POSTHARVEST CHALLENGES ON POTATO IN NORTHERN ZONE OF BANGLADESH

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DHAKA-1207

JUNE, 2012

25

POSTHARVEST CHALLENGES ON POTATO IN NORTHERN ZONE OF BANGLADESH

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A Thesis
Submitted to the Department of Horticulture
Sher-e-Bangla Agricultural University, Dhaka
in partial fulfilment of the requirements for the degree
of

MASTER OF SCIENCE (MS)
IN
HORTICULTURE

SEMESTER: JANUARY-JUNE/2012

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This is to certify that the thesis entitled, **"POSTHARVEST CHALLENGES ON POTATO IN NORTHERN ZONE OF BANGLADESH"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka in the partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE in HORTICULTURE,** embodies the result of a piece of *bona fide* research work carried out by **MD. ANOWER HOSSAIN,** Registration No. **10-04217** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Dated: June, 2012

Dhaka, Bangladesh

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I dedicate this
to my
beloved parents.

ACKNOWLEDGEMENTS

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ABSTRACT

This study was conducted to find out the postharvest challenges on potato in northern zone of Bangladesh. Both primary and secondary data were used in this study. Study areas were Shibganj of Bogra and Kalai of Joypurhat district and a total of 120 respondents were randomly selected for interview. The selected characteristics: age, education, experience in potato cultivation, farm size, family size and annual income were selected for exploring their relationships with faced challenges by the respondents. In order to compare the challenges faced by the farmers, a challenge facing index (CFI) was computed for each aspects. All the postharvest challenges were measured in terms of severity. Among the challenges, rank 1st was low market price, rank 2nd was lack of marketing facilities and 3rd was lack of processing facilities during potato growing season 2010-11. Probable suggestion to overcome the existing challenges of the potato farmers were collected by their opinions. It may conclude that until the potato farmers are free from different challenges, they will not be in a position to adopt improved technology in potato cultivation.

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LIST OF ABBREVIATED TERMS

ABBREVIATIONS	FULL WORD
A.D.	After
Agril.	Agricultural
B.C.	Before Christ
BADC	Bangladesh Agricultural Development Corporation
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
BCR	Benefit Cost Ratio
CFI	Constraint facing index
CIP	International Potato Centre
CIPC	Chloroisopropyl-n phenylcarbamate
DAE	Department of Agriculture Extension
DEA	Data Envelopment Analysis
Dev.	Development
df	Degrees of freedom
e.g.	Example given
et al.	And others
etc.	Etcetera
EU	European Unions
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
ha	Hectare
HYV	High Yielding Variety
Kg	Kilogram
kg ha^{-1} day^{-1}	Kilogram per hectare per day
Km	Kilometer
Max.	Maximum
Mil	Million
Min.	Minimum
ml	Mili-litre
MS	Master of Science
mt	Metric tons
N/m	Not mentioned
NGO	Non Government Organization
No.	Number
NS	Non significant

ABBREVIATIONS	FULL WORD
NS	Not significant
r	Co-efficient of correlation
SAARC	South Asian Association of Regional Co-Operation
SAU	Sher-e-Bangla Agricultural University
Std.	Standard Deviation
Sust.	Sustainable
Tk/kg	Taka per kilogram
USA	United States of America
var.	Variety
Via	By way of
Viz.	Namely
%	Percent
@	At the rate
0C	Degree Celsius
&	And

CHAPTER-I
INTRODUCTION

1.1 General Background

Potato (*Solanum tuberosum* L.) popularly known as 'The king of vegetables', has emerged as fourth most important food crop in Bangladesh. Bangladeshi vegetable basket is incomplete without Potato. Potato is a staple food in the developed countries and which accounts for 37% of the total potato production in the world (FAO and CIP, 1995). The cost of potato cultivation is high compared with that of other crops, but the return of potato is also high (Elias *et al*., 1984).

Bangladesh is the 4th largest potato producing country in Asia and among the top 15 producers in the world. Bangladesh produces a total amount of 6-7 million mt per year where as the total cold storage capacity is about 1.8 million mt only. The growth of the industrial potato processing and export in Bangladesh is relatively slow. (Husain, 2010).

Recently, the government has been trying to diversify food habits and encourage potato consumption to reduce pressure on rice. So, potato is becoming an important food for food security in Bangladesh. It is reported in different newspapers that 5 thousands of tons of potatoes are going to rot due to lack of adequate cold storage facility (Moazzem and Fujita, 2004).

Postharvest 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 postharvest 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 (Iqbal, 1996; Ilangantileke *et al*., 1996). Reducing post-harvest losses is one of the efficient approaches in the improvement of potato farmers' livelihood (Yang, 2000).

Postharvest for potato is the critical sector for employment and potato farmers' basic interest. The potato is one of the most sensitive agricultural commodities to open competition, especially on post-harvest process, because of its social and technical implications (Gitomer and Charles, 1996).

The greater Bogra district (Bogra and Joypurhat) contributes about 8% of the total potato crop on 10.7% of the land under potato. The main producing areas are Kalai, khetlal, Bogra sadar, Shibganj and Gabtali upazila. The average yield is about 7.2 mt/ha (Rahman 1990).

Total cultivated area of potato in two upazilas (Kalai and Shibganj) was 27,414 ha and the maximum was 17,597 ha at Shibgonj of Bogra district. Area coverage by potato cultivation was 77% among the total cultivated area. Total production was 3, 32,424 mt, whereas the maximum was 1, 84,523 mt at Shibganj and the minimum 39,240 mt at Kalai. Average yield of potato was 14.34 mt/ha for these upazilas in 2009 which was below than the national average of potato growing countries (Uddin, 2009).

The present study was, therefore, designed to identify the postharvest challenges of potato and to suggest probable solutions in northern zone of Bangladesh which may be the common feature of whole Bangladesh.

1.2 Objectives of the study

From all the points of view, the present investigation was undertaken with the following objectives.

1. To identify the present status and postharvest position of potato.

2. To identify post harvest challenges of potato and probable solutions to overcome the challenges.

3. To study the relationship of characteristics of farmers and postharvest challenges on potato.

CHAPTER II
REVIEW OF LITERATURE

Potato now a day considered as being the most important crop of farmers. However, this sub-sector is not paying regular dividend as faces several challenges, out of them diseases and post harvest loss are considerably important. Potato are grown mostly everywhere in Bangladesh with special concentration in Northern zone of Bangladesh and central part also. The relevant information available on this area generated from different studies has been reviewed in this chapter.

2.1 Postharvest Challenges on Potato in Northern Zone of Bangladesh:

Alam's (1981) investigation reveals 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.

Area under potato (301.2 thousand hectares) covered 3.57% of cultivable land (8,440 thousand hectares). It covered 4% area of total crop grown in Rabi season. The average national yield of potato is quite low. As a vegetable crop, potato area is more than the total area of all other winter vegetables in Bangladesh (BBS, 2008).

At the grower level, potatoes sell at Tk 3-5 per kg now; it is almost half of the last year's harvest season prices. Most of the storage owners served notice on farmers and traders through local dailies and loudspeakers to take out their stock within October 15. The storage owners also warned that they would realize outstanding charges from the traders in case of missing the deadline (The Financial Express Bangladesh-October 08, 2011).

Azimuddin *et al.* (2009) expressed in a study that though Bangladesh has become a major potato producer in the SAARC countries, the status of this

crop has remained vegetable in the country. The time has come now for all of us to understand and appreciate the role of potato that can play an important role in the present food situation of Bangladesh. One of the major problems faced by developing countries in general and Bangladesh in particular, is the ever increasing population. As per the current trend, the population in Bangladesh is expected to be around 172.9 million by the year 2020. In order to further increase agricultural production, the only option is to grow high productivity crops, like potato. We have been relying heavily on the major cereal crops- rice, wheat and maize to feed the ever increasing population in our country. Such an over dependence on cereals should be reduced gradually if we have to ensure food security, in the decades to come. Potato can help to widen the food supply base and thereby help to minimize the risk of serious food shortages in the tropics and sub-tropics. Potato, one of the most productive crops can play a significant role in ensuring foods security.

Bakhsh and Ahmad (2006) estimated the technical efficiency in potato production by employing the Cobb-Douglas stochastic production frontier approach in Pakistan. The results indicated that potato farmers were 84% technically efficient, implying significant potential in potato production that can be developed. By shifting the average farmer to the production frontier, the average yield would increase from 20.825 mt/ha to 24.75 mt/ha using the available resources.

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 tonnes 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 (The Daily Star Bangladesh, April 17, 2011).

Ezekiel and Pandey (2008) showed in their study that potato has special significance since it gives exceptionally high yields per unit area in a relatively

short period. The dry matter production in potato is about 47.6 kg/ha/ day whereas wheat, rice and maize produce only 18.1, 12.4 and 9.1 kg/ha/day respectively.

Fuglie (2003) studied that simple processing of potato by farmers is including the starch-processing, noodles processing, dry-chips processing can generate good income if well organized in processing and marketing, as there is still a big market for the processed potato products. Surveys in Shandong, Sichuan and Inner Mongolia of China show that the whole village or township can become very specialized in potato processing, the whole village work on potato processing and make stable but higher income than other farmers without any post-harvest processing and more farmer labors, especially the young farmers, prefer to stay in their home village for the kind of self-employment to make more income by the product processing.

Gitomer and Charles (1996) studied in a study that postharvest for potato is the critical sector for employment and potato farmers' basic interests. Globalization and free trade pose a challenge to the economies of the developing countries. The potatoes are one of the most sensitive agricultural commodities to open competition, especially on postharvest process, because of its social and technical implications.

Hossain (2009) calculated in a study the disposal pattern of potato at farm level was that about 2.92% potato was used for family consumption, 0.52% was gifted to relatives or others, 62.04% was sold during harvesting period, 12.73% potato was stored in cold storage as seed and another 23.04% (cold storage 19.70% and home storage 3.34%) was stored as table potato and sold it later when price became high. Average harvesting loss in all areas was found to be 5.65% of total production. Harvesting loss comprised insect damage (1.21%), rotten loss (1.40%), cutting loss (1.14%); potato remained under soil during harvesting (0.89%), and other losses (1.02%) such as off size, green potato etc. Farmers stored 3.34% of potato in traditional storage for a period of 3 to 4 months. In this period the storage loss was found to be 7.35%. Total pre-

storage loss (harvesting, curing, cleaning and sorting) at farm level was 8.15% and total post harvest loss was found to be 15.50% including farm level storage loss.

