ADOPTION OF COMMONLY USED INTEGRATED PEST MANAGEMENT (IPM) PRACTICES BY THE BORO RICE GROWERS

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CERTIFICATE

This is to certify that the thesis entitled **"Adoption of Commonly Used Integrated Pest Management (IPM) Practices by the Boro Rice Growers"** submitted to the faculty of agriculture, Sher-e-Bangla Agricultural University, Dhaka-1207, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE in AGRICULTURAL EXTENSION**, embodies the result of a piece of bona fide research work carried out by **Md. Zul-Ekram**, Registration No. **07-02529** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

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The Author

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ABSTRACT

The focus of the present study was to determine the adoption of commonly used integrated pest management (IPM) practices by the boro rice growers and to explore the relationships between the adoption of commonly used IPM practices in boro rice cultivation and the twelve selected characteristics of the boro rice growers. Data were collected from 130 randomly selected respondents of the two selected villages of Dhontola union under Baliadangi upazila of Thakurgaon district. Data were collected by using an interview schedule from the respondents during 21 April to 6 May, 2015. Adoption of commonly used IPM practices was measured on the basis of average mean area adoption of 10 commonly used IPM practices in boro rice cultivation. The highest proportion (57.69 percent) of the respondents had medium adoption, while 42.31 percent had low adoption of commonly used IPM practices in boro rice cultivation. Pearson's Product Moment Correlation co-efficient (r) was also computed to explore the relationships between the dependent and independent variables. The correlation analysis found that, training exposure, attitude towards harmful effects of chemical pesticide and contact with IPM club/FFS showed significant positive relationship with the adoption of commonly used IPM practices in boro rice cultivation. However, age, family agriculture workforce, annual family income, education, farm size, knowledge on pesticide application, awareness about environmental pollution, contact with pesticide dealers and cost of pesticide showed non significant relationship with the adoption of commonly used IPM practices in boro rice cultivation.

CHAPTER 1

INTRODUCTION

1.1 General Background

Agriculture is the main source of livelihood for the most of the people of Bangladesh. Out of total GDP agriculture constitutes 16.33 percent (BBS, 2014). About 47.5 percent of the total population of this country is directly or indirectly involved in agricultural activities (BBS, 2010). Rural economy of Bangladesh is mainly rice based. At present, rice covers about 11,800,000 ha of the cultivated land in Bangladesh (Abdullah, 2012) which is almost 75.0 % of total land.

Bangladesh is a small country but its population density is probably the highest in the world. To feed the ever increasing population it is imperative to increase crop production. One of the main problems to increase crop production is the pest. The word 'pest' refers to organisms such as insects, rodents and birds that cause damage or annoyance to man, his animals, crops or possessions. According to an estimate, annual yield loss due to insect pest alone is 16% for rice (Ahmed *et al*, 2001)

In Bangladesh, chemical control has been the principal method of pest control. Although pesticides may provide temporary relief from pest problems, long-term dependency on pesticides is not desirable. It is now widely accepted that indiscriminate use of pesticides not only creates serious environmental and human health problems but also promotes development of pest resistance too insecticides, destroys beneficial insect, upsets the balance between the pests and their natural enemies leading to the increase in the population of the target pests and even the creation of new pest problems. To avoid such consequences and at the same time to increase the crop production on a sustainable basis, a viable alternative to sole dependence on chemical pesticides is Integrated Pest Management (IPM).

Integrated Pest Management (IPM) is a broad ecological approach to pest control using various pest control tactics in a compatible manner. IPM has no standard definition, but comprises approaches that range from carefully-targeted used of chemical pesticides to biological techniques that use natural parasites and predators to

control pests (Sorby *et al*, 2003). In the contemporary usage, IPM is not limited to dealing with pesticides and pest management, in fact, IPM has holistic approaches to crop production based on sound ecological understanding. FAO first introduced IPM in Bangladesh in the year of 1981 in rice cultivation, but its gained popularity in the year 1987. Government formulated National IPM policy in 2002. Next in 1995 with the finance of UNDP, DAE take five years project named DAE-UNDP IPM Project. In 1997 with the finance by Danish Government, DAE started an IPM project named DAE-DANIDA SPPS Project. Later on IPM project is being implemented phase by phase as different names with the finance of Bangladesh government. At present IPM activities cover almost all districts and upazillas of Bangladesh.

Now the question came how far rice growers adopt IPM practices. Extent of adoption of IPM practices by the growers will determine the success and failure of IPM projects and help to readdress the projects in future.

1.2 Statement of the Problem

Rice is the staple food crop in Bangladesh. Rice is grown in three season's viz. Aus, Aman and Boro. The country produced 34,265 thousands m.tons rice in the year 2014. Boro rice production constitutes 55.21% of total rice production (BBS, 2014). According to an estimate, annual yield loss due to insect pest alone is 16% for rice (Ahmed *et al*, 2001). The humid tropical climatic condition of Bangladesh is conductive for the development of various pests of rice. Farmers control pest by using different kinds of pesticides. 211 trade names of pesticides have been registered in Bangladesh (Islam, 2005). Pesticide consumption increased to 9.8 kg per ha in 2009 in Bangladesh which was 0.7 kg per ha in the year 2000 (Abdullah, 2012). In the year of 2007, 37,712.20 m.tons of pesticide sold in Bangladesh at different trade name and among them 22,118 m.tons which is nearly 86.81% was used in rice production (Rahman, 2011) though the Department of Agricultural Extension (DAE) started disseminating rice IPM since 1981 through different IPM projects. Among all other agricultural practices IPM is the best practice to increase the crop production by effecting the human health and environment as less as possible. Some farmers realized

the benefits of the practices and responded positively to adopt this practice. Some farmers in contrast, showed totally reverse attitude.

The researcher attempted the present study to seek answer to the following research questions:-

a) What was the extent of adoption of IPM practices by the farmers in boro rice cultivation?

b) What were the farmers' preferences in adoption of different IPM practices in boro rice cultivation?

c) What were the farmers selected characteristics that contributed to the extent of adoption of IPM practices in boro rice cultivation?

So, Findings of the extent of adoption of IPM practices would be helpful in determining the effectiveness of projects implemented by DAE. On the above considerations, the researcher of this study felt necessity to conduct the research entitled **"Adoption of Commonly Used Integrated Pest Management (IPM) Practices by the Boro Rice Growers".** It is assumed that if the extent of adoption could be identified then the DAE can be able to take appropriate step to disseminate rice IPM.

1.2 Objectives of the Study

The following objectives were framed out in order to give an appropriate track to the research work:-

1. To determine and describe the selected personal and socio-economic characteristics of the boro rice growers, the selected characteristics were:
   a. Age
   b. Education
   c. Family agriculture workforce
   d. Farm size
   e. Annual family income
   f. Training exposure
   g. Knowledge on pesticide application
   h. Awareness about environmental pollution
   i. Attitude towards harmful effects of chemical pesticide
   j. Contact with pesticide dealers
   k. Cost of pesticide
   l. Contact with IPM clubs/ FFS
2. To determine the extent of adoption of commonly used IPM practices by the boro rice growers ;
3. To compare the preferences in adoption of different IPM practices by the boro rice growers; and
4. To explore the relationship between adoption of commonly used IPM practices by the boro rice growers and their selected characteristics

1.3 Justification of the Study

It is obviously true that farmers are the key elements of adoption of integrated pest management practices in Boro rice cultivation. At present, there is a lack of adequate understanding as to how the characteristics of the farmers influence their adoption of integrated pest management (IPM) practices in rice cultivation. These facts indicate

the need for an investigation to ascertain the relationships of the characteristics of the farmers with their adoption of integrated pest management practices in Boro rice cultivation. Findings of this study, therefore, will be helpful to the planners and extension workers in planning and execution of programmes for dessiminating rice IPM. The findings of the study will also manifest the extent of adoption of integrated pest management practices in Boro rice cultivation by the farmers and will be able to give a hypothetical thought all over the nation. It is expected that this study will inspire other researchers to conduct same sorts of research in other parts of the country. Lastly, it is assumed that recommendation of this study will be helpful in formulating effective extension programs that will increase the rate of adoption of integrated pest management practices in rice cultivation.

