

PEST MANAGEMENT PROBLEMS FACED BY POTATO FARMERS

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**PEST MANAGEMENT PROBLEMS FACED BY
POTATO FARMERS**

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This is to certify that the thesis entitled, “**PEST MANAGEMENT PROBLEMS FACED BY POTATO FARMERS**” submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **Master of Science (MS) in Agricultural Extension**, embodies the result of a piece of bonafide research work carried out by **S. J. M. R. FARUK**, Registration No. 10-03778, under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.

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

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DEDICATION

DEDICATED TO

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

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The Researcher

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LIST OF ABBREVIATIONS AND GLOSSARY

Abbreviation	Full word
Ag. Ext. Ed.	Agricultural Extension Education
Ag. Ext. and Info. Sys.	Agricultural Extension and Information System
ANOVA	Analysis of Variance
B	Multiple regression
BBS	Bangladesh Bureau of Statistics
BRRRI	Bangladesh Rice Research Institute
CCWPU	Columbus's contribution to world population and Urbanization
CWHFP	Cambridge World History of Food- Potatoes
DAE	Department of Agricultural Extension
<i>et al.</i>	All Others
GDP	Gross Domestic Product
OIA	Office of International Affairs
POP	Potatoes to Plastics
OLS	Ordinary Least Squares
SAAO	Sub Assistant Agriculture Officer
SPSS	Statistical Package for Social Science
UNDP	United Nations Development Program

PEST MANAGEMENT PROBLEMS FACED BY POTATO FARMERS

S. J. M. R. FARUK

ABSTRACT

The objectives of the study is to determine the extent of pest management problems faced by the farmers in potato cultivation and to explore the contribution of the selected characteristics of the cultivators to the pest management problems. The study was conducted at Burail, Telabudul, Malipara, Mundail and Vashali villages of Khetlal upazila under Joupurhat district. Data were collected from 105 potato cultivators from 15 January, 2017 to 10 February, 2017. Descriptive statistics, stepwise multiple regression were used for analysis of the data. The highest (61.0%) percentage of potato cultivators belong to the group of medium pest management problems and the lowest (15.2 %) percentage in high problem during potato cultivation. Among the influential variables- time spent in potato farming alone contribute 77.3 % of the variation where level of education (5.4 %), amount of credit receipt (0.6 %), farm size (1.9 %) and extension contact (1.1 %) variation to the pest management problems faced by the farmers. It is concluded that most of the farmers faced pest management problems in potato cultivation which needs efficient intervention by different NGOs and Department of Agricultural Extension (DAE) to ensure sustainable potato cultivation.

Key words: Potato cultivation, Pest, Disease, Management problem;

CHAPTER I

INTRODUCTION

1.1 General Background

Potato (*Solanum tuberosum* L.) is the world's most important tuber crop (FAO, 2012), and is an important vegetable and a source of cash income in the Bangladesh. Bangladesh is mainly an agro-based country. It is a thickly populated small country with an area of 14.48 million ha. According to an estimate by Bhuiyan *et al.*, 2002, net cultivable land would decrease from 8.42 million ha in 2000 to 7.89 million ha in 2025 and population would increase from 127.22 million in 2000 to 168.96 million in 2025. The per capita net cultivable land would reduce from 0.066 ha in 2000 to 0.047 ha in 2025 (Bhuiyan *et al.*, 2002). The population has doubled in the last 30 years despite a decline in the annual population growth rate from 2.26 in 1961 to 1.47 in 2004. Potato is a staple food in the developed countries and which accounts for 37% of the total potato production in the world (FAO, 2008). Considering the trend of population growth and consequently the increased demand for food in the country and dwindling cultivable land area, the potato is likely to play a very important role in the future. Potato is a popular vegetable in Bangladesh. For the whole year, it is used as main vegetable.

Potato crop, the world's number one non-grain food commodity, is the fourth main food crop in the world after maize, rice and wheat. Potatoes are grown in more than 100 countries, mainly in Asia (136 million tons) and Europe (130 million tons; FAO, 2012). They have good gustative and nutritional qualities and can be grown under various climates. Potato can help fulfill the first United Nations Organization's (UNO) sustainable development goal that aims at zero hunger - end hunger, achieve food security and improved nutrition and promote sustainable agriculture. However, potato (*Solanum tuberosum*) crop can suffer more than 40 pests and diseases caused by insects, nematodes, viruses, bacteria, and fungi.

Diseases, insect pests, price fluctuations, and low market prices are the most constraints in potato production, in order of decreasing importance. Major yield losses are predominantly due to late blight (*Phytophthora infestans* (Mont.) de Bary) and reached 100 % without chemical control. On average, farmers have little to moderate knowledge about pest characteristics. The predominant control methods were use of fungicides and insecticides. On an average, only a few farmers aware about insect pests and their natural enemies. This lack of knowledge calls for training of both farmers and extension workers in insect pest identification, their biology, and control. Empowering farmers with knowledge about insect pests is essential for the reduction of pesticide misuse and uptake of more environmentally friendly approaches. Field surveys would need follow-up in order to assess the actual field infestation rates and intensities of each insect pest, diseases problems and compare the results with the responses received from farmers.

The atmosphere of Bangladesh is described by a tropical monsoon with three fundamental seasons having moderately little variety from month to month. Hence, great agronomical qualities are winning here to develop more potato products in Bangladesh. Yet, the cultivation of potato is assaulted by insect, diseases and weeds and so forth. As Bangladesh being the tropical and humid nation, the pervasion of insect pest, diseases problems are exceptionally basic here. In any case, a little data was available in regards to the pest management problems faced by potato farmers. In this way, it was felt to embrace the status to discover the present status of ‘Pest Management Problems Faced by Potato Farmers’.

1.2 Statement of the Problem

Potato (*Solanum tuberosum*) is the third biggest sustenance crop in Bangladesh and has as of late possessed an essential place in the rundown of main food and cash crops of Bangladesh (Ali and Haque, 2011). The potato harvest positions first among the vegetable in Bangladesh both in region and production (BBS, 2006). Its zone and production are expanding step by step (BBS, 2009).

Guaranteeing sustenance security for all is one of the real difficulties in Bangladesh today. Thus, to guarantee sufficient food supply, it is important to offer push to expand sustenance generation utilizing enhanced assortment and prescribed practices with a view to overcoming the pest, diseases problems. By overcoming the pest, diseases problems of the farmers in potato cultivation could uplift the food production and net wage of the farmers. Normally farmers take after alternate levels of production advances relying on their infrastructural and financial conditions which at last brought about inconstancy in yields of potato (Elias *et al.*, 1992). Farmer's production performance relies on upon physical resources and technology available to them and in addition existing farm management conditions. Proficient utilization of inputs and technologies could help farmers to get higher production from a given amount of resources.

With a specific end goal to figure appropriate key measures for the change of the contemplated pest management problems faced by potato farmers, this exploration concentrates on socio-economic characteristics of farmers and their existing situation towards pest management problems in potato cultivation. This was finished by looking for answers to accompany the queries:

- What is the extent of pest management problem faced by potato farmers?
- What were the characteristics of the potato farmers?
- Was there any contribution of selected characteristics of the potato farmers to their pest management problems in potato cultivation?

In order to get a clear view of the above questions the investigator undertook a research entitled 'Pest management Problems Faced by Potato Farmers'.

1.3 Objectives of the Study

The focal point of the research work was to explore the trends of pest management problems faced by the farmers in potato cultivation. This is why the following objectives were structured out in order to provide an appropriate track to the research work:

- i. To assess the extent of pest management problems faced by the farmers in potato cultivation
- ii. To describe the following selected characteristics of the potato farmers:
 - Age
 - Education level
 - Farm size
 - Annual family income
 - Annual family income from potato production
 - Extension contact
 - Amount of credit receipt
 - Time spent in potato farming
 - Organizational participation
 - Training in potato cultivation
- iii. To explore the contribution of the potato farmers' selected characteristics to their pest management problems in potato cultivation

1.4 Scope of the Study

The present study was designed to have an understanding pest management problems faced by potato farmers and to explore its contribution with their selected characteristics.

- i. The findings of the study will, in particular, be applicable to the study area at Khetlal upazila in Joypurhat district. The findings may also be applicable to other locale of Bangladesh where socio-cultural, psychological and economic circumstance do not differ much than those of the study areas.
- ii. The findings of the study may also be subsidiary to the field worker of extension service to enhance their action strategies on plant protection management practices in potato cultivation.
- iii. The findings of the study will be conducive to accelerate the improvement in agriculture, farmers' logistic supports, information needs and the way

of dissemination especially tuned to key role players in the society as well as the awareness on pest management problems in potato cultivation. The outcomes might also be helpful to the planners and policy makers, extension workers and beneficiaries of the agriculture.

- iv. To the academicians, it may help in the further conceptualization of the systems model for analyzing the pest management problems by the farmers in potato cultivation. In addition, the findings of this study may have other empirical evidence to all aspects of management problems faced by the farmers in potato cultivation.

1.5 Justification of the Study

Potato cultivation practice is complex and requires both specialized learning and management expertise. Potato producers must apply this knowledge and aptitude to ensure profitable yields of quality potatoes for the fresh, processing, or seed markets. The securing of self-sufficiency in food production is the fundamental point of agricultural improvement in Bangladesh. To accomplish that objective, it is compulsory to provide thrust to increase food production awaking pest management problems. The knowledge and awaking of pest management problems in potato cultivation by the farmers could help to easily overcome this issue. A few research has conducted on pest management problems faced by potato farmers. Therefore, the researcher needs to enquire about the pest management problems faced by potato farmers.

So, it is logical to investigate about the pest management problems faced by potato farmers. The finding of the study will be especially applicable to the Khetlal upazila under the district of Joypurhat. The findings will also have suggestions and appropriateness for different zones of the nation, having likenesses similarities in physical, socio-economic and socio-cultural conditions with the study area. Thus, the findings are expected to be useful to extension workers and planners for their preparation of extension programmers for creation the rapid awareness on pest management problems in potato cultivation. The findings of the study are also therefore, anticipated that would

be helpful for the scientists, academicians and strategy makers who are concerned with of potato cultivation. Keeping the above facts in view, a research entitled ‘Pest Management Problems Faced by Potato Farmers’.

1.6 Assumptions of the Study

An assumption is the supposition that an apparent fact or principle is true in the light of available evidence (Goode and Hatt, 1952). The researcher had considered the following assumptions while undertaking the study:

- i. The respondents were capable of furnishing proper answers to the questions contained in the interview schedule.
- ii. The data collected by the researcher were free from any bias and they were normally distributed.
- iii. The responses answered by the respondents were valid, acceptable and reliable.
- iv. Information sought by the researcher elicited the real situation and was the representative of the whole population of the study area to gratify the objectives of the study.
- v. The researcher was well adjusted to himself with the social contiguous of the study area. Hence, the collected data from the respondents were free from favoritism.
- vi. The selected characteristics and the pest management problems faced by potato farmers of the study were normally and independently allotted with respective means and standard deviation.