Hossain (2009) found in a study that average post-harvest losses in the household and restaurant levels were 3.24, and 4.52%, respectively of purchased potato. This loss comprised rotten loss and processing loss. Total losses of traditional stored potatoes including consumers' loss were found to be 27.65% where for cold stored potatoes it was 23.11%. Total losses excluding consumer losses for traditional stored and cold stored potatoes were found to be 24.61% and 19.90%, respectively

Hossain (2009) identified two different types of potato marketing that were traditional stored and cold stored potato marketing. In the case of traditional stored potato, *Bepari* and *Faria* bought potatoes from farmer. The share of purchasing potato by *Bepari* (60.9%) was higher than the *Faria* (36.2%). *Bepari* bought a large amount of potatoes from farmers and directly sold to *Paiker* (38.9%), retailers (26.2%) and *Aratdar* (21.6%). Similarly, *Faria* bought potatoes directly from farmers and mostly sold them to *Bepari* (25.8%) and a small portion (10.4%) to retailer through *Aratdars*. *Paiker* bought a major portion of potato directly from *Bepari* (38.9%) and a very small amount from farmers (2.1%). They also bought a good amount of potatoes (20.9%) from *Faria* and other *Beparis* through *Aratdars*. *Paikers* sold their entire potatoes directly to the retailers. Retailers sold their whole quantity (100%) of potatoes to consumers. For cold stored potato marketing, *Bepari* and *Paiker* bought potatoes from cold storage (farmer/Stockiest). The share of purchasing potato by *Bepari* (73.2%) was higher than the *Paiker* (24.4%). *Paiker* also bought some potatoes (1.8%) from *Bepari*. *Aratdar* bought all of his potatoes of *Bepari*) from *Bepari* and sold 42.1% to the *Paiker* and 29.3% to the retailer. *Paiker* sold maximum amount (68.1%) of potato to retailer and a very small quantity too directly to consumer (0.2%). Retailer sold his whole quantity of (100.0%) but 99.8% of the channel of potatoes to the consumers. The average

losses at traders' level for traditional and cold stored potatoes were 11.95 and 9.61%, respectively.

Hossain (2009) studied the technical efficiency of potato storage system in cold storage. Here presented that different physical and biological factors are associated with cold storage to produce good quality of potato after storage of certain period. These inputs are social, financial, physical, environmental and biological. So, the management of a cold storage is a complex and difficult task. To estimate the efficiency, all of the factors are to be considered. It is necessary to identify the factors those have direct or indirect influence on the efficiency of cold storage system. Therefore, the storage efficiency or technical efficiency of cold storage is needed to access to identify its lacking so that its efficiency can further be improved.

Hossain *et al.* (2008) estimated the technical efficiency of potato production in Bangladesh. This study was carried out in three potato growing areas, viz. Munshigonj, Bogra and Jessore covering 75 potato growers to measure technical efficiency and economic performance of potato production. The estimated results showed that the average level of technical efficiency among the sample farmers was 75%. This implies that given the existing technology and level of inputs the output could be increased by 25%. Training on the potato production, extension linkage and quality seed played a significant role in the technical efficiency of the potato production.

Hundreds of potato growers in Shibganj upazila in the northern district have earned less than expected this season. Farmers cultivated a wide variety of potatoes, inspired by their high rate of production, but it failed to boost their income. In the last two months since the beginning of the harvest, the retail prices slumped more than 60 percent to Tk. 6-8 a kilogram at city markets, according to Trading Corporation of Bangladesh data (Dainik Amar Desh-February 1, 2011).

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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.

Moazzem and Fujita (2004) showed in their study that 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 are also made from potato. Recently, the government has been trying to diversify food habits and encourage potato consumption to reduce pressure on rice. So, potato is becoming an important food for food security in Bangladesh. It is reported in different newspapers that 5 thousand tons of potatoes are going to rot due to lack of adequate cold storage facility.

Nowadays, potato has emerged as a major food crop in Bangladesh and is being cultivated throughout the country. The total production of potato is 6648 thousands tons from the area of 400 thousands hectares. (BBS, 2008).

Postharvest losses from farm to market are high as a result of poor handling, storage and transportation techniques. At present the preserving capacity of 330 cold storages is about 2.6 million tonnes while around the country's annual consumption of potato is estimated at 6.0 million to 7.0 million tons (The Financial Express, December 4, 2010).

Potato should be stored in a suitable environment to prevent weight loss, rot, shrinkage, and sweetening, discolor 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). However, the storability of potatoes is already determined before the beginning of storage, by such factors as cultivar,

growing techniques, diseases before harvesting, and maturity of potatoes at the time of harvesting, damage to tubers during lifting, transport and filling of the store (Rastovesky, 1987; Burton *et al*., 1992).

Rashid (2008) found in a study that there are about 300 cold storages in Bangladesh with a capacity of 2.2 million tons. In the year 2008, about 27.5% of total production of potato was stored in the cold storage including seeds.

Rashid (2008) showed in a study that postharvest losses of vegetables are high as 20-50% in developing countries. Iqbal and Ilangantileke *et al*. (1996) showed that in India, postharvest losses of potato are 17% and in Pakistan these losses ranged 15-40%. But, in Bangladesh data on postharvest 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.

Rashid *et al.* (2001) identified problems of the potato growers during 2000-2001 that were in order of rank 1. Lack of quality seed, 2. Lack of cash money, 3. Higher price of inputs, 4.Lack of storage facility, 5. Lower price of product at harvesting period, and 6. Lack of adequate labor in the production period.

Scott (1985) showed in a study that the expansion of production over the same period has been even stronger rising from 0.12 to 1.16 million mt at an average annual growth rate of 23%.

Scott (1985) showed in his study that potato has become an increasingly an import crop in Bangladesh. From 1955 to 1985 the annual area planted to potatoes increased from 25,900 to 111,300 ha with an average annual growth rate of 10%.

Shetty, 1998 found that when potatoes lose excessive moisture they shrink and may become unmarketable. Sprouting will significantly increase water loss in stored and transported potatoes. Sprouting will also diminish the nutritive

quality of the potato. Therefore, sprout inhibitors are required after potatoes pass their dormant phase.

Skerritt and Greg (2001) studied the actual situations in the rural areas of Asian developing countries indicate that need for low-cost technology to produce, process and add-value, while maintaining quality of its products. Research on both technology and improvement in infrastructure is critical in reaching this goal.

Tsubota (1999) noted that post-harvest technologies become more complex along with economic development. Technologies are generally more agricultural production and product-oriented during the early stages of economic development. In this phase, technologies are not sophisticated and post-harvest enterprises are small-scale, and post-harvest chains are short and simple. Technologies and systems become more complex with development, and at present, many Asian countries are somewhere in the middle stage.

Tsubota (1999) studied in a study that the postharvest processing of potato is a major practice for adding value to this crop through traditional processing or modern technology in developing countries. 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 post harvest practices used for processing of potato in rural and peril-urban areas. These processing technology increases the income of the rural people. This enhances the use of potatoes during the harvesting season and reduces the pressure of storage of potato in cold storage. This may also enhance more consumption of potato as alternative food rather than cereals. The integration of traditional practice and modern technology also help both the farmers and the processing industries which tend to generate more jobs. Potato fries and chips can be processed using the traditional indigenous practices, varies from place to place. In the hilly areas, the traditional practice is the major way of keeping the potato as staple. The technologies used for the traditional practices are simple, in most case, are

still by manual or facilitated by very simple machines. Industrial processing with modern technology can be applied to potato starch processing, food processing, and manufacturing of alcohol, synthetic rubber, cellulose, rayon, perfume, glucose, amylase, and sugar syrup. New technology has developed in the developed countries to process potato into starch or modified starch for textile, foundry, iron-casting, electronic, paper-making, pharmaceutical, rubber and chemical industries.

Wang (2000) studied that processing and exports of potato are market opportunities to expand potato production and stabilize prices. Nevertheless access of smallholders to the industrial production market has been quite limited because industry suppliers prefer to deal with a group number of large producers. In addition, most of frozen fries used by trans-national fast-food corporations and franchises are imported from developed countries. The possibility of building local processing plants has been hampered by the low competitive advantage of local raw material that does not meet price expectations or quality standards. Exports of potatoes in-nature from developing countries to Europe or North America face severe phytosanitary barriers. Exclusion of smallholders from the specialized segments of the market may lead to a process of concentration of property that may force many farmers to go back to subsistence agriculture or look for alternative crops or, even worse, migrate to cities where employment opportunities are scarce.

Yang (2000) concluded in a study that postharvest is one of the efficient approaches in the improvement of potato farmers' livelihood. The actual situations in the rural areas of Asian developing countries indicate that the needs for low-cost technology to produce, process and add-value while maintaining quality of its products. Research on both technology and improvement in infrastructure is critical in reaching this goal.

Yang (2000), Lin et al. (2003) and Huang et al. (2003) noted the same idea in their study that the development of an agro-processing of agricultural

commodities can generate employment in several ways. First, there is an employment in the processing industries themselves. Second, there is employment in wholesale and retail trade, bringing raw materials from farms to processors and finished products from processors to consumers. Third, agro-processing can generate more employment by increasing the demand for the agro-commodity. This stimulates more farm production than would have been the case without agro-processing, creating more farm work. Finally, expansion of agro-processing creates employment in related industries, such as suppliers of machinery and other inputs to the processing enterprises.

2.2 The Post harvest Challenges on Potato faced by the farmers and their selected characteristics

Gaikwad et al. (1969) in a study found a positive relationship between size of farm and adoption behavior.

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

Hossain (1985) in a study on landless laborers in Bhabakhali union of Mymensingh district found that there was no relationship between age of the landless laborers and their problem confrontation.

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

Ismail (2001) conducted a study and revealed that there was no significant relationship between education and problem confrontation of farm youth. Similar findings were obtained by Raha (1989) in his respective studies. Thus it

could be concluded that an overwhelming majority of the researchers found a negative relationship between these two variables.

Kashem (1977) in his study on the landless laborers on Barakhata union under Rangpur district examined the relationship between farm size of landless laborers and their problem confrontation. He found a significant negative relationship between barga farm size of the landless laborers and their problem confrontation.

Lionberger (1966) after reviewing the situational factors from the related literature in the field of adoption of new ideas and practices concluded that size of farm was nearly always positively related to the adoption of new farm practices.

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

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.

Rashid (1975) in his study found that there was no relationship between the farm size and their agricultural problem confrontation.

2.3 Conceptual Framework of the study

Based on this discussion and review of literature the conceptual framework of this study has been formulated and shown in the Figure 1.