1.5 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 the following assumptions in his mind while undertaking this study:

1. The respondents included in the sample of the study were able to provide their opinions and were competent enough to satisfy the queries.
2. The information furnished by the respondents was reliable.
3. The commonly used IPM practices of rice cultivation included in the study were known to the respondents.
4. The collected data from the respondents were free from bias.
5. Views and opinions furnished by the respondents included in the sample were the representative views and opinions of the whole population of the area concerned.
6. The findings of the study would be useful for planning and execution of the programs in connection with diffusion of integrated pest management practices in rice cultivation.

1.6. Hypothesis of the Study

Hypothesis may be broadly divided into two categories, namely, research hypothesis and null hypothesis. However, for the present study the hypothesis were formulated in null form.

The following null hypothesis was formulated to explore the relationship between the selected characteristics of the farmers with their adoption of commonly used IPM practices in boro rice cultivation.

"*There is no relationship between the selected characteristics of the boro rice growers and their adoption of commonly used integrated pest management practices in boro rice cultivation"*

1.7 Limitations of the Study

Considering the time, money and other necessary resources available to make the study manageable and meaningful, it was necessary to consider the following limitations:

1. The study was confined Dhontola union of Baliadangi upazilla of Thakurgaon District. The Dhontola union consisted of eight villages. Among eight villages, only two villages were selected purposefully for this study.

2. There were many farmers in the study area, but only the farmers who were involved in Boro rice cultivation were considered for this study.

3. Characteristics of the farmers were many and varied but only twelve (12) characteristics were selected for investigation in this study.

4. During data collection the researcher had to depend on data furnished by the respondents. As none of the farmers kept records of their farming activities, they furnished information to the different questions by recall.

5. Conceptually, extents of adoption of the farmers were determined from their statements.

6. Adoption of the farmer could be measured in various ways. However in this study these were measured by using some specific point rating scale.

7. The present study highlights a new dimension of research in the field of agricultural extension in Bangladesh and so the researcher could not provide sufficient evidence in equipping his study report with relevant literature reviews.

1.8 Definition of Terms

Different terms used throughout the study are defined and interpreted below for clarity of understanding:

1.8.1 Adoption

According to Rogers (1995), "Adoption is a decision to make full use of an innovation as the best course of action available". When an individual takes up a new idea as the best course of action and practices it, the phenomenon is known as adoption (Ray, 1991). In this study, adoption of commonly used IPM practices by the boro rice growers means percentages of average mean area adoption of 10 commonly used IPM practices in boro rice cultivation.

1.8.2 Integrated pest management (IPM)

According to Food and Agricultural Organization (FAO, 2001) IPM can be defined as "A pest management system that, in the context of the associated environment and the population dynamics of the pest species, utilizes all suitable techniques and methods in a compatible manner as possible and maintains the pest populations at levels below those causing economic injury." In this study, commonly used IPM practices means 10 selected IPM practices generally advocate by Department of Agricultural Extension (DAE) and Bangladesh Rice Research Institute (BRRI) to practice in rice cultivation.

1.8.3 Age

Age of a respondent was defined as the period of time in actual years from his birth to the time of interviewing.

1.8.4 Education

Empirically it was defined to the development of desirable changes in knowledge, skill and attitudes in an individual through reading, writing, working, observation and other selected activities. It was measured on the basis of classes passed from a formal educational institution by the rice farmers.

1.8.5 Family agriculture workforce

Family agriculture workforce of a rice farmer was defined as the number of individuals in his family including himself, his wife, children and other dependent members who engaged actively in farming activities.

1.8.6 Farm size

The term related to the hectare of land owned by a farmer on which he carried his farming and family business, the area being estimated in terms of full benefit to the farmer. A farmer was considered to have full benefit from cultivated area either owned by himself or obtained or, lease from others and half benefit from the area which *was* either cultivated on borga or given to others for cultivation on borga basis.

1.8.7 Annual family income

Annual family income referred to the total annual earnings of all the family members of a respondent from agriculture, livestock, fisheries and other accessible sources (business, service, daily working etc.) during a year.

1.8.8 Training exposure

Training exposure referred to organized instruction aimed at improving knowledge, skill and attitude of respondents that they can perform his/her functions more effectively. Training experience referred to number of days the respondents received training in different aspects of agriculture.

1.8.9 Knowledge on pesticide application

Knowledge referred to a theoretical or practical understanding of a subject. In this study knowledge on pesticide application referred to extent of basic knowledge of the farmers in different aspects of pesticide application.

1.8.10 Awareness about environmental pollution

Awareness is the ability to perceive, to feel, or to be conscious of events, objects, thoughts, emotions, or sensory patterns. In this level of consciousness, sense data can be confirmed by an observer without necessarily implying understanding. It referred to the awareness of farmers about pollution of environment by various insincere act of human.

1.8.11 Cost of pesticide

Cost of pesticide referred to the cost incurred for buying chemical pesticide like weedicide, insecticide, fungicide etc. to control rice pest in the last season.

1.8.12 Contact with pesticide dealers

It referred to the extent of contact with pesticide dealers for various purposes by the boro rice growers.

1.8.13 Contact with IPM club/FFS

It referred to the extent of contact with IPM club or Farmers Field School (FFS) for various purposes by the boro rice growers.

1.8.14 Attitude towards harmful effects of chemical pesticide

Attitude is an enduring tendency to perceive or act towards persons or situations in a particular way. Attitude towards harmful effects of chemical pesticides means one's feeling and actions towards the harmful effects of chemical pesticides. It was organized by developing on attitude scale, following likert method of summated rating.

1.8.15 Pesticide

Pesticides were the toxic chemical substances released intentionally into our environment to kill living things. This includes substances that kill weeds (herbicides), insects (insecticides), fungus (fungicides), rodents (rodenticides), and others.

1.8.16 Pesticide dealers

It referred to the person who sells the pesticide among the farmers who may be wholesaler or retailer.

CHAPTER 2

REVIEW OF LITERATURE

The purpose of this Chapter is to present the reviews of researches relate to the investigation. The reviews are conveniently presented based on the major objectives of the study. This Chapter is divided into three sections. The first section deals with the findings on the extent of adoption of integrated pest management practices by the farmers; second section is devoted to a discussion on the findings of studies exploring relationship between the selected characteristics of the farmers and their extent of adoption and third section presents the conceptual framework of the study.

2.1 Extent of Adoption of IPM Practices by the farmers

Sardar (2002) studied on "Adoption of IPM practices by the farmers under PETRRA Project of RDRS". He observed that majority (45.9 percent) of the farmers had medium, 38.3 percent had low and 15.8 percent had high adoption of IPM practices.

Hossain (2004) studied Adoption of Selected Modern Boro Rice Cultivation Technologies by the Farmers of Homna Upazila in Comilla District. He found that, the highest proportion (60 percent) of farmers fell under the medium adoption category, while 21 percent had high adoption and 19 percent had low adoption.

Hasan (1996) found in his study that the highest proportion (44 percent) of the respondents perceived the existence of medium adoption, compared to 26 percent low adoption and 3 percent high adoption in respect of selected agricultural technologies.

Haque (2003) found that the majority (47 percent) of the maize growers had medium adoption of modern maize cultivation technologies while 28 percent had high adoption and 25 percent low adoption.

Juliana *et al.* (1991) undertook a study on adoption of integrated management practices in five villages of vasusdevanallar block in Tirunelvi district, Tamilnaru, India. They found that about 50 percent of marginal farmers, 47.50 percent of small farmers and 52.50 percent of big farmers had medium adoption and 42.50 percent of

big farmers, 22.50 percent of small farmers and percent of the marginal farmers had high level of adoption. In both adopts level of big farmers' participation was higher in comparison to other categories of farmers. .

Gogoi and Gogoi (1989) conducted a study on adoption of recommended Plant protection practices in rice in Zorhat district of Assam state in India. The study revealed that among the respondents, 50 percent had low level of 35.36 percent medium level of adoption and 13.64 percent had high adoption of recommended plant protection practices.

Rahman (1986) conducted a research study on the extent of adoption of four improved practices, which were use of fertilizers, line sowing, irrigation and use of insecticides in transplanted aman rice cultivation in two village of Mymensingh district. It revealed that 22 percent of the farmers adopted all the four practices compared to 49 percent adopted three practices, 22 percent adopted two practices, 5 percent adopted one practices and only 2 percent adopted of the four practices.

Mohammad (1974) studied the extent of adoption of insect control measures by the farmers in Khamar union of Rajshahi district. He found that among the respondent farmers, 25 percent did not adopt insect control measure; 28 percent had high level of adoption; 32 percent had medium level of adoption and 25 percent had low level of adoption.