1.7 Limitations of the Study

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

- i. Only Khetlal upazila in Joypurhat district was selected for conducting the research which may fail to represent the actual scenario of the whole situation as people develop their strategies according to the concrete situation they face.
- ii. Getting exact information on pest management problems indicator was difficult from the potato farmers as many of them are illiterate.
- iii. Characteristics of the potato farmers were many and varied, but only ten characteristics were selected for the research study.
- iv. There were embarrassment situations at the time of data collection. So, the researcher had to manage proper rapport with the respondents to collect maximum proper information.
- v. Different scales, methods and statistical tests have been utilized in this study over a relatively short period of time.

1.8 Definition of Important Terms

Pest: A pest is "a plant or animal detrimental to humans or human concerns (as agriculture or livestock production)", alternative meanings include organisms that cause nuisance and epidemic disease associated with high mortality (specifically: plague). In its broadest sense, a pest is a competitor of humanity.

Pest management: Pest management is therefore a means to reduce pest numbers to an acceptable threshold. An acceptable threshold, in most cases, refers to an economically justifiable threshold where application of pest control measures reduces pest numbers to a level below which additional applications would not be profitable. Pest eradication is usually not a viable option.

Problem: A matter or situation regarded as unwelcome or harmful and needing to be dealt with and overcome.

Age: Age of the farmers was measured in terms of actual years from their birth to the time of the interview.

Level of education: Education was measured by assigning score against successful years of schooling by a farmer.

Farm size: Farm size of a farmer referred to the total area of land on which his/her family carried out the farming operation, the area being in terms of full benefit to the family.

Annual family income: The term annual family income refers to annual gross income of potato cultivators and members of his family from different sources.

Annual family income from potato production: Annual family income from potato production refers to total financial return from potato in one year.

Extension contact: It is defined as one's extent of exposure to different communication media related to farming activities.

Amount of credit receipt: Amount of credit receipt refers to the total financial credit received from different sources in one year.

Time spent in potato farming: Time spent in potato farming is defined by the total hours of time involved in potato farming per week.

Organizational participation: Organizational participation of a respondent is computed on the basis of his/her participation in different organizations.

Training in potato cultivation: Training in potato cultivation is determined by the total number of days a respondent attended in different training programs in his life regarding potato cultivation.

CHAPTER II

REVIEW OF LITERATURE

Review of literature gives the clear and concise direction of the researcher for conducting the experiment. In this chapter, review of literatures relevant to the objectives of this study was presented. This was mainly concerned with ‘pest management problems faced by potato farmers’. There was serious dearth of literature with respect to research studies on this aspect. So, the directly related literatures were not readily available for this study. Some researchers addressed various aspects of the problems on various issues and its effect on client group and suggesting strategies for their emancipation from socio-economic deprivations. A few of these studies relevant to this research are briefly discussed in this chapter under the following six sections:

Section 1: General review on potato, potato’s origin and distribution, potato’s history in Bangladesh, potato varieties cultivated in Bangladesh, Demand-supply scenario for potato seed in Bangladesh, production of potato in Bangladesh

Section 2: Review on insect pest and diseases in potato cultivation

Section 3: Literature related to problems faced by the respondent’s in different aspects of agriculture

Section 4: Review concerning the relationship between selected characteristics of the respondent and their problem confrontation

Section 5: Research gap of the study

Section 6: Conceptual framework of the study

2.1 General Review on Potato, Potato’s Origin and Distribution, Potato’s History in Bangladesh, Potato Varieties Cultivated in Bangladesh, Demand-Supply Scenario for Potato Seed in Bangladesh, Production of Potato in Bangladesh

2.1.1 General review on potato

Potatoes are utilized for an assortment of purposes, and not just as a vegetable for cooking at home. Truth be told, it is likely that less than 50 percent of potatoes grown worldwide are consumed fresh. The rest are handled into potato

nourishment items and sustenance fixings; encouraged to dairy cattle, pigs, and chickens; prepared into starch for industry. Potatoes are used to brew alcoholic beverages such as vodka, potcheen, or akvavit. They are also used as food for domestic animals. Potato starch is used in the food industry as, for example, thickeners and binders of soups and sauces, in the textile industry, as adhesives, and for the manufacturing of papers and boards (Campbell *et al.*, 1997). Many companies are exploring the possibilities of using waste potatoes to obtain polylactic acid for use in plastic products; other research projects seek ways to use the starch as a base for biodegradable packaging (Gopal and Khurana, 2006). Potato skins, along with honey, are a folk remedy for burns in India (POP, 2009). Burn centers in India have experimented with the use of the thin outer skin layer to protect burns while healing.

Potatoes (*Solanum tuberosum* L.) are named as a horticultural crop and are one of the most important cash and food crops in the world over (POP, 2009). The world's fourth most important food crop after wheat, rice, and maize in terms of production volumes and consumption in potato (Eltawil *et al.*, 2006). About 35% of world production is in developing countries where potato is an important part of the diet (CIP, 2002).

For small scale farmers, potato is an important food crop that is often available when adverse climatic conditions threaten basic food supply and during the lean seasons. Potatoes are rich in carbohydrates, have high quality protein (albeit low per unit value) and high levels of Vitamin C (Fialdo *et al.*, 2000; Worthington, 2001). In addition to food, potatoes are a source of income to small scale farmers (Scott, 2002).

Potatoes are a semi perishable product that requires appropriate and efficient postharvest technology to minimize losses and maintain quality ((Eltawil *et al.*, 2006; Suttle, 2004). French (1981) explains that potato quality consists of three categories: sensory, consumer (appearance) and storage qualities. Carbohydrate content and the *glycoalkaloid* content of potatoes affect the

sensory quality of potatoes. Greening, size, sprouting, diseases and pest damage affect potato appearance quality. The keeping quality of potatoes in storage is in part pre-determined by cultivar; production practices and maturity of tubers at the time of harvesting (Kehoe, 2000; Rastovski, 1987; Wilson *et al.*, 1995).

2.1.2 Potato's origin and distribution

The potato was first domesticated in the region of modern-day southern Peru and extreme northwestern Bolivia (Spooner *et al.*, 2005) between 8000 and 5000 BC (OIA, 1989). It has since spread around the world and become a staple crop in many countries. Sailors returning from the Andes to Spain with silver presumably brought potatoes for their own food on trip.

Africa with colonists, who consumed them as a vegetable rather than as a staple starch (CWHFP, 1994). Shipping records from 1567 show that the first place outside of Central and South America where potatoes were grown were the Canary Islands (Williams, 2007). Edward Terry mentioned the potato in his travel accounts of the banquet at Ajmer by Asaph Khan to Sir Thomas Roe, the British Ambassador in 1675. It is the earliest mention in history of India. The vegetable gardens of Surat and Karnataka had potatoes as mentioned in Fyer's travel record of 1675. The Portuguese introduced potatoes and called it 'Batata', in India in early seventeenth century when they cultivated it along the western coast of India.

2.1.3 Potato's history in Bangladesh

The potatoes were introduced by Portuguese; they called it 'Batata', in India in early seventeenth century when they cultivated it along the western coast of India. The British traders introduced potatoes in Bengal as a root crop, 'Alu'. By the end of eighteenth century, it was cultivated across northern hill areas of India (CCWPU, 2009). Potatoes were introduced to Tibet by nineteenth century through trade route from India (Srivastava, 2008). The potato was introduced in the Philippines during the late 16th century and to Java and China during the

17th century. It was well established as a crop in Africa by the mid-20th century (CCWPU, 2009).

2.1.4 Potato varieties cultivated in Bangladesh

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

2.1.5 Demand-supply scenario for potato seed in Bangladesh

About 8,06,294 acres land has been used in Bangladesh for potato production. For this purpose, about 3,50,000 m tons of seed potatoes are necessary. Most of the seeds used are not of high quality. The farmers generally use the tubers they keep for their own consumption as seeds. This results in poor yield in the following season. Usually, two types of potato seeds are imported by the government, one known as foundation or basic seeds, and the other certified seeds. Bangladesh Agricultural Development Corporation (BADC) distributes

certified seeds to the growers produced locally from the imported foundation seeds in their own farms or in lands of farmers on contract basis. BARI has now started producing seed potatoes in its own farms at the Debiganj Breeders Potato Seed Production Centre to make seeds available to growers at a reasonable price. Available quality seeds, however, are not sufficient to meet the demand.

2.1.6 Production of potato in Bangladesh

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

2.2 Review on Insect Pest and Diseases in Potato Cultivation

Each technical choice made by farmers concerning the way of growing potatoes plays a predominant role on the quantitative and qualitative yield. Plant protection practices in potato cultivation are described below:

Potato disease and pest control is vital to ensuring good yields, maintaining produce quality and maximizing marketable yield (Larkin, 2008). The potato is subject to more than a hundred diseases caused by fungi, bacteria and viruses (Hide and Lapwood, 1992). Fortunately, few potato diseases are a serious problem in any given production area (Hide and Lapwood, 1992). However, post-harvest potato diseases are responsible for significant economic losses (Mills, 2004).

2.2.1 Insect pests of potato in Bangladesh

The researches show that Cutworm (*Agrotis ipsilon*), Aphid (*Macrosiphum euphorbiae*), Potato tuber worm (*Phthorimaea operculella*), Leaf hopper (*Empoasca fabae*) are the significant insect pests of potato in Bangladesh. Among these insect pests, cutworm attacks seedling, aphids pierce veins, stems, growing tips, and blossoms with their needle-like mouthparts, Potato tuberworm feed on potato leaves, stems, petioles, and more importantly potato tubers in the field and in storage, leaf hopper causes the twisting up of takes off. Some other minor insects such as Leaf miner (*Liriomyza huidobrensis*), Field cricket (*Gryllotalpa pennsylvanicus*), Green bug (*Nezera viridula*), Yellow mites (*Polyphagotarsonemus latus*), , White fly (*Bemisia tabaci*) etc.

2.2.2 Insect pests of potato in worldwide

Wireworms are a standout amongst the most ruinous insect pests in the Pacific Northwest. Nearly 40 species from 12 genera attack potato, but yet just a couple are monetarily vital (Hoy *et al.*, 2008). Wireworms are the larval stage of click beetles. Wireworms can make harm potatoes by sustaining upon potato seed pieces and sprouts in the spring, facilitating infection by pathogens or other insect pests. The latter damage can result in reduction in yield and/or

rejection of the entire crop. In the U.S. there is zero tolerance for live larvae in tubers. Wireworms tend to be most damaging in potatoes that follow corn or small grains (wheat, barley) and on ground just entering cultivation. Potatoes, corn, wheat and grass are hosts for several species of wireworms in the Pacific Northwest. Also, beans, carrots, peas, and other annual crops may be infested; while melons, beet roots, and strawberry fruits are affected less frequently.

The Colorado potato beetle, *Leptinotarsa decemlineata* (Say), first described in 1824 by Thomas Say, is associated with potato plants and its solanaceous relatives such as nightshade. It is the most important defoliating insect pest of potato. Its remarkable ability to develop insecticide resistance, incredible reproductive potential and sustained feeding by larvae and adults, makes the management of this pest challenging (Hoy *et al.*, 2008). The Colorado Potato Beetle (CPB) is a yellow and black striped beetle, about 1.3 cm long and 0.6 cm wide. They can be found in almost all U.S. potato regions. This beetle can cause complete defoliation and nearly complete crop loss if allowed to reproduce unchecked. Both larvae and adults feed on potato foliage throughout the season. Potatoes and other solanaceous plants such as eggplant, nightshade, horse nettle and buffalo bur are preferred hosts of this pest.