Dimensions of challenges

- Yields of potato

Independent variables

Farmer's characteristics
• Age
• Education
• Farm size
• Annual income
• Experience on potato cultivation
• Family size

Dependent variables

Postharvest Challenges faced by the farmers on Potato

• Marketing facilities
• Preservation facilities
• Low market price
• Rot in home or cold storage
• Cold storage availability
• Processing facilities
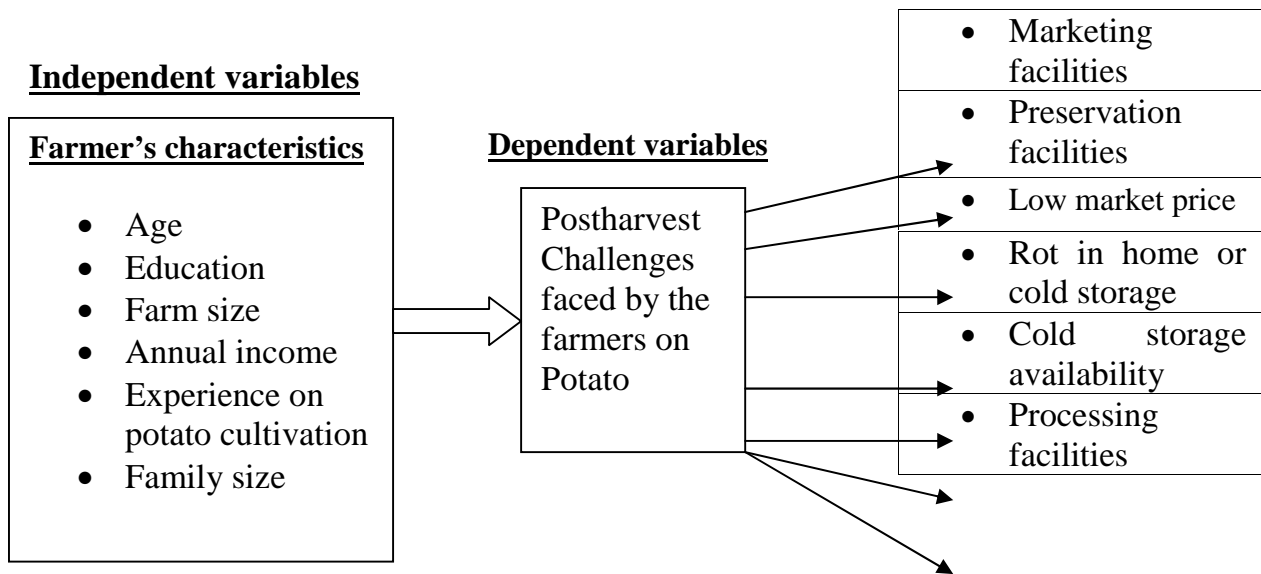
Figure 1 Conceptual framework of this study

CHAPTER III

MATERIALS AND METHODS

Details of experimental materials and methods followed during the time of the present investigation are described in this chapter.

3.1. Postharvest challenges

The input cost is sometimes higher than output cost because of various mismanagement and wrong policy which can be called as Post harvest challenges. Data were collected on various Postharvest challenges by their severity faced by potato growers. Therefore, there is a need for both short and long term storage of potato. After harvesting, a series of operations need to reach in the consumers' table termed as postharvest operations. During these operations, some losses occur is called post-harvest losses (Ritenour, 2003).

3.2 Study Areas:

There were 51 blocks under 17 unions in two selected upazilas such as Shibgonj of Bogra and Kalai of Joypurhat district of Bangladesh. Potato production related information of these upazilas was collected. These two upazillas were considering the local of northern zone of Bangladesh and these areas are one of the major potato growing zone. On preference, it was selected for this study.

3.2.1 Shibganj

Shibganj is an Upazila of Bogra District in the Division of Rajshahi, Bangladesh. Shibganj is a very beautiful upazila of Bogra District. Shibganj Upazila with an area of 314 square kilometers is bounded by Gobindaganj upazila on the north, Bogra Sadar, Kahaloo and Dupchanchia upazilas on the south, Sonatola and Gabtali upazilas on the east, and Kalai and Khetlal upazilas on the west. There are 12 unions in Shibganj upazila. Those are Buriganj, Atmul, Pirob, Majhihotto, Bihar, Kichak, Roynagar, Deuli, Mokamtala, Saidpur, Moydanhata and Shibganj.

Statistics: Population 312773; male 51.39%, female 48.61%; Muslim 94.46%, Hindu 5.39%, others 0.15%. Average literacy 24.1%

Agricultural Contribution: Main crops are Paddy, wheat, potato, onion, garlic, ginger, turmeric, betel leaf, jute and sugarcane.

Fruits: Main fruits Mango, jackfruit, litchi, banana, papaya, guava, futi (a native variety of melon) etc.

Fig-2: Map of Shibganj upazila in Bogra district, Bangladesh

(Source: Banglapedia: internet)

3.2.2 Kalai Upazila

Kalai Upazila is an important upazila in Joypurhat District which was established in 1981 with an area of 166.30 sq km. There are special cultures, tradition and activities are here. This upazila is known to all as a communal delight upzila in Joypurhat district. Most of people in this district are gentle and Law and Order situation are also good without some exception. It is bounded by Panchbibi and Gobindagonj upazilas on the north, Shibgonj and Gobindaganj upazilas on the east, Khetlal and Shibganj upazilas on the south and Khetlal and Joypurhat sadar upazilas on the west. Main rivers are Harabati and Nagor.

Fig-3: Map of Kalai upazila in Joypurhat district, Bangladesh

(Source: Banglapedia: internet)

Statistics: Population 114183; male 50.86%, female 49.14%; Muslim 95.06%, Hindu 4.76%, Tribal and others 0.18%. Average literacy 23.6%%

Agricultural Contribution: Main crops are Paddy, jute, wheat, mustard seed, potato, sugarcane and vegetables. Cultivable land 13017 hectares, fallow land 3625 hectares; single crop 1%, double crop 75% and triple crop 24%; cultivable land under irrigation 98%.

Fruits: Main fruits are Mango, jackfruit and papaya.

3.3. Sampling Technique

A total of 120 respondents were randomly selected for collecting primary data and information for the present study. Among total respondents, 60 potato growing farmers from each upazilla were selected for interview irrespective of farm size (e.g. small, medium, large, etc.). They were interviewed for gathering data and information regarding potato processing, marketing, storing and post-harvest losses. Interviews were held at their house or their field while respondents were working. From each upazilla, we were randomly selected and interviewed. Here the researcher were excluded the landless because they were maximum engaged with day laboring not in potato growing.

3.4. Preparation of questionnaire

A questionnaire was prepared for data collection in English keeping the objectives of the study in view. The questionnaire was both simple and direct form of question to collect data on the selected variables. The interview questionnaire was modified according to expert's comments and with the help of my supervisor. The interview questionnaire was pre-tested and then finalized after completing necessary corrections. The interview questionnaire was then multiplied in its final form to collect data.

3.5. Method of data Collection

Pre-tested interview questionnaire were used for collecting data and information from potato farmers. Data and information were collected by the

direct supervision of farmers and discuss with them. Data were collected by direct interview with a set of questionnaire designed for this study. For present study, in case of farmer's fields, the simple random survey method was used and it was made multiple visits to collect recent data. Questions were asked in such a way as to create interest among the respondents avoid boring. In case of any inconsistency, data were rechecked and corrected through repeated visits.

3.6. Data collection parameter

1. Name and address of the respondents

2. Farm size including homestead area

3. Sources of income of the respondents

4. Financial support and the expense in potato cultivation

5. Factors affecting on potato yield

6. Consumption, storage, and sale condition of potato

7. Post harvest problems and their nature of potato

8. Potato use rather than other vegetables

9. Average wholesale price and yield of potato

10. Sources of potato seed

11. Why farmers to grow potato

12. Major problems in potato cultivation

13. Preference of growing vegetable crops

14. Land use by major varieties of potato and total production of potato in Shibgonj and Kalai upazila

15. Suggestions to overcome the existing challenges

3.7. Selection of variables

The personal and socio-economic conditions (variables) of the respondents were included in this study. The independent variables are age, occupation,

education, annual income, family size, farm size and involvement duration of potato cultivation. Data were collected on various parameters such as yields, market price, post harvest problems of potato cultivation and their nature, probable suggestions etc. which are dependent variables.

3.7.1. Independent variables

3.7.1.1 Age: There is no relationship between the age of the farmers and their faced constraints in potato cultivation. Age of a respondent was measured in terms of actual years from his birth to the time of interview. A score of one (1) was assigned for each year of age. No fraction of year was considered.

3.7.1.2 Education: Education of an individual farmer was defined as the formal education received up to a certain level from an educational institute at the time of interview. It measured in terms of actual years of successful schooling. Education was measured in terms of grades of education (school/college) completed by an individual. It was expressed in terms of year of schooling. A score of one (1) was assigned for each year of successful schooling completed. For example, If a respondent did not know how to read and write, his education score was given as '0' (zero), if he passes the final examination of class five, his education score was given as 5, if he passes the final examination of class eight, his education score was given as 8, if a respondent passed the S.S.C examination, his education score was given as 10, if he passed the HSC examination, his education score was given as 12 and if he passed the BA examination, his education score was given as 14.

3.7.1.3 Farm size: Farm size of the respondents refers to the area owned by a farmer on which he carries 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 him on

borga or given others for cultivation on *borga* basis. Farm size was measured for each respondent in terms of hectares by using the following formula:

Farm size= $A_1 + A_2 + \frac{1}{2}(A_3 + A_4) + A_5$

Where,

A_1= homestead area of the respondent (own house)

A_2= Own land under own cultivation

A_3= Area taken on *borga* system

A_4= Area given to others on *borga* system

A_5= Area taken from others on lease

3.7.1.3 Family size: Family size of the respondent refers to the total numbers of family members of a respondent on which he carries his family. Family size of the respondents was measured by the numbers of existing family members.

3.7.1.6 Annual income: Annual 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 and was expressed in taka. Family income of a respondent was measured on the basis of total yearly earning from agriculture and other sources (service, business, daily labor etc.) by the respondent himself and other family members. For calculation of income score, one (1) score was assigned for one thousand taka yearly income.

3.7.1.6 Experience on potato cultivation: Usually Experience on potato cultivation of an individual is judged by duration in involvement on potato cultivation. However, in this study experience deals with only on potato cultivation.

3.7.2. Dependent variables

3.7.2.1 Yields of potato: Yields of potato refers to collected amount of potato from the farm when it is harvested. Data was collected in mound (about 37.5 kg) which was transferred into kg and then in ton (1000 kg). Challenge regarding yields of potato was measured by its severity faced by the potato growers.