Muttaleb *et al.* (1998) found that over all adoption of plant protection practices was medium. Among the plant protection practices high adoption were observed in fungicides, insecticide and soil treatment and low adoption were found that treatment and low adoption were found in suberization of cut tuber hand picking of cutworm and rouging of diseased plant.

Hossain (1971) carried out a research study on the adoption of four improved practices in Gouripur of Mymensingh District. The practices were (i) plant protection measure, (ii) recommended variety of paddy, (iii) line transplanting d (iv) recommended dose of fertilizers. It revealed that among the responded farmers 57.40 percent adoption plant protection measure, 35.51 percent adoption recommended

variety of paddy, 25.36 percent adoption line transplanting and 11.52 percent adoption recommended dose of fertilizers.

2.2 Findings Relating to the Relationships between Farmers' Characteristics and Adoption of IPM Practices

2.2.1Age and adoption of IPM practices

Gogoi and Gogoi (1989) and kashem (2003) observed that there was no relationship between age of the farmers and their adoption IPM Practices.

Talukder (2006) found that the age of the farmers had a significant positive relationship with their adoption of selected rice production practices.

Aurangozeb (2002) observed that there was significant negative relationship between age and adoption of integrated homestead farming technologies.

Kashem (1991) observed that there was positive and significant relationship between the ages of the marginal farmers with their adoption of jute technologies.

Khan (2003), Rahman (2004) and Singh and Rajendra (2005) observed significant and positive relationship between age of the farmers and their adoption of IPM Practices.

2.2.2 Education and adoption of IPM practices

Alam (2000), Balasubramanian (2000), Patil, Haque(2003), Islam (2002), Okoro & Obibuaka, Khan and Kashem (2003) and Singh (2005) observed that there were significant and positive relationship between education of the farmers and their adoption of IPM Practices.

Hossain (2004) concluded that education of the farmers had a significant and positive relationship with their adoption of modern boro rice cultivation practices.

Sardar (2002) found that the education of the farmers had significant positive relationship with their adoption of IPM practices.

Aurangozeb (2002) studied on the extent of adoption of integrated homestead farming technologies by the rural women in RDRS. He observed that there was positive relationship between education and adoption of integrated homestead farming technologies.

2.2.3 Family agriculture workforce and adoption of IPM practices

Islam (2007) found that the number of family labor of the farmers had significant positive relationship with their adoption of mixed cropping.

Alam (2000), Haque (2003) and Hossain (2001) and Osunlogun *et al.* (2003) reported that family size of the farmers had no significant relationship with their adoption of IPM Practices.

Islam (2002), Okoro and Obibuaka (2003), Rahman (2004) reported that family size of the farmers had significant and positive relationship with their adoption of IPM Practices.

Talukder (2006) found that the family size of the farmers had no significant and negative relationship with their adoption of selected rice production practices.

Hossain (2003) revealed that family size of the farmers had a significant and positive relationship with their knowledge and adoption of modern Boro rice cultivation practices.

Sardar (2002) found that the family size of the farmers had significant positive relationship with their adoption of IPM practices.

Chowdhury (1997) conducted a research study on adoption of selected BINA technologies by the farmers of Boira union in Mymensingh District. He observed that family size of the farmers had positive and significant relationship with the adoption of selected BINA technologies.

2.2.4 Farm size and adoption of IPM practices

Ali *et al.* (2000), Alam (2000), Gogai & Gogai (1989), Hossain (2001), Islam (2002) and Khan (2003) found a strong negative relationship between farm size and adoption of IPM practices of the farmers.

Muttalab (1998), Okoro and Obibuaka (2003) and Rahman (2004) reported that farm size had significant and positive relationship with the adoption of IPM Practices of the fanners.

Hossain (2006) found that farm size of the farmers had no significant and positive relationship with their adoption of selected high yielding varieties of rice.

Hossain (2004) concluded that farm size of the farmers had significant and positive relationship with their adoption of modern Boro rice cultivation practices.

Rahman (2001) conducted a study on knowledge, attitude and adoption of the farmers regarding Alok 6201 hybrid rice in Sadar upazila of Mymensingh district. He found that farm size of the farmers had significant and positive relationship with their adoption of Alok 6201 hybrid rice.

2.2.5 Annual family income and adoption of IPM practices

Haque (2003), Hossain (2001), Hossain (2004), Rahman (2004) and Singh (2005) found that income of the farmers was associated with the adoption of IPM practices.

Hossain (2003) revealed that annual family income of the farmers had a significant and positive relationship with their knowledge and adoption of modern Boro rice cultivation practices.

Hanif (2000) found that there was a negative insignificant relationship between annual income of the respondents and their awareness on environmental pollution

Bari (2000) observed that the belief of the farmers had significant relationship with their attitude towards the hybrid Rice Aalok 6201.

2.2.6 Training exposure and adoption of IPM practices

Haque (2003) found a positive relationship with training exposure and adoption of modern technologies.

Rahman (2001) observed in study that training received of the farmers had a significant and positive relationship with their adoption regarding Aalok 6201 hybrid rice.

A positive relationship was also found between training exposure and adoption of improved practices in transplanted Aman rice by Rahman (1986).

Rahman (2010) found a strong positive relationship between training experience of the farmers and attitude towards IPM practices.

2.2.7 Knowledge on pesticide application and adoption of IPM practices

Pandya (1981) in his study conducted on transfer of plant protection technology revealed that those farmers who know about the effects of diseases and pests on their crops adopt plant protection measures. The main cause of non-adoption was reported to be ignorance.

Nand *et al.*(1981) in a study at Haryana reported that farmers' ignorance about plant protection recommendations stood out as the most important reason for non-adoption of plant protection measures.

2.2.8 Awareness about environmental pollution and adoption of IPM practices

Rahman (2010) found a positive relationship between knowledge about environmental pollution of the farmers and attitude towards IPM practices.

2.2.9 Attitude toward harmful effects of chemical pesticide and adoption of IPM practices

Dhaliwal *et al.* (1996) stated that the insect pests arc controlled with the use of chemicals, which have destructive influence on the useful fauna, anti create environmental pollution.

Akbar (2008) found that more than half (63.3 percent) of the respondents had low perception of the harmful effects of pesticides compared to only 3.3 percent having high perception.

Islam (1990) opined that the success of pesticides in controlling on a short-term basis cannot be denied but their tong term effect on the ecosystems including human health and environment arc very much doughtful for two major regions. One is the rapid evolution or new breed pests, resistant to the pesticides applied, and another in the increasing pesticide hazards. According to Swaminathan (1982) indiscriminate use of pesticides, fungicides and herbicides could cause biological imbalance as well as to increase the incidence of cancer and other diseases through the toxic residues being present in gains or other edible parts of the plant.

Gani (1997) reported that use of' pesticides kills beneficial creatures and insect's that make the land fertile. Beside, the indiscriminate use of pesticides creates a resistance against insects and pests, which in turn creates an increased threat to the crops.

Islam (1994) stated that use or different types of pesticides has been controlling to the evolution of "Super pests" that are immune to the chemicals. Resistant to pesticide has been developed in certain species of fungi as well as in weeds.

2.2.10 Contact with pesticide dealers and adoption of IPM practices

No literature was found on the relationship between contacts with pesticide dealers and adoption of IPM practices. Probably, no precious research was done yet about these characteristics of farmers.

2.2.11 Cost of pesticide and adoption of IPM practices

Haider *et al.* (2012) found that the highest proportion (45%) of the respondents belonged to low cost compared to 35% and 20% having medium cost and high cost of pesticides used respectively.

2.2.12 Contact with IPM club/FFS and adoption of IPM practices

No literature was found on the relationship between contact with IPM club/FFS and adoption of IPM practices. Perhaps, no research was conducted yet about these characteristics of farmers.

2.3 The Conceptual Framework of the Study

In scientific research, selection and measurement of variables constitute an important task. Properly constructed hypothesis of any research contain at least two variables namely, "dependent variable" and "independent variable". Selection and measurement of those variables is also crucial. A dependent variable is that which appears, disappears or varies as the researcher introduces, remove 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. Based on these above discussion and the review of literature, the conceptual framework of this study has been formulated and shown in Figure 2.1.