The aphid population in western North America, north of Mexico, is comprised of 1,020 species in 178 genera in 15 subfamilies (Pike *et al.*, 2003). Several aphid species are known to be pests of potatoes, but the green peach aphid, *Myzus persicae* (Sulzer), and potato aphid, *Macrosiphum euphorbiae* (Thomas), are two of the most important vectors of diseases in the Pacific Northwest. Aphids are important due to their ability to transmit viruses. According to Hoy *et al.*, (2008) there are six commonly found potato viruses transmitted by aphids: Potato leafroll virus (PLRV), multiple strains of Potato virus Y (PVY), Potato virus A (PVA), Potato virus S (PVS), Potato virus M (PVM), and alfalfa mosaic virus (AMV). PLRV and PVY are transmitted by several species of aphids but primarily by green peach aphid. The potato aphid transmits PVY and PVA. In general, aphids injure plants directly by removing

sap juices from phloem tissues. They also reduce the aesthetic quality of infested plants by secreting a sugary liquid called "honeydew" on which a black-colored fungus called "sooty mold" grows. The "sooty mold" reduces the photosynthetic potential of the plant. Most importantly, aphids transmit plant diseases, particularly viruses. Aphids on potato are serious pests because of their ability to transmit several plant diseases such as PLRV (transmitted mainly by green peach aphid) and PVY (transmitted by several species of aphids). The green peach aphid, also known as tobacco or spinach aphid, survives the winter in the egg stage on peach trees. They can also overwinter on various perennial, biennials, and winter annual weeds; besides potatoes and peaches, other hosts include lettuce, spinach, tomatoes, other vegetables and ornamentals (Dickson and Laird, 1967; Wallis, 1967; Tamaki *et al.*, 1980; Barry *et al.*, 1982)

The beet leafhopper, *Circulifer tenellus* Baker, is the carrier of the beet leaf hopper transmitted virescence agent (BLTVA) phytoplasma (a.k.a., Columbia Basin potato purple top phytoplasma) that causes significant yield losses and a reduction in potato tuber quality.

Beet leafhoppers feed the phloem of the plant. Direct feeding can cause relatively minor damage ("hopperburn"); however, BLTVA is a very destructive and detrimental disease affecting potatoes. BLTVA can cause a wide range of symptoms in potatoes, including leaf curling and purpling, aerial tubers, chlorosis, and early senescence. Most BLTVA infection occurs early in the season, during May and June (Munyaneza, 2003; Munyaneza and Crosslin, 2006). Potato is not a preferred host for BLH and will not spend much time on the crop (however it does spend enough time to transmit BLTVA) (Schreiber *et al.*, 2010). They also thrive on radishes, sugar beet (Meyerdirk and Hessein, 1985), and carrots (Munyaneza, 2003).

The potato tuberworm, *Phthorimaea operculella* Zeller, is one of the most economically significant insect pests of cultivated potatoes worldwide. The

first significant economic damage to potato crops in the Columbia Basin region occurred in 2002, when a field in Oregon showed high levels of tuber damage associated with potato tubeworm. By 2003, the pest was a major concern to all producers in the region after potatoes from several fields were rejected by processors because of tuber damage. Since then, potato tubeworm has cost growers in the Columbia Basin millions of dollars through increased pesticide application and unmarketable potatoes (Rondon, 2010). Tubeworm larvae behave as leaf miners. They can also live inside stems or within groups of leaves tied together with silk.

The most important damage is to tubers, also a food source for the larvae, especially exposed tubers, or those within centimeters of the soil surface. Larvae can infest tubers when foliage is vine killed or desiccated right before harvest (Clough *et al.*, 2010). Tunnels left by tubeworms in tubers can be full of droppings or excrement that can be a potential source for secondary infections. Although the potato tubeworm host range includes a wide array of Solanaceous crops such as tomatoes, peppers, eggplants, tobacco, and weeds such as nightshade, the pest has been found only on potatoes in the Pacific Northwest region (Rondon, 2010).

The two-spotted spider mite, *Tetranychus urticae* Koch, is the most abundant mite species found in potatoes in the Pacific Northwest. They can occasionally be considered pests of potatoes when crops such as beans, corn, alfalfa or clover seed are planted nearby (Hoy *et al.*, 2008).

2.2.3 Diseases of potato in Bangladesh

The potato is prone to more than a hundred diseases caused either by bacteria, fungi, viruses or mycoplasmas. However, Early blight or Alternaria blight is worldwide in distribution and is one of the most important foliage diseases in areas with favorable weather conditions (CIP, 1996). Early blight, that is caused by two species of genus *Alternaria* (*A. solani* and *A. alternata*), occurs worldwide on potato crops, particularly in the regions with high temperature

and alternating periods of dry weather and high humidity and/or irrigated potato soils, light-textured, sandy, low in organic matter (Pasche *et al.*, 2004). *A. solani* and *A. alternata* - causal agents of the early blight are more and more risk-important pathogens on potato crops. The early blight occurs in all potato production areas, but there is a significant impact on the tuber yield and the quality only in warm, wet conditions in the early season, which favours a rapid disease development. Quantity share of both species varies and is dependent on the climate / on the weather conditions (Leiminger and Hausladen, 2007; Kapsa, 2007). Early blight is a very common disease of both potato and tomato.

Late blight of potato caused by *Phytophthora infestans* (Mont. De Bary), is among the most important diseases, being especially devastating in the major potato growing areas. Serious economic consequences often result from complete or partial devastation of infected fields. It is the widest spread throughout the world and causes serious tuber losses globally (Erwin and Ribeiro, 1996; Fry and Goodwin, 1997; Garrett *et al.*, 2001).

Diseases Potatoes suffer from various diseases which are classified according to their causal agents, such as virus, bacteria, fungus, and nematodes. Some nonparasitic diseases or physiological diseases caused by environmental factors or physiological deficiencies are also noticeable. Among the viral diseases, the Mild Mosaic, Rugose Mosaic, and Latent Mosaic diseases are important. Symptoms of mosaic diseases include mottling of leaves with different shades and spots, necrosis and curling. Often, the disease does not exhibit any appreciable symptom.

The notable bacterial diseases of potato of this country are the Blackleg, Brown Rot, Bacterial Wilt, and Ring Rot. The Blackleg is caused by *Erwinia atroseptica*, affects growing plants, and tubers in storage; it is so named because the base of the stem becomes shriveled and blackened.

Brown rot is caused by *Pseudomonas solanacearum*. This disease causes the leaves to wilt, shrivel, and finally death of the plant. The disease is also seen in

many other tropical countries, and besides potato, tomato, brinjal, chilli, tobacco etc. are also affected. Ring rot is the result of infection with *Corenybacterium sepedonicum*. The symptoms of the affected plant are similar to those of brown rot. The first symptom is pale yellow chlorosis between the veins of the leaves.

Important fungal diseases of potatoes are the Late Blight, Early Blight, Black Scurf and Stem Rot. Late Blight is the most serious and widespread of all potato diseases. The causal organism is *Phytophthora infestans*, a parasitic fungus. The first signs of the disease are brownish to black lesions on any portions of the plant tops, principally on the leaves. On the underside of the leaf white mildew appears. Tubers may be subjected to infection while in the field, during harvest, or in storage. Infected tubers are the principal source for overwintering of this disease pathogen and of primary infection.

2.3 Literature Related to Problems Faced by the Respondent's in Different Aspects of Agriculture

Mortuza (2015) revealed that more than two third (67.10 %) of the respondents faced medium problem in maize production activities and 19.50 percent faced low problems and 13.40 percent faced high problems.

Baten (2014) found that the majority (73.3 %) of the farmers faced medium problem in cotton cultivation, while 16.4 percent low and 10.3 percent high problem in cotton cultivation.

Salam (2003) in his study identified constraints in adopting environmentally friendly farming practices. Top six identified constraints according to their rank order were: (i) low production due to limited use of fertilizer, (ii) lack of organic matter in soil, (iii) lack of Govt. support for environmentally friendly farming practices, (iv) lack of capital and natural resources for integrated farming practices, (v) lack of knowledge on integrated farm management and (vi) unavailability of pest resistant varieties of crops.

Ismail (2001) conducted a study on problem faced by the farm youth of haor area of Mohongonj upazila. The study revealed six top problems in rank order which were: (1) no arrangement of loan for the farm youth for fishery cultivation, (2) lack of government programs in agriculture for the farm youth, (3) absence of loan giving agencies for establishing farm in locality, (4) general people face problem for fishery due to government leasing of Jalmohal, (5) lack of government programs for establishing poultry farm and (6) lack of agricultural loan for the farm youth.

Muttaleb *et al.* (1998) revealed that among different constraints, high fertilizer cost, high seed cost, lack of quality seed, lack of awareness, lack of technological knowledge and low price of potato at harvest period were perceived as barriers for the adoption of potato technologies.

Freeman and Breth (1994) conducted a study on productivity of agricultural systems in the West African savanna. The study showed several constraints in farming practices such as intensified land use, fallow period decline and crop cultivation spreading ecologically fragile lands. In the absence of appropriate resource management technologies, those practices inevitably led to degradation of the resource base with important implication with soil productivity, household food security and rural poverty.

Chander *et al.* (1990) in their study identified constraints in potato cultivation. Main constraints were ignorance about improved cultivars and cultivation practice, ignorance about time and number of irrigations, ignorance about scientific method of sowing, lack of guidance of marketing of potato, high cost of improved cultivars, high cost of fertilizers, pesticide and irrigation, lack of enough space for storing potatoes scientifically and so on.

Zinyama (1988) conducted a relative observation to find out the farmers' perception of the constraints against increased crop production in the subsistence communal farming sector of Zimbabwe. Five of the most frequently cited constraints were (1) lack of money with which to purchase

seasonal agriculture inputs, particularly fertilizer (2) lack of basic farming implements, notably the ox driven single furrow plough (3) lack of draught cattle, (4) inadequate arable land and (5) inadequate family labour for agricultural work.

Kher and Halyal (1988) administered a research work to identify the constraint in adoption of sugarcane production technology. The most important constraint identified regarding the adoption of input in sugarcane production technology were irregular and insufficient electricity supply, small size of holding for green manuring, inconvenience of inter cropping due to weeds, high cost of farm fuel, scare irrigation facility, absence of location specific recommendations for earthing up, lack of drought resistant varieties and lack of technical knowledge about plant protection and chemical fertilizer.

Arya and Shah (1984) conducted a study in the mid-Himalayan Region of Uttar Pradesh of India to find out the existing and potential level of food production and main constraints on the adoption of new technology for rainfed agriculture. The main constraint identified were (1) small and skewedly distributed holdings, (2) fragmented and scattered holdings, (3) shortage of labour, (4) lack of availability of inputs and funds and (5) lack of education, training and extension especially for women.

King (1980) showed that the problems of cotton development project in Gambia were dominated by three main factors that are: (1) low yield, (2) high labor input (3) the relative price paid to the farmers for groundnut and cotton. There were no technical reasons why cotton cannot be grown.