3.7.2.2 Preservation facilities: The term preservation facilities meant the entire handling procedures, i.e. harvesting, grading, packaging, marketing, cooling and storage. Challenge regarding preservation facilities of potato was measured by its severity faced by the potato growers.

3.7.2.3 Processing facilities: The term processing facilities meant the procedures of making food items or alternative use of potato. Challenge regarding processing facilities of potato was measured by its severity faced by the potato growers.

3.7.2.4 Marketing facilities: The term marketing means the entire process of directing the flow of goods and services from producer to consumer. Challenge regarding marketing facilities of potato was measured by its severity faced by the potato growers.

3.7.2.5 Market price: Market price is defined as unit price (Tk /kg or Tk / mound). Data was collected in Tk/mound which was transferred into Tk /kg and then in Tk/mt (1000 kg). Challenge regarding yields of potato was measured by its severity faced by the potato growers. Again to find out profitable variety of potato, it needs to calculate Benefit Cost Ratio (BCR) as follows–

$$BCR = \frac{Gross\ return\ (Tk/kg)}{Cost\ of\ input\ (Tk/kg)}$$

3.7.2.6 Rot in home or cold storage: Rot in home or cold storage is defined as the loss of potato due to rough weather or by attacking pathogens. Challenge regarding rot in home or cold storage was measured by its severity faced by the potato growers.

All the post harvest challenges were measured in terms of severity. If it was not severe the score was given as 0, it was less severe the score was given as 1, if it was moderate severe the score was given as 2 and if it was high severe the score was given as 3. The potato post harvest challenges score could range from 0 to 24 for any one of the selected dimensions where up to 8 indicated low challenge facing, 9 to 16 indicated medium challenge facing and 17 to 24 indicated high constraint facing.

3.8 Data processing

After completion of survey the entire interview schedules that was complied for data processing. At the beginning of the data processing all the qualitative data were converted into quantitative form by means of suitable code and score whenever necessary. Local units were converted into standard units.

3.9 Statistical treatment

In order to explore the relationships between the constraints of the farmers and the selected independent variables, Co-efficient of correlation (r) was measured. The computed value of 'r' was compared with the table value of 'r' to find out whether it was significant or nonsignificant. As a rough and ready guide to the meaning of '(r)' the table (1&2) offers a descriptive interpretation.

Table 1 The values of '(r)' and their corresponding meaning

'(r)' value	Meaning
0.00 to 0.19	very low correlation
0.20 to 0.39	low correlation
0.40 to 0.69	moderate correlation
0.70 to 0.89	high correlation
0.90 to 1.00	very high correlation

Table 2 Table value '(r)' with (80-2) =78 degrees of freedom

Level	Table value '(r)' with (80-2)=78 degrees of freedom
0.05 Level	0.221
0.01 Level	0.286
0.001 Level	0.368

*=   Significant at 0.05 level of probability where table value**'(r=0.221)'** with **(80-2)=78 degrees of freedom**

=   Significant at 0.01 level of probability where table value'(r=0. 286)'** with **(80-2)=78 degrees of freedom**

***= Significant at 0.001 level of probability where table value**'(r=0.368)'** with **(80-2) =78 degrees of freedom**

NS= Not significant

Source: Choen and Holliday, 1982

3.10 Comparative Constraints/Challenges Facing Index of farmers in eight selected dimensions of Post-harvest challenges

Comparative challenge facing index of farmers in eight selected Postharvest problems and their nature faced by potato farmers according to their opinion on potato cultivation were investigated in this study. It was considered necessary to have an understanding about the nature of challenges facing by the farmers in these different dimensions, namely low market price, lack of marketing facilities, lack of processing facilities, lack of preservation facilities, rot in home storage, rot in cold storage, cold storage availability, and low yield. For this purpose, a Constraint/Challenge Facing Index (CFI) was computed for each of the eight dimensions by using the following formula as used by Mansur (1989) and Raha (1989).

Constraint/ Challenge Facing Index (CFI) = P_l x 1 + P_m x 2 + P_h x 3

Where

P_l = Percentage of farmers having low challenge facing

P_m = Percentage of farmers having medium challenge facing

P_h = Percentage of farmers having high challenge facing

Challenge Facing Index (CFI) for any one of the selected dimensions could range from 0 to 360 where up to 120 indicated low challenge facing, 121 to 240 indicated medium challenge facing and 241 to 360 indicated high constraint facing.

3.11 Suggestions to overcome the existing challenges

Data were collected by giving suggestions to overcome the existing challenges. For calculation of score, one (1) score was assigned for one suggestion of the respondents.

CHAPTER IV
RESULTS AND DISCUSSION

Presented in this chapter are the findings of the study and interpretations of results. This chapter is divided into three sections and presented according to the objectives of the study.

4.1 Socio-economic Characteristics of Potato Farmers

Different farmers possess different characteristics. The selected characteristics of the farmers were; age, education, experience in potato cultivation, farm size, family size and annual income. These six characteristics of the farmers with their relationships to the postharvest challenges faced in potato cultivation have been described in this chapter.

Table 3 Characteristics profile of the respondents

Sl. No	Characteristics	Measured by	Actual value		Mean value
			Minimum	**Maximum**	
01	Age	Year	27	65	40.93
02	Education	Scoring	0	14	7.05
03	Experience on potato cultivation	Year	5	32	18.17
04	Farm size	Hectare	0.21	3.38	1.4795

05	Family size	Person	3	9	4.33
06	Annual income	Taka in thousand	46	310	162.33

Data presented in table 3 shows the actual value and the mean value of every selected characteristics of the farmers overall in the study area. The minimum age of the respondents was 27 years and maximum was 65 years with a mean of 40.93. Education level was scoring according to passing years in which "o" means no education of the respondents and 14 means graduate level education. Education level was ranged from 0 to 14 with a mean of 7.05. Experience on potato cultivation of the respondents was measured by years in which minimum experience was 5 years and maximum was 32 years with a mean of 18.17. Farm size of the respondents was measured by hectares in which minimum farm size was 0.21 hectares and maximum was 3.38 hectares with a mean of 1.4795. Family size of the respondents was measured by number of the members in which minimum family size was 3 persons and maximum was 9 persons with a mean of 4.33. Annual income of the respondents was measured by Taka in thousand in which minimum Annual income was 46 thousand taka and maximum was 310 thousand taka with a mean of 162.33.

4.1.1 Age of the respondents

Most of the farmers (52.5%) in Shibganj upazila and Kalai upazila were relatively in the age group of 35-50 years. But in Shibganj upazila the highest age group of farmers (48%) was in the age range of 35-50 years followed the young farmers (30%) in the age range of under 35 years. The higher number of old farmers (above 50 years) was engaged in potato farming than the youth group (below 35 years) in all study areas where the share of the old was 27.5% and the youth farmers was 20%. About one fourth old (above 50 year) farmers out of the total were engaged in potato farming in Shibganj and Kalai upazila areas because many young farmers of these places had been working in foreign countries and engaged in various work. Average share of below 35

years, 35-50 years and age above 50 years of the sampled potato farmers of all study areas were 20, 52.5, and 27.5%, respectively.

Table 4 Classification of the farmers according to their age

Categories	Age in Years	Potato farmers of Shibganj upazila		Potato farmers of Kalai upazila		All areas	
		Number	%	Number	%	Number	%
Young	Up to 34	18	30	06	10	24	20
Middle-aged	35to 50	29	48	34	57	63	52.5
Old	Above 50	13	22	20	33	33	27.5
Total		60	100	60	100	120	100

4.1.2 Level of education

22% of in Shibganj upazila and 28% the farmers of Kalai upazila areas completed primary level education (up to Class V). The most the farmers (41%) of Shibganj upazila of Bogra and the farmers (35%) of Kalai upazila of Joypurhat areas are completed secondary level education (Class VI- X). The notable numbers of above secondary level education completed farmers (17%) of Shibganj upazila of Bogra and Kalai upazila of Joypurhat (15%) were engaged in potato farming because relatively young farmers cultivated potato commercially in this area. The level of illiterate farmers was found in Shibganj and Kalai upazila were 20% and 22% respectively. The level of literacy in all areas was found higher (79%) than the average in Bangladesh.

Table 5 Classification of the farmers according to their education

Categories	Level of Education	Shibganj upazila		Kalai upazila		all areas	
		Number	%	Number	%	Number	%
No education	Unable to read and write	12	20	13	22	25	21
Primary education	Class I to V	13	22	17	28	30	25
Secondary education	Class VI to X	25	41	21	35	46	38
Above secondary education	Above class X	10	17	09	15	19	16

Total	60	100	60	100	120	100

Most of the sampled potato farmers (63%) in the study areas reached the primary and secondary education. Generally, during primary and secondary schooling, the fathers or guardians of the sampled potato farmers gave the charge of their family and   lands to their elder sons and thus they could not further continue their higher education. Sometimes they forced to leave school and engaged in family earning due to economic crisis.

4.1.3 Experience in potato Cultivation

Computed scores of the farmers about experience in potato cultivation ranged from 5 to 32. On the basis of experience of the respondents were classified into three categories as follows in table 6.

Table 6 Classification of potato farmers according to their experience on potato cultivation

Categories	Experience in Years	Potato farmers		Average
		Number	**%**	
low experience	Up to 10	16	13.33	8.5
Medium experience	11to 25	85	70.83	18
High experience	Above 25	19	15.84	28
Total		120	100	

Data contained in table 6 shows that most of farmers (70.83 **%**) had a moderate experience to more experience (15.84 **%**) in potato cultivation as compared (only 13.33 **%**) having low experience respectively.

4.1.4 Farm Size

Farm size of the respondents ranged from 0.54-3.38 hectare. On the basis of their farm size, the farmers were classified into three categories as shown in table 7.

Table 7 Classification of farmers according to their farm size

Categories	Farm size in (ha)	Potato farmers of Shibganj		Potato farmers of Kalai		Potato farmers all areas	
		Number	%	Number	%	Number	%
Small farm	Up to 1	20	33.33	15	25	35	29.17
Medium farm	Above 1.1 to 3	37	61.67	41	68.33	78	65
Large farm	Above 3	3	5	4	6.67	7	5.83
Total		60	100	60	100	120	100

Data presented in the table 7 shows that overall in the study area the highest proportion (65 **%**) of the farmers had medium farm compared to 29.17 % having small farm and only 5.83 **%** had large farm. The findings indicate that 70.83 **%** of the potato farmers had medium to large farm size.