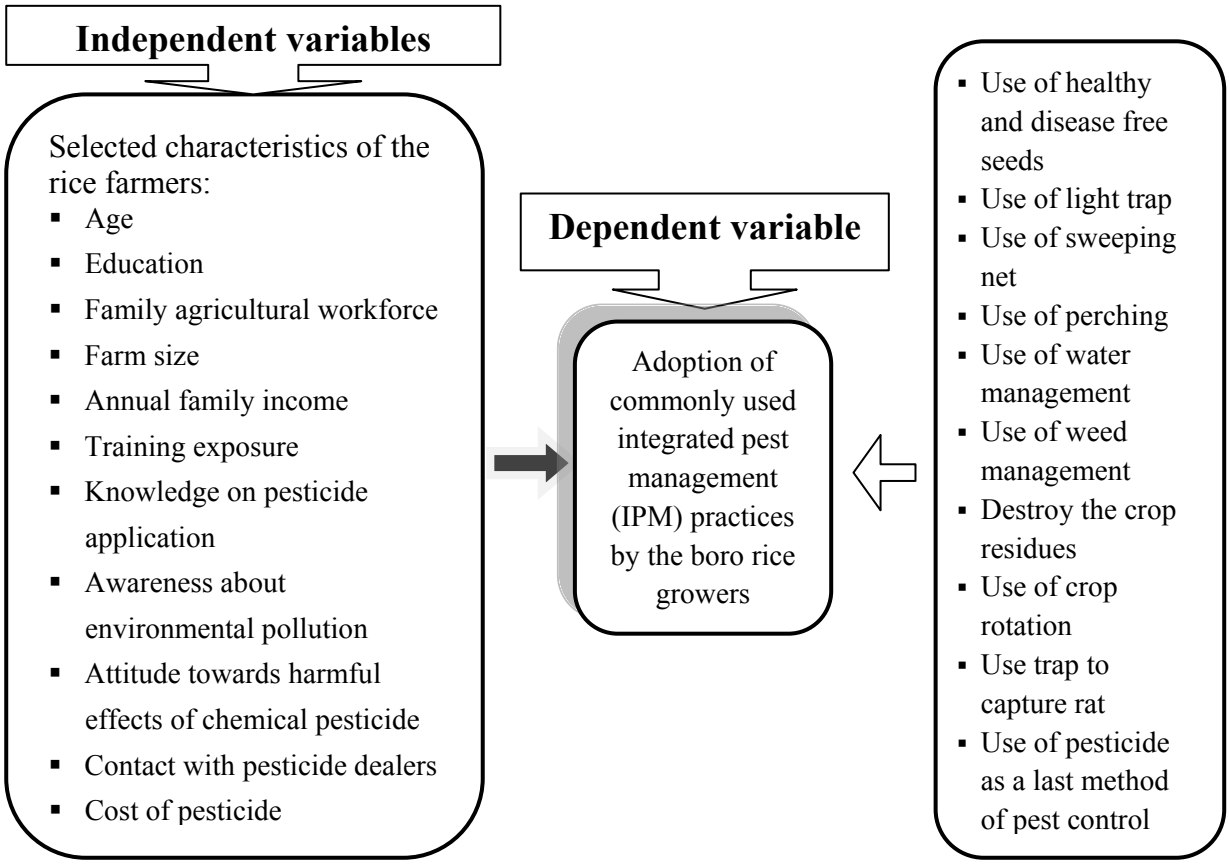

Figure 2.1 Conceptual framework of the study

CHAPTER 3

METHODOLOGY

Methodology deserves a very careful consideration in a scientific research. Methodology of any study should be such as to enable the researcher to collect valid and reliable information to analyze the same properly and to arrive at appropriate decisions. Methods and procedures followed in conducting this study had been discussed in this chapter.

3.1 Locale of the Study

Nagesharbari and Choutaki villages in Dhantola union of Baliadangi upazila under Thakurgaon district were purposively selected because these two were intensive boro rice growing areas. Besides, IPM clubs/ FFSs are being operated here by the Department of Agricultural Extension (DAE). These two villages constituted the locale of the study.

3.2 Population and Sample of the Study

The Researcher himself with the help of local leaders and concerned Sub-Assistant Agriculture Officer (SAAO) prepared an updated list of all the boro rice growers of the selected villages. The total numbers of farm families (boro rice growers) in these villages were 615, where 375 farm family heads from Nagesharbari village and 240 from Choutaki village, which constituted the population of the study. According to Yamane's (1967) formula, sample size was determined as 130. In calculating sample size from the following formula, 10% precision level, 50% degree of variability and value of Z= 2.57 at 99% confidence level were chosen:

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

Where, n = sample size
N = population size
e = the level of precision
Z = the value of the standard normal variable gives the chosen confidence level
P = the proportion or degree of variability

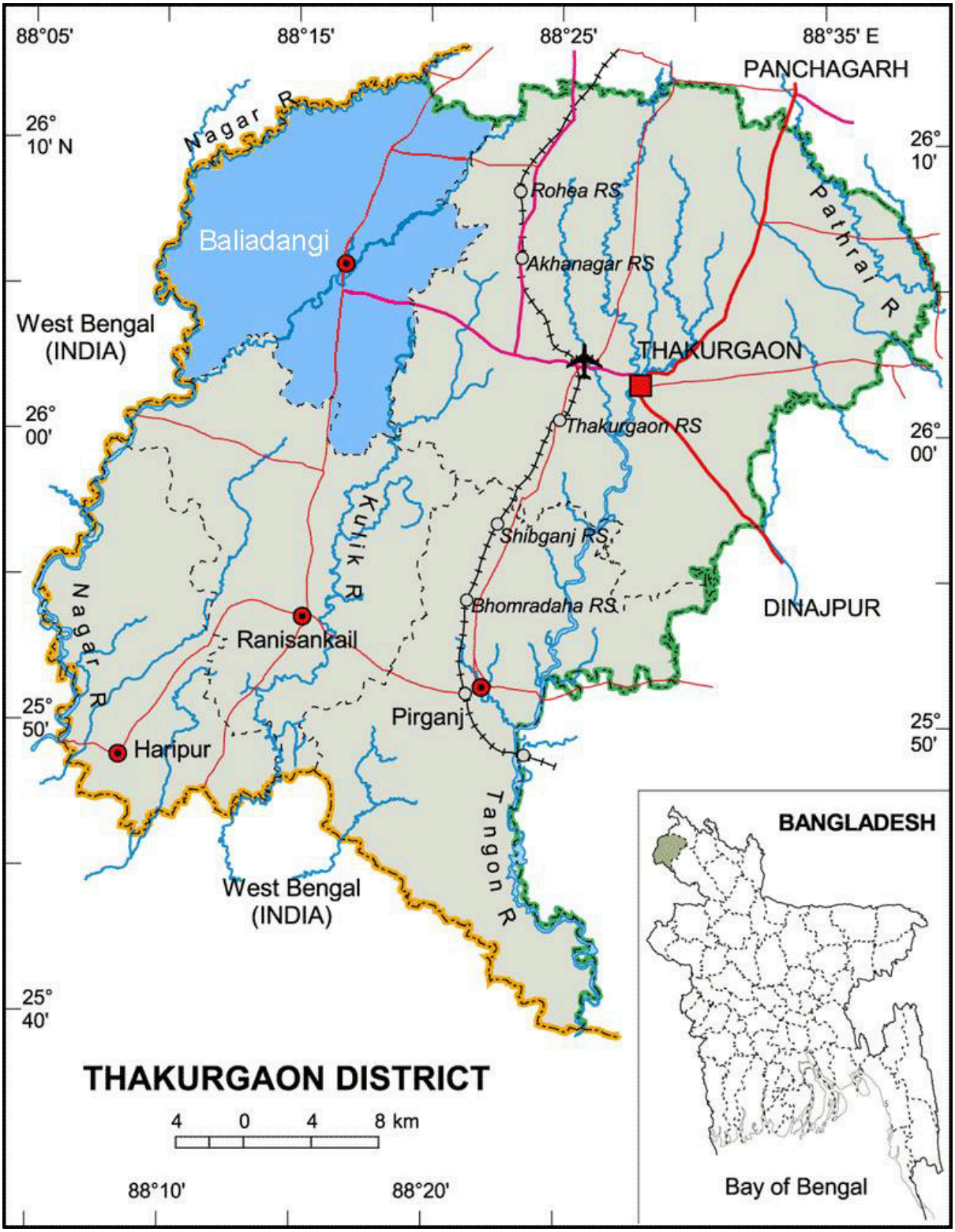

Figure 3.1 Map of Thakurgaon district showing the Baliadangi upazila

Figure 3.2 Map of Baliadangi upazila showing the study area of Dhantola union

Then 130 farmers were selected following simple random sampling technique. A reserve list of 15 farmers was also prepared. Farmers in the reserve list were used only when a respondent in the original list was not available. The distribution of the sample farmers and those in the reserved list from the villages is shown in Table 3.1.