2.4 Review Concerning the Relationship between Selected Characteristics of the Respondent and Their Problem Faced

2.4.1 Age and problem confrontation

Mortuza (2015) found that age had no significant relationship with their problems faced in maize cultivation.

Baten (2014) revealed that age had no significant relationship with their problem faced in cotton cultivation.

Bhuiyan (2002) in his study found a positive and significant relationship between age of the farmers and their constraints in banana cultivation. Similar findings were obtained by Rahman (1996) in his respective study.

Rashid (1999) found that age of the rural youth had significant negative relationship with problem in selected agricultural production activities.

Kashem (1997) conducted study on the landless laborers of Barakhata Union under Rangpur district and determined the relationship between age of the landless laborers and their problem confrontation. He found no relationship between age of the landless laborers and their problem confrontation.

Mansur (1989) found that age of the farmers had no significant relationship with the feeds and feeding problem confrontation.

Hossain (1985) in a study on landless labourers in Bhabakhali Union of Mymensingh district found that there was no relationship between the landless labourers and their problem confrontation. Similar findings were obtained by Rahman (1995), Ali (1999), Rashid (1999), Pramanik (2001), Ahmed (2002) and Salam (2003) in their respective studies.

2.4.2 Level of education and problem confrontation

Mortuza (2015) found that level of education had no significant relationship with their problems faced in maize cultivation.

Baten (2014) revealed that education had significant negative relationship with their problem faced in cotton cultivation.

Kashem (1997) in his study found a significant negative relationship between education of the landless laborers and their problem confrontation.

2.4.3 Farm size and problem confrontation

Mortuza (2015) found that farm size had no significant relationship with their problems faced in maize cultivation.

Ali (2014) found that farm size had non-significant positive relationships with problem confrontation of betel leaf farmers.

Baten (2014) revealed that land possession had significant negative relationship with their problem faced in cotton cultivation.

Rashid (2003) found that farm size of the rural youth had no relationship with problem confrontation in selected agricultural activities.

Hoque (2001) revealed that significant positive relationship existed between farm size and problem confrontation of the FFS farmers in practicing IPM.

Kashem (1997) found a significant negative relationship between borga farm size of the landless laborers and their problem confrontation.

Hossain (1985) in his study found a significant relationship between borga farm size of the landless laborers and their problem confrontation.

2.4.4 Family annual income and problem confrontation

Mortuza (2015) found that annual family income had no significant relationship with their problems faced in maize cultivation.

Baten (2014) revealed that annual family income had no significant relationship with their problem faced in cotton cultivation.

Raha (1989) found in his study that income of the farmers had no significant relationship with their irrigation problem confrontation.

Islam (1987) reported that the relationship between income and artificial insemination problem confrontation was negatively significant.

Saha (1983) found in his study a negative relationship between income of the farmers and their poultry problem confrontation.

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

2.4.5 Extension contact and problem confrontation

Mortuza (2015) revealed that extension media contact had significant and negative relationship with their problems faced.

Baten (2014) revealed that extension media contact had significant negative relationship with their problem faced in cotton cultivation.

Ismail (2001) revealed that there was no significant relationship between media exposure of the farmers and their agricultural problem confrontation. Similar findings were obtained by Hoque (2001) in his study.

Raha (1989) Found that extension contact of the farmers had no significant relationship with immigration problem confrontation. However, the relationship showed a tendency in the negative direction.

2.4.6 Organizational participation and problems faced by farmers

Ali (2014) found that social organizational participation had significant relationships with problem confrontation of betel leaf farmers.

Rahman (1995) found in his study that there was no relationship between the farmers' social participation and their faced constraints in cotton cultivation.

Ali (1978), Saha (1983), Sarker (1983) and Mansur (1989) found in their studies that social participation of the farmers had a significant negative relationship with the agricultural constraints faced. On the other hand, Islam (1987) and Raha (1989) found no significant relationship with their agricultural constraints faced.

Rashid (1975) concluded in his study that social participation of the farmers had no significant relationship with their agricultural problem confrontation.

Mahboob (1966) undertook a study on the personality characteristics of the main county extension personnel in Wisconsin and based on finding of his study he concluded that participation in society is desirable for extension worker as it developed leadership qualities. Conclusion suggested that social participation of individuals may lessen their problem and thus enhance performance.

2.4.7 Other selected characteristics of farmers and problem faced by farmers in different agricultural activities

There was found a very little or no review on effective annual family income from potato production, amount credit receipt, time spent in potato farming, training in potato cultivation of the farmers and problem confrontation of different agricultural activities.

2.5 Research Gap of the Study

Very few researches had been done to solely assess the pest management problems faced by potato farmers. Only a few researchers followed systematic method. Therefore, the systematic method to assess pest management problems faced by potato farmers has also limited. This was one of the research gaps of the study. Hence, the researcher carried out the present study to assess the pest management problems faced by potato farmers of Khetlal upazila of Joypurhat district following the method which is important to be able to identify and understand the research approach suitable for any given study because the selection of a research approach influences the methods chosen, the statistical analyses used, the inferences made and the ultimate goal of the research. Furthermore, according to Bryman (2001) an area can be explored in two ways, with an unstructured approach to data collection in which participants' meaning are the focus of attention, and more structured approach of quantitative research to investigate a specific set of issues.

Therefore, no research was undertaken previously following the methodology which was followed by the researcher. This was also a significant research gap of the study. The methodology of the present work was very unique in this regard. So, the researcher implemented the research program following the methodology as mentioned.

Additionally, no research was carried out taking the indicators of pest management problems faced by potato farmers into consideration which were carried out by the researcher in the present study. This is another research gap of the present work. Hence, the researcher followed the current research program using those indicators to assess the pest management problems faced by potato farmers. Lastly, very few researches were conducted to assess the pest management problems faced by potato farmers taking the variables which were used in the present study. This is also a research gap of the present research. The researcher carried out present study using variables as mentioned.

2.6 Conceptual Framework of the Study

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

This study is concerned with the ‘Pest Management Problems Faced by Potato Farmers’. Thus, pest management problems in potato cultivation were the dependent variable and 10 selected characteristics of the potato cultivators were considered as the independent variables under the study. Pest management problems faced by potato farmers may be affected through interacting forces of many independent variables. It is not possible to deal with all of the independent variables in a single study. It was therefore, necessary to limit the independent variables, which were age, education level, farm size, annual family income, annual family income from potato production, extension contact, amount of credit receipt, time spent in potato farming, organizational participation and training in potato cultivation for this study.

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

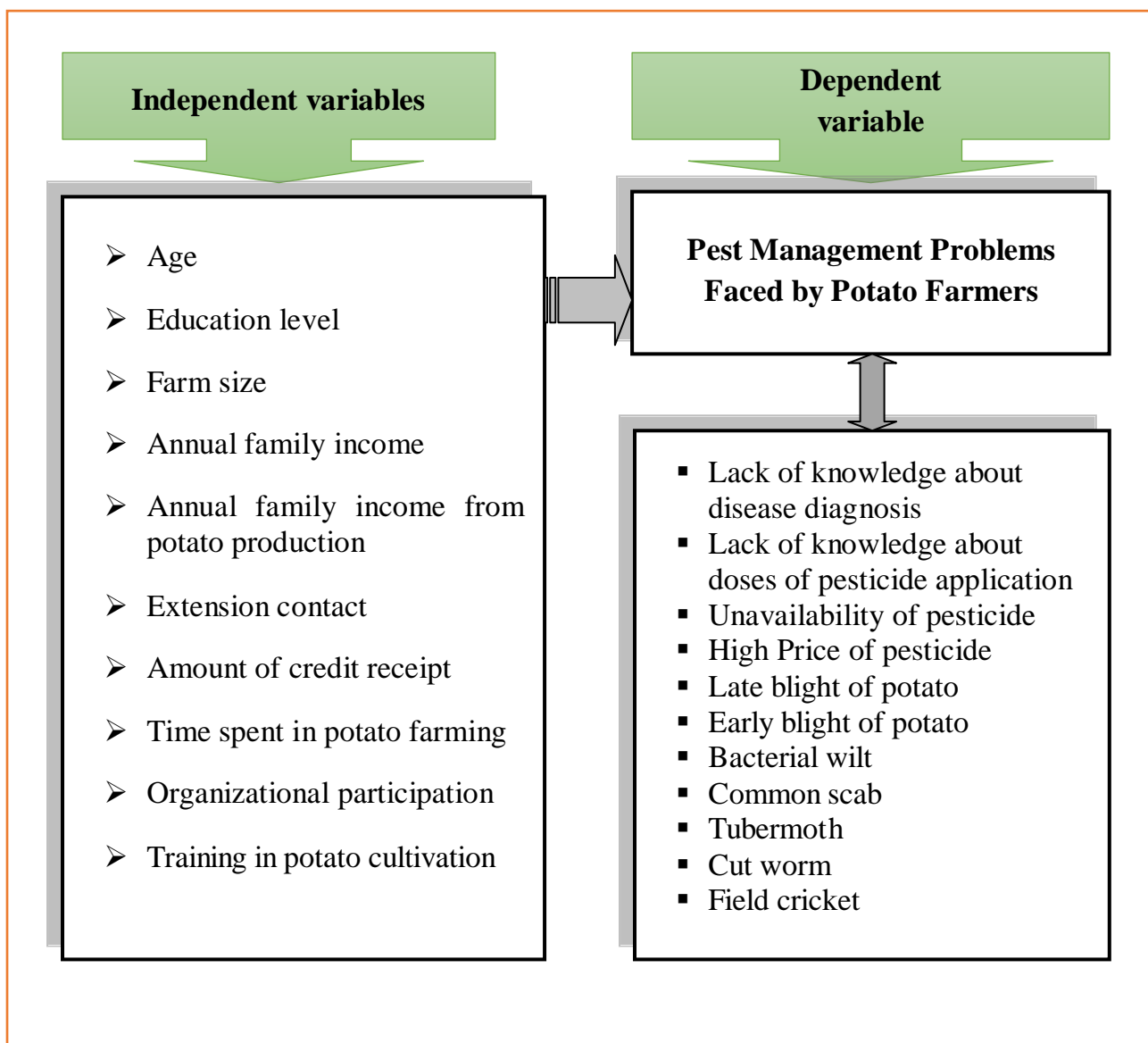


Figure 2.1 The conceptual framework of the study

CHAPTER III

MATERIALS AND METHODS

Methods and procedures maintained for collection and analysis of data are essential for any kind of scientific research. It is one of the most important parts before conducting a research work. To fulfill the objectives of the study, a researcher should be very careful while formulating methods and procedures in conducting the research. According to Mingers (2001), research method is a structured set of guidelines or activities to generate valid and reliable research results. The researcher has great responsibility to describe clearly as to what sorts of research design, methods and procedures he would follow in collecting valid and reliable data and to analyze and interpret those to arrive at correct summery and conclusion.

The methods and procedures followed in conducting these observations have been discussed in this chapter. Further, the chapter includes the operational format and comparative reflection of some variables used in the study. Also statistical methods and their use have been mentioned in the later section of this Chapter. A chronological description of the methodology followed in conducting this research work has been presented in this chapter.