4.1.4 Family Size

On the basis of family size, the respondents were categorized into three groups as shown in table 8. Data presented in the table 8 shows that overall in the study area the highest proportion (63.33 **%**) of the farmers had Small family compared to 32.50 **%** having medium family and only 4.17 **%** had large family. The findings indicate that 95.83 **%** of the potato farmers had small to medium family size.

Table 8 Classification of potato farmers according to their Family Size

Categories	family size in (person)	Potato farmers	
		Number	**%**
Small family	Up to 4	76	63.33
Medium family	5 to 7	39	32.50
Large family	Above 7	5	4.17
Total		120	100

Family size of the farmers ranged form 3 to 9 person. The average family size of the sampled potato farmers of all study areas was found to be 4.33 which is

less than average of Bangladesh which is 5.11 (BBS-2011) respectively. Its significance is not important because this data is collected from randomly selected respondents.

4.1.6 Annual Income

Annual income of the farmers ranged form 46 to 310 thousand taka. On the basis of annual income, the respondents were categorized into three groups as shown in table 9.

Table 9 Classification of potato farmers according to their annual Income

Categories	Annual income (taka in thousand)	Potato farmers	
		Number	%
Low income	Up to 120	33	16.5
Medium income	121 to 250	62	51.67
High income	Above 250	25	20.83
Total		120	100

Data presented in table 9 shows that overall in the study area the highest proportion (51.67 **%**) of the respondents had medium income that was followed by low (27.50 **%**) and high (20.83 **%**) income earners. Generally higher income gives an individual better status in the society. Therefore, the higher incomes increase the risk taking capacity of the farmers in potato cultivation.

4.2.1 Postharvest potato using pattern of potato

Postharvest using pattern of potato at farm level is shown in table 10. The highest quantity of potato produced per farm family was in Kalai upazila and the lowest in Shibganj upazila areas. This might be due to higher yield and use of more HYV in Kalai upazila area than that of Shibganj upazila.

Average potato production per farm was 27320.52 kg for all area. About 1.65% of the potatoes were used for family consumption by the potato farmers and

3.25% of the potatoes were used as seed. A major portion (69.21%) of the potatoes was sold during the harvesting period.

About 9.92% of the potatoes were traditionally stored in house and 15.97% of the potatoes were stored in cold storage (Table-10). The potatoes stored in home storage or cold storage were used as seed for planting in the next season or as table potato and sold later when prices became high. But the potato market during 2010-11 was ill fated to the farmers.

Average potato production per farm in Shibganj upazila was 23800.25 kg but in Kalai upazila more than Shibganj upazila which was 30840.80 kg per farm. About 1.75% of the potatoes for family consumption, 4.31% for seed purpose, 72.27% for direct sale during harvest time and rest of the amount (21.67%) were stored by the potato farmers in home or cold storage for sale or seed purpose (Table 10) in Shibganj upazila. On the other hand, Post harvest potatoes were used as food (1.54%), seed (2.20%), homestorage (12.28%), cold storage (17.83%) and direct sale (66.15%) during harvest period in Kalai upazila.

Table 10: Postharvest using pattern of potato

Post harvest potato using as	Shibganj upazila		Kalai upazila		All area	
	Average amount (kg/year)	% of total use	Average amount (kg/year)	% of total use	Average amount (kg/year)	% of total use
food	417.75	1.75	473.62	1.54	445.68	1.65
seed	1025	4.31	679.68	2.20	852.34	3.25
sale	17200	72.27	20400	66.15	18800	69.21
home storage	1800	7.56	3787.5	12.28	2793.75	9.92
cold storage	3357.50	14.11	5500	17.83	4428.75	15.97
total	23800.25	100	30840.80	100	27320.52	100

4.2.2: Comparative study of land use for potato cultivation, average wholesale price and yield.

Data presented in table 11 shows the comparative study of land use (ha/farm), average wholesale price (Tk /kg) and average yield of potato (mt/ha) in overall study area of four years from 2008 to 2011.

Table 11: Comparative study of land use for potato cultivation, average wholesale price and yield

Particulars	2008	2009	2010	2011
Land use for potato cultivation (ha/farm)	1.60	1.66 (+ 3.75%)	1.74 (+4.82%)	1.55 (-10.92%)
Average wholesale price (Tk./ kg)	-	6.16	5.04 (-18.18%)	5.36 (+10.92%)
Average yield of potato (mt/ha)	-	19.496	21.389 (+9.71%)	22.178 (+3.73%)

The highest average land use for potato cultivation (ha/farm) was 1.74 in 2010 that was followed by the lowest average land use for potato cultivation (ha/farm) was 1.55 in 2011. Again the average land use for potato cultivation (ha/farm) was 1.60 in 2008 and 1.66 was in 2009. The highest average wholesale price (Tk / kg) was 6.16 in 2009 that was followed by the lowest average wholesale price (Tk / kg) was 5.04 in 2010 and 5.52 was in 2011. On the other hand, the highest average yield of potato (mt/ha) was 22.178 in 2011 that was followed by the lowest average was 19.496 in 2009 and 21.389 was in 2010. It reveals that Land use for potato cultivation (ha/farm) is higher when the average wholesale price (Tk / kg) is higher in the previous year. When the average wholesale price (Tk / kg) is high, then average yield of potato (mt/ha) is low. On the other hand, when the average yield of potato (mt/ha) is high, then the

average wholesale price (Tk / kg) is low. Some times, the average wholesale price (Tk / kg) is so low that potato growers can not get back their investment. It is the great drawbacks to sustain potato cultivation. So this discriminatory behavior of potato pricing is a big challenge.

4.2.3 Profitable variety of potato

Data presented in table 12 shows that overall in the study area the highest BCR was 1.30 for the variety of Dimont and the lowest was 1.02 for the Granola. The highest average output/ha107.91 (taka in thousand) for the variety of Dimont and the lowest was 78.05(taka in thousand) for the Granola. On the other hand, the highest average input/ha 83.91 (taka in thousand) for the variety Telpakri and the lowest was 76.30 for the Granola. But, the highest average profit/ha was 25.83 (taka in thousand) for the variety Dimont and the lowest was 1.75 (taka in thousand) for the Granola.

Table 12: Profitable variety of potato

variety of potato	Average output/ha (taka in thousand)	Average input/ha (taka in thousand)	Profit (taka in thousand)	Cost Benefit Ratio (CBR)	Ranked of Profitable variety
Dimont	107.91	83.08	25.83	1.30	1
Lalpakri	102.65	82.96	21.69	1.23	2
Hagrai	96.20	82.64	13.56	1.16	3
Cardinal	92.97	82.96	21.69	1.12	4
Telpakri	91.79	83.91	7.88	1.09	5
Suriyamukhi	86.10	81.06	5.04	1.06	6

Alvery	79.67	77.02	2.65	1.03	7
Granola	78.05	76.30	1.75	1.02	8

Based on the above findings, it may be concluded that Dimont and Granola were the most and the least profitable variety of potato respectively.

4.2.4 Source of financial support for potato cultivation by various Farm groups

Data presented in table 13 shows that overall in Shibganj upazila the highest proportion (26.5 %) of the small farm group managed their financial support for potato cultivation by taking loan from various source that was followed by Medium (8.75 %) and Large (0 %) farm group. On the other hand, the potato farmers in Kalai upazila the highest proportion (23.5 %) of the small farm group managed their financial support for potato cultivation by taking loan from various source that was followed by Medium (10 %) and Large (0 %) farm group. Average loan taking of various farm groups was 11.46% of total respondents in overall study area.

Table 13: Source of financial support for potato cultivation by various farm groups

Farm size	Shibganj upazila (%)		Kalai upazila (%)		all area (Average %)	
	loan	own	loan	own	loan	own
Small	26.5	73.5	23.5	76.5	25	75

Medium	8.75	91.25	10	90	9.37	90.63
Large	0	100	0	100	0	100
Average	11.75	88.25	11.17	88.83	11.46	88.54

Based on the above findings, it may be concluded that large farm group managed the source financial support for potato cultivation by them; they did not take any loan for this purpose. Small farm group managed the source financial support (25%) for potato cultivation by taking loan from various source. They repay their loan after harvest by selling potato at low price during harvest period. So they face challenge severely. On the other hand, Medium farm group managed the source of financial support (9.37%) for potato cultivation by taking loan from various source. Generally higher income group leads a better status in the society. Therefore, the large farm group has the risk taking capacity of the farmers in potato cultivation. So they need not take any loan for this purpose.

4.2.5 Why farmer to grow Potato

Data were collected by giving opinion of the respondents to identify Why farmer to grow Potato. For calculation of score, one (1) score was assigned for one opinion by one respondent and they could choice one option. Based on the collecting data, it is safely to conclude that the farmers were interested to grow potato because of profitable, easy growing, huge demand, high yielding than others, and potato growing region. Data presented in table 14 shows that 1st ranked option was Potato growing region and least was easy growing.

Table 14: Why farmer to grow Potato:

Particulars	Shibganj upazila		Kalai upazila		All area		
	score	%	score	%	score	%	Rank
Potato growing region	26	43.33	27	45	53	44.17	01
HY. than others	21	35	24	40	45	37.50	02
Profitable	7	11.67	5	8.33	12	10	03
Huge demand	5	8.33	4	6.67	9	7.50	04
Easy growing	1	1.67	0	0	1	0.83	05
If others	0	0	0	0	0	0	-
Total	60	100	60	100	120	100	

4.2.6 Potato consumption and marketing

Data presented in table 15 shows that overall in study area the highest potato was used for consumption and seed purpose (8.66%) by small farm group that was followed by medium (5.19%) farm group, and only 2.57% by large farm group. The highest amount of potato marketing was (97.43%) by large farm group that was followed by medium amount (94.81%) of potato marketing by medium farm group and 91.34% by small farm group. The average potato marketing by all farm groups was 94.53%.

Table 15: Potato consumption and marketing

Farm size	purpose		marketing pattern	
	Consumption and seed	Marketing (%)	Direct sell (%)	Through middle-men (%)

	purpose (%)			
small	8.66	91.34	37.33	62.67
medium	5.19	94.81	47.33	52.67
large	2.57	97.43	52.32	47.68
Average	5.47	94.53	45.66	54.34

On the above data, it was found that overall in study area the potato marketing pattern 37.33% direct sell and 62.67% through middle men by small farm group that was followed by 47.33% direct sell and 52.67% through middle men by medium farm group and 52.32% direct sell and 47.68% through middle men by large farm group. The average marketing pattern by all farm groups was 45.66% direct sell and 54.34% through middle men.