Table 3.1 Distribution of the boro rice growers according to population and sample size

Name of village	Population of rice growers	Number of rice growers included in the sample	Number of rice growers included in the reserve list
Nagesharbari	**375**	**91**	**10**
Choutaki	**240**	**39**	**5**
Total	**615**	**130**	**15**

3.3 Instrument for Data Collection

A previously structured interview schedule was used as data gathering instrument keeping in view the objectives of the study. It may be recalled that the schedules were pre-tested in actual field situations before using the same for final data collection among 15 respondents of the study area. Necessary corrections, modifications and additions were made in interview schedule on the basis of results of pre-test. The interview schedule was then printed in its final forms. A copy of the interview schedule in English version has been furnished in Appendix-A.

3.4 Collection of Data

The researcher himself collected data from the sample farmers through the personal interview schedule during April 21 to May 6, 2015. Before starting collection of data, the researcher met the respective Upazila Agriculture Officer (UAO), Agriculture Extension Officer (AEO) and the concerned Sub Assistant Agriculture Officer (SAAO). The researcher also discussed the objectives of the present study with the respondents so that they did not feel hesitate at the time of interview. However, if any respondent failed to understand any question, the researcher took utmost care explain

the issue as far as possible. After completion of the interview, it was checked and editing was done in case of necessity. The researcher did not face any major problem in collecting data. Excellent co-operation and co-ordination were extended by the respondents and other concerned persons at the time of data collection.

3.5 Variables of the Study

In the present study, the respondents' selected characteristics viz age, education, family agriculture workforce, training exposure, farm size, annual income, cost of pesticide, knowledge of pesticide application, awareness about environmental pollution, attitude towards harmful effects of chemical pesticide, contact with pesticide dealer, contact with IPM club/FFS were independent variables and their adoption of commonly used IPM practices in Boro rice cultivation constituted dependent variable.

3.6 Measurement of Variables

3.6.1 Measurement of independent variables

3.6.1.1 Age

Age of a respondent was measured in terms of actual years from his birth to the time of interview. A score of one (1) was assigned for each year of age. It was measured in complete years as reported by a respondent.

3.6.1.2 Education

Education of a respondent was measured in terms of years of schooling completed by an individual in educational institute. If a respondent did not how to read and write his literacy was taken as zero (0). A score of (0.5) was given to that respondent who could sign his name only. Besides a respondent got actual score of one for every year of schooling i.e. '1' for class one, '2' for class two and so on.

3.6.1.3 Family agriculture workforce

Family agriculture workforce was estimated by computing the total number of member of a respondent's family, who engaged actively in farming activities. A score of '1' was assigned to each family agriculture worker and '2' for two members and so on.

3.6.1.4 Farm size

Farm size was measured as the size of the respondent's farm on which he/she continued his/her farming operations during the period of study. The area was being estimated in terms of full benefit to the growers. The data were first recorded in terms of local unit i.e; *bigha, katha or pakhi* and then were converted to hectare and the size was measured by using the following formula:

$FS = A_1 + A_2 + 1/2(A_3 + A_4) + A_5 + A_6$

Where, FS = Farm size

A_1 = Homestead area (Including pond)

A_2 = Own land under own cultivation

A_3 = Land given to others as borga

A_4 = Land taken from others as borga

A_5 = Land taken from others on lease

A_6 = Fallow land

3.6.1.5 Annual family income

The income of a farmer is an important indicator of how much he can invest in his rice cultivation. Annual income of a respondent was measured in taka on the basis of total yearly earnings from rice cultivation and other sources in which the respondent as well as his family members were involved. The method of ascertaining income from farming involved different aspects. The aspects are: agriculture, poultry rearing,

domestic animal, fish, service, business and others. In calculating the annual income of the respondents, the total yield from all the sources making in the preceding year were converted into cash income according to the prevailing market price and added together to obtain total income of a respondent. However unit score of 1 was taken for every Tk 1000/- of annual income.

3.6.1.6 Training exposure

Training exposure of a respondent was measured on the basis of number of days of training received from different sources in the last five years. Training exposure score of a respondent was measured in terms of number of days for receiving training. For example, if a farmer received no training his/her score was zero (0) and score one was assigned for receiving one day training.

3.6.1.7 Knowledge on pesticide application

Knowledge is defined in this study included those behaviours and test situations which emphasized the remembering either by recognition or recall of ideas, material or phenomenon (Bloom *et al*, 1956). This variable indicated the extent of knowledge the respondent possessed at the time of interview as evident from his responses to a set of questions related to pesticide application.

The respondents were asked to select appropriate answer from variety of possible answers. A score of '1' was given for each correct reply and '0' for incorrect reply for each item. The summation of scores for correct replies of all the 16 items of a particular respondent indicated his knowledge on pesticide application.

3.6.1.8 Awareness about environmental pollution

Fifteen statements were selected in the interview schedule for measuring boro rice growers' environmental pollution awareness score (Appendix-A). Boro rice growers were asked to answer whether the statements were true or false. If a farmer responded true for true and false for false statement could get score '1', otherwise he could get score zero (0). Weights for responses on the 15 statements of a respondent were added together to get his score for awareness on environmental pollution. Awareness on

environmental pollution scores could thus range from 0 to 15, where 0 indicating no awareness and 15 indicating very high awareness.

3.6.1.9 Attitude towards harmful effects of chemical pesticide

Farmers' attitude towards harmful effects of chemical pesticide has been measured by constructing 5- point Likert type scale. The scale contained 12 statements out of which 6 statements were positive and 6 statements were negative. These positive and negative statements were arranged alternatively. A statement was considered positive only when it reflected the idea of unfavourableness towards the effect of chemical pesticide. Scoring was made in the following manner;

Responses	Weights	
	For positive statement	For negative statement
Strongly agree	5	1
Agree	4	2
No opinion	3	3
Disagree	2	4
Strongly disagree	1	5

Hence, attitude towards harmful effects of chemical pesticide score of a respondent was determined by summing up the scores obtained by him for all the statements in the scale. The possible attitude towards harmful effects of chemical pesticide scores of a respondent could range from 12 to 60, where 60 indicating very high unfavourable attitude towards harmful effects of chemical pesticide and 12 indicating very low unfavourable attitude towards harmful effects of chemical pesticide.

3.6.1.10 Contact with pesticide dealers

The contact with pesticide dealer was computed for each respondent to determine the degree of his contact on the basis of his visit to the pesticide dealers on different purposes. The following scale was used for computing the contact with pesticide dealer's scores of the item:

Nature of visit	Score
Not at all	0
Rarely	1
Frequently	2
Regularly	3

Logical frequencies of visit were assigned to each four alternative nature of visit as indicated in the interview schedule.

Finally, contact with pesticide dealers score of a respondent was measured by adding all the scores obtained from visit for all the 12 purposes. Thus score of a respondent could range 0 to 36 while 0 indicating no contact with pesticide dealers and 36 indicating very high contact with pesticide dealers.

3.6.1.11 Cost of pesticide

Cost of pesticide was measured on the basis of the cost of used insecticide, fungicide & weedicide in the last boro season. Cost of pesticides score of a respondent was measured in taka on the basis last season costing for pesticide in boro rice cultivation.

3.6.1.12 Contact with IPM club/FFS

The contact with IPM club/FFS was computed for each respondent to determine the degree of his contact on the basis of his visit to the IPM club/FFS on different purposes. The following scale was used for computing the contact with IPM club/FFS scores of the item:

Nature of visit	Score
Not at all	0
Rarely	1
Frequently	2
Regularly	3

Logical frequencies of visit were assigned to each four alternative nature of visit as indicated in the interview schedule.

Finally, contact with IPM club's score of a respondent was measured by adding all the scores obtained from visit for all the 10 purposes. Thus score of a respondent could range from 0 to 30 while 0 indicating no contact with IPM club/FFS and 30 indicating very high contact with IPM club/FFS.