3.1 Research Design

Detailed plan of investigation refers to research design. It is the mastermind of the detailed procedure of testing the hypothesis and analysis of the obtained data. The research design followed in this study was *ex-post facto*, because of uncontrollable and non-manipulating variables. This is absolute descriptive and diagnostic research design. A descriptive research design is used for fact findings with adequate interpretation. Diagnostic research design, on the other hand, is concerned with testing the hypothesis for specifying and interpreting the relationship of variables

3.2 Locale of the Study

The study was conducted in the Khetlal upazila under Joypurhat district. The area of Khetlal upazila (Joypurhat district) is 142.60 sq km, located in between 24°56' and 25°08' north latitudes and in between 89°02' and 89°12' east longitudes. It is bounded by Joypurhat sadar upazila on the north, Akkelur and Dhupcchanchia upazilas on the south, Kalai and Shibganj upazilas on the east, Joypurhatsadar upazila and Akkelur upazilas on the west. The features of the farmers and agriculture at Khetlal upazila are like- Ownership of agricultural land Landowner 64.85%, landless 35.15%; Main crops: Paddy, jute, wheat, potato, mustard; Main fruits: Mango, jackfruit, guava, banana, papaya; Main sources of income Agriculture 77.60%, non-agricultural laborers 1.31%, commerce 8.28%, transport and communication 4.68%, service 3.07%, construction 0.79%, religious service 0.16%, rent and remittance 0.21% and others 3.90% etc. Khetlal upazila under Joypurhat district was selected randomly as the study area. The present study was conducted at the Burail, Telabudul, Malipara, Mundail and Vashali villages of Khetlal upazila based on the population size in the selected area. The farmers of the study area are involved in potato cultivation. The numbers of farmers in the study area were 876.

The map of the Joypurhat district has been presented in Figure 3.1. and the specific study location- Khetlal upazila have also been shown in Figure 3.2.



Figure 3.1 Map of Joypurhat district showing the study area of Khetlal upazila



Figure 3.2 Map of Khetlal upazila showing the study area of Khetlal paurashova

3.3 Population and Sample of the Study

People who cultivated potato in the selected villages were constituted the active population of this study. As all population of the study area could not possible to measure, head of the farm families of Burail, Telabudul, Malipara, Mundail and Vashali villages of Khetlal upazila under Joupurhat district were the population of the study. However, representative sample from the population were taken for collection of data following random sampling technique. Updated lists of all farm families who cultivated potato of the selected villages were prepared with the help of SAAO and local leader (Matobbor). The total number of potato cultivators in these villages was 876; where 128 from Burail village, 325 from Telabudul village, 112 from Malipara village, 165 from Mundail village and 146 from Vashali village under the Khetlal paurashova which constituted the population of the study. Thus, 876 potato cultivators constituted the population of study which is shown in the following Table 3.1.

Table 3.1 Population of the study area

Name of the selected upazila	Name of the selected area	Name of the selected villages	Number of the respondents
Khetlal	Khetlal Paurashova	Burail	128
		Telabudul	325
		Malipara	112
		Mundail	165
		Vashali	146
Total			876

3.3.1 Determination of sample size

There are several methods for determining the sample size; here, the researcher used Yamane's (1967) formula for calculating sample size as follows:

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

Where, n = Sample size;

N, Population size = 876;

e, The level of precision = 9%;

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

P, The proportion or degree of variability = 50%;

The sample size (n) is = 105

3.3.2 Distribution of the population, sample size and reserve list

According to Yamane's formula, the respondents comprised of 105 potato cultivators. A reserve list of 10 potato cultivators (ten percent of the sample size) were also prepared so that the potato cultivators of this list could be used for interview if the potato cultivators included in the original sample were not available at the time of conduction of interview. The farmers of the selected areas were taken according to the proportionate of the total sample size (876). The distribution of the population, sample size and reserve list are given in Table 3.2.

Table 3.2 Distribution of the potato cultivators according to population, sample size and reserve list

Upazila	Selected area	Selected villages	Population	Sample size	Reserve list
Khetlal	Khetlal Paurashova	Burail	128	15	2
		Telabudul	325	39	2
		Malipara	112	13	2
		Mundail	165	20	2
		Vashali	146	18	2
Total			876	105	10

3.4 Data Collection Methods and Tools

3.4.1 Data collection methods

The survey method was used to collect quantitative data that allow to answer the research questions framed and to gain an understanding of the determinants of pest management problems faced by potato farmers. Individual interviews were used in the survey and were conducted in a face-to-face (Bryman, 2001) situation by the researcher. This method is useful to get unanticipated answers and to allow respondents to describe the world as they really see it rather than as the researcher does (Bryman, 2001).

3.4.2 Data collection tools

Structured interview schedule was prepared to reach the objectives of the study. A structured interview schedule was prepared containing open and closed questions. The open questions allowed for the respondents to give answers using their own language and categories (Casley and Kumar, 1998). The questions in this schedule were formulated in a simple and unambiguous way and arranged in a logical order to make it more attractive and comprehensive. The instruments were first developed in English and then translated into Bengali. The survey tools were initially constructed based on an extensive literature reviews and pre-tested. The schedule was pre-tested with 15 randomly selected farmers in the study area. The pre-test was helpful in identifying faulty questions and statements in the draft schedule. Thus, necessary additions, deletions, modifications and adjustments were made in the schedule on the basis of experiences gained from pre-test. The questionnaires were also checked for validity by supervisor and educational experts at Sher-e-Bangla Agricultural University (SAU). Finally, based on background information, an expert appraisal and the pre-test, the interview schedule was finalized. Data was gathered by the researcher personally. During data collection, necessary cooperation was obtained from field staff of different GOs and NGOs and local leader. The pre-test was conducted from 05 January, 2017 to 12 January, 2017 for pre-test. Books, journals, reports and internet

documents were used as secondary sources of data supporting or supplementing the empirical findings of the study. Data collection was started in 15 January, 2017 and completed in 10 February, 2017.

3.5 Variables and Their Measurement Techniques

The variable is a characteristic, which can assume varying, or different values in successive individual cases. A research work usually contains at least two important variables viz. independent and dependent variables. An independent variable is that factor which is manipulated by the researcher in his attempt to ascertain its relationship to an observed phenomenon. A dependent variable is that factor which appears, disappears or varies as the researcher introduces, removes or varies the independent variable (Townsend, 1953). In the scientific research, the selection and measurement of variable constitute a significant task. Following this conception, the researcher reviewed literature to widen this understanding about the natures and scopes of the variables relevant to this research. At last he had selected 10 independent variables and one dependent variable. The independent variables were: age, education level, farm size, annual family income, annual family income from potato production, extension contact, amount of credit receipt, time spent in potato farming, organizational participation and training in potato cultivation . The dependent variable of this study was the ‘Pest management Problems Faced by Potato Farmers’. The methods and procedures in measuring variables of study are presented below:

3.5.1 Measurement of independent variables

The 10 characteristics of the potato farmers mentioned above constitute the independent variables of this study. The following procedures were followed for measuring the independent variables.

3.5.1.1 Age

Age of the farmers was measured in terms of actual years from their birth to the time of the interview, which was found on the basis of the verbal response of the rural people (Rashid, 2014). A score of one (1) was assigned for each year

of one's age. This variable appears in item number 1 in the interview schedule as presented in Appendix-I.

3.5.1.2 Level of education

Education was measured by assigning score against successful years of schooling by a farmer. One score was given for passing each level in an educational institution (Rashid, 2014).

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

3.5.1.3 Farm size

Farm size of a farmer referred to the total area of land on which his/her family carried out the farming operation, the area being in terms of full benefit to the family. The term refers to the cultivated area either owned by the farmer or cultivated on sharecropping, lease or taking from other including homestead area and measured using the following formula (Rashid, 2014):

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

Where,

FS = Farm size,

A = Homestead area including garden and pond

B = Own land under own cultivation

C = Land taken from others as borga

D = Land given to other as borga

E = Land taken from others on lease

The data was first recorded in terms of local measurement unit i.e. kani or decimal and then converted into hectare. The total area, thus, obtained is considered as his farm size score (assigning a score of one for each hectare of land). This variable appears in item number three (3) in the interview schedule as presented in Appendix-I.

3.5.1.4 Annual family income

The term annual family income refers to the annual gross income of potato cultivators and the members of his family from different sources. It was expressed in taka. In measuring this variable, total earning taka of an individual potato cultivator was converted into score. A score of one was given for every one thousand taka. The method of ascertaining income involved three phases. Firstly, the income from agricultural crops in the preceding year was noted and converted into taka and secondly, income from animals and fish resources. Thirdly, other source income included earning form small business, service, other family members' income, day laborer, fishing and others if any. This variable appears in item number 4 in the interview schedule as presented in Appendix-I.

3.5.1.5 Annual family income from potato production

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

3.5.1.6 Extension contact

It was defined as one's extent of exposure to different communication media related to farming activities. Extension contact of a farmer was measured by computing extension contact score on the basis of their nature of contact with ten extension media. Each farmer was asked to indicate his nature of contact

with five alternative responses, like regularly, frequently, sometimes, rarely and not at all basis to each of the ten media and score of four, three, two, one and zero were assigned for those alternative responses, respectively. These five options for each medium were defined specially to each medium considering the situation, rationality and result of pre-test. Logical frequencies were assigned for each of the five-alternative nature of contact. Extension media contact of the farmers was measured by adding the scores of ten selected source of information. Thus, extension contact score of a farmer could range from 0 to 40, where zero indicated no extension contact and forty indicated highest level of extension contact. This variable appears in item number 6 in the interview schedule as presented in Appendix-I.

3.5.1.7 Amount of credit receipt

Amount of credit receipt refers to the total financial credit received from different sources in one year. It was expressed in Taka. A score of 1 was assigned for Tk. 1000. For an amount, less than Tk.1000, a fraction score was computed and added with the main score. This variable appears in item number 7 in the interview schedule as presented in Appendix-I.

3.5.1.8 Time spent in potato farming

Time spent in potato farming was determined by the total time involved in potato farming per week. A score of one (1) was assigned for each hour potato farming activities. This variable appears in item number 8 in the interview schedule as presented in Appendix-I.

3.5.1.9 Organizational participation

Organizational participation of a respondent was computed on the basis of his/her participation in different organizations. This variable appears in item number nine (9) in the interview schedule as presented in Appendix-I. Scoring of the organizational participation was done using the following formula and in the following way:

$$OP = P_{om} + P_{em} + P_{eo}$$

Where, OP = Organizational participation score,

P_{om} = Participation as ordinary committee member,

P_{em} = Participation as executive committee member and

P_{eo} = Participation as executive committee officer (president/secretary)

Nature of participation	Score assigned
No participation	0
Participation as ordinary member	1
Participation as executive member	2
Participation as secretary/ president	3

For example, if a respondent participated as an executive committee member of school committee, an ordinary member at NGO organized society and no participation in other organizations, that respondent would have a total score 3.