4.2.7 Alternative crops rather than potato

Data were collected by giving opinion of the respondents to identify the alternative crops rather than potato. For calculation of score, one (1) score was assigned for one opinion. Based on the collecting data, the investigator concluded that there were the most wanted alternative crops rather than potato was mustard and the least wanted was teasle gourd.

Table 16: Alternative crops rather than potato:

Alternative crops	Shibganj upzila		Kalai upzila		All area		
	score	ranked	score	ranked	score	%	ranked
Mustard	17	1	27	1	44	36.67	1
Maize	12	3	13	2	25	20.63	2

Wheat	07	4	11	3	18	15	3
Cucumber	13	2	02	5	15	12.5	4
Bottle gourd	05	5	03	4	08	6.67	5
Ash gourd	03	6	02	5	05	4.17	6
Brinjal	02	7	01	6	03	2.5	7
Teasle gourd	01	8	01	6	02	1.67	8
If others	0	-	0	-	0	-	-
Total	60		60		120	100	

Among the vegetables (Table16), the ranking position of the alternative crops rather than potato by the opinion of potato growers top to bottom were Mustard , Maize, Wheat, Cucumber, Bottle gourd, Ash gourd, Brinjal and Teasle gourd during 2010-11.

4.2.8 Preference of growing vegetable crops according to their importance   by the opinion of potato growers

Data were collected by giving opinion to identify the preference of growing vegetable crops according to their importance by the opinion of potato growers. For calculation of score, one (1) score was assigned for one opinion of the respondents. Every respondent gave opinions according to importance of vegetable. Based on the collecting data, the investigator concluded that there was the most preferable vegetable was potato and the least preferable vegetable was Spinach.

Table 17: Preference of growing vegetable crops according to their importance by the opinion of potato growers

Vegetable	score	percentage	ranked

Potato	118	35.39	1
Brinjal	65	19.45	2
Teasle gourd	47	14.07	3
Cucumber	26	7.78	4
Tomato	16	4.79	5
Bottle gourd	13	3.88	6
Amaranth	08	2.40	7
Pumpkin	07	2.10	8
Okra	07	2.10	8
Red amaranth	06	1.80	9
Swamp Cabbage	05	1.50	10
Bean	05	1.50	10
Indian spinach	03	0.88	11
Bitter gourd	03	0.88	11
Aroid	03	0.88	11
Spinach	02	0.60	12
Other if any	-	-	-
Total	334	100	

Among the vegetables (Table17), the preference position of growing vegetable crops according to their importance by the opinion of potato growers top to bottom were Potato, Brinjal, Teasle gourd, Cucumber, Tomato, Bottle gourd, Amaranth, Pumpkin and Okra (8th

Jointly), Red amaranth (9th), Swamp Cabbage and Bean (10th Jointly), Bitter Gourd, Aroid and Indian spinach (11th Jointly), and Palong shak (12th) during 2010-11.

4.3 Some selected postharvest Challenge faced by the potato farmers

4.3.1 Challenge faced by the farmers in low market price

The Challenge faced by the farmers in low market price computed scores could range from 0 to 24 with an average of 17.60 and a standard deviation of 3.625 and the probable percentage of the respondents could range of 0 to 100. Considering the challenge score regarding low market price, the farmers were classified into three groups as shown in table 18.

Table 18. Classification of the farmers according to their low market price challenge facing scores

Categories	Scores	Potato farmers		Mean	Standard deviation
		Number	%		
Low challenges facing	1to 8	8	6.67		
Medium challenges facing	9 to 16	16	13.33	17.60	3.625
High challenges facing	Above 16	96	80		
Total		120	100		

Data furnished in above table 18 indicates that the majority 80 % of the potato farmers had high challenge facing compared to 13.33 % having medium challenge facing. Only 6.67 % respondents had low challenge facing incase of low market price of potato.

4.3.2 Challenge faced by the farmers in lack of potato Marketing facilities

Challenge facing scores in Marketing were computed to measure the extent of challenge faced by the potato farmers. The probable percentage scores of the respondents could range from 0 to 100. However, the possible range 0 to 24 with a mean of 13.93 and standard deviation of 3.675. Based on the computed scores, the potato farmers were classified into three categories as shown in the following table (19).

Table 19 Classification of the potato farmers according to their   challenge facing in potato marketing

Categories	Scores	Potato farmers		Mean	Standard deviation
		Number	%		
Low challenge facing	0-8	25	20.83	13.93	3.675
Medium challenge facing	9-16	89	74.17		
High challenge facing	17-24	6	5		
Total		120	100		

Data furnished in above table 19 indicates that the majority 74.17 % of the potato farmers had medium challenge facing compared to 20.83 % having low challenge facing. Only 5 % respondents had high challenge facing in marketing of potato. Some regulations of marketing eliminated the middle men and hindrances in marketing of this crop.

4.3.3 Challenge faced by the farmers in lack of potato processing facilities

Challenge facing scores in Marketing were computed to measure the extent of challenge faced by the potato farmers. The probable percentage scores of the respondents could range from 0 to 100. However, the computed scores of the respondents ranged from 0 to 24 with a mean of 16.47 and standard deviation of 2.973. Based on the computed scores, the potato farmers were classified into three categories as shown in the following table (20).

Table 20. Classification of the farmers according to their lack of processing facilities challenge facing scores

Categories	Scores	Potato farmers	Mean	Standard

		Number	%		deviation
Low challenges facing	0 to 8	0	0		
Medium challenges facing	9 to 16	93	77.50	16.47	2.973
High challenges facing	Above 16	27	22.50		
Total		120	100		

Data furnished in above table 20 indicates that the majority 77.50 % of the potato farmers had medium challenge facing compared to 22.50 % having high challenge facing. Respondents did not face low challenge in potato processing facilities. If government or NGOs will take any initiatives about potato processing potato farmers must be benefited incase of minimize their post harvest losses.

4.3.4 Challenge faced by the farmers in potato preservation

The obtained farmers own Potato storage condition scores could range from 0 to 24 against the probable percentage scores of the respondents could range of 0 to 100 with an average of 12.40 and a standard deviation of 4.703. Considering the challenge score regarding farmer's own Potato storage condition, the farmers were classified into four groups as shown in table 21.

Table 21: Classification of the farmers according to their challenge faced by the farmers in potato preservation

Categories	Scores (0-24)	Potato farmers		Mean	Standard deviation
		Number	%		
Low challenge facing	0-8	15	22.5		
Medium challenge facing	9-16	29	27.5		
High challenge facing	17-24	68	43.75	12.40	4.703
Did not have store place	24	8	6.25		
Total		120	100		

Data in table 21 shows that majority of the potato farmers (43.75%) faced high challenge compared to 27.5% faced medium challenge, 22.5% farmers faced low challenge and there was eight respondents that did not have store place. So it was obvious that preservation is an important for increase the potato production. This finding indicated that all most all potato farmers faced high to low challenge regarding in potato preservation.

Table 22: Classification of the farmers according to their rot in home storage challenge facing scores

Categories	Scores	Potato farmers		Mean	Standard deviation
		Number	%		
Low challenge facing	1to 8	79	65.83		
Medium challenge facing	9 to 16	32	26.67	12.40	4.703
High challenge facing	Above 16	9	7.50		
Total		120	100		

Data furnished in above table 22 indicates that the majority (65.83 **%**) of the potato farmers had low challenge facing compared to 26.67 **%** having medium challenge facing. Only 7.50 **%** respondents had high challenge facing incase of rot in home storage of potato.

4.3.6 Challenge faced by the farmers incase of rot in cold storage

The Challenge faced by the farmers incase of rot in cold storage scores could range from 0 to 24 against the probable percentage scores of the respondents

could range of 0 to 100 with an average of 9.47 and a standard deviation of 4.406. Considering the challenge score regarding rot in cold storage, the farmers were classified into three groups as shown in table 23.

Table 23. Distribution of the farmers according to their rot in cold storage challenge facing scores

Categories	Scores	Potato farmers		Mean	Standard deviation
		Number	%		
Low challenges facing	1to 8	94	78.33		
Medium challenges facing	9 to 16	14	11.67	9.47	4.406
High challenges facing	Above 16	12	10		
Total		120	100		

Data furnished in above table 23 indicates that the majority (78.33 **%**) of the potato farmers had low challenge facing compared to 11.67 **%** having medium challenge facing. Only 10 **%** respondents had high challenge facing incase of potato rot in cold storage.

4.3.7 Challenge faced by the farmers incase of potato cold storage availability

The Challenge faced by the farmers incase of potato cold storage availability scores could range from 0 to 24 against the probable percentage scores of the respondents could range of 0 to 100 with an average of 12.07 and standard deviation of 5.522. Considering the challenge score regarding potato cold storage availability, the farmers were classified into three groups as shown in table 24.

Table 24. Distribution of the farmers according to their cold storage availability challenge facing scores

Categories	Scores	Potato farmers		Mean	Standard deviation
		Number	%		
Low challenges facing	1to 8	65	54.17		
Medium challenges facing	8 to 16	39	32.50	12.07	5.522
High challenges facing	Above 16	16	13.33		
Total		120	100		

Data furnished in above table 24 indicates that the majority (54.17 **%**) of the potato farmers had low challenge facing compared to 32.50 **%** having medium challenge facing. Only 13.33 **%** respondents had high challenge facing incase of potato cold storage availability.

4.3.8 Challenge faced by the farmers in low yield of potato

The Challenge faced by the farmers incase of low yield scores could range from 0 to 24 against the probable percentage scores of the respondents could range of 0 to 100 with an average of 9.20 and a standard deviation of 4.315. Considering the challenge score regarding low yield price, the farmers were classified into three groups as shown in table 25.

Table 25. Distribution of the farmers according to their low yield challenge facing scores

Categories	Scores	Potato farmers		Mean	Standard deviation
		Number	%		
Low challenges facing	1to 8	91	75.83		
Medium challenges facing	9 to 16	23	19.17	9.20	4.315
High challenges facing	Above 16	6	5		
Total		120	100		

Data furnished in above table 25 indicates that the majority (75.83 **%**) of the potato farmers had low challenge facing compared to 19.17 **%** having medium challenge facing. Only 5 **%** respondents had high challenge facing incase of low yield of potato.

4.4.1 Comparative Constraints/Challenges Facing Index of Farmers in eight Selected Dimensions of Potato Cultivation:
Comparative constraints facing index of farmers in eight selected Postharvest problems and their nature faced by potato farmers according to their opinion on potato cultivation were investigated in this study. It was considered necessary to have an understanding about the nature of challenges facing by the farmers in these different dimensions, namely low market price, lack of marketing

facilities, lack of processing facilities, lack of preservation facilities, rot in home storage, rot in cold storage, cold storage availability, and low yield.