3.6.2 Measurement of dependent variable

Adoption of commonly used integrated pest management (IPM) practices by the boro rice growers was the dependent variable of the study. The commonly used IPM practices were determined from literatures, discussion with IPM experts and concerned Boro rice growers. The selected practices were: use of light trap, use trap to capture rat, use of healthy and disease free seeds, use of crop rotation, use of water management, use of weed management, use of sweeping net, destroy the crop residues, use of perching in the field to sit the birds, use of pesticide as a last method of pest control. Adoption can be measured in various ways. But in this study multiple technologies adoption quotient method (Ray, 1998; Bhuiyan, 2012) was used to determine adoption of commonly used IPM practices in Boro rice cultivation. Adoption of commonly used IPM practices was measured by the summation of mean ($\bar{x}$) adoption of different practices for particular time period divided by the number of practices. It was expressed in percentage resulting mean area coverage. Thus the formula would be:

$$\text{Multiple practices adoption quotient} = \frac{\sum \bar{x}}{No.\ of\ practices} \times 100$$

Mean ($\bar{x}$) adoption of a practices was measured by calculating summation of proportions of area coverage with dividing time period. In this study, three Boro seasons of consecutive years were considered for calculating adoption. Proportion of area coverage means land allotted for particular practice (l) out of potential land (L) for that particular practice.

The mean ($\bar{x}$) adoption of a practice was measured like the following example:

Name of practices	Year of the adoption			$\sum \frac{l}{L}$	Mean ($\bar{x}$) adoption
	2013	2014	2015		
Use of light trap					
Allotted area for cultivation(l)	2	2	3	1.75	0.58
Potential area (L)	4	4	4		
Proportion of area coverage($\frac{l}{L}$)	0.50	0.50	0.75		

So, the mean adoption of ten IPM practices was calculated and summed up. Then, average adoption of ten IPM practices for a respondent were determined which could range from 0 to 100% where 0% indicating no adoption at all and 100% indicating fully adoption of commonly used IPM practices.

To compare adoption of different IPM practices by the Boro rice growers, Individual Practice Adoption Index (IPAI) was calculated on the basis of summation of proportion of area coverage. Summation of proportion area coverage score of a practice for 3 years could range from 0 to 3. Thus, Individual Practice Adoption Index (IPAI) for a IPM practice could range from 0 to 390 by summing up all score of 130 respondents.

3.7 Categorization

For describing the various independent and dependent variables, the respondents were classified into several categories in respect of each variable. These categories were developed by considering the nature of distribution of data and general understanding prevailing in the social system. The procedure for categorization of data in respect of different variables will be elaborately discussed while describing those variables in Chapter 4.

3.8 Methods of Data Analysis

The collected data were compiled, tabulated, coded and analyzed in accordance with the objectives of the study. The statistical measures such as number and percentage distribution, range, mean, standard deviation and rank order were used for describing the variables of the study. To find out the relationships between adoption of commonly used IPM practices in boro rice cultivation and the selected characteristics of the boro rice growers, the Pearson's Product Moment Correlation coefficient (r) was computed. Correlation matrix was also computed to determine the inter-relationships among the variables. If the computed value of co-efficient of correlation 'r' was equal to or greater than the table value of co-efficient at designated level of significance for the relevant degree of freedom, the null hypothesis was rejected and it was concluded that there was significant relationship between the concerned variables. However, when the computed value of co-efficient of correlation was found to be smaller than the tabulated value at the designated level of significance for the relevant degree of freedom, it was concluded that the nun hypothesis could not be rejected and hence there was no relationship between the concerned variables.

CHAPTER 4
RESULTS AND DISCUSSION

A sequential and detailed discussion on the findings of the study has been presented in this Chapter. The Chapter is divided into three sections. In the first section, independent variables i.e. characteristics of the respondents have been discussed. The second section dealt with dependent variable i.e., adoption of commonly used IPM practices by the boro rice growers and finally, the relationship between the dependent and independent variables have been discussed in the third section.

4.1 Selected Characteristics of the Boro Rice Growers

Twelve characteristics of the boro rice growers were selected to describe and to find out their relationships with their adoption of commonly used IPM practices in boro rice cultivation. These selected characteristics were age, education, family agriculture workforce, farm size, annual family income, training exposure, cost of pesticide, knowledge on pesticide application, awareness about environmental pollution, attitude towards harmful effects of chemical pesticide, contact with pesticide dealers, contact with IPM club/FFS. The salient features of the twelve characteristics of the boro rice growers, each of which constituted an independent variable, are presented in Table 4.1.

Table 4.1 Salient features of the boro rice growers' selected characteristics

Characteristics	Measuring unit	Range		Categories	Respondents		Mean	SD
		Possible	Observed		Number (N=130)	Percent (%)		
Age	Actual Years	Unknown	24-78	Young aged (≤ 35)	33	25.38	44.94	11.62
				Middle aged (36-50)	62	47.70		
				Old aged(> 50)	35	26.92		
Education	Year of schooling	Unknown	0-15	Illiterate (0-0.5)	27	20.77	5.87	3.94
				Primary education (1-5)	44	33.85		
				Secondary education (6-10)	50	38.46		
				Above secondary education (>10)	9	6.92		
Family agriculture workforce	Number of members	Unknown	2-12	Small workforce (≤ 3)	29	22.31	4.65	1.78
				Medium workforce (4-5)	71	54.61		
				Large workforce (> 5)	30	23.08		
Farm size	Actual (in ha)	Unknown	0.1- 4.8	Marginal (<0.2 ha)	4	3.07	1.03	0.95
				Small (0.20 - < 1 ha)	68	52.31		
				Medium (1-3 ha)	53	40.77		
				Large (> 3.00)	5	3.85		
Annual family Income	Taka ('000)	Unknown	10-348	Low income (<60)	74	56.92	74.877	60.50
				Medium income (60-150)	44	33.85		
				High income (>150)	12	9.23		
Training exposure	Days obtained	Unknown	0-20	No training exposure (0 days)	104	80	1.88	4.95
				Low training exposure (1-2 days)	11	8.46		
				Medium training exposure (>2days)	15	11.54		
Knowledge on pesticide application	Scores	0-16	8-15	Low knowledge (<10)	15	11.54	11.13	1.38
				Medium knowledge (10-12)	98	75.38		
				High knowledge (>12)	17	13.08		
Awareness about environmental pollution	Scores	0 -15	6-14	Low awareness (< 8)	14	10.76	9.12	1.61
				Medium awareness (8-11)	104	80		
				High awareness (> 11)	12	9.24		
Attitude towards harmful effects of chemical pesticide	Scores	12 -60	31-51	Low unfavorable attitude (<37)	20	15.39	41.04	4.19
				Moderate unfavorable attitude (37-45)	93	71.54		
				High unfavorable attitude (> 45)	17	13.07		
Contact with pesticide dealer	Scores	0-36	4-19	Very Low contact (<10)	11	8.46	12.82	2.42
				Low contact (10-14)	87	66.92		
				Medium contact (>14)	32	24.62		
Cost of pesticide	Actual (in Taka)	Unknown	300-15000	Low pesticide cost (< 2000 Tk)	59	45.39	3596.92	3425.12
				Medium pesticide cost (2000-5000 Tk)	36	27.69		
				High pesticide cost (> 5000 Tk)	35	26.92		
Contact with IPM club/FFS	Scores	0-30	0-14	No contact (0)	114	87.69	1.05	2.96
				Very low contact (≤10)	12	9.23		
				Low contact (>10)	4	3.07		

4.1.1 Age

The age of the sample farmers ranged from 24 to 78 years with an average of 44.94 and standard deviation of 11.62. The respondents were classified into three categories on the basis of their age (Table 4.2) following Hossain *et al.* (2011).

Table 4.2 Distribution of the boro rice growers according to their age

Categories	Respondents		Mean	Standard deviation
	Number	Percent		
Young aged (≤ 35)	33	25.38	44.94	11.62
Middle aged (36-50)	62	47.70		
Old aged(> 50)	35	26.92		
Total	130	100		

Data indicate that the highest proportion (47.70 %) of the boro rice growers were middle aged compared to 26.92 percent old and 25.38 percent being young aged. According to Lionberger (1960) elderly farmers seem to be somewhat less inclined to adopt new farm practices than younger ones. Young and middle aged people generally show more favourable attitude towards trying new ideas. The extension agents can target those people in designing their extension activities.