3.5.1.10 Training in potato cultivation

Training in potato cultivation was determined by the total number of days when respondent attended in different training programs in his life regarding potato cultivation. A score of one (1) was assigned for each day of training attended. This variable appears in item number ten (10) in the interview schedule as presented in Appendix-I.

3.5.2 Measurement of dependent variable

Pest management problems in potato cultivation was measured on the basis of extent of problems faced by the farmers on different aspects of potato cultivation. The following scores were assigned against each of the problems:

Extent of problems	Score
High	3
Medium	2
Low	1
No	0

Pest management problems in potato cultivation was measured by asking him/her 11 questions related to different components of pest management problems for potato cultivation. Thus, pest management problems in potato cultivation score of a respondent could range from 0 to 33 where '0' indicated no problem and '33' indicated highest pest management problems faced by potato farmers.

3.6 Hypothesis of the Study

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

3.6.1 Research hypothesis

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

“Each of the 10 selected characteristics (age, education level, farm size, annual family income, annual family income from potato production, extension contact, amount of credit receipt, time spent in potato farming, organizational participation and training in potato cultivation) of the potato farmers has significant contribution to their pest management problems.”

3.6.2 Null hypothesis

A null hypothesis states that there is no contribution between the concerned variables. The following null hypothesis was formulated to explore the contribution of the selected characteristics on pest management problems faced by potato farmers. Hence, in order to conduct tests, the earlier research hypothesis was converted into null form as follows:

“There is no contribution of the selected characteristics (age, education level, farm size, annual family income, annual family income from potato production,

extension contact, amount of credit receipt, time spent in potato farming, organizational participation and training in potato cultivation) of potato farmers to their pest management problems.”

3.7 Data Processing

After completion of field survey, all the data were coded, compiled and tabulated according to the objectives of the study. Local units were converted into standard units. All the individual responses to questions of the interview schedule were transferred in to a master sheet to facilitate tabulation, categorization and organization. In case of qualitative data, appropriate scoring technique was followed to convert the data into quantitative form.

3.8 Statistical Analysis

The data were analyzed in accordance with the objectives of the proposed research work. Qualitative data were converted into quantitative data by means of suitable scoring technique wherever necessary. The statistical measures such as range, means, standard deviation, number and percentage distribution were used to describe the variables. The analysis of data was performed using statistical treatment with SPSS (Statistical Package for Social Sciences) computer program, version 20. Regression analysis was used to identify the linear combination between independent variables used collectively to predict the dependent variables (Miles and Shevlin, 2001). Regression analysis helps us understand how the typical value of the dependent variable changes when any one of the independent variables is varied. Ordinary Least Squares (OLS) is used most extensively for estimation of regression functions. In short, the method chooses a regression where the sum of residuals, $\sum U_i$ is as small as possible (Gujarati, 1995). As shown in the following equation, explanatory variable included in model consist of those measuring various asset endowment and demographic characteristics of farmers.

In order to estimate the contribution of the selected characteristics of potato farmers to the problem faced by them in pest management, multiple regression

analysis (B) was used. Throughout the study, five (0.05) percent and one (0.01) percent level of significance were used as the basis for rejecting any null hypothesis. If the computed value of (B) was equal to or greater than the designated level of significance (p), the null hypothesis was rejected and it was concluded that there was a significant contribution between the concerned variable. Whenever the computed value of (B) was found to be smaller at the designated level of significance (p), the null hypothesis could not be rejected. It was concluded that there was no contribution of the concerned variables.

The model used for this analysis can be explained as follows:

$$Y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + b_9x_9 + b_{10}x_{10} + e$$

Where, Y= Pest management problems;

Of the independent variables, x_1 is the potato farmers age, x_2 is educational level, x_3 is farm size, x_4 is annual family income, x_5 is annual family income from potato production, x_6 is extension contact, x_7 is amount credit receipt, x_8 is time spent in potato farming, x_9 is organizational participation and x_{10} training in potato cultivation . On the other hand, $b_1, b_2, b_3, b_4, b_5, b_6, b_7, b_8, b_9$ and b_{10} are regression coefficients of the corresponding independent variables, and e is random error, which is normally and independently distributed with zero mean and constant variance.

CHAPTER IV

RESULTS AND DISCUSSION

Result and discussion is a mirror of a research work. A consequential and detailed discussion on the findings of the scientific research study has been presented in this chapter. These are presented in three sections according to the objective of the study. The first section deals with the selected characteristics of the farmers, while the second section deals with pest management problems faced by potato farmers. The third section deals with contribution of the farmers' selected characteristics to their pest management problems faced.

4.1 Characteristics of the Farmers

Behavior of an individual is determined to a large extent by one's personal characteristics. There were various characteristics of the farmers that might have consequence to potato production. But in this study, ten characteristics of them were selected as independent variables, which included their age, education level, farm size, annual family income, annual family income from potato production, extension contact, amount credit receipt, time spent in potato farming, organizational participation and training in potato cultivation that might be greatly influenced the pest management problems faced by potato farmers are presented below:

4.1.1 Age

The age of the farmers has been varied from 20 to 66 years with a mean and standard deviation of 39.78 and 9.75 respectively. Considering the recorded age farmers were classified into three categories namely 'young', 'middle' and 'old' aged following MoYS (2012). The distributions of the potato farmers in accordance of their age are presented in Table 4.1.

Table 4.1 Distribution of the potato farmers according to their age

Category	Range (years)		Farmers		Mean	SD
	Score	Observed	Number	Percent		
Young aged	≤ 35	20-66	39	37.1	39.78	9.75
Middle aged	36-50		55	52.4		
Old aged	> 50		11	10.5		
Total			105	100.0		

Table 4.1 reveals that the middle-aged farmers comprised the highest proportion (52.4 %) followed by young aged category (37.1 %) and the lowest proportion were made by the old aged category (10.5 %). Data also indicates that the middle and young aged category constitute 78.6 percent of total farmers. The young and middle aged farmers were generally more involved in farm activities than the older.

4.1.2 Education level

The level of educational scores of the farmers ranged from 0 to 18 with a mean and standard deviation of 7.19 and 5.48 respectively. Based on the educational scores, the farmers were classified into five categories. The distributions of potato farmers according to their level of education are presented in Table 4.2.

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

Category	Range (years)		Farmers		Mean	SD
	Score	Observed	Number	Percent		
Can't read and sign	0	0-18	4	3.8	7.19	5.48
Can sign only	0.5		29	27.6		
Primary education	1-5		13	12.4		
Secondary education	6-10		32	30.5		
Above secondary	>10		27	25.7		
Total			105	100.0		

Table 4.2 shows that farmers under secondary education category constitute the highest proportion (30.5 %) followed by can sign only (27.6 %). On the other hand, the lowest 3.8 percent in can't read and sign category followed by primary education category (12.4 %) and 25.7 percent respondents were above secondary education category.

4.1.3 Farm size

The effective farm size of the farmers ranged from 0.12 ha to 5.35 ha with a mean and standard deviation of 0.91 and 0.56 respectively. Based on their farm size, the farmers were classified into five categories following the categorization used by DAE. The distribution of the potato farmers according to their farm size is presented in Table 4.3.

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

Category	Range (ha)		Farmers		Mean	SD
	Score (ha)	Observed	Number	Percent		
Landless	≤0.02	0.12-5.35 (ha)	0	0	0.91	0.56
Marginal	0.021-0.20		3	2.9		
Small	0.21-1.00		37	35.2		
Medium	1.01-3.0		55	52.4		
Large	>3		10	9.5		
Total			105	100.0		

Table 4.3 indicates that the medium farm holder constitutes the highest proportion (52.4 %) followed by small farm holder (35.2 %). The findings of the study reveal that majority of the farmers were small to medium sized farm holder. The average farm size of the farmers of the study area (0.91 ha) was higher than that of national average (0.60 ha) of Bangladesh (BBS, 2014).

4.1.4 Annual family income

The score of annual family income of the potato farmers ranged from 50 to 630 thousand (BDT) with a mean and standard deviation of 199.50 and 130.07 respectively. On the basis of annual family income, the potato farmers were classified into three categories (Mean ± Standard Deviation) namely ‘low’, ‘medium’ and ‘high’ annual family income. The distribution of the potato farmers according to their annual family income is presented in Table 4.4.

Table 4.4 Distribution of the potato farmers according to their annual family income

Category	Range ('000' BDT)		Farmers		Mean	SD
	Score	Observed	Number	Percent		
Low income	≤ 70	50-630	22	21.0	199.50	130.07
Medium income	71-330		67	63.8		
High income	> 330		16	15.2		
Total			105	100.0		

Data reveals that the potato farmers having medium annual family income constitute the highest proportion (63.8 %), while the lowest proportion in high family income (15.2 %) and the low annual family income constituted with 21.0 percent. Overwhelming majority (84.80 %) potato farmers have low to medium level annual income.

4.1.5 Annual family income from potato production

The score of annual family income from potato production of the potato farmers ranged from 30 to 510 thousand (BDT) with a mean and standard deviation of 102.32 and 80.47 respectively. On the basis of annual family income from potato production, the potato farmers were classified into three categories (Mean ± Standard Deviation) namely 'low', 'medium' and 'high' annual family income from potato production. The distribution of the potato farmers according to their annual family income from potato production is presented in Table 4.5.

Table 4.5 Distribution of the potato farmers according to their annual family income from potato production

Category	Range ('000' BDT)		Farmers		Mean	SD
	Score	Observed	Number	Percent		
Low income	≤ 21	30-510	0	0	102.32	80.47
Medium income	22-182		93	88.6		
High income	> 182		12	11.4		
Total			105	100.0		

Data reveals that the potato farmers having medium annual family income from potato production constitute the highest proportion (88.6 %), while followed by high annual family income from potato production was 11.4 percent potato farmers.

4.1.6 Extension contact

The observed score of agricultural extension contact of the farmers ranged from 22 to 35. The average score of the farmers' extension contact score was 27.66 with a standard deviation 3.52 (Table 4.6). The farmers were classified into three categories (Mean \pm Standard Deviation) on the basis of their extension contact namely 'less', 'medium' and 'high' extension contact of the farmers. The distribution of the potato farmers according to their extension contact is presented in Table 4.6.

Table 4.6 Distribution of the potato farmers according to their extension contact

Category	Range		Farmers		Mean	SD
	Score	Observed	Number	Percent		
Less contact	≤ 24	22-35	21	20.0	27.66	3.52
Medium contact	25-31		63	60.0		
High contact	>31		21	20.0		
Total			105	100.0		

Data shows that the highest proportion (60.0 %) of the farmers had medium extension contact as compared to 20.0 percent of them having less as well as 20 percent of them having high extension contact (Table 4.6). From this table, it might be said that majority (80 %) of the farmers had medium extension contact which demands for strengthening and improving the communication strategies.

4.1.7 Amount of credit receipt

The score of amount of credit receipt from different sources by the potato farmers ranged from 0 to 43 thousand (BDT) with a mean and standard deviation of 14.39 and 11.29 respectively. On the basis of available information

cited by potato farmers on amount of credit receipt, the potato farmers were classified into three categories (Mean \pm Standard Deviation) namely ‘low’, ‘medium’ and ‘high’ amount of credit receipt. The distribution of the potato farmers according to their credit receipt is presented in Table 4.7.