Constraint/Challenge Facing Index (CFI) for any one of the selected dimensions could range from 0 to 360 where below 120 indicated low Challenge facing, 121 to 240 indicated medium Challenge facing and 241 to 360 indicated high constraint facing. However, Challenge Facing Index for the eight selected aspects of potato cultivation ranged from 09 to 272. Comparative pictures of the eight selected aspects have been shown in table (26) on the basis of their Challenge Facing Index (CFI).

The CFI in the table 26 indicates that the farmers faced highest Challenge in low market price (CFI = 272). It was followed by Challenges in lack of marketing facilities (CFI=196), lack of processing facilities (CFI= 146), lack of preservation facilities (CFI= 123), rot in home storage (CFI=102), rot in cold storage (CFI= 72), cold storage availability (CFI= 27), and low yield (CFI= 09).

Table 26: Postharvest challenges and their nature faced by potato farmers according to their opinion on potato

problems	Severity of challenges (%)				total	CFI	Ranking
	highly severe	moderately severe	Less severe	not at all			
Low market price	86	0	14	0	100	272	01
Lack of marketing facilities	13	70	17	0	100	196	02
Lack of processing	14	45	14	27	100	146	03

facilities							
Lack of preservation facilities	0	43	37	20	100	123	04
Rot in home storage	0	46	10	40	100	102	05
Rot in cold storage	0	0	72	28	100	72	06
Cold storage availability	0	0	27	73	100	27	07
Low yield	0	0	09	91	100	09	08

Among the challenges in case of post harvest on potato (Table 26), rank 1st was low market price, rank 2nd was lack of marketing facilities, 3rd lack of processing facilities, 4th was lack of preservation facilities, 5th was rot in home storage, 6th of rot in cold storage, 7th of cold storage availability, and 8th of low yield during potato growing season 2010-11.

4.4.2 Suggestions to overcome the existing challenges

Data were collected by giving suggestions to overcome the existing challenges. Possible scores could range from 0 to 120.

Table 27: Suggestions to overcome the challenges faced by potato farmers according to their opinion on potato

Suggestions and their ranking	Shibgonj upazila		Kalai upazila		All area	
	Score	Ranked	Score	Ranked	A.Score	Ranked
To fix minimum price rate for sale this is more than production cost	96	1	87	1	91.5	1
Rich and improve marketing facilities	74	2	79	2	76.5	2
Quality seed supply	65	3	67	3	66	3
Easy termed agricultural equipments supply	39	5	58	4	48.5	4
Controlled fertilizer and pesticide price	46	4	42	5	43	5
Introduction of govt. Potato buy policy	38	6	35	6	36.5	6
Increasing storage facilities	32	8	34	7	33	7
Rich cold storage facilities	32	8	33	8	32.5	8
Multipurpose potato food processing	21	11	33	8	27	9
Easy term loan facilities	25	9	28	9	26.5	10
Govt. Marketing policy for potato buying	25	9	28	9	26.5	10
To control the effect of the middle men	33	7	14	13	23.5	11

Fertilizer availability	21	10	24	10	22.5	12
Low irrigation cost	21	11	24	10	22	13
Easy supply of quality pesticide	9	13	28	9	18.5	14
Potato mutual co-operation summit is needed	17	12	19	11	18	15
Potato price fixed by potato mutual co-operation summit	17	12	19	11	18	15
More cold storage	9	13	16	12	12.5	16
Search for new potato export market	17	12	8	14	12.5	16
Increasing irrigation facilities	9	13	7	15	8	17
Improve transport facilities	6	14	8	14	7	18
Clear about potato policy to the farmer	4	15	5	16	4.5	19

Data furnished in above table 27 indicates that the most important suggestion of the potato farmers had "To fix minimum price rate for sale this is more than production cost", 2nd ranked suggestion of the potato farmers had "rich and improve marketing facilities", 3rd was "quality seed supply", 4th was "easy termed agricultural equipments supply", 5th was "controlled fertilizer and pesticide price" and the last (18th) was "clear about potato policy to the farmer".

4.5 Relationship of the Selected Characteristics of the Farmers with their Constraints Facing in respect of potato post harvest operations

The computed values of Co-efficient of correlation '(r)' showing the relationship of six characteristics of the farmers with their faced Challenges in respect of potato post harvest operations have been presented in table (28). The computed values of co-efficient of correlation (r) showing the relationship between the independent variable and overall dependent variable have been presented in table 28.

Table 28 Results of the correlation analysis between the selected characteristics (independent variables) of the farmers and their postharvest challenges faced in respect of potato postharvest operations (dependent variables) (N=120)

NS = not significant, level of probability, 0.01 level of efficient of correlation

*= Significant at 0.05 **= Significant at probability, r = Co-correlation.

Farmers characteristics	Values of 'r' with 78 df
Age	0.017 NS
Education	-0.564**
Farm size	-0.541**
Family size	0.035 NS
Annual income	-0.480**
Experience in potato cultivation	-0.580**

Computed value of correlation between the coefficient of age of the farmers and overall challenges in respect of potato post harvest operations was found to be 0.017 as shown in table 28. The computed value of 'r' ('r'= 0.017) was found to be smaller than the table value ('r'=0.221) with 78 degrees of freedom at 0.05 level of probability. Thus, statistically the relationship was not significant. It was concluded that there was no significant relationship between age of the farmers and overall Challenges in respect of potato post harvest operations.

Computed value of 'r' ('r'= -0.564) was found to be larger than the table value ('r'=0.286) with 78 degrees of freedom at 0.01 level of probability. Thus, statistically the relationship was significant at 0.01 levels. There was significant negative relationship between education of the farmers and overall Challenges in respect of potato post harvest operations. It was concluded that overall potato postharvest Challenges minimize gradually with the increasing level of education of the farmers.

Computed value of 'r' ('r'= -0.541 was larger than the table value ('r'=0.286) with 78 degrees of freedom at 0.01 level of probability. Thus, statistically the relationship was significant at 0.01 levels. There was significant negative relationship between farm size of the farmers and overall Challenges in respect of potato post harvest operations. So, it was concluded that higher the farm size of the farmers, lower was their faced constraints in respect of potato postharvest operations.

Computed value of the coefficient of correlation between Family size of the farmers and overall challenges in respect of potato post harvest operations was found to be 0.035 which was found to be smaller than the table value ('r'=0.221) with 78 degrees of freedom at 0.05 level of probability. Thus, statistically the relationship was not significant. The investigator concluded that there was no significant relationship between Family size of the farmers and overall Challenges in respect of potato postharvest operations.

Computed value of the coefficient of correlation between annual income of the farmers and overall challenges in respect of potato post harvest operations was found to be -0.480 which was found to be larger than the table value ('r'=0.286) with 78 degrees of freedom at 0.01 level of probability. There was significant negative relationship between annual income of the farmers and overall

Challenges in potato cultivation. This indicated that higher the annual income of the farmers, lower was their challenges face in respect of potato postharvest operations.

Computed value of the coefficient of correlation between experience of the farmers in potato cultivation and overall challenges in respect of potato post harvest operations was found to be -0.580 which was found to be larger than the table value ('r'=0.286) with 78 degrees of freedom at 0.01 level of probability. There was significant negative relationship between agricultural knowledge of the farmers and overall Challenges in potato cultivation. This indicated that the farmers who has high experience, they faced lower challenges in respect of potato postharvest operations.

Chapter V
Summary and Conclusion

Potato has emerged as a major food crop in Bangladesh and is being cultivated throughout the country. The total production of potato is 6648 thousands tons from the area of 400 thousands hectares. Bangladesh is the 4th largest potato producing country in Asia and among the top 15 producers in the world (BBS, 2008). Northern zone is one of most prominent region for potato cultivation. But the people of northern zone of Bangladesh face a lot of post harvest challenges on potato. This study was conducted to find out post harvest challenges on potato in northern zone of Bangladesh and their probable solutions which may be the common feature of whole Bangladesh.

A total of 120 respondents were randomly selected for collecting primary data. Different respondents possess different characteristics. The selected characteristics of the respondents were; age, education, experience in potato cultivation, farm size, family size and annual income. These six characteristics of the farmers were selected for exploring their relationships with their faced challenges. Age of farmers ranged from 27 to 65 years, the average being 40.93 years. More than half (52.5 %) of the farmers fell in the middle aged category (35 to 50 years) compared to 20 % falling in the young category (up to 34 years) and 27.5 % in old aged category (above 50 years). Incase of education, 20.83 % illiterate while 38.33 % of the farmers had secondary level education and 25 % of the farmers had primary level education and 15.84 % of the farmers had above secondary level education. Highest proportion (65 %) of the farmers had medium farm (1.1 to 3 ha) compared to 29.17 % of small farm (up to 1 ha). Highest proportion (63.33 %) of the farmers had small family (1 to 4 persons) compared to 32.50 % of medium family (5 to 7 persons) and only 4.17 % of large family (above 7 persons). It was observed that 16.5 % of the farmers had low income (up to 120,000.00 Tk. per year) compared to 51.67 % of the farmers having medium annual income (Tk.121, 000.00 to Tk. 250,000.00 per year) and 20.83 % of the farmers having high annual income (above Tk.250, 000.00 per year). Most of the farmers having moderate experience (70.83%) and 15.84 percent had more experience in potato cultivation.

All the postharvest challenges were measured in terms of severity. If it was not severe the score was given as 0, it was less severe the score was given as 1, if it was moderate severe the score was given as 2 and if it was high severe the score was given as 3. Challenges facing in potato low market price had shown that the majority (80 %) of the potato farmers faced high challenges while 13.33 % faced medium challenges and only 6.67 % faced low constraints in respect of low market price. Constraints facing in marketing had shown that the majority (74.17 %) of the potato farmers faced medium challenges while 20.83 % faced low challenges in respect of

lacking of potato marketing. The majority 77.50 % of the potato farmers had medium challenge facing compared to 22.50 % having high challenge facing according to their lack of processing facilities. About a half (43.75%) of the farmers faced high challenge in respect of potato preservation, compared to 27.50 % faced medium challenge and there was 22.50% farmers faced low challenge. But there were 6.25% farmers had no store place, they faced acute challenge. Challenge facing in respect of rot in home storage had shown that the majority (65.83 %) of the potato farmers faced low challenge while 26.83 % faced medium challenge. Challenge facing incase of rot in cold storage had shown that the majority (78.33 %) of the potato farmers faced low challenge while 11.67 % faced medium challenge. It was shown that the majority (54.17 %) of the potato farmers faced low challenge in the respect of the cold storage availability while 32.50 % faced medium challenge. On the other hand, the majority (75.83 **%)** of the potato farmers had low challenge facing compared to 19.17 **%** having medium challenge facing and only 5 **%** respondents had high challenge facing incase of low yield of potato.