4.1.2 Education

Education of the respondents was measured by following the procedure as discussed earlier in Chapter 3. The education ranged from 0-15, with an average of 5.87 and standard deviation of 3.94. The respondents were classified into four categories on the basis of their education (Table 4.3) following Hossain *et al.* (2011).

Table 4.3 Distribution of the boro rice growers according to their education

Categories	Respondents		Mean	Standard deviation
	Number	Percent		
Illiterate (0-0.5)	27	20.77	5.87	3.94
Primary education (1-5)	44	33.85		
Secondary education (6-10)	50	38.46		
Above secondary education(>10)	9	6.92		
Total	130	100		

It is evident from the Table 4.3 that 38.46 percent comprised secondary education, 33.85 percent comprised of primary education, 20.77 percent of the respondents were illiterate and 6.92 percent had above secondary education. Table 4.3 also shows that almost three-fourth of the respondents got primary to secondary level education. Jalal (2009) also find similar findings in his study.

The findings indicate that education of an individual is likely to be more receptive to the modern facts and ideas; they have much mental strength in deciding on a matter related to problem solving or adoption of technologies in their daily life. Thus, farming community in the study area may be well considered as a suitable ground for the adoption of technologies, or execution of change programme whatever needed.

4.1.3 Family agriculture workforce

The family agriculture workforce of the respondents under this study ranged from 2-12, with an average of 4.65 and standard deviation of 1.79 as shown in Table 4.4.

Table 4.4 Distribution of the boro rice growers according to their family agriculture workforce

Categories	Respondents		Mean	Standard deviation
	Number	Percent		
Small workforce (≤ 3)	29	22.31	4.65	1.78
Medium workforce (4-5)	71	54.61		
Large workforce (> 5)	30	23.08		
Total	130	100		

Data presented in the Table 4.4 indicates that majority (54.61 %) of the respondents' family had medium agricultural workforce compared to 23.08 percent large and 22.31 percent small agricultural workforce. The findings of the study revealed that overwhelming majority (77.69 %) of the farmers had medium to large agriculture workforce size. Jalal (2009) also found similar findings in his study. The findings also indicates that respondents' average family size were at least equal or higher than average family agricultural workforce (4.65) .The people of the study area should alert to keep their family size small. Low agriculture workforce can educate their

children properly and can enjoy other social amenities. However, high agriculture workforce can handle work easily by dividing the work among them.

4.1.4 Farm size

Farm size varied from 0.1 to 4.8 hectares with an average of 1.03 hectares and standard deviation of 0.95. The respondents were classified into four categories on the basis of their farm size (Table 4.5) following Hossain *et al.* (2011).

Table 4.5 Distribution of the boro rice growers according to their farm size

Categories	Respondents		Mean	Standard deviation
	Number	Percent		
Marginal (<0.2 ha)	4	3.07	1.03	0.95
Small (0.20 - < 1 ha)	68	52.31		
Medium (1-3 ha)	53	40.77		
Large (> 3.00)	5	3.85		
Total	130	100		

Data in the Table 4.5 reveal that more than half of the respondent (52.31 %) had small farm, 40.77 percent had medium farm, 3.85 percent had large and 3.07 percent had marginal farm. Table 4.5 also shows that overwhelming majority (92.08 %) of the boro rice growers had small to medium farm size. Hossain *et al.* (2011) also found similar findings in his study. The average farm size of the farmers of the study area (1.03 hectares) was higher than that of national average (0.60 hectare) of Bangladesh (BBS, 2008). The farmer with small farm size has very little scope to experiment about new technologies as their earnings depend on agriculture. On the other hand the farmer with large farm size can easily adopt new innovation in a part of their farm as experiment & they play the role of early adopters.

4.1.5 Annual family income

The annual income of the boro rice growers ranged between 10 to 348 thousands taka with the mean and standard deviation of 74.877 and 60.50 respectively. On the basis of income of the farmers, they were classified into three categories. The categories and distribution of the respondents were shown in Table 4.6.

Table 4.6 Distribution of the boro rice growers according to their annual family income

Categories	Respondents		Mean	Standard deviation
	Number	Percent		
Low income (<60)	74	56.92	74.877	60.50
Medium income (60-150)	44	33.85		
High income (>150)	12	9.23		
Total	130	100		

Data in the Table 4.6 show that 56.92 percent of the farmers had low annual income, 33.85 percent of the respondents had medium income and 9.23 percent had high income. Islam (2002) also found almost similar findings in his study.

The average income of the farmers of the study area is much lower. The reason was more than half of the farmer's belonged to small farmers. The other reason might be due to the fact that most of the farmers of the study area were only engaged in agriculture. They didn't earn from other sources such as service, business etc. Farmers with the low income generally hesitate to adopt innovations in their own farms because of their lower risk bearing ability and their inability to make necessary financial investment.

4.1.6 Training exposure

Training exposure scores of the farmers ranged from 0 to 20 with a mean and standard deviation of 1.88 and 4.95, respectively. Based on their length of training score, the respondents were classified into three categories. The distribution of the respondents according to their training exposure has been presented in Table 4.7

Table 4.7 Distribution of the boro rice growers according to their training exposure

Categories	Respondents		Mean	Standard deviation
	Number	Percent		
No training exposure(0 days)	104	80.0	1.88	4.95
Low training exposure (1-2 days)	11	8.46		
Medium training exposure(>2days)	15	11.54		
Total	130	100		

Data in Table 4.7 indicate that highest proportion (80.0 %) of the respondents fell in no training exposure group, while 11.54 percent had medium training and only 8.46 percent of them had low training exposure. Training helps the farmers to acquire deep knowledge and improve skills about the respected aspects. Trained farmers can cope with and handle smoothly the adverse situation in their cultivation. So, they show favourable attitude toward adoption of IPM practices.

4.1.7 Knowledge on pesticide application

Knowledge on pesticide application scores of the farmers ranged from 8 to 15 against the possible range from 0 to 16 with an average of 11.13 and standard deviation of 1.38. On the basis of knowledge on pesticide application scores, the respondents were classified into three categories that were shown in Table 4.8.

Table 4.8 Distribution of the boro rice growers according to their knowledge on pesticide application

Categories	Respondents		Mean	Standard deviation
	Number	Percent		
Low knowledge (<10)	15	11.54	11.13	1.38
Medium knowledge (10-12)	98	75.38		
High knowledge (>12)	17	13.08		
Total	130	100		

Data in the Table 4.8 show that the highest proportion (75.38 %) of the respondents had the medium knowledge, 13.08 percent had high knowledge and 11.54 percent respondents had low knowledge on pesticide application.

Knowledge on anything increases one's awareness, mental alertness and makes one familiar or acquaint with facts, objects, concepts, or practices. Knowledge is quite likely to be inter-linked with education. Education enables a farmer to gain knowledge and helps him to become rational which in turn increases his perceptibility. In order to perform crop production and crop protection successfully, the respondents should have adequate knowledge on the application of pesticide. However, it is observed that majority percent of farmers in the study area had medium knowledge on pesticide

application. Therefore, one may apprehend that due to high knowledge, most of the farmers in the study area might have used pesticide in crop production indiscriminately and which ultimately hampered crop production as well as environment. Hence, government agricultural extension department and other GOs and NGOs may give greater emphasis to train farmers to improve their knowledge on the judicious application of pesticide for achieving sustainable agricultural development.

4.1.8 Awareness about environmental pollution

Awareness about environmental pollution scores ranged from 6 to 14 against the possible range from 0 to 15 with an average of 9.12 and standard deviation of 1.61. On the basis of awareness about environmental pollution score, the respondents were classified into three categories following Akbar (2008) that were shown in Table 4.9.

Table 4.9 Distribution of the boro rice growers according to their Awareness about environmental pollution

Categories	Respondents		Mean	Standard deviation
	Number	Percent		
Low awareness (< 8)	14	10.76	9.12	1.61
Medium awareness (8-11)	104	80		
High awareness (> 11)	12	9.24		
Total	130	100		

Data in the Table 4.9 show that the highest proportion (80.0 %) of the respondents had the medium awareness compared to 10.76 percent had low and 9.24 percent had high awareness about environmental pollution. Majority (90.76 %) of the farmers in the study area were low to medium awareness about environmental pollution. Akbar (2008) also found similar findings in his study. So, there is a great scope to convert low and medium awareness farmers to high awareness farmers about environmental pollution that ultimately increase adoption of IPM practices in their farming.