Table 4.7 Distribution of the potato farmers according to their amount of credit receipt

Category	Range (‘000’ BDT)		Farmers		Mean	SD
	Score	Observed	Number	Percent		
Low credit receipt	≤ 3	0-43	15	14.3	14.39	11.29
Medium credit receipt	4-25		71	67.6		
High credit receipt	>25		19	18.1		
Total			105	100.0		

Data reveals that the potato farmers having medium amount of credit receipt constituted with 67.6 percent farmers as the highest proportion, while the lowest proportion in low amount of credit receipt was 14.3 percent and the high amount of credit receipt from different sources constituted with 18.1 percent farmers. Overwhelming majority (81.9 %) potato farmers have medium to high level amount credit receipt from different sources.

4.1.8 Time spent in potato farming

Time spent in potato farming of the potato farmers ranged from 22 to 56 hours per week with a mean and standard deviation of 44.44 and 6.53 respectively. Based on the time spent in potato farming score, the potato farmers were classified into three categories (Mean \pm Standard Deviation) namely minimum, average and maximum time spent in potato farming. The distribution of the potato farmers according to their time spent in potato farming is presented in Table 4.8.

Table 4.8 Distribution of the potato farmers according to their time spent in potato farming

Category	Range (year)		Potato farmers		Mean	SD
	Score	Observed	Number	Percent		
Minimum time spent	≤ 37	22-56	12	11.4	44.15	6.53
Average time spent	38-50		73	69.5		
Maximum time spent	> 50		20	19.1		
Total			93	100.0		

Table 4.8 indicates that the highest proportion (69.5 %) of the potato farmers had average time spent compared to 11.4 percent in minimum time spent and 19.1 percent in maximum time spent category, respectively.

4.1.9 Organizational participation

Organizational participation score of the potato farmers ranged from 0 to 9 with a mean and standard deviation of 4.46 and 2.67 respectively. Based on organizational participation score, the potato farmers were classified into three categories (Mean ± Standard Deviation) namely low, medium and high participation. The distribution of the potato farmers as per their organizational participation is presented in Table 4.9.

Table 4.9 Distribution of the potato farmers according to their organizational participation

Category	Range		Farmers		Mean	SD
	Score	Observed	Number	Percent		
Low participation	≤ 2	0-9	16	15.2	4.46	2.67
Medium participation	3-7		71	67.5		
High participation	> 7		18	17.3		
Total			105	100.0		

Data reveals that the highest proportion (67.5 %) of the potato farmers had medium organizational participation, while 17.3 percent had high organizational participation and the lowest 15.2 percent had low organizational participation.

4.1.10 Training in potato cultivation

Training in potato cultivation score of the potato farmers ranged from 0 to 14 with a mean and standard deviation of 5.55 and 3.48 respectively. Based on the training in potato cultivation score, the potato farmers were classified into four categories namely ‘no training’, ‘low’, ‘medium’ and ‘high’ training in potato cultivation. The distribution of the potato farmers according to their training in potato cultivation is presented in Table 4.10.

Table 4.10 Distribution of the potato farmers according to their training in potato cultivation

Category	Range (score)		Farmers		Mean	SD
	Score	Observed	Number	Percent		
No training	0	0-14	5	4.8	5.55	3.48
Low training	1-2		12	11.4		
Medium training	3-9		71	67.6		
High training	>9		17	16.2		
Total			105	100.0		

Table 4.10 indicates that the highest proportion (67.6 %) of the potato farmers had medium training exposure compared to 16.2 percent in high training exposure and 11.4 percent in low training exposure category, respectively and the lowest proportion (4.8 %) had no training.

4.2 Pest Management Problems Faced by Potato Farmers

Pest management problems faced by potato farmers is the dependent variable of this study and it was measured by computing scores according to extent of problems with each of 11 selected problems. Pest management problems score varied from 13.00 to 27.00 with the mean and standard deviation of 19.86 and 3.68 respectively. On the basis of pest management problems score, the potato farmers were classified into three categories (Mean \pm Standard Deviation) namely low, medium and high pest management problems. The distribution of the farmers according to their pest management problems score under the study is given in Table 4.11.

Table 4.11 Distribution of the potato farmers according to their pest management problems faced by them

Category	Range		Farmers		Mean	SD
	Score	Observed	Number	Percent		
Low problems	≤ 16	13-27	25	23.8	19.86	3.68
Medium problems	17-23		64	61.0		
High problems	≥ 24		16	15.2		
Total			105	100.0		

Table 4.11 indicates that among the respondents, the highest 61.0 percent potato farmers belong to the group of medium pest management problems and the lowest 15.2 percent fell in high problem while low problem constituted 23.8 percent potato farmers. Overwhelming majority (84.8 %) of the potato farmers had low to medium pest management problems.

4.3 Contribution of Selected Characteristics of the Farmers to Their Pest Management Problems

For this study ten characteristics of the respondents were selected and each of the characteristics was treated as independent variable. Of the independent variables, x_1 is the potato farmers age, x_2 is educational level, x_3 is farm size, x_4 is annual family income, x_5 is annual family income from potato production, x_6 is extension contact, x_7 is amount of credit receipt, x_8 is time spent in potato farming, x_9 is organizational participation and x_{10} training in potato cultivation . $Y=$ is the pest management problems faced by the farmers as dependent variable of this study.

Full model regression analysis was initially run with the 10 independent variables. But it was observed that the full model regression results were misleading due to the existence of interrelationships among the independent variables. Therefore, in order to avoid the misleading results and to determine the best explanatory variables, the method of stepwise multiple regressions was administrated and 10 independent variables were fitted together in step-wise multiple regression analysis. Table 4.12 shows the summarized results of step-wise multiple regression analysis with 10 independent variables on pest

management problems faced by the farmers. It was observed that out of 10 variables only 5 independent variables namely time spent in potato farming (x_8), educational level (x_2), amount of credit receipt (x_7), farm size (x_3) and extension contact (x_6) were entered into the regression equation. The other five variables were not entered into regression equation. The regression equation so obtained is presented below:

$$Y = 39.134 - 0.214 X_8 - 0.173 X_2 + 0.072 X_7 - 0.813 X_3 - 0.306 X_6$$

Table 4.12 Summary of step wise multiple regression analysis showing the contribution of selected characteristics of the potato farmers to the pest management problems faced by the farmers

Variables entered	Standardized Partial 'b' Coefficients	Value of 't' (with probability level)	Adjusted R ²	Increase in R ²	Variation explained in percent
Time spent in potato farming (x_8)	-0.214	-4.127 (0.000)	0.773	0.773	77.3
Educational level (x_2)	-0.173	-3.186 (0.002)	0.827	0.054	5.4
Amount of credit receipt (x_7)	0.072	4.733 (0.000)	0.833	0.006	0.6
Farm size (x_3)	-0.813	-4.705 (0.000)	0.852	0.019	1.9
Extension contact (x_6)	-0.306	-2.948 (0.004)	0.863	0.011	1.1
Total				0.863	86.3

Multiple R = 0.932; R-square = 0.869;
 Adjusted R-square = 0.863; F-ratio = 8.690;
 Standard error of estimate = 1.36; Constant = 5.027;

The multiple R and R² values were found 0.932 and 0.869 respectively and the corresponding F-ratio was 8.690 which were significant at 0.000 levels. For determining unique contribution of each of the five variables the increase in R² value was determined on pest management problems faced by the potato farmers. These five variables combinedly explained 86.3 percent of the total

variation to the pest management problems faced by the farmers. Time spent in potato farming alone contribute 77.3 percent of the variation where educational level (5.4 %), amount of credit receipt (0.6 %), farm size (1.9 %) and extension contact (1.1 %) had rest of variation to the pest management problems faced by the potato farmers.

4.3.1 Contribution of time spent in potato farming to the pest management problems faced by the farmers

The contribution of time spent in potato farming to the pest management problems faced by the farmers was measured by testing the following null hypothesis:

“There is no contribution of time spent in potato farming to the pest management problems faced by the farmers”.

The following observations were made on the basis of the value of the concerned variable of the study under consideration.

- a. The contribution of the time spent in potato farming was 77.3 percent.
- b. It was the highest contribution to the pest management problems faced by the farmers.
- c. The null hypothesis could be rejected.

Based on the above finding, it can be stated that a respondent’s time spent in potato farming had an effect on pest management problems faced by the farmers. Time spent in potato farming enhances the abilities of the respondents at a short time to understand about the pest and disease on their potato field than others which transformed them to take the action against pest management problems faced by the farmers.

4.3.2 Contribution of educational level to the pest management problems faced by the farmers

The contribution of educational level to the pest management problems faced by the farmers in potato cultivation was measured by testing the following null hypothesis:

“There is no contribution of educational level to the pest management problems faced by the farmers in potato cultivation”.

The following observations were made on the basis of the value of the concerned variable of the study under consideration.

- a. The contribution of the educational level was 5.4 percent.
- b. It was the importation contributor to the pest management problems faced by the farmers in potato cultivation.
- c. The null hypothesis could be rejected.

Based on the above finding, it can be stated that a respondent’s educational level had an effect on the pest management problems faced by the farmers. Educational level enhances the abilities of the respondents at a short time to understand about the pest and disease on their potato field than others which transformed them to take the action against pest management problems faced by the farmers.

4.3.3 Contribution of amount of credit receipt to the pest management problems faced by the farmers

The contribution of amount credit receipt to the pest management problems faced by the farmers in potato cultivation was measured by testing the following null hypothesis:

“There is no contribution of amount credit receipt to the pest management problems faced by the farmers in potato cultivation”.

The following observations were made on the basis of the value of the concerned variable of the study under consideration.

- a. The contribution of the amount credit receipt was 0.6 percent.
- b. It was the importation contributor to the pest management problems faced by the farmers in potato cultivation.
- c. The null hypothesis could be rejected.

Based on the above finding, it can be stated that a respondent’s amount credit receipt had an effect on the pest management problems faced by the farmers. Amount credit receipt enhances the abilities of the respondents at a short time

to understand about the pest and disease on their potato field than others which transformed them to take the action against pest management problems faced by the farmers.

4.3.4 Contribution of farm size to the pest management problems faced by the farmers

The contribution of farm size to the pest management problems faced by the farmers in potato cultivation was measured by testing the following null hypothesis:

“There is no contribution of farm size to the pest management problems faced by the farmers in potato cultivation”.

The following observations were made on the basis of the value of the concerned variable of the study under consideration.

- a. The contribution of the farm size was 1.9 percent.
- b. It was the importation contributor to the pest management problems faced by the farmers in potato cultivation.
- c. The null hypothesis could be rejected.

Based on the above finding, it can be stated that a respondent’s farm size had an effect on the pest management problems faced by the farmers. Farm size enhances the abilities of the respondents at a short time to understand about the pest and disease on their potato field which transformed them to take the action against pest management problems faced by the farmers.

4.3.5 Contribution of extension contact to the pest management problems faced by the farmers

The contribution of extension contact to the pest management problems faced by the farmers in potato cultivation was measured by testing the following null hypothesis:

“There is no contribution of extension contact to the pest management problems faced by the farmers in potato cultivation”.