In order to compare the challenges faced by the farmers in eight selected aspects during potato cultivation, a constraint/ challenge facing index (CFI) was computed for each aspects. Challenge Facing Index (CFI) for any one of the selected dimensions could range from 0 to 360 where up to 120 indicated low challenge facing, 121 to 240 indicated medium challenge facing and 241 to 360 indicated high constraint facing. However, challenge Facing Index for the eight selected aspects of potato cultivation obtained from 09 to 272 where the farmers faced highest challenges in low market price (CFI = 272). This was followed by constraints in lack of marketing facilities (CFI=196), lack of processing facilities (CFI= 146), lack of preservation facilities (CFI= 123), rot in home storage (CFI=102), rot in cold storage (CFI= 72), cold storage availability (CFI= 27), and low market price (CFI= 09).

It was investigated the relationships of those selected characteristics of the farmers with their faced challenges in postharvest operation on potato. There was no significant relationship between the age of the farmers and their faced challenges. Same result was found incase of the family size. There was a significant negative relationship between the education of the farmers and overall challenges on post harvest operation in potato cultivation at 0.01 level of probability. The same result was found incase of the farm size, the annual income and the experience in potato cultivation of the farmers with overall challenges on post harvest operation in potato cultivation. So, it should be needed to take proper initiatives to overcome the challenges incase of post-harvest operation of potato.

Conclusions

The study investigated the extent of postharvest challenges faced by the farmers on potato in eight selected dimensions. The extent of challenges faced by the farmers in low market price of potato was the highest ranked. The potato farmers face a lot of challenges during the post harvest period. Among them the main challenges were low market price, lack of marketing facilities, lack of processing facilities, lack of preservation facilities etc. The average farm size in the study area is usually medium. The findings indicate that a negative relationship between farm size of the potato farmers and their challenges in all dimensions of post harvest

operation on potato. In the context of Bangladesh, it is difficult to increase the farm size. However, the small farm owners with small income may be helped by different government organizations and NGOs to provide credit facilities for purchasing various inputs for production and overcome their challenges. Annual income had significant negative relationships with their challenges in overall challenges. This means that higher income of the potato farmers lower was their challenges. The findings indicate that experience of the farmers in potato cultivation had significant negative relationship with their overall challenges. Experience of the farmers in potato cultivation helps them to understand the various complex and complicated issues of potato cultivation and post harvest operation. It may conclude that until the potato farmers are not free from different challenges in potato production, they need support in case of postharvest challenges.

Recommendations

However, the farmers in the study area faced the extent of challenges faced by the farmers incase of market price, preservation facilities and processing facilities of potato. They also face some pre-harvest challenges such as lack of quality seed, insect and disease attack, lack of credit, lack of required input arrangement etc. which may create post harvest challenge. It is need to identify their lack by similar further studies.

On the basis of findings, it should be recommended that fixing minimum price rate for sale which is more than production cost should be ensured to overcome the challenge which is the first priority for the potato farmers. Increasing cold storage facilities, easy term loan facilities, rich marketing facilities, low cost irrigation facilities, improve transport facilities, should be ensured to overcome the challenges. Controlled price of fertilizer, pesticide and agricultural equipments with available supply should be ensured. Quality seed supply of hybrid potato should be ensured to overcome the disease problems of potato during post harvest operations. Govt. marketing policy for potato buying policy should be ensured to control the effect of the middle men. Searching of new potato export market and multipurpose potato food processing is to be needed to enhance the potato farmers to cultivate regularly. Potato mutual co-operation summit establishment and Potato price fixed by them is to be needed to overcome the challenges. Finally, it is need to clear about Govt. potato policy to the farmer. So, the potato farmers can choose the right path to overcome the postharvest challenges.

APPENDIX

APPENDIX -I: Shibganj upazila potato cultivation information during potato growing season 2010-11

Variety	cultivated area (ha)				Average yield (mt/ha)				Gross production "000" (mt)			
	2007-08	2008-09	2009-10	2010-11	2007-08	2008-09	2009-10	2010-11	2007- 08	2008- 09	2009- 10	2010- 11
Cardinal	4500	2000	2000	2693	16	15.50	13	19	72	31	26	48.47
Diamont	2500	1400	1000	395	16	15.50	14	21	40	21.70	14	8.295

Alvery	1000	1000	1500	488	12	13.00	14	20	12	13	21	9.76
Granola	2000	5800	7500	9988	14	16.00	16	20.5	28	92.80	120	204.75
Astorix	-	-	-	131	-	-	-	25	-	-	-	3.275
Suriyamukhi/ kufrisunduri	1000	1000	500	305	13	13.00	13	18	13	13	5.49	
Lal pakri	2700	2600	3000	2273	10	10.00	9	12	27	26	27	27.28
Pahri pakri	700	800	500	1119	11	11.00	11	13	5.4	8.80	5.5	14.55
Tel pakri	700	750	400	558	9.5	10.00	9	10.5	6.65	7.50	3.6	5.86
Shil pakri	600	500	-	-	9	10.50	-	-	5.4	5.25	-	-
Hagrai	330	350	100	50	8	8.00	7.8	10	2.64	2.975	0.7	0.5
Total/ average	16030	16200	16500	18000	13.28	13.705	13.60	18.23	212.09	222.025	224.38	328.23

APPENDIX –II: Kalai upazila potato cultivation information during potato growing season 2010-11

Variety	Cultivated area (ha)				Gross production "000" (mt)			
	2008-09	2009-10	2010-11	2011-12	2008-09	2009-10	2010-11	2011-12
Pakri	-	-	-	-	35.5	23.098	36.35	49.16
Granola	-	-	-	-	102.6	173.73	205.03	95.086
Cardinal	-	-	-	-	7.98	9.58	11.55	11.38
Others	-	-	-	-	6.27	41.68	75.85	84.89
Total	11650	11900	12085	11000	38.0875	62.022	82.195	60.129
Average	-	-	-	-	152.35	248.088	328.78	240.516

APPENDIX –III: Questionnaire for collection data from the potato farmers
A STUDY ON POST HARVEST CHALLENGES OF POTATO IN NORTHERN ZONE OF BANGLADESH
(English version of the Interview Schedule for the farmers)
Serial Number ☐

1. Name of the respondent:-

   …..

2. Address:
   Vill:..Post:...
   UP: .... Upazila: .... District: ....

3. Age: .... Years

4. Education status: ………………….

5. Marital status: Married / Unmarried

6. Family type: Nuclear family / Joint family

7. Family size: Male: .... Female: .... Total: ....

8. Experience in Farming:
   a) How many years you are related to Agriculture:
   b) How many years you are related to Potato Cultivation:

9. Farm size including homestead area :
   (a)During winter-

Land ownership	Bigha	Decimals
Homestead area		
Potato Cropped area (own)		
Potato Cropped Area taken on Borga system		
Area given to others on Borga system		
Total Potato Cropped area(own+leased)		
Total others cropped area............................		

   (b)During summer-

Land ownership	Bigha	Decimals
Homestead area		
Paddy Cropped area (own)		
Paddy Cropped Area taken on Borga system		
Area given to others on Borga system		
Total Paddy Cropped area(own+leased)		
Total others cropped area............................		

10. Post harvest potato using information. (mound)

Total Production	Personal use as food	Personal use as seed	Sale	Home storage	Cold storage

11. Sources of income:
   a) Gross income (GI) :-

Sources of income	Total Production (Mound)	Sell Quantity (Mound)	Unit price (Tk/Mound)	Amount(GI) (Total Tk)
Paddy cultivation				
Potato				

cultivation				
Other (specify)				

b) Net income in Tk:

Sources	Production cost(PC)	GI-PC	Net Income
Paddy cultivation			
Potato cultivation			
Other (specify)			

12. Farm size:

Group	Land ownership (ha)	' ' Mark
Small	0.20-1.00(1.5-7.5 Bigha)	
Medium	1.00-3.00(7.5-22.70 Bigha)	
Large	>3.00(>22.70 Bigha)	

Ref: Anonymous, **1999**

13. From where do you get financial support? Put Tick ( )

Banks		.... %
NGOs		.... %
Others (Specify)		.... %

14. What factors affect your yield? Put Tick ( )

Natural Calamities		Lack of Knowledge	
Lack of Finance		Unavailability of Resources	
Disease		Others (Specify)	

15. a) How much do you consume and sale your Potato?

Purpose	Amount (mound)	% of total production
Consumption		
Sale		

16. How do you market your Potato? Put Tick ( )

Direct		.... %	Through Middle Man		.... %

17. Do you have storage place for your yield? Put Tick ( )

Yes: If yes, for how much quantity (...................................)		% of total
No		

18. Amount of Potatoes for sale?

Year	Amount(Mound)	Year	Amount(Mound)
2010		2008	

2009		2007	

19. Post harvest problems and their nature:- Put Tick ( )

Problems	Severity of Problem			
	Highly Severe	Moderately Severe	Less Severe	Not at all
Low yield				
Low market price				
Lack of marketing facilities				
Lack of preservation facilities				
Lack of processing facilities				
Rot in home storage				
Rot in cold storage				
Cold storage availability				
Other (if any)				

20.Land use for Potato cultivation-

Year	Amount(Bigha)	Year	Amount(Bigha)
2010		2008	
2009		2007	

21.Average wholesale price and yield?

Year	Average price(Tk/mound)	Yield (Mound/Bigha)
This year		
The last year		

22.Source of Potato seed

Year	Own Seed (%)	Sold from local market (%)	Sold from Govt. organization /NGO(%)
2010			
2009			

23. Why do you grow Potato? (Put tick)

Profitable		High yielding than others		Potato growing area	
Easy to grow		Huge demand		If others (specify)	

24. What could be other crops alternative to Potato?

....

25.Preference of growing vegetable crops:-(Mention accordance their importance)
    a).........................b)..............................c).......................d)......................
    e).......................f)..............................g).........................h)......................

26. Suggestions to overcome the challenges
a)..
b)..
c)..
d)..
e)..
f)..
    Thanks to give your information.

    ....
    Signature of the Interviewer

    Date..............................

APPENDIX- V. Pictorial view of different post harvest activities

Plate-1. Spading in potato field before Potato collection

Plate-2. Potato collection by hand

Plate-3. Washing of potato after harvesting

Plate-4. Carrying of harvested potato from field to home

Plate-5. Bagging of potato for storage or marketing

Plate-4. Potato selling in local market at Bogra