damage. These losses occur during harvesting, sorting and cleaning, handling and packing, transportation, storage, distribution or marketing and processing. Potato should be stored in a suitable environment to prevent weight loss, rot, shrinkage, sweetening, discolour and sprouting (Gottschalk and Christenbury, 1998). Additionally, seed potato needs to be stored to maintain its dormancy before planting to the next season. Storage

losses are mainly caused by the processes like respiration, sprouting, evaporation of water from the tubers, spread of diseases, changes in the chemical composition and physical properties of the tuber. These processes are influenced by storage conditions (Gottschalk, 1999). Good storage should prevent excessive loss of moisture, development of rots, and excessive sprout growth. Temperature, humidity, carbon dioxide and air movement are the most important factors during storage (Harbenburg et al., 1986; Maldegem, 1999).

Post-harvest losses of vegetables are high as 20-50% in developing countries (Rashid, 2008). But, in Bangladesh data on post-harvest losses of potato at different post-harvest operations are lacking. Therefore, it is necessary to quantify the post-harvest losses of potatoes in different post-harvest operations like harvesting, cleaning, grading, bagging, transportation, processing and storage. Minimizing post-harvest problems of potato is a very effective way of increasing food availability and ensuring food security in Bangladesh solving the postharvest problems and distribution in Bangladesh will require cooperation and effective communication among all researcher extension workers and industry personnel involved. In most cases, solutions to existing problems in the post-harvest activities s require use of available information and application of available efforts at the appropriate scale and also trying as much as possible to increase the efforts to be more effective. Also, overcoming the socio economic constraints is essential to achieving the goal of reducing post-harvest problems. Conclusively, reduction of post-harvest problems to the barest minimum continues to be of utmost importance to the country's aspiration for the attainment and sustenance of national food security.

The researcher intended to take an attempt to realize how the post-harvest problems are being encountered by the potato farmers. Viewing and analyzing the aforesaid conditions the researcher has become interested to undertake a research entitled "Post-harvest problems of potato farmers in Joypurhat district".

1.2. Statement of the problem

The purpose of the study had an understanding of the post-harvest problems of potato farmers. Moreover, since various characteristics of an individual are likely to have an influence on the post-harvest problems of potato farmers, it would be necessary to ascertain the associations and contributions of such factors with respect to the problem. Therefore, examining the associations and contributions of a set of personal, socio-economic and socio-psychological characteristics of the potato growers with their Post-harvest problems would be considered pertinent to the study. In view of the above background and facts, the present study was undertaken with the title "Post-harvest problems of potato farmers in Joypurhat district". In the light of the above discussion and the background information, the present study has been undertaken with the following research questions:

- i. What are the problems being faced by the Potato farmers in post-harvest activities?
- ii. What are the farmers' characteristics (personal, social, economic and psychological) that are directly related to their problems faced in post-harvest activities?
- iii. How much do the selected characteristics of the Potato farmers' contribute to their post-harvest problems?

An understanding to these queries is likely to be helpful for the extension organizations to provide different methods to reduce the post-harvest problem of potato.

The above-mentioned questions obviously inspired the researcher for conducting the present research entitled "Post-harvest problems of potato farmers in Joypurhat district".

1.3. Specific objectives of the study

The focal point of the research work was to explore the Post-harvest problems of potato farmers in Joypurhat district. This is why the following objectives were framed out in order to provide an appropriate track to the research work:

1. To determine and describe the influential characteristics of potato growers:

- Age
- Education
- Farm size
- Land under potato cultivation
- Annual family income
- Annual family income from potato production
- Distance to market place
- Distance to cold storage
- Availability of marketing information

2. To determine the extent of post-harvest problems faced by the potato farmers;

3. To explore each identified factors' contribution on the post-harvest problems of potato farmers;

1.4. Scope or rationale of the study

- i. The present study was designed to have an understanding of post-harvest problems of potato farmers and to explore its relationship with their selected characteristics.
- ii. The findings of the study will, in particular, be applicable to the study area at Ahmedabad union under Kalai Upazila of Joypurhat district. The findings may also be applicable to other areas of Bangladesh where socio-cultural, psychological and economic status do not differ much than those of the study areas.
- iii. The findings of the study may also be helpful to the field worker of extension service to improve their action strategies for reducing the post-harvest problems.
- iv. The findings of the study will be helpful to accelerate the development in agriculture, farmers' logistic supports, information needs and the way of dissemination especially tuned to key role players in the society as well as

reducing the post-harvest problems of the potato farmers. The findings might also be helpful to the planners and policy makers and extension workers.

- v. To the academicians, it may help in the further conceptualization of the systems model for analyzing the problems of potato farmers. In addition, the findings of this study may have other empirical evidence to all aspects of post-harvest problems faced by potato farmers which may be used to build an adequate theory of post-harvest activities.

1.5. Justification of the study

In 2013, the total production of potato was 8603 MT from the area of 443934 ha in our country (FAOSTAT, 2013). Though the last few seasons saw bumper production in Bangladesh aided by favorable climate, the growers are now staring at losses.

Joypurhat district is an intensively potato growing area compared to other areas of Bangladesh. The total production was 7756 MT in 90497 acres in 2010-11 (BBS, 2011) where the total production of our country was 8326 MT. It is about 9.3% of the total production. With the time, it has been increased.

Therefore, it is necessary to quantify the post-harvest losses of potatoes in different post-harvest operations like harvesting, cleaning, grading, bagging, transportation, processing and storage. In Bangladesh, latest data and information on postharvest losses of potato are limited and it is necessary to quantify the postharvest losses of potatoes in different postharvest operations. Farmers in Joypurhat, the country's highest potato growing district, always depended on their returns from this crop for buying the inputs for boro rice. Potato prices cause distress to these growers. The farmers are also worried unable to store their harvest as the wealthy hoarders against the insufficient cold storage space. Taking advantage of the situation some of the cold storage owners are charging exorbitantly.

However, the findings may also be applicable to other areas of Bangladesh where socio-cultural, psychological, and economic situation do not differ much than those

of the study area. The findings may be also helpful to the field works of agricultural marketing service providers to improve strategies of action for adopting potato marketing. Lastly, it is assumed that the recommendation of this study will be helpful in formulating necessary action for improving the marketing status of potato.

Only a few researches have so far been conducted in Bangladesh on post-harvest problems of potato farmer. From the extension and overall national development point of view, a research study on post-harvest problems of potato farmers is important to understand and to get schematic knowledge about farmers' condition in this society. The researcher intended to make an attempt to realize what could uplift their socio-economic condition being in the vicinity of Post-harvest activities. The researcher also aimed to know present condition of the farmers. Therefore the study "Post-harvest problems of potato farmers in Joypurhat district" has been undertaken.

1.6. Assumptions of the study

An assumption is the supposition that an apparent fact or principle is true in the light of available evidence (Goode and Hatt, 1952).

The researcher had considered the following assumptions while undertaking the study:

- i. The respondents were capable of furnishing proper responses to the questions contained in the interview schedule.
- ii. The data collected by the researcher were free from bias and they were normally distributed.
- iii. The responses provided by the respondents were valid and reliable.
- iv. Information sought by the researcher revealed the real situation and was the representative of the whole population of the study area to satisfy the objectives of the study.
- v. The researcher was well adjusted to himself with the social environment of the study area. Hence, the collected data from the respondents were free from interviewer's bias.

- vi. The selected characteristics and post-harvest problems of potato farmers of the study were normally and independently distributed with respective means and standard deviation.

1.7. Limitations of the study

Considering the time, respondents, communication facilities and other necessary resources available to the researcher and to make the study manageable and meaningful, it became necessary to impose certain limitations as mentioned bellow-

- The study was confined to one union named Ahmedabad under Kalai Upazila of Joypurhat district.
- It is difficult to get the accurate distance between farmers' field or home and the cold storage or market place on basis of the farmers concept only, no GPS system was used to determine the distance.
- It is difficult to get the accurate information from the respondents regarding the problems from the respondents many of them can sign only, not proper educated.
- Collection of all relevant data was limited to the farmers growing potato in the study area.
- Characteristics of the farmers were many and varied, but only nine characteristics were selected for the research work.
- The researcher was a male person and the respondents were both males and females. The researcher had to manage proper rapport with the respondents to collect maximum accurate information.

1.8 Definition of terms

Age: Age of a respondent is defined as the span of his/her life and is operationally measured by the number of years from his/her birth to the time of interviewing. Age

of a respondent was measured by the period of time from their birth to the time of interview and it was measured in terms of complete years on the basis of their response.

Education: Education refers to the development of desirable knowledge, skill, attitudes, etc. of an individual through the experiences of reading, writing, observation and related matters. Education was measured in terms of grades (class) passed by respondent. If a respondent received education outside the school, their education was assessed in terms of education of the school.

Annual family income: Annual family income was defined as total earning of a farmer and the members of his family from farming and other sources (business, services etc) during a year. In fact, it was gross family income of a respondent.

Annual family income from potato cultivation: Annual family income from potato cultivation was defined as total earning of a farmer and the members of his family only from potato cultivation during a year.

Farm size: Farm size of a respondent referred to the area owned by a farmer on which he carried his farming and family business, the area being estimated in terms of full benefit to the farmers. A farm was considered to have full benefit from the cultivated area either owned by him or obtained on lease from others and half benefit from the area which was either cultivated by him on barga or given to others for cultivation on barga basis.

Problems: are the elements which hinder/resist/oppose in doing some activities or operations in a certain field. The problems in technology transfer are those, which act as the barriers to the adoption of technologies by the potential users (Kashem and Halim, 1991).

Post-harvest problem of potato: Post-harvest problem indicates the argument, altercation or conflict that acts as barrier in potato harvesting, cleaning, grading, bagging, transportation, marketing, processing and storage.

Marketing: Marketing is the process of handover goods or products from growers to consumers either directly or through some channel.

Marketing information: Marketing information means the different information like as demand, supply and marketing price of specific products.

Distance of market place: Distance of market place means how far away the markets are situated from the residence of potato growers.

Storage facilities: Storage facilities refer to convenient places to keep the potato for different periods before marketing. Storage facilities may be for short term, medium term and long term.

Rot in home: Rot in home is defined as the loss of potato due to rough weather or by attacking pathogens.

CHAPTER II

REVIEW OF LITERATURE

The purpose of this Chapter is to review the past studies conducted by different researchers related to the present study. As far as possible the researcher tried to review the available literature from different countries related to Post-harvest problem of potato farmers. Unfortunately, a very few of these studies were directly related to the present study. This section deals with a review of the previous research study to the problem related to Post-harvest problem of potato farmer. However, the researcher tried to collect most reliable information. This chapter comprises of the following sections:

Section 1: General review on potato and its related issues

Section 2: literatures relating to concept of Post-harvest problem faced by the
Potato farmers in different agricultural aspects

Section 3: Review on the relationship of selected characteristics of individuals
with their problems faced

Section 4: Research gap of the study

Section 5: Conceptual framework of the study

2.1 General review on potato and its related issues

2.1.1 General review on potato

Potatoes are used for a variety of purposes, and not only as a vegetable for cooking at home. In fact, it is likely that less than 50 percent of potatoes grown worldwide are consumed fresh. The rest are processed into potato food products and food ingredients; fed to cattle, pigs, and chickens; processed into starch for industry; and re-used as seed tubers for growing the next season's potato crop. Potatoes are used to brew alcoholic beverages such as vodka, potcheen, or akvavit. They are also used as food for domestic animals. Potato starch is used in the food industry as, for example, thickeners and binders of soups and sauces, in the textile industry, as adhesives, and for the

manufacturing of papers and boards (Campbell *et al.*, 1997). Many companies are exploring the possibilities of using waste potatoes to obtain polylactic acid for use in plastic products; other research projects seek ways to use the starch as a base for biodegradable packaging (Gopal and Khurana, 2006). Potato skins, along with honey, are a folk remedy for burns in India (POP, 2009). Burn centers in India have experimented with the use of the thin outer skin layer to protect burns while healing.