4.1.9 Attitude towards harmful effects of chemical pesticide

Attitude towards harmful effects of chemical pesticide observed scores ranged from 31 to 51 against the possible range from 12 to 60 with an average of 41.04 and

standard deviation of 4.19. On the basis of attitude towards harmful effects of chemical pesticide scores, the respondents were classified into three categories that were shown in Table 4.10.

Table 4.10 Distribution of the boro rice growers according to their Attitude towards harmful effects of chemical pesticide

Categories	Respondents		Mean	Standard deviation
	Number	Percent		
Low unfavorable attitude (<37)	20	15.39	41.04	4.19
Moderate unfavorable attitude (37-45)	93	71.54		
High unfavorable attitude (> 45)	17	13.07		
Total	130	100		

Data in the Table 4.10 show that the highest proportion (71.54 %) of the respondents had the moderate unfavorable attitude towards harmful effects of chemical pesticide, 15.39 percent respondents had low unfavorable and 13.07 percent had high unfavorable attitude towards harmful effects of chemical pesticide. Unfavorable attitude towards harmful effects of chemical pesticide refrain farmers from injudicious application of pesticide which ultimately increase adoption of IPM practices in farming.

4.1.10 Contact with pesticide dealers

Contact with pesticide dealers observed scores ranged from 4 to 19 against the possible range from 0 to 36 with an average of 12.82 and standard deviation of 2.42. On the basis of contact with pesticide dealer scores, the respondents were classified into three categories that were shown in Table 4.11.

Table 4.11 Distribution of the boro rice growers according to their contact with pesticide dealers

Categories	Respondents		Mean	Standard deviation
	Number	Percent		
Very Low contact (<10)	11	8.46	12.82	2.42
Low contact (10-14)	87	66.92		
Medium contact (>14)	32	24.62		
Total	130	100		

Data in the Table 4.11 show that the highest proportion (66.92 percent) of the respondents had low contact compared to 24.62 percent had medium contact and 8.46 percent respondents had very low contact with pesticide dealers.

4.1.11 Cost of pesticide

Cost of pesticide varied from 300 to 15000 taka with an average of 3596.92 taka and standard deviation of 3425.12. Based on their cost of used pesticide the farmers were classified into three categories that were shown in Table 4.12.

Table 4.12 Distribution of the boro rice growers according to their cost of pesticide

Categories	Respondents		Mean	Standard deviation
	Number	Percent		
Low pesticide cost (< 2000 Tk)	59	45.39	3596.92	3425.12
Medium pesticide cost (2000-5000 Tk)	36	27.69		
High pesticide cost (> 5000 Tk)	35	26.92		
Total	130	100		

Data in the Table 4.12 reveal that the majority of the respondent (45.39 %) belonged to low pesticide cost group, 27.69 percent had medium and 16.92 percent had high pesticide cost group in the last boro season. Extent of money spent for pesticide depends on intensity of pest attack, farm size, adoption of IPM practices, annual family income etc. But through adopting IPM practices significant amount of cost for pesticide can be reduced.

4.1.12 Contact with IPM club/ FFS

Contact with IPM club/ FFS observed scores ranged from 0 to 14 against the possible range from 0 to 30 with an average of 1.05 and standard deviation of 2.96. On the basis of contact with IPM club scores, the respondents were classified into three categories that were shown in Table 4.13.

Table 4.13 Distribution of the boro rice growers according to their contact with IPM club/ FFS

Categories	Respondents		Mean	Standard deviation
	Number	Percent		
No contact (0)	114	87.69	1.05	2.96
Very low contact (≤10)	12	9.23		
Low contact (>10)	4	3.07		
Total	130	100		

Data in the Table 4.13 show that the highest proportion (87.69 %) of the respondents had no contact, 9.23 percent respondents had very low contact and 3.07 percent had low contact with IPM club. The findings of the study indicate that majority (87.69 %) of the farmers had no connection with IPM club or FFS although more than 90 % of them had low to medium contact with pesticide dealers. The reason may be low number of IPM club or FFS in the study area or low motivational activities to attract IPM clubs/ FFS by the extension workers. Interaction with IPM club or FFS enhances adoption of IPM practices in rice cultivation. So, the concerned authority should take initiative to form more IPM club or FFS in the study area.

4.2 Adoption of Commonly Used IPM Practices in Boro Rice Cultivation

Percentage of adoption of commonly used IPM practices by the Boro rice growers ranged from 30 to 71 against the possible range from 0 to 100 percent with an average of 40.85 and standard deviation of 8.40. On the basis of percentage of adoption of commonly used IPM practices in boro rice cultivation, the respondents were classified into two categories that were shown in Table 4.14.

Table 4.14 Distribution of the boro rice growers according to their adoption of commonly used IPM practices in boro rice cultivation

Categories	Respondents		Mean	Standard deviation
	Number	Percent		
Low adoption (<40 %)	55	42.31	40.85	8.40
Medium adoption (≥40 %)	75	57.69		
Total	130	100		

Data in the Table 4.14 show that the more than half (57.69 %) of the respondents had medium adoption and 42.31 percent had low adoption of commonly used IPM practices in boro rice cultivation. Sardar (2002) also found almost similar findings in his study. The findings of the present study reveal that adoption of commonly used IPM practices by the boro rice growers was not satisfactory. Cent percent of the boro rice growers had low to medium adoption of commonly used IPM practices. The reasons may be most of the boro rice growers had no training (80.0 %) and no connections with IPM clubs/ FFS (88.0 %).

4.3 Comparison among Adoption of the Different IPM Practices by the Boro Rice Growers

To compare the adoption of commonly used IPM practices in boro rice cultivation, Individual Practice Adoption Index (IPAI) was calculated. An Individual Practice Adoption Index (IPAI) for each of the practices could range from 0 to 390. The ten commonly used IPM practices have arranged in rank order in Table 4.15 on the basis of their IPAI. The observed IPAI ranged from 12.8 to 383.6.

4.15 Rank order of the adoption of different IPM practices by the boro rice growers

Sl no.	Name of commonly used IPM practices	IPAI	Rank order
1	Use of healthy and disease free seeds	383.6	1
2	Use of weed management	381.5	2
3	Use of water management	378.0	3
4	Destroy the crop residues	130.0	4
5	Use of crop rotation	124.7	5
6	Use of perching	111.7	6
7	Use of pesticide as a last method of pest control	32.5	7
8	Use of light trap	23.3	8
9	Use of trap to capture rat	13.1	9
10	Use of sweeping net	12.8	10

On the basis of computed IPAI, it was observed that the use of healthy and disease free seeds were adopted by the farmers to the highest extent (383.6) and it was closely followed by the use of weed management (381.5) and use of water management (378). On the other hand, practices like use of pesticide as a last method of pest control (32.5), use of light trap (23.3), use of trap to capture rat (13.1) and use of sweeping net (12.8) were adopted by the farmers to the lowest extent.

The findings indicate that seeds are one of the basic inputs of agricultural production. To increase production there is no alternative of using quality seed. Almost all of the farmers in the study area collect healthy and disease free seed from local seed dealers of BADC. That is why farmers adopt these practices to the highest extent. Weeding is an age-old practice used by the farmers in all areas. Farmers adopt this practice because it is very easy to handle and little technical knowledge is needed. Underground water and surface water are easily available in the locality. Very little technical knowledge is needed to supply irrigation in the field. For this reason, this practice ranked 3rd among the ten practices.

On the other hand, sweeping net is not a realistic practice for large area though it is suggested for primary infestation. Sweeping net may damage crops during capturing insect. So, it was the least practice. Rodenticides are easily available in the village area and which are sold at cheaper rate. Meanwhile technical knowledge is needed to make the trap to capture rat. Light trap is a combined practice which should be use all the farmers in the locality at a time, otherwise farmers will not be benefitted by this practice. Farmers were habituated to use of pesticide. Mechanical and biological methods of pest control are time consuming. So they adopt use of pesticides as the last method of pest control to the lower extent.

4.4 Relationship between Individual Characteristics of the Boro Rice Growers and their adoption of Commonly Used IPM Practices in Boro Rice Cultivation

Pearson's Product Moment Correlation Co-efficient (r) was computed in order to find out the extent of relationship between adoption of commonly used of integrated pest

management practices by the boro rice growers and their selected characteristics. To reject or accept the null hypothesis, 5% level of probability was used.

As mentioned earlier, the twelve selected characteristics of the farmers were the independent variables of the study. The variable were age, education, family