The following observations were made on the basis of the value of the concerned variable of the study under consideration.

- a. The contribution of the level of education was 5.4 percent.
- b. It was the importation contributor to the pest management problems faced by the farmers in potato cultivation.
- c. The null hypothesis could be rejected.

Based on the above finding, it can be stated that a respondent's extension contact had an effect on to the pest management problems faced by the farmers. Extension contact enhances the abilities of the respondents at a short time to understand about the pest and disease on their potato field than others which transformed them to take the action against pest management problems faced by the farmers.

CHAPTER V

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

The study was conducted in the Khetlal pauroshava of Khetlal upazila in Joypurhat district to find out the pest management problems faced by potato farmers. Total 876 potato farmers were selected from the study area as the population and according to Yamane's formula, the respondents comprised of 105 potato farmers constituted the sample of the study. A well-structured interview schedule was developed based on objectives of the study for collecting information. The independent variables were: age, education level, farm size, annual family income, annual family income from potato production, extension contact, amount credit receipt, time spent in potato farming, organizational participation and training in potato cultivation . Data collection was started in 15 January, 2017 and completed in 10 February, 2017. Various statistical measures such as frequency counts, percentage distribution, average, and standard deviation were used in describing data. In order to estimate the contribution of the selected characteristics of potato farmers to their problems faced by the farmers in potato production, multiple regression analysis (B) was used. The major findings of the study are summarized below:

5.1 Major Findings

5.1.1 Selected characteristics of the potato farmers

Age: The middle-aged potato farmers comprised the highest proportion (52.4 %) and the lowest proportion by old aged category (10.5 %).

Educational level: Secondary education constituted the highest proportion (30.5 %) and the lowest 3.8 percent in can't read and sign category.

Family size: The medium farm holder constituted the highest proportion (52.4 %), whereas the landless farm holder was not found.

Annual family income: The medium annual family income constituted the highest proportion (63.8 %), while the lowest proportion in high family income constituted with 15.2 percent farmers.

Annual family income from potato production: medium annual family income from potato production constitute the highest proportion (88.6 %), while followed by high annual family income from potato production was 11.4 percent potato farmers.

Extension contact: the highest proportion (60.0 %) of the farmers had medium extension contact as compared to 20.0 percent of them having less and high extension contact category.

Amount of credit receipt: The potato farmers having medium amount credit receipt constituted with 67.6 percent farmers as the highest proportion, while the lowest proportion in low amount credit receipt was 14.3 percent farmers.

Time spent in potato farming: The highest proportion (69.5 %) of the potato farmers had average time spent compared to 11.4 percent in minimum time spent.

Organizational participation: The highest proportion (67.5 %) of the potato farmers had medium organizational participation and the lowest 15.2 percent had less organizational participation.

Training in potato cultivation : The highest proportion (67.6 %) of the potato farmers had medium training exposure and 4.8 percent had no training exposure category.

5.1.2 Pest management problems faced by potato farmers

The highest 61.0 percent potato farmers belong to the group of medium pest management problems and the lowest percentage 15.2 percent in high problem.

5.1.3 Contribution of selected characteristics of the farmers to their pest and disease management problems

The multiple R and R^2 values were found 0.932 and 0.869 respectively and the corresponding F-ratio was 8.690 which were significant at 0.000 levels. For determining unique contribution of each of the five variables the increase in R^2 value was determined on pest management problems faced by the potato farmers. These five variables combinedly explained 86.3 percent of the total variation to the pest management problems faced by the farmers. Time spent in potato farming alone contribute 77.3 percent of the variation where level of education (5.4 %), amount of credit receipt (0.6 %), farm size (1.9 %) and extension contact (1.1 %) had rest of variation to the pest management problems faced by the potato farmers.

5.2 Conclusions

The findings and relevant facts of research work prompted the researcher to draw following conclusions.

- i. It may be concluded that the composite problems faced by the farmers in potato production needs to minimize for sustainable potato production.
- ii. It may be concluded that time spent in potato farming of the farmers had influenced to reduce the pest management problems faced by the farmers in potato production.
- iii. Conclusion could be drawn that farmers could be more ameliorated in all aspects of socio-economic of life if government takes more educational project to make it more educated.
- iv. It may be concluded that amount of credit receipt had an effect to the pest management problems in potato cultivation.
- v. Conclusion could be drawn that these farmers could be more taken more protection measures in case of large potato production.

- vi. It may be concluded that extension media contact of the farmers had influenced to reduce the problems faced by the farmers in potato production.

5.3 Recommendations

5.3.1 Recommendations for policy implications

On the basis of observation and conclusions drawn from the findings of the study following recommendations are made:

- i. It is recommended that an effective step should be taken by the Department of Agricultural Extension (DAE) and Non-Government Organizations (NGOs) for strengthening the farmers' qualities in favor of reduce the problems faced by the farmers in potato production to a higher degree.
- ii. It is recommended that the extension workers should encourage the farmers to spend more time in potato farming so that farmers themselves could identify manage pest management problems as early possible.
- iii. It is recommended that arrangements should be made for enhancing the education level of the potato farmers by the concerned authorities through the establishment of night school, adult education and other extension methods as possible.
- iv. It is recommended that arrangements should be made for enhancing the awareness of the potato farmers by the concerned authorities in case of taking credit from different sources.
- v. In case of potato production with a large farm area, it is recommended that awareness should be made among the potato farmers by the different government and non government organization through implementation of programs and projects.
- vi. The DAE and other NGOs should take necessary steps to increase the extension media contact of the farmers. Therefore, it is recommended that

the extension worker should provide supplementary supports to motivate farmers for increasing the extension media contact.

5.3.2 Recommendations for further study

On the basis of scope and limitations of the present study and observation made by the researcher, the following recommendations are made for future study.

- i. The present study was conducted in Khetlal upazila under Joupurhat district. It is recommended that similar studies should be conducted in other areas of Bangladesh.
- ii. This study investigated the contribution of ten characteristics of the farmers with their pest management problems faced by them as dependent variables. Therefore, it is recommended that further study should be conducted with other characteristics of the farmers with their pest management problems faced by the farmers in potato production.
- iii. The present study was concern only with the extent of pest management problems faced by the farmers in potato production. It is therefore suggested that future studies should be included more reliable measurement of concerned variable is necessary for further study.
- iv. The study was based on the farmers' pest management problems faced in potato production. Further studies may be conducted in respect of pest management problems faced by the farmers of other crop production.

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APPENDIX-I

English Version of the Interview Schedule

Department of Agricultural Extension and Information System
Sher-e-Bangla Agricultural University, Dhaka-1207.

Interview schedule for data collection for the research on
‘Pest management Problems Faced by Potato Farmers’

Serial No. :

Name of the respondent :

Address :

:

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

1. Age

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

2. Education level

State your level of education? Give (√) to appropriate place

What is your level of education?

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

3. Farm size

(Please mention the area of your land according to use)

Sl. No.	Types of land use	Area of land	
		Local unit	Hectare
F1	Homestead land		
F2	Land under own cultivation		
F3	Land given to others on Joypurhat		
F4	Land taken from others on Joypurhat		
F5	Land taken from others on lease		
F6	Others		
Total farm size = $F1+F2+1/2(F3+F4) +F5+F6$			

4. Annual family income

(Please mention the amount of annual income from the following sources)

a) Income from Agricultural Crops

SL. No.	Crop Name	Production (Kg or Maund)	Income /Kg or Maund (Tk)	Total Income (Tk)
1.	Aman rice			
2.	Boro rice			
3.	Oil crop			
4.	Potato			
5.	Vegetables			
Total				

b) Income from animals and fish resources

SL. No.	Crop Name	Production (Kg or Maund)	Income /Kg or Maund (Tk)	Total Income (Tk)
1.	Cow, goat, ram, buffalo			
2.	Poultry			
3.	Fish resources			
Total				

c) Income from other resources

SL. No.	Income resources	Total Income (Tk.)
1.	Service	
2.	Business	
3.	Day labor	
4.	Other family members	
5.	Others income source	
Total		

5. Annual family income from potato production

Describe your annual family income from potato production

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

6. Extension contact

(Please mention the extent of your extension contact)

SL. No.	Contact with the persons	Extent of contact				
		Regularly (4)	Frequently (3)	Occasionally (2)	Rarely (1)	Not at all (0)
1.	Contact with AEO/AO	≥ 6 times/year	4-5 times/year	2-3 times/year	Once/year	Not even once
2.	Contact with SAAO	≥ 2 times/month	1-2 times/2 month	1-2 times/3 month	Once/6 month	Not even once
3.	Contact with NGO officer	≥ 3 times/month	1-2 times/month	1-2 times/3 month	Once/6 month	Not even once
4.	Participation in training	≥ 2 times/year	1 time/year	1 time/2 year	1 time/4 year	Not even once
5.	Attend method demonstration	≥ 3 times/year	2 times/year	1 times/year	1 times/2 year	Not even once
6.	Conducted result demonstration	≥ 6 time in life	4-5 time in life	2-3 time in life	Once in life	Not even once
7.	Listening krishi radio program	≥ 4 times/month	3 times/month	2 times/month	Once/month	Not even once
8.	Watching Tv program	≥ 4 times/month	3 times/month	2 times/month	Once/month	Not even once
9.	Attend agricultural group meeting	≥ 4 times/year	3 times/year	1-2 times/year	Once/year	Not even once
10.	Read krishi katha, krishi magazine, leaflet, etc.	≥ 10 times/year	6-9 times/year	3-5 times/year	1-2 times/year	Not even once

7. Amount of credit receipt

Please provide your credit receiving information on the following table:

SL. No.	Sources of credit	Amount (TK.)
1.	Bank	
2.	Village money lender	
3.	NGO	
4.	Relatives	
5.	Others (if any)	
Total		

8. Time spent in potato farming

How much time do you spend in potato farming?hours/week

9. Organizational participation

Please mention the nature and duration of your participation.

Sl. No.	Name of Organizations	NI (0)	Nature of Participation		
			OM (1)	EM (2)	EO (3)
1	Masjid/Mandir committee				
2	School committee				
3	Samabay samity				
4	Mass literacy samity				
5	Local samity of NGO's				
6	Union parishad				
7	IPM club				

Note: NI= Not Involved, OM=Ordinary Member, EM= Executive Member, EO= Executive officer;

10. Training in potato cultivation

Have you received any training related to potato cultivation?

(Please Put a Tick mark)

i) YES

ii) No

If YES. Then mention the name the following ones:

Sl. No.	Name of the training course	Organization	Days
01.			
02.			
03.			
04.			
05.			

11. Pest mangement problems

Please indicate the severity of pest and disease infestations-

Sl. No.	Problems on pest	Nature of Severity			
		High (3)	Medium (2)	Low (1)	No (0)
1.	Lack of knowledge about disease diagnosis				
2.	Lack of knowledge about doses of pesticide application				
3.	Unavailability of pesticide				
4.	High Price of pesticide				
5.	Late blight of potato				
6.	Early blight of potato				
7.	Bacterial wilt				
8.	Common scab				
9.	Tubermoth				
10.	Cut worm				
11.	Field cricket				

Thank you for your kind co-operation.

Date:

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(Signature of the interviewer)