2.1.2 Origin and distribution of potato

The potato was first domesticated in the region of modern-day southern Peru and extreme northwestern Bolivia (Spooner *et al.*, 2005) between 8000 and 5000 BC (OIA, 1989). It has since spread around the world and become a staple crop in many countries. Sailors returning from the Andes to Spain with silver presumably brought potatoes for their own food on the trip (Ames, 2008). It is generally believed that potatoes entered Africa with colonists, who consumed them as a vegetable rather than as a staple starch (CWHFP, 1994). The Portuguese introduced potatoes, they called it 'Batata', in India in early seventeenth century when they cultivated it along the western coast of India. The British traders introduced potatoes in Bengal as a root crop, 'Alu'. By the end of eighteenth century, it was cultivated across northern hill areas of India (CCWPU, 2009). Potatoes were introduced to Tibet by nineteenth century through trade route from India (Srivastava, 2008).

2.1.3 History of potato in Bangladesh

The Portuguese introduced potatoes; they called it 'Batata', in India in early seventeenth century when they cultivated it along the western coast of India. The British traders introduced potatoes in Bengal as a root crop, 'Alu'. By the end of eighteenth century, it was cultivated across northern hill areas of India (CCWPU, 2009). Potatoes were introduced to Tibet by nineteenth century

through trade route from India (Srivastava, 2008). The potato was introduced in the Philippines during the late 16th century and to Java and China during the 17th century. It was well established as a crop in Africa by the mid-20th century (CCWPU, 2009).

2.1.4 Variety of potato cultivated in Bangladesh

Several hundred varieties of potatoes are grown in the world. These differ in appearance, tuber structure, size and color, time of maturity, cooking and marketing qualities, yield, and resistance to pests and diseases. A variety that grows well in one area may do poorly in another. Potato varieties that are cultivated in Bangladesh are broadly categorized into two groups, local and high yielding. The so-called local varieties are in fact, not strictly native. In the distant past those were brought to this part of the subcontinent but in the absence of varietal improvement efforts, gradually degenerated, showing poor yield performance. In spite of poor yields, some of the local varieties are still being cultivated because of their taste and cooking qualities. There are about 27 local varieties of potatoes cultivated in different parts of the country. They have familiar local names. The familiar local varieties are (a) Sheel Bilatee- mostly cultivated in Rangpur. The tuber is oblong, reddish. Each tuber weighs about 30 g. (b) Lal Sheel- primarily cultivated in Bogra with tubers rounded, reddish, each having a weight of about 55 g. This variety is also known as Lal Mada and Bograi. (c) Lal Pakri -cultivated widely in Dinajpur, Bogra and Sirajganj districts with tubers reddish and round, each weighing about 30 g. (d) Duhajari - mostly cultivated in the Chittagong area. Tubers appear round and pale, each weighing about 25 g. Among other indigenous varieties Jhau Bilatee and Suryamukhi are notable. Bangladesh Agricultural Research Institute (BARI) has already released high yielding potato varieties. The HYV and other local potato varieties are presented below:

Potato varieties	Potato varieties	Potato varieties
BARI Alu-1 (Hira)	BARI Alu-22 (Saikot)	BARI Alu-36
BARI Alu-4 (Ialsha)	BARI Alu-23 (Utra)	BARI Alu-37
BARI Alu-7 (Diamant)	BARI Alu-24 (Dura)	BARI Alu-38 (Omega)
BARI Alu-8 (Cardinal)	BARI Alu-25 (Aesterix)	BARI Alu-39 (Belini)
BARI Alu-11 (Chomok)	BARI Alu-26 (Felsina)	BARI Alu-40
BARI Alu- 12 (Dhira)	BARI Alu-27 (Spirit)	BARI Alu-41
BARI Alu- 13 (Granolla)	BARI Alu-28 (Lady Rosetta)	BARI Alu-42 (Ezila)
BARI Alu-15 (Binella)	BARI Alu-29 (Courage)	BARI Alu-43 (Atlas)
BARI Alu-16 (Arinda)	BARI Alu-30 (Meridian)	BARI Alu-44 (Elgar)
BARI Alu- 17 (Raja)	BARI Alu-31 (Sagita)	BARI Alu-45 (Stafy)
BARI Alu-18 (Baraka)	BARI Alu-32 (Quiensce)	BARI Alu-46 (LB-7)
BARI Alu- 19 (Binti)	BARI Alu-33 (Almera)	Gurguri
BARI Alu- 20 (Jarla)	BARI Alu-34 (Laura)	Lal-Pakhri
BARI Alu-21 (Provento)	BARI Alu-35	Shil-Bilati
BARI TPS-1	BARI TPS-2	

(BARI, 2016)

2.1.5 National demand-supply scenario for potato seed

In Bangladesh potato is grown in an area of about 8,06,294 acres. For this purpose about 3,50,000 m tons of seed potatoes are necessary. Most of the seeds used are not of high quality. The farmers generally use the tubers they keep for their own consumption as seeds. This results in poor yield in the following season. Usually, two types of potato seeds are imported by the government, one known as foundation or basic seeds, and the other certified seeds. Bangladesh Agricultural Development Corporation (BADC) distributes certified seeds to the growers produced locally from the imported foundation seeds in their own farms or in lands of farmers on contract basis. Directly imported seeds are also sold to growers through local BADC offices. BARI has now started producing seed potatoes in its own farms at the Debiganj Breeders

Potato Seed Production Centre to make seeds available to growers at a reasonable price. Available quality seeds, however, are not sufficient to meet the demand. During 1997-98, the country imported 396,331kg fresh or chilled potato seeds (BBS, 2000).

2.1.6 Production of potato in Bangladesh

Potato production in Bangladesh in fiscal year (FY) 2012-13 hit a new record of 8.603 million tons surpassing the past record of 8.38 million tons in FY'11. The production witnessed a negative growth in FY'12 when it plunged to 8.205 million tons- a 2.08 percent fall compared to that of FY'11. The government statistics provider Bangladesh Bureau of Statistics (BBS) in its latest release said potato, the most consumed vegetable item of the country was cultivated on 0.444 million hectares of land in FY'13. The acreage had increased by 14,000 hectares compared to that of FY'12 which also helped achieve a higher output. Potato was produced on 4.6 million hectares in FY'11. In FY'11, per hectare yield was 18.21 tons which reached 19.07 tons in FY'12 and hit a new record of 19.307 tons in fiscal year'13. Annual demand for the carbohydrate-rich vegetable has now stood at 6.5 to 7.0 million tons. That indicates a 1.5m to 2.0m tons are surplus production. However, the farmers got Tk.5.5 to Tk.6.5 per kg during harvesting season in FY'13 which was only Tk.1.5-Tk.2.0 during FY'11 and FY'12, Department of Agricultural Marketing data showed. Production cost was between Tk.4 and Tk.5.5 per kg across the country, according to DAM. The price of potato, mainly Granola variety is now sold at Tk.13- Tk.18 at the country's retail market. The price of per kg potato is 30-35 per cent lower now compared to the corresponding period of last year, according to DAM. The country has a storage capacity of 4.2 million tons of potato in 382 cold storages, which is less than half in terms of the total production (DAM, 2015).

2.2 Literatures relating to concept of Post-harvest problems faced by the Potato farmers

2.2.1 Problem related to storage

Potatoes are mostly produced during the winter season from November to March, but are consumed year-round. Therefore, storage plays an important role in the creation of time and place utilities.

In a workshop entitled “Post-harvest issues of potatoes in Asia and the pacific region (2011), Food and Agricultural Organization (FAO) showed that storage is an important post-harvest activity in seed production. Storage under specific conditions is important to prevent excessive loss of weight as a result of driage and to preserve germination quality.

Bhukta and De (1997) stated that Potato is mainly a seasonal crop. About 90 percent of potatoes are produced in the winter season but their demand spread over the year, necessitating cold storing for regulating market supply around the year. Storage creates time utilities in marketing of farm products and plays a vital role.

Iqbal (1996) Ilangantileke *et al.* (1996) studied that it is necessary to quantify the postharvest losses of potatoes in different post-harvest operations like harvesting, cleaning, grading, bagging, transportation, processing and storage

FAO (2011) stated that in case of potato production, small farmers who depend on their own production for seed in the next season have primitive or minimally improved farm storage. Most seed storage in this case is either in farm houses or in small sheds. Some farmers improve storage conditions by providing ventilation and also using structures with diffuse light to help keep the seed potatoes. In most cases, however, the conditions are poor and result in wastage, thus reducing the total amount of potatoes left for seed to be planted in the next season.

Islam (1987) conducted a study on potato preservation in cold storage in Bangladesh including the marketing aspects. He found that price spread per

metric ton of potatoes appropriated by traders was higher in case of cold stored potatoes than non-stored potatoes.

Meyhuay (2001) studied Post-harvest Operations of potato and showed that losses during the storage are affected so much by physiologic tuber condition, mechanical damage suffered during harvest and handling, as well as by storage conditions mechanical damage (cuts and contusions) facilitates invasion and development of microorganisms that cause illnesses and rottenness. It is necessary to reduce tubers physical damage to minimize losses during storage. He also showed that the storage objective is to control these processes to maintain quality and to minimize losses tubers weight. There is not a storage method that is the most effective for potato handling. Method selection depends on technical, social, economic and financial factors.

Gottschalk and Christenbury (1998) found that Potato should be stored in a suitable environment to prevent weight loss, rot, shrinkage, sweetening, discolor and sprouting.

2.2.2 Problem related to transport

Anam *et al.* (2013) found in a case study that transportation is another important factor to keep the price at par. Significant amount of cost incurs during transportation leading to a higher price of potato.

Alam (1981) investigation revealed the following facts about the existing problems of potato marketing in Dhaka city: a) lack of efficient transport b) lack of storage facilities c) improper grading d) dominance of whole sellers e) lack of proper market information and f) lack of adequate finance

Meyhuay (2001) showed that the potato is a substantial, perishable product of low intrinsic cost and high transport expense, which limits its export possibilities.

Zheng *et al.* (1999) observed that the main factors responsible for postharvest losses were lack of proper packaging, no precooling, no proper transportation, and lack of good storage techniques.

2.2.3 Problem related to marketing

Export of potato from the northern districts of Bangladesh has generated a ray of hope for the farmers and traders which, if continues till June, may help them break even. Traders have set a target to export about 2 lakh tons of potato from the northern districts. About 50,000 mt have been exported in the last two months, while the rest will be shipped in phases (DAM, 2015).

Hossain and Miah (2009) stated that the potato is a semi-perishable commodity. Appropriate and efficient post-harvest technology and marketing are critical to the entire production-consumption system of potato because of its bulkiness and perishability.

Elias *et al.* (1984) concluded in a study that the cost of potato cultivation is high compared with that of other crops, but the return of potato is also high.

Naik and Patnaik (1983) showed that Potato being a semi perishable commodity requires quick transport facilities because it can't withstand high temperature of plains after the crop is harvested. Moreover, lack of adequate transport facilities hamper the efficient potato distribution in the country. They also showed that transportation is essential to uniformly distribute regulate the production among the consumers living in different places.

It was found that under tropical and sub-tropical conditions, the losses due to poor handling and storage are reported to be in between 40-50 per cent. The post-harvest losses of potatoes are defined as qualitative and quantitative losses. The qualitative losses greatly reduce the price of potatoes. (PHMEP, 2003)

Sharma and Sharma (1996) showed that Price fluctuation is a common phenomenon in case of seasonal and perishable commodities like potato. Malik *et al.* (1995) also found the similar findings.

Yulafci and Cinemre (2007) conducted a study to explore marketing structures of fresh fruits and vegetables and found that the most important problem of fresh vegetable and fruit marketing was not being able to find quality crops.

Kaguongo *et al.* (2008) showed that most farmers did not store potatoes but sold directly from the field leading to glut periods, depressed prices and correspondingly low net returns to farmers.

Moazzem and Fuzita (2004) found that the majority of the farmers, especially large and medium landowners, sell harvested potatoes in their homestead and receive cash from traders immediately or only some part of it is paid later, but within a week. Landless tenants and small landowners with less than 0.50 acres, on the other hand, sometimes sell their small amount to traders who are waiting in the nearby marketplace.

Anonymous (2005) reported that moreover, it is very regrettable that post-harvest losses of fruits and vegetables are about 30% due to the lack of proper post-harvest management and marketing system. In effect, it means that 30% of land, input and labor used to produce fruits and vegetables go to misuse.

Kasso and Bekele (2016) mentioned that marketing situation as major cause of post-harvest loss and quality deterioration was listed by more than 17% of the respondents. The distance of the market, low price, lack of proper means of transportation and conditions of road were mentioned as discouraging factors. In addition, producing similar type of horticultural crops at the same time has affected the market value.

2.2.4 Problem related to presence of middle man

Sandip *et al.* (2013) found that large middleman margins that restrict prices received by poor farmers in least developed countries (LDCs) are often believed to constrain growth and poverty reduction.

Gumataw *et al.* (2016) stated that middlemen play an important role by linking farmers to traders and final markets. This is particularly the case in developing countries, where market failure is ubiquitous and food chains still consist of many stages.

Yang (2000) concluded in a research that reducing post-harvest losses is one of the efficient approaches in the improvement of potato farmers' livelihood.

Rashid (2008) found that Post-harvest losses of vegetables are high as 20-50% in developing countries.

2.3 The Post-harvest problems faced by the Potato farmers and their selected characteristics

Hossain (1985) found in a study on landless laborer in Bhabakhali union of Mymensingh district that there was no relationship between age of the landless laborers and their problem confrontation. Similar findings were obtained by Hossain (2002) and Salam (2003) in their respective studies.

Bhuyan (2002) found a positive and significant relationship between age of the farmers and their problems in banana cultivation.

Rashid (2003) in his study found that age of the rural youth had significant negative relationship with problem confrontation in selected agricultural production activities.

Kashem (1997) in his study on the landless laborers on Barakhata union under Rangpur district concluded the relationship between age of landless laborers and their problem confrontation. He found that there was no relationship between age of the landless laborers and their problem confrontation.

Ali (1978) in his study determined the extent of constraints faced by the farmer of Phulpur upazila under Mymensingh district in four selected dimensions of improved cattle management. He found a positive relationship between age and cattle problem confrontation of farmers.

Saha (1983) in a study on poultry problem confrontation in respect of breeding of poultry stated that there was no relationship between age of the farmers and their poultry problem confrontation. But a negative trend was found i. e. the younger farmers faced more poultry problem.

Sarker (1983) stated that age of the farmers had a significant negative relationship with their poultry problem confrontation.

Hossain (1989) in a study on landless labourers in Bhabakhali union of Mymensingh district found that there was no relationship between age of the landless labourers and their problem confrontation.

Raha (1989) in his study on deeptubewell irrigation constraints of farmers in the cultivation of modern variety of boro paddy observed that there was no relationship between the age of the farmers and irrigation constraints confrontation. However, the relationship showed a positive trend.

Mansur (1989) in his study on the feeds and feeding constraints confrontation found that there was no significant relationship between the age of the farmers and feeds and feeding constraints confrontation.

Rahman (1995) in his study on constraints faced by the farmers in cotton cultivation at Muktagacha thana under Mymensingh district observed that there was no significant relationship between the age of the farmers and their faced constraints in cotton cultivation.

Rashid (1975) conducted a study to determine the relationship between the personal characteristics and agricultural constraints faced by the farmers in Madhupur union of Tangail district. He states that there was no significant relationship between education of the farmers and the agricultural problem confrontation.

Kashem (1997) in his study on the landless labourers on Barakhata union under Rangpur district examined the relationship between education of landless labourers and their problem confrontation. He found a significant negative relationship between education of the landless labourers and their problem confrontation.

Ali (1978) in his study determined the extent of constraints faced by the farmer of Phulpur upazila under Mymensingh district in four selected dimensions of improved cattle management. He found that there was no significant relationship between level of education of the farmers and cattle problem confrontation of farmers.

Hossain (1979) observed that education had a negative effect on problem confrontation. He observed that some of the group members who could read and write after giving them literacy education, could then approach the bank independently for their credit needs.

Saha (1983) in his study on poultry problem confrontation in respect of breeding of poultry stated that there was negative relationship between education of the farmers and their poultry problem confrontation.

Islam (1987) in his study on artificial insemination problem confrontation of the farmers found a negative significant relationship between education and poultry problem confrontation.

Raha (1989) in his study on deep tube well irrigation constraints of farmers in the cultivation of modern variety of boro paddy observed that there was no significant relationship between the education of the farmers and irrigation constraints confrontation. However, a positive trend was noticed in the relationship.

Mansur (1989) in his study on the feeds and feeding constraints confrontation found a significant negative relationship between the education of the farmers and feeds and feeding constraints confrontation. Similar findings were obtained by Haque (1995), Rahman (1996), Karim (1995), Faroque (1997), Pramanik (2001), Ahmed (2002), Hossain (2002), Bhuyan (2002), and Salam (2003) in their respective studies.

Hoque (2001) found a significant negative relationship between education and problem confrontation of the FFS farmers in practicing IPM.

Ismail (2001) found in his study that there was no significant relationship between education and problem confrontation for farm youth. Similar relationships were obtained by Raha (1989) and Halim (2003) in their respective studies. Thus it could be concluded that an overwhelming majority of the researchers found a negative relationship between these two variables.

Rahman (1995) in his study on constraints faced by the farmers in cotton cultivation at Muktagacha thana under Mymensingh district observed had significant negative relationship between the education of the farmers and their faced constraints in cotton cultivation. The findings indicated that the higher the education of the farmers, the lower was their faced constraint in cotton cultivation.

Hossain (1985) found a significant positive relationship between income of the farmers and constraints faced of the landless labourers.

Rashid (1975) in his study found that there was no relationship between the annual family income of the farmers and their agricultural problem confrontation.

Kashem (1997) in his study examined the relationship between annual family income of landless laborer and their problem confrontation. Though the relationship was not statistically significant, the data indicated an appreciable negative trend between the two variables.

Ali (1978) in his study found that there was no significant relationship between the annual family income of the farmers from the cattle and the problem confrontation of fanners.

Saha (1983) in his study found a positive relationship between the annual family income of the farmers and poultry constraints faced by the farmers in this study.

Hossain (1989) in his study on landless labourers in Bhabakhali union of Mymensingh district found a significant positive relationship between annual family income of the landless laborers and their problem confrontation.

Islam (1987) in his study on artificial insemination problem confrontation of the farmers found a negative significant relationship between annual family income of the farmers and poultry problem confrontation.

Mansur (1989) in his study on the feeds and feeding constraints confrontation found a significant relationship between the annual family income of the farmers and feeds and feeding constraints confrontation, but showed a negative trend.

Raha (1989) in his study found that annual family income of the farmers had no significant relationship with their irrigation constraints confrontation. However, a positive trend was noticed in the relationship.

Rahman (1995) in his study found that a significant negative and substantially relationship between the annual family income of the farmers and their faced constraints in cotton cultivation.

Rahman (1993) conducted a study in Munshigonj and Narayangonj to investigate the comparative cost and return as well as loss arising from storing potato under traditional as well as in cold storage and marketing channel. A fact that emerged is gross return as well as net return was higher under nearer distance to the long distance. Although total cost of storing potato in cold storage plants was higher than the traditional method, the former is more profitable than the other method.

2.4 Research gap of the study

Joypurhat district along with Bogra contribute nearly 8% of the total potato production occupying 10.7% of the land surface. Kalai is one of the main potato producing area along with Khetlal, Bograsadar, Shibganj and Gabtali upazila (Rahman 1990). Area covers under potato cultivation in Bogra and Joypurhat districts about 77% of the total cultivated area (Uddin et al., 2009). Latest information on potato production in northern part of Bangladesh is limited. So, it is necessary to quantify the potato production scenario in the area.

There are lots of researches on problem face in potato production. Many of them studied production problems of potato farmers but very few researches had been done to solely assess the post-harvest problems of potato farmers.

Most of the researcher studied on marketing problem of potato and the locales were Munshiganj, Comilla etc. But, to the best of this author's knowledge, it was found that only two studies on potato problems in the north Bengal area of Bangladesh other than Joypurhat.

No research was undertaken previously following the methodology which was followed by the present researcher. Most of the previous studies conducted by correlation analysis, but the present study followed multiple regression analysis.

Additionally, the past studies related to problem face in post-harvest processing of potato didn't consider the spatial or geographical factors whereas the current study analyze influence of some spatial factors on post-harvest problems of potato farmers in joypurhat district.

2.5 The conceptual framework

In scientific research, selection and measurement of variables constitute an important task. Studies on individual, group and society revealed that acceptance of modern technologies is conditional upon many factors. Some of these are social, personal, economical and situational factors and the behavior of potato cultivators are influenced by these characteristics. The hypothesis of a research while constructed properly consist at least two important elements i.e.: a dependent variable and an independent variable. A dependent variable is that factor which appears, disappears or varies as the researcher introduces, removes or varies the independent variables (Townsend, 1953). An independent variable is that factor which is manipulated by the researcher in his attempt to ascertain its relationship to an observed phenomenon. Variables together are the causes and the phenomenon is effect and thus, there is cause effect relationship everywhere in the universe for a specific events or issues.

This study is concerned with the ‘Post-harvest Problems of Potato Farmers in Joypurhat District’. Thus, plant protection management practices were the dependent variable and 09 selected characteristics of the rice cultivators were considered as the independent variables under the study. Post-harvest problems of potato farmers may be affected through interacting forces of many independent variables. It is not possible to deal with all of the independent variables in a single study. It was therefore, necessary to limit the independent variables, which age, education, farm size, land under potato cultivation, annual family income, annual family income from potato production, distance to market place, distance to cold storage and availability of marketing information for this study.

Considering the above-mentioned situation and discussion, a conceptual framework has been developed for this study, which is diagrammatically presented in the following Figure 2.1.

Independent variables

Dimensions of problems

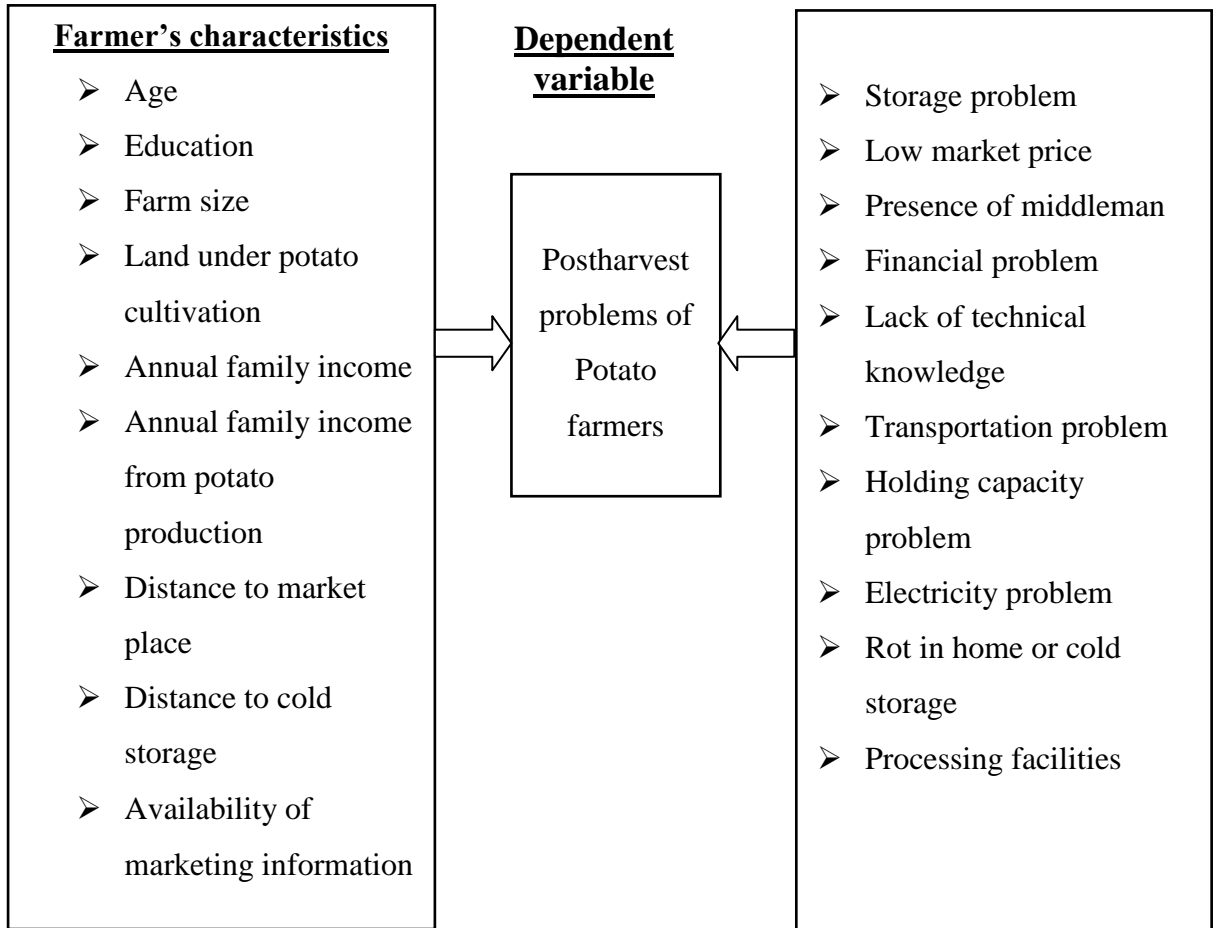


Figure 2.1 Conceptual framework of this study

CHAPTER III

MATERIALS AND METHODS

This chapter deals with the procedures for the collection of valid information as well as procedure of data coding and also data analysis. For conduction, a research work smoothly proper methodology is an obligatory one and it is very difficult to address the study objectives with a scientific manner without a define methodology. A sequential description of the methodologies that was followed in conducting this research work has been presented in this chapter under the following headings-

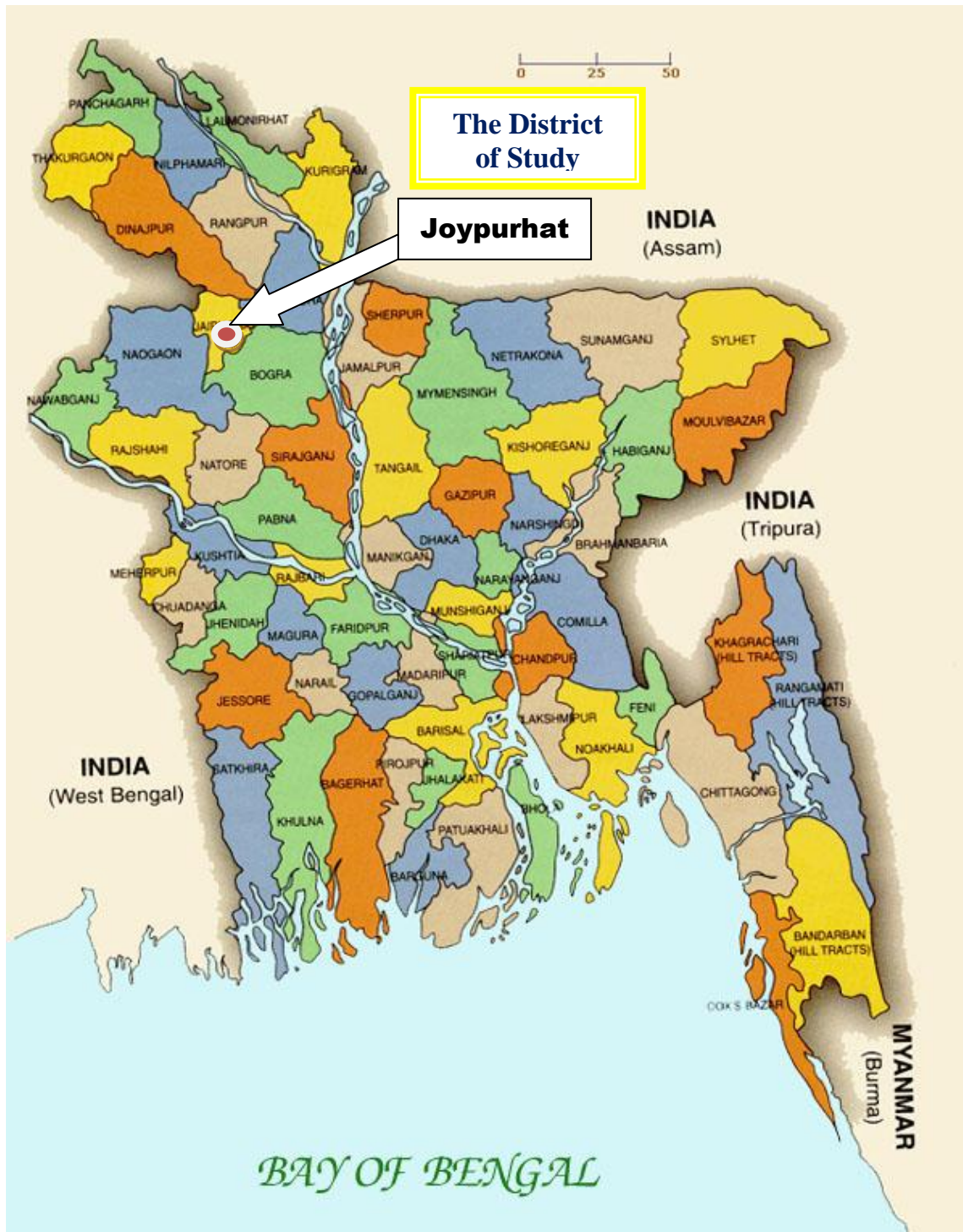
3.1 Locale of the study

The north-east small district ‘Joypurhat’ is the second largest potato growing area in Bangladesh. Nowadays, the district is facing a lot of post-harvest problems and the farmers are being deprived from the desired benefits. After being a number of news covered in the media, the researcher selected the locale purposively. The study was conducted in the Ahamedabad union of kalai upazila under Joypurhat district. Kalai upazila has 05 unions; out of these Ahamedabad union was selected purposively as the study area, which possesses the lowest population among the 05 union according to the “Offie of the Upazilla Agriculture Officer”. Among the 3 villages of Ahamedabad Union, Banihara, Hatior and Balait village were selected purposively for the study. Thus, locale of the study was selected. A map of Bangladesh showing Joypurhat district and a map of Joypurhat district showing Kalai upazila considered as study area have been presented in Figure 3.1 and 3.2, respectively.

3.2 Population and sample of the study

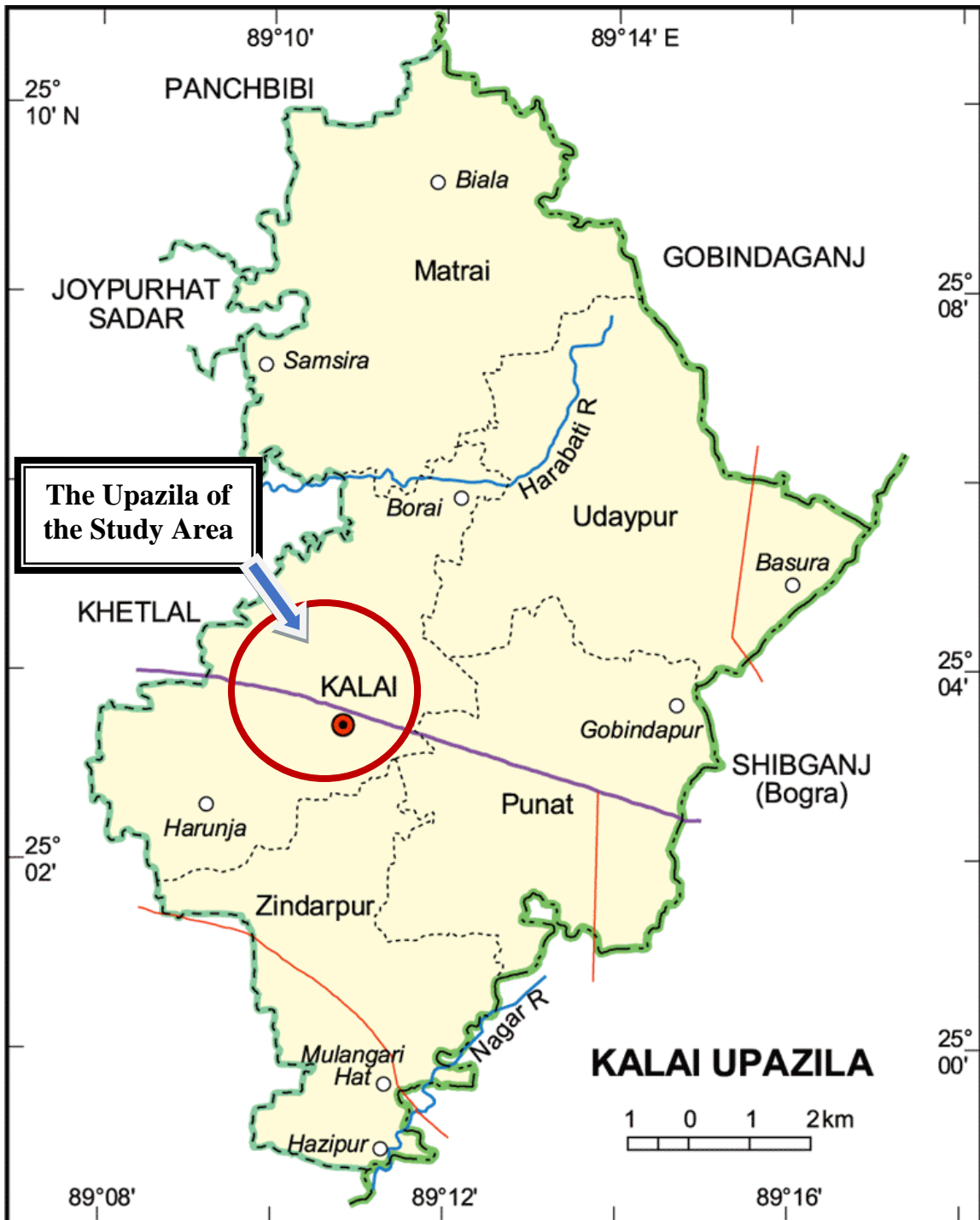
The potato farmers of Banihara, Hatior and Balait village of Ahamedabad union in the Kalai upazila under Joypurhat district constituted the population of the study. An update statistics of Potato farmers of the selected village area was

collected from Upazila Agriculture Officer (UAO) of this locality. The total number of potato farmers in these villages was 456; where 209 farm family heads from Banihara village, 163 from Hatior village and 84 from Balait village under the union of Ahamedabad which constituted the population of the study. Thus, 456 potato farmers constituted the population of the study.



Source: Internet

Figure 3.1 Map of Bangladesh showing Joypurhat district



Source: Internet

Figure 3.2 Map of Kalai upazila under Joypurhat district showing the study area

3.2.1. Sampling of the study

There are several methods for determining the sample size. Here, researcher used Yamane's (1967) formula for study group:

$$n = \frac{z^2 P (1-P) N}{z^2 P (1-P) + N (e)^2}$$

Where,

n = Sample size

N (Population size) = 456

e (The level of precision) = 9%

z = the value of the standard normal variable given the chosen confidence level (e.g., z = 1.96 with a confidence level of 95 %) and

P (The proportion or degree of variability) = 50%

So, the sample size (n) is 94 for this study

3.2.2 Distribution of the population, sample size and reserve list

According to Yamane's formula, the respondents comprised of 94 potato farmers. A reserve list of 10 potato farmers was also prepared by the same method so that the respondents of this list could be used for interview if the respondents included in the original sample were not available at the time of conduction of interview. The distribution of the population sample and number of respondent in the reserve list are given in Table 3.1.

Table 3.1 Distribution of the potato farmers according to population and sample size and reserve list

Name of unions	Name of villages	Population of potato farmers	Sample size	Number of potato farmers included in the reserve list
Ahmedabad	Banihara	209	43	6
	Hatior	163	34	3
	Balait	84	17	1
		456	94	10

3.3 Measurement of variables

The variable is a characteristic, which can assume varying or different values in successive individual cases. A research work usually contains at least two important variables viz. independent and dependent variables. An independent variable is that factor which is manipulated by the researcher in his attempt to ascertain its relationship to an observed phenomenon. A dependent variable is that factor which appears, disappears or varies as the researcher introduces, removes or varies the independent variable (Townsend, 1953). In the scientific research, the selection and measurement of variable constitute a significant task. Following this conception, the researcher reviewed literature to widen this understanding about the natures and scopes of the variables relevant to this research. At last he had selected 09 independent variables and one dependent variable. The independent variables were: age, education, farm size, land under potato cultivation, annual family income, annual family income from potato production, distance to market place, distance to cold storage and availability of marketing information. The dependent variable of this study was the ‘Post-harvest problems of potato farmers in Joypurhat district’. The methods and procedures in measuring the variables of this study are presented below:

3.4 Measurement of independent variables

The 09 characteristics of the potato farmers mentioned above constitute the independent variables of this study. The following procedures were followed for measuring the independent variables.

3.4.1 Age

Age of respondent potato farmers was measured by the period of time from their birth to the time of conducting interview and it was measured in terms of complete years on the basis of their response. A score of one (1) was assigned for each year age. This variable appears in item number one (1) in the interview schedule as presented in Appendix.

3.4.2 Education

Education was measured by assigning score against each successful year of schooling by a respondent. One score was given for passing each level in an educational institution (Amin, 2004).

For example, if a respondent passed the final examination of class five or equivalent examination, his/her education score has given five (5). Each respondent of can't read & write has given a score of zero (0). A person not knowing reading or writing but being able to sign only has given a score of 0.5. If a farmer did not go to school but took non-formal education, his educational status was determined as the equivalent to a formal school student. This variable appears in item number two (2) in the interview schedule as presented in Appendix.

3.4.3 Farm size

Farm size of a respondent referred to the total area of land on which his family carried out the farming operation, the area being in terms of full benefit to the family. The term refers to the cultivated area either owned by the respondent or cultivated on share-cropping, lease or taking from other including homestead area. It was measured in hectares for each respondent using the following formula (Khan, 2004):

$$FS = A + B + \frac{1}{2}(C + D) + E$$

Where, FS = Farm size,

A = Homestead area including garden and pond,

B = Own land under own cultivation,

C = Land taken from others as borga

D = Land given to other as borga,

E = Land taken from others on lease,

The data was first recorded in terms of local measurement unit i.e. decimal and then converted into hectare. The total area, thus, obtained is considered as his farm size score (assigning a score of one for each hectare of land). This variable

appears in item number three (3) in the interview schedule as presented in Appendix.

3.4.4 Land under potato production

Land under potato production refers to the area used in potato production only by the potato farmers. It was first recorded in terms of local measurement unit i.e. decimal and bigha. Then it was converted in hectare (ha). The total area thus obtained was considered as the score of land under potato production by assigning 1 score for one hectare (ha)' of land. This variable appears in item number four (4) in the interview schedule as presented in Appendix.

3.4.5 Annual family income

Annual family income refers to the total financial return from different financial activities in one year. It was expressed in Taka. One score was given for 1000 taka. A score of 1 was assigned for Tk. 1000. For an amount less than Tk.1000, a fraction score was computed and added with the main score. This variable appears in item number five (5) in the interview schedule as presented in Appendix.

3.4.6 Annual income from potato production

Annual income refers to the total financial return from potato production in one year. It was expressed in Taka. One score was given for 1000 taka. A score of 1 was assigned for Tk. 1000. For an amount less than Tk.1000, a fraction score was computed and added with the main score. This variable appears in item number six (6) in the interview schedule as presented in Appendix.

3.4.7 Distance to the market

Distance to the market place was marked by asking the question “what is the distance of market place from your farm or home”. The respondents replied based on their idea. This variable was measured by the actual figure (kilometer). A score of 1 was assigned for each kilometer. From their responses as the distance of the market place was categorized as short, medium and high distance. This variable

appears in item number seven (7) in the interview schedule as presented in Appendix.

3.4.8 Distance to the cold storage

Distance to the cold storage was asked by asking the question “what is the distance of cold storage from your farm or home”. The respondents replied based on their idea. This variable was measured by the actual figure (kilometer). A score of 1 was assigned for each kilometer. From their responses as the distance of the market place was categorized as short, medium and high distance. This variable appears in item number eight (8) in the interview schedule as presented in Appendix.

3.4.9 Availability of marketing information

Availability of marketing information of the respondents was measured by computing a score on the basis of potato farmers’ reply to six questions. The score of a respondent for the response of the entire six questions was added together to compute their availability of marketing information scores. Each question was assigned 2, 1, 0 score for regularly, occasionally and not at all respectively. Therefore, six questions will carry a total score of 12 for regular marketing information and zero for no marketing information and others score for other combinations. The sum of total scores for all the six questions will make marketing information score of a respondent. Thus, marketing information score of the respondent was ranged from zero to 12, where respondent will obtain score up to 0 indicating low levels of marketing information, 12 indicating high level market information. This variable appears in item number nine (9) in the interview schedule as presented in Appendix.

3.5 Measurement of dependent variable: Post-harvest problems of potato farmers

Ten post-harvest problems were selected to measure the post-harvest problems of the farmers. The procedure followed in measuring the dependent variable is added

the score of each problem. This variable appears in item number ten (10) in the interview schedule as presented in Appendix.

Post-harvest problems of potato farmers were measured on the basis of ten problems. Each problem was categorized into severe, medium, low and score assigned against each of them was 3, 2, 1 respectively. However, no problem assigned score of zero.

$$PHP = SP \times 3 + MP \times 2 + LP \times 1 + NP \times 0$$

Where, PHP = Post-harvest problems, SP = Severe problems, MP = Medium problems, LP = Low problems and NP = No problem

Thus, Post-harvest problem score of a respondent was determined summing up the weights of their responses to all the ten statements. Thus, post-harvest problem score of the respondent was ranged from zero to 30, where respondent will obtain score lowest '0' indicating no problem of post-harvest problems, highest '30' indicating severe post-harvest problems of potato farmers.

3.6 Hypothesis of the study

According to Kerlinger (1973) a hypothesis is a conjectural statement of the relation between two or more variables. Hypothesis are always in declarative sentence form and they are related, either generally or specifically from variables to variables. In broad sense hypotheses are divided into two categories: (a) Research hypothesis and (b) Null hypothesis.

3.6.1 Research hypothesis

Based on review of literature and development of conceptual framework, the following research hypothesis was formulated:

“Each of the 09 selected characteristics (age, education, farm size, land under potato production, annual family income, annual income from potato production, distance to the market, distance to the cold storage and availability of marketing

information) of the potato farmers has significant contribution to post-harvest problem.”

However, when a researcher tries to perform statistical tests, then it becomes necessary to formulate null hypothesis.

3.6.2 Null hypothesis

A null hypothesis states that there is no contribution between the concerned variables. The following null hypothesis was formulated to explore the contribution of the selected characteristics in empowering the farmers through e-Agriculture. Hence, in order to conduct tests, the earlier research hypothesis was converted into null form as follows:

“There is no contribution of the selected characteristics (age, education, farm size, land under potato production, annual family income, annual income from potato production, distance to the market, distance to the cold storage and availability of marketing information) of potato farmers on post-harvest problem.”

3.7 Instrument for collection of data

In order to collect reliable and valid information from the respondents, an interview schedule was prepared for collection of data from respondents keeping the objectives of the study in mind. The question and statements contained in the schedule were simple, direct and easily understandable by the farmers. Simple and direct question, different scales, closed and open form statements and questions were included in the interview schedule to obtain necessary information. The draft interview schedule was prepared in accordance with the objective of the study. The interview schedule was pre-tested with 10 respondents of the farmers in the study area during 05 to 06 November, 2016.

The draft interview schedule was pretested in actual field situation before finalizing it for collection of data. The pre-test was helpful to identify inappropriate questions and statements in the draft schedule. Necessary addition, alternation and adjustments were made in the schedule on the basis of the

experience of the pretest. The interview schedule was then cyclostyled in its final form for the collection of data. The interview schedule was then printed in its final form. An English version of the interview schedule has been shown in Appendix.

3.8 Data collection

Data were collected personally by the researcher himself through personal interview schedule from the sampled farm families of the selected villages. Before starting the collection of data; the researcher met the respective Upazila Agriculture Officer (UAO), Additional Agriculture Officer (AAO) and the concerned SAAOs. The researcher also discussed the objectives of the present study with the respondents and above mentioned officers and requested them to provide actual information. A rapport was established with the rural people so that they feel easy to answer the questions. The researcher took all possible care to establish rapport with the respondents so that they would not feel any indecision while starting the interview. Very good cooperation was obtained from the field extension workers and the local leaders. No serious difficulty was faced by the researcher during the collection of data. The interviews were made individually in the houses of respondents. Questions were asked in different ways so that the respondents could easily understand the questions. Whenever a respondent faced difficulty in understanding any questions, care was taken to explain the same clearly with a view to enabling him to answer it properly.

Before going to the respondents' home for interviewing they were informed verbally to ensure their availability at home as per schedule date and time. In the case of failure to collect information from the respondents due to their other business, a revisit was made with prior to appointments. If any respondent failed to understand any question, the researcher took great care to explain the issue. If the respondents could not clear about what was wanted to know then supplementary questions were asked for further clarification. The researcher received full cooperation from the respondents during the time of interview. Data were collected during 05 November, 2016 to 04 December, 2016.

3.9 Compilation of data

After completion of field survey, data recorded in the interview schedules were coded, compiled, tabulated and analyzed in accordance with the objectives of the study. In this process, all the responses in the interview schedule were given numerically coded values. Local units were converted into standard units and qualitative data were converted into quantitative ones by means of suitable scoring whenever necessary. All the collected data were checked and cross-checked before transplanting to the master sheets. To facilitate tabulation, the collected data were properly coded and transferred from interview schedule to a master sheet. Tabulation and cross tabulation was done on the basis of categorization developed by the researcher.

3.10 Categorization of respondents

For describing the various independent and dependent variables the respondents were classified into various categories. In developing categories, the researcher was guided by the nature of data and general consideration prevailing on the social system. The procedures have been discussed while describing the variable in the sub-sequent sections of next chapter.

3.11 Statistical analysis

Data collected from the respondents were analyzed and interpreted in accordance with the objectives of the study. The analysis of data was performed using statistical treatment with SPSS (Statistical Package for Social Sciences) computer program, version 20. Statistical measures as a number, range, mean, standard deviation and rank order were used in describing the variables whenever applicable. In order to explore the contribution of the selected characteristics of potato farmers to post-harvest problems, multiple regression analysis (B) was used. Throughout the study, five percent (0.05) level of significance was used as the basis for rejecting any null hypothesis. If the computed value of (B) was equal to or greater than the designated level of significance (p), the null hypothesis was

rejected and it was concluded that there was a significant contribution between the concerned variable.

Whenever the computed value of (B) was found to be smaller at the designated level of significance (p), the null hypothesis could not be rejected. Hence, it was concluded that there was no contribution of the concerned variables. The model used for this analysis can be explained as follows:

$$Y_i = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + b_9x_9 + e$$

Where,

Y is the post-harvest problems,

Of the independent variables, x_1 is the respondent's age, x_2 is education, x_3 is a level of farm size, x_4 is land under potato production, x_5 is the annual family income, x_6 is annual income from potato production, x_7 is distance to the market, x_8 is the distance to the cold storage and x_9 is the availability of marketing information. b_1 , b_2 , b_3 , b_4 , b_5 , b_6 , b_7 , b_8 and b_9 are regression coefficients of the corresponding independent variables, and e is random error, which is normally and independently distributed with zero mean and constant variance.

CHAPTER IV

RESULTS AND DISCUSSION

The recorded observations in accordance with the objective of the study were presented and probable discussion was made of the findings with probable justifiable and relevant interpretation under this chapter. The chapter content in three (3) sections. The first section of this chapter deals with the characteristics of the potato farmers. The second section deals with the post-harvest problems of potato farmers. The third section deals with the contribution between individual characteristics of the potato farmers and their post-harvest problems of potato.

4.1 Characteristics of the potato farmers

For assess the adoption of modern technologies by the potato farmers in potato cultivation various interrelated characteristics were collected under the present study. It was therefore, hypothesized that the characteristics of the potato farmers correlated with their post-harvest problem in potato cultivation. However, the 09 selected salient features of the potato farmers such as age, education, farm size, land under potato production, annual family income, annual income from potato production, distance to the market, distance to the cold storage and availability of marketing information that might be greatly influenced the post-harvest of potato are presented below-

4.1.1 Age

The score of the potato farmers was varied from 20 to 66 years with a mean and standard deviation of 39.51 and 9.490 respectively. Considering the recorded age potato farmers were classified into three categories namely 'young', 'middle' and 'old' aged following Rashid (2014). The distribution of the potato farmers in accordance of their age are presented in Table 4.1.

Table 4.1 Distribution of the potato farmers according to their age

Category	Range (Years)		Respondents'		Mean	Standard deviation
	Score	Observed	Number	Percent		
Young aged	Up to 35	20-66	35	37.2	39.51	9.490
Middle aged	36-50		50	53.2		
Old aged	Above 50		9	9.6		
Total			94	100		

From Table 4.1 it was revealed that the middle-aged potato farmers comprised the highest proportion (53.2 percent) followed by young old aged category (37.2 percent) and the lowest proportion were made by the old aged category (9.6 percent). Data also indicates that the middle and young aged respondents constitute almost 91 percent of total respondents. The young and middle aged respondents were generally more involved in potato cultivation than the older.

4.1.2 Level of education

The level of educational scores of the potato farmers ranged from 0 to 18 with a mean and standard deviation of 7.51 and 5.47 respectively. Based on the educational scores, the respondents were classified into five categories such as 'can't read of sign' (0), 'can sign only' (0.5), 'primary education' (1 to 5), 'secondary education' (6 to 10), above secondary (above 10). The distributions of the respondents according to their level of education are presented in Table 4.2.

Table 4.2 Distribution of the potato farmers according to their level of education

Category	Range (School years)		Respondents'		Mean	SD
	Score	Observed	Number	Percent		
Can't read and sign	0	0-18	3	3.2	7.51	5.477
Can sign only	0.5		24	25.5		
Primary education	1-5		12	12.8		
Secondary education	6-10		30	31.9		
Above secondary	> 10		25	26.6		
Total			94	100		

Table 4.2 shows that respondent under secondary education category constitute the highest proportion (31.9 percent) followed by above secondary (26.6 percent). On the other hand, the lowest 3.2 percent in can't read and sign category followed by primary education category (12.8 percent) and can sign only category (25.5 percent). Education broadens the horizon of outlook of potato farmers and expands their capability to analyze any situation related to potato production. An educated potato farmer is likely to be more responsive to the modern facts, ideas, technology and information of potato production. To adjust with the same, they would be progressive minded to adopt as well as involve with modern cultural, processing and marketing facilities of potato along with searching for the opportunities to export their potato in different countries through proper marketing channel.

4.1.3 Farm size

The farm size of the potato farmers' scores ranged from 0.17 to 8.35 with a mean and standard deviation of 1.55 and 1.23 respectively. Based on their farm size, the respondents were classified into five categories following the categorization of DAE. These categories were marginal landless (≤ 0.02), marginal farm holder (0.021-0.20 ha), small farm holder (0.21-1.00 ha), medium farm holder (1.01 ha to 3.0 ha) and high farm holder (above 3.0 ha). The distribution of the potato farmers according to their farm size is presented in Table 4.3.

Table 4.3 Distribution of the potato farmers according to their farm size

Categories	Range (Hectare-ha)		Respondents'		Mean	SD
	Score (ha)	Observed	Number	Percent		
Landless	≤ 0.02	0.17-8.35	0	0	1.55	1.23
Marginal	0.021-0.20		1	1.1		
Small	0.21-1.00		31	33.0		
Medium	1.01-3.0		52	55.3		
Large	>3		10	10.6		
Total			94	100		

Table 4.3 indicates that the medium farm holder constitutes the highest proportion (55.3 percent) followed by small farm holder (33.0 percent), whereas 1.1 percent was marginal farm holder. The findings of the study reveal that majority of the potato farmers were small to medium sized farm holder. The average farm size of the farmers of the study area (0.92 ha) was higher than that of national average (0.60 ha) of Bangladesh (BBS, 2014). The farmer with marginal farm size has very little scope to experiment about new technologies as their earnings depend on mainly in agriculture.

4.1.4 Land under potato cultivation

The score of land under potato cultivation of potato farmers ranged from 13 to 5.39 with the mean and standard deviation of .917 and .789 respectively. On the basis of land under potato cultivation, the respondents were divided into three categories (Mean \pm Standard Deviation) as shown in Table 4.4.

Table 4.4 Distribution of the respondents' potato farmers according to land under Potato cultivation

Categories (Mean \pm SD)	Range (Hectare)		Respondents'		Mean	SD
	Score (ha)	Observed	Number	Percent		
Small farmer	Upto 0.128	.13-5.39	0	0	.917	.789
Medium farmer	0.129-1.706		86	91.5		
Large farmer	Above 1.706		8	8.5		
Total			94	100		

Table 4.4 indicates that medium farm land under potato cultivation constitutes the highest proportion (91.5 percent) followed by large farm land under potato cultivation (8.5 percent), whereas no farmers were small farm land under potato cultivation. The findings of the study reveal that majority of the potato farmers were medium to large sized farm land under potato cultivation.

4.1.5 Annual family income

The score of annual family income of the potato farmers ranged from 20 to 500 with a mean and standard deviation of 117.01 and 152.12, respectively. On the basis of annual income, the potato farmers were classified into three categories (Mean \pm Standard Deviation) viz. low, medium and high annual income. The distribution of the potato farmers according to their annual income is presented in Table 4.5.

Table 4.5 Distribution of the respondents' potato farmers according to annual family income

Categories (Mean \pm SD)	Range ('000' Taka)		Respondents'		Mean	SD
	Score	Observed	Number	Percent		
Low	Up to 35	20-500	11	11.7	152.12	117.01
Medium	36-270		66	70.2		
High	Above 270		17	18.1		
Total			94	100		

Data revealed that potato farmers having medium annual income constitute the highest proportion (70.2 percent), while the lowest proportion in low income (11.7 percent) followed by high income (18.1 percent). Overwhelming majority (88 percent) potato farmers have medium high level annual family income.

4.1.6 Annual income from potato production

The score of annual income from potato production of the potato farmers ranged from 05 to 200 with a mean and standard deviation of 56.30 and 41.86 respectively. On the basis of annual income from potato production, the potato farmers were classified into three categories (Mean \pm Standard Deviation) viz. low, medium and high annual income from potato production. The distribution of the potato farmers according to their annual income from potato production is presented in Table 4.6.

Table 4.6 Distribution of the respondents' potato farmers according to annual family income from potato production

Categories (Mean±SD)	Range ('000' Taka)		Respondents'		Mean	SD
	Score	Observed	Number	Percent		
Low	Up to 15	5-200	15	16.0	56.30	41.86
Medium	16-99		59	62.8		
High	Above 99		20	21.3		
Total			94	100		

Data revealed that potato farmers having medium annual income from potato production constitute the highest proportion (62.8 percent), while the lowest proportion in low annual income from potato production (16.0 percent) followed by high income (21.3 percent). Overwhelming majority (83 percent) potato farmers have medium to high level annual income from potato production.

4.1.7 Distance to the market

The score of distance to the market of the potato farmers ranged from 1 to 5 with a mean and standard deviation of 4.04 and .738 respectively. On the basis of distance to the market, the potato farmers were classified into three categories (Mean ± Standard Deviation) viz. low, medium and high distance to the market. The distribution of the potato farmers according to their distance to the market is presented in Table 4.7.

Table 4.7 Distribution of the respondents' potato farmers according to distance to the market

Categories (Mean±SD)	Range (km)		Respondents'		Mean	SD
	Score	Observed	Number	Percent		
Low	Up to 3	1-5	3	3.2	4.04	.738
Medium	3.1- 5		91	96.8		
High	Above 5		0	0		
Total			94	100		

Data revealed that potato farmers having medium distance to the market constitute the highest proportion (96.8 percent), while the lowest proportion in distance to the market (3.2 percent). No respondents were high distance to the market. Overwhelming all (100 percent) the potato farmers have low to medium distance to the market.

4.1.8 Distance to the cold storage

The score of distance to the cold storage of the potato farmers ranged from 1 to 7 with a mean and standard deviation of 5.98 and 2.20 respectively. On the basis of distance to the cold storage, the potato farmers were classified into three categories (Mean \pm Standard Deviation) viz. low, medium and high Distance to the cold storage. The distribution of the potato farmers according to Distance to the cold storage is presented in Table 4.8.

Table 4.8 Distribution of the respondents' potato farmers according to distance to the cold storage

Categories (Mean \pm SD)	Range (km)		Respondents'		Mean	SD
	Score	Observed	Number	Percent		
Low	Up to 3.9	1-7	17	18.1	5.98	2.20
Medium	4-8		77	81.9		
High	Above 8		0	0		
Total			94	100		

Data revealed that potato farmers having medium distance to the market constitute the highest proportion (81.9 percent), while the lowest proportion in distance to the cold storage (18.1 percent). No respondents were high distance to the cold storage. Overwhelming all (100 percent) the potato farmers have low to medium distance to the cold storage.

4.1.9 Availability of marketing information

Availability of marketing information score of the potato farmers ranged from 2 to 9 with a mean and standard deviation of 4.64 and 1.44 respectively. On the basis of availability of marketing information, the potato farmers were classified into three categories (Mean \pm Standard Deviation) viz. low, medium and high availability of marketing information. The distribution of the potato farmers according to availability of marketing information is presented in Table 4.9.

Table 4.9 Distribution of the respondents' potato farmers according to availability of marketing information

Categories (Mean \pm SD)	Range (Score)		Respondents'		Mean	SD
	Score	Observed	Number	Percent		
Low	Up to 3	2-9	22	23.4	4.64	1.44
Medium	4-6		62	66.0		
High	Above 6		10	10.6		
Total			94	100		

Data revealed that potato farmers having medium availability of marketing information constitute the highest proportion (66.0 percent), while the lowest proportion in availability of marketing information were high (10.6 percent) followed by low availability of marketing information (21.3 percent). Overwhelming majority (88 percent) potato farmers have low to medium level availability of marketing information.

4.2 Measurement of dependent variable; Post-harvest problems of potato farmers

Post-harvest problems of potato farmers are the dependent variable of this study and it was measured by computing scores according to extent of post-harvest problems with each of 10 selected technologies. Post-harvest problems of potato cultivation by the potato farmers scored varied from 2 to 18 with the mean and standard deviation of 8.88 and 3.41 respectively. On the basis of post-harvest problems of potato farmers scores, the potato farmers were classified into three

categories namely, low, medium and high post-harvest problems of potato farmers. The distribution of the cultivators according to their post-harvest problems score under the study is given in Table 4.10.

Table 4.10 Distribution of the potato farmers according to their post-harvest problems of potato farmers

Categories (Mean±SD)	Range (Score)		Respondents'		Mean	SD
	Score	Observed	Number	Percent		
Low	Up to 5	2-18	14	14.8	8.88	3.41
Medium	6-12		68	72.3		
High	Above 12		12	12.9		
Total			94	100		

Table 4.10 indicates that among the respondents the highest 72.3 percent potato farmers belong to the group of medium post-harvest problems and the lowest 12.9 percent in high post-harvest problems followed by low post-harvest problems (14.8 percent) by the potato farmers in post-harvest problems. Among the cultivators most of the potato farmers (87 percent) have low to medium post-harvest problems of potato cultivation.

4.3 Contributing factors on the post-harvest problems of potato farmers

In order to estimate the post-harvest problems of potato farmers from the independent variables, multiple regression analysis were used which is shown in the Table 4.11.

Table 4.11 Multiple regression coefficients of contributing factors related to the post-harvest problems of potato farmers

Dependent variable	Independent variables	B	<i>p</i>	R ²	Adj. R ²	F	p
Post-harvest problems of potato farmers	Age	-.046	.237	.491	.473	21.323	0.000**
	Education	-.105	.009**				
	Farm size	.316	.417				
	Land under potato production	-.602	.307				
	Annual family income	.001	.820				
	Annual income from potato production	.000	.975				
	Distance to the market	.761	.037*				
	Distance to the cold storage	.233	.041*				
	Availability of marketing information	-.358	.003**				

** Significant at $p < 0.01$;

* Significant at $p < 0.05$

The data in Table 4.11 test the final null hypothesis: There is no contribution of the selected characteristics (age, education, farm size, land under potato production, annual income from potato production, distance to the market, distance to the cold storage and availability of marketing information) of post-harvest problems of potato farmers. In order to assess which factors, contribute to post-harvest problems of potato farmers, multiple regression analysis was used.

4.3.1 Contribution of Education in post-harvest problems of potato farmers in Joypurhat district

The contribution of Education in post-harvest problems of potato farmers by testing the following null hypothesis; “There is no contribution of education in post-harvest problems of potato farmers in Joypurhat district”.

The adjusted R^2 value of the concerned variables was found .009. The following observations were made on the basis of the value of the concerned variable of the study under consideration.

- a. The contribution of the education was at 1% significance level. So, the null hypothesis could be rejected.

Based on the above finding, it can be summarized that a potato farmer had more education increased the capabilities to reduce post-harvest problems of potato farmers in Joypurhat district. Education enhances the abilities of the potato farmers at short time than others which enabled them to reduce post-harvest problems. So, education has significantly contributed to the reduction of post-harvest problems of potato farmers.

4.3.2 Contribution of availability of marketing information in post-harvest problems of potato farmers in Joypurhat district

The contribution of Education in post-harvest problems of potato farmers by testing the following null hypothesis; “There is no contribution of availability of marketing information in post-harvest problems of potato farmers in Joypurhat district”.

The adjusted R^2 value of the concerned variables was found .003. The following observations were made on the basis of the value of the concerned variable of the study under consideration.

- a. The contribution of the availability of marketing information was at 1% significance level. So, the null hypothesis could be rejected.

Based on the above finding, it can be summarized that the people of this particular area were not in contact of market information. So, they are being deprived to get a good price in the appropriate time. Educated people usually try to keep themselves updated about the marketing information. They seek market

information from different sources to get a good and reasonable price for their hard-earned crops. More marketing information means greater opportunity to justify the market condition for the best time and place to sell their harvested crops. So, the availability of marketing information has significantly contributed to the reduction of post-harvest problems of potato farmers in Joypurhat district.

4.3.3 Contribution of distance to the market in post-harvest problems of potato farmers in Joypurhat district

The contribution of Education in post-harvest problems of potato farmers by testing the following null hypothesis; “There is no contribution of distance to the market in post-harvest problems of potato farmers in Joypurhat district”.

The adjusted R^2 value of the concerned variables was found .037. The following observations were made on the basis of the value of the concerned variable of the study under consideration.

- a. The contribution of distance to the market was at 5% significance level. So, the null hypothesis could be rejected.

Based on the above finding, it can be summarized that distance to the market had a vital role to increase the input cost. A high input cost is always challengeable for the potato farmers to make it profitable. If the distance of a market place become shorter and nearer to the production field, it will be easy to reduce post-harvest problems of potato farmers in Joypurhat district within minimum transportation cost of the harvested crops. So, distance to the market has significantly contributed to the reduction of post-harvest problems of potato farmers in Joypurhat district.

4.3.4 Contribution of distance to the cold storage in post-harvest problems of potato farmers in Joypurhat district

The contribution of Education in post-harvest problems of potato farmers by testing the following null hypothesis; “There is no contribution of distance to the cold storage in post-harvest problems of potato farmers in Joypurhat district”.

The adjusted R^2 value of the concerned variables was found .041. The following observations were made on the basis of the value of the concerned variable of the study under consideration.

- a. The contribution of distance to the cold storage was at 5% significance level. So, the null hypothesis could be rejected.

Based on the above finding, it was concluded that for the distance of cold storage had a significant role in increasing the post-harvest problems of the potato farmers. In this particular area there are enough cold storage facilities. But the number of the cold storage is not enough in the comparison of the large production of this area. Along with this, the location of the cold storage is not well-planned. So, the long distance of cold storage is more costly for the potato farmers for conserving this perishable crops to get a suitable time to sell their hard-earned crops at a good profit. So, distance to the cold storage has significantly contributed to the reduction of post-harvest problems of potato farmers in Joypurhat district.

Table 4.11 shows that there is a significant contribution of level of education and availability of marketing information on post-harvest problems of potato farmers and all of these were the most important contributing factors (significant at the 1% level of significance). Distance to the market, distance to the cold storage were also the important contributing factors (significant at the 5% level of significance).

$R^2 = 0.491$ of the variation in the respondents changed post-harvest problems of potato cultivation can be attributed to their respondents' level of education, distance to the market, distance to the cold storage and availability of marketing information, making this an excellent model (Table 4.11). The F value indicates that the model is significant ($p < 0.000$). However, each predictor may explain some of the variance in respondents' post-harvest problems of potato farmers simply by chance. The adjusted R^2 value (0.473) penalizes the addition of extraneous predictors in the model, but values of 0.473 still show that the variance in respondents' post-harvest problems in potato cultivation technologies can be attributed to the predictor variables rather than by chance, and that both are suitable models (Table 4.11). In summary, the models suggest that the respective authority should consider the respondents' level of education, distance to the

market, distance to the cold storage and availability of marketing information on post-harvest problems of potato farmers.

4.4 Rank order of problem faced by respondents

Rank order of the ten dimensions of Post-harvest problems of potato farmer is presented in the following Table 4.12. According to Problem Faced Index (PFI), presence of middle man positioned the 1st and lack of technical knowledge in the last.

Post-harvest problems of potato farmers in Joypurhat district according to descending order through analysis of the received data from respondents are presence of middle man, low market price, electricity problem, holding capacity problem, Rot in home, transportation problem, financial problem, storage problem, lack of processing facilities and lack of technical knowledge.

Table 4.12 Rank order of the post-harvest problems of potato farmers in the locale

Sl No	Dimensions of post-harvest problems	Severe (3)	Medium (2)	Low (1)	No (0)	PFI Score	Rank
1.	Presence of middleman	18	42	22	11	160	1 st
2.	Low market price	9	30	43	15	130	2 nd
3.	Electricity problem	2	22	57	0	107	3 rd
4.	Holding capacity problem	7	19	28	0	87	4 th
5.	Rot in home	5	9	50	0	83	5 th
6.	Transportation problem	1	13	46	0	75	6 th
7.	Financial problem	10	6	26	0	68	7 th
8.	Storage problem	0	7	39	50	53	8 th
9.	Lack of processing facilities	6	12	9	0	51	9 th
10.	Lack of technical knowledge	0	2	16	0	20	10 th

The results showed that the highest problem among the post-harvest-problems faced by the respondents was presence of middleman. This was due to poor

communication system with the large market place, their lack of awareness and lack of seasonal market places. The lowest problem in post-harvest problems was lack of technical knowledge. This happened because the respondents use some local techniques and 70% of the respondents are literate. For this reason they are technically sound through participating in workshop and seminars organized by the local GOs and NGOs.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of findings

5.1.1 Post-harvest problems of potato farmers

Post-harvest problems of potato farmers scored varied from 2 to 18 with the mean and standard deviation of 8.88 and 3.41 respectively. On the basis of post-harvest problems of potato farmers' scores, the potato farmers were classified into three categories namely; low, medium and high post-harvest problems of potato farmers. Among the potato farmers, the highest 72.3 percent potato farmers belong to the group of medium post-harvest problems and the lowest percentage 12.9 percent in high post-harvest problems followed by low post-harvest problems (14.8 percent) by the potato farmers in post-harvest problems. Among the cultivators most of the potato farmers (87 percent) have low to medium post-harvest problems of potato cultivation.

5.1.2 Characteristics of the farmers

▪ Age

Age of the farmers ranged from 20 to 66 years with a mean and standard deviation of 39.51 and 9.490 respectively. the middle-aged potato farmers comprised the highest proportion (53.2 percent) followed by young old aged category (37.2 percent) and the lowest proportion were made by the old aged category (9.6 percent)

▪ Education

The level of educational scores of the potato farmers ranged from 0 to 18 with a mean and standard deviation of 7.51 and 5.47 respectively. Respondent under secondary education category constitute the highest proportion (31.9 percent) followed by above secondary (26.6 percent). On the other hand, the lowest 3.2 percent in can't read and sign category followed by primary education category (12.8 percent) and can sign only category (25.5 percent)

▪ **Farm size**

The farm size of the potato farmers ranged from 0.17 ha to 8.35 ha with a mean and standard deviation of 1.55 and 1.23 respectively. The researcher found that the medium farm holder constitutes the highest proportion (55.3 percent) followed by small farm holder (33.0 percent), whereas 1.1 percent was marginal farm holder. The findings of the study reveal that majority of the potato farmers were small to medium sized farm holder

▪ **Land under potato cultivation**

Land under potato cultivation of potato farmers ranged from 13ha to 5.39ha with the mean and standard deviation of .917 and .789 respectively. The researcher found that medium farm land under potato cultivation constitutes the highest proportion (91.5 percent) followed by large farm land under potato cultivation (8.5 percent), whereas no farmers were small farm land under potato cultivation.

▪ **Annual family income**

Annual family income of the potato farmers ranged from 20 to 500 thousand taka with a mean and standard deviation of 117.01 and 152.12, respectively. The researcher found that potato farmers having medium annual income constitute the highest proportion (70.2 percent), while the lowest proportion in low income (11.7 percent) followed by high income (18.1 percent).

▪ **Annual income from potato production**

Annual income from potato production of the potato farmers ranged from 05 to 200 thousand taka with a mean and standard deviation of 56.30 and 41.86 respectively. The researcher found that potato farmers having medium annual income from potato production constitute the highest proportion (62.8 percent), while the lowest proportion in low annual income from potato production (16.0 percent) followed by high income (21.3 percent).

▪ **Distance to the market**

Distance to the market of the potato farmers ranged from 1 to 5 kilometers with a mean and standard deviation of 4.04 and .738 respectively. The researcher found that potato farmers having medium distance to the market constitute the highest proportion (96.8percent), while the lowest proportion in distance to the market (3.2 percent).

▪ **Distance to the cold storage**

Distance to the cold storage of the potato farmers ranged from 1 to 7 kilometers with a mean and standard deviation of 5.98 and 2.20 respectively. The researcher found that potato farmers having medium distance to the market constitute the highest proportion (81.9 percent), while the lowest proportion in distance to the cold storage (18.1 percent). No potato farmers were high distance to the cold storage.

▪ **Availability of marketing information**

Availability of marketing information of the potato farmers ranged from 2 to 9 score with a mean and standard deviation of 4.64 and 1.44respectively. The researcher found that potato farmers having medium availability of marketing information constitute the highest proportion (66.0 percent), while the lowest proportion in availability of marketing information were high (10.6 percent) followed by low availability of marketing information (21.3 percent).

5.2. Factors related in post-harvest problems of potato farmers

There is a significant contribution of level of education and availability of marketing information on post-harvest problems of potato farmers and all of these were the most important contributing factors (significant at the 1% level of significance). Distance to the market, distance to the cold storage were also the important contributing factors (significant at the 5% level of significance).

Adjusted $R^2 = 0.473$ of the variation in the potato farmers changed post-harvest problems of potato cultivation can be attributed to their potato farmers' level of

education, distance to the market, distance to the cold storage and availability of marketing information. The F value indicates that the model is significant ($p < 0.000$). However, each predictor may explain some of the variance in potato farmers' post-harvest problems of potato farmers simply by chance. The adjusted R-square value penalizes the addition of extraneous predictors in the model, but values of 0.473 still show that the variance in potato farmers' post-harvest problems in potato cultivation technologies can be attributed to the predictor variables rather than by chance.

5.3. Rank order of problem faced by the potato farmers

Rank order of the ten dimensions of post-harvest problems of potato farmers was measured. As per Problem Faced Index (PFI) presence of middle man positioned the 1st and lack of technical knowledge was in the last position.

5.4. Conclusions

i) Distance to market place is the 1st highest contributor to Post-harvest problems of potato farmers in Joypurhat district. If the distance of a market place become shorter and nearer to the production field, it will be easy to reduce post-harvest problems through minimizing transportation cost of the produce.

ii) Availability of marketing information is the 2nd highest contributor to post-harvest problems of potato farmers in this locale. The farmers are being deprived of getting a good price in the appropriate time. More marketing information means greater opportunity to justify the market condition for the best time and place to sell their harvested crops.

iii) Most of the respondents marked distance to cold storage as low to medium problem. But the number of the cold storage is not enough in comparison of the large production of this area. Along with this, the location of the cold storage is not well-planned. So, the long distance of cold storage is more costly for the

potato farmers for conserving this perishable crop till a suitable time to sell their hard-earned crops at a good price for earning a good profit.

iv) Near about 30% potato farmers are less literate in this study area. A potato farmer with more education increased the capabilities to reduce post-harvest problems of potato farmers in Joypurhat district. Education enhances the ability of the potato farmers to face the post-harvest problems and reduce it at short time than others.

5.5 Recommendations

5.5.1 Recommendations for policy implications

On the basis of observation and conclusions drawn from the findings of the study following recommendations are made to the planners and policy makers in contriving micro or macro level policy for increasing of potato production:

i) Infrastructural development such as roads, cold storage etc. needs to be constructed to mitigate the distance problems

ii) Marketing facilities can be increased by the concerned authorities such as Department of Agricultural Marketing (DAM) and other NGOs.

iii) Bangladesh government through Bureau of Non-formal Education (BNFE) and NGOs can take necessary steps to increase farmers' primary level of education through non-formal education (adult education) and regular farmers' training, workshop, rally needs to be organized to broaden their knowledge

iv) Availability of market information was the most important contributing factors in post-harvest problem of potato. Therefore, it may be recommended that measurement should be taken by the concerned authorities through providing accurate and reliable market information at the right time.

5.5.2 Recommendations for further study

i) Post-harvest problems of potato farmers were conducted in one selected union of Joypurhat district. Findings of the study may be verified by similar research in other areas of Bangladesh.

- ii) The study examined the effects of nine selected characteristics of the farmers. Therefore, it is recommended that further research may be undertaken involving other variables in this regard.
- iii) This study was conducted at 10% level of precision of the population. It would.
- iv) The post- for the better output problems of potato farmers can be determined by using harvest be conducted at below 5% level of precision of the population other ways and methods which may be used in conducting further research.

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English Version of the Interview Schedule
 Department of Agricultural Extension and Information System
 Sher-e-Bangla Agricultural University, Dhaka-1207.

Interview schedule for data collection for the research on
“Post-harvest Problems of Potato Farmers in Joypurhat District”

Serial No. :

Name of the respondent :

Address :

:

Please answer the following questions. Information given by you will be kept confidential and only be used for research work.

1. Age

What is your age? ----- Years.

2. Education:

What is the level of your education?

- a) I don't know how to read and write ()
- b) I don't know how to read and write but can sign only ()
- c) I studied up to class

3. Farm size

Please state your land

Sl. No.	Type of land be used	Land area	
		Local unit (decimal)	Hectare
1	Homestead		
2	Own land under own cultivation		
3	Own land given to others		
4	Land taken from others		
6	Others (write down specific)		
	Total		

4. Land under potato cultivation

(Please mention the amount of land in hectare that you use for potato cultivation)

Land ha

5. Annual family income

Please indicate your annual family income (in Taka)

Sl. No.	Source of income	Amount of income (in Taka)
1	Agriculture	
2	Livestock (cattle, goat etc.)	
3	Poultry (duck, poultry etc.)	
4	Fisheries	
5	Service	
6	Business	
7	Other (Please specify)	
Total		

6. Annual family income from potato production

Describe your annual family income from potato production

Sl. No.	Source of income	Amount of income (Taka)
1.	From tuber	
2.	From residues as (FYM)	
3.	From seed	
4.	Others (write down specific)	
Total		

7. Distance to market place

(Please mention the distance of market place from your farm or home)

Distance km

8. Distance to cold storage

(Please mention the distance of cold storage from your farm or home)

Distance km

9. Availability of marketing information

Sl No.	Item	Regularly (2)	Occasionally (1)	Not at all (0)
1.	Information about market price			
2.	Information about ware house			
3.	Information about quality product			
4.	Information related to production			
5.	Information about product demand			
6.	Information about marketing facilities			

10. Post-harvest problems of potato farmers:

Mention the extent of the following problems you face during marketing?

Sl. No.	Problems	Severe (3)	Medium (2)	Low (1)	No Problem (0)
a.	Storage problem				
b.	Low market price				
c.	Presence of middleman				
d.	Financial problem				
e.	Lack of technical knowledge				
f.	Transportation problem				
g.	Holding capacity problem				
h.	Electricity problem				
i.	Rot in home				
j.	Lack of processing facilities				

Thanks for your co-operation.

Signature of the Interviewer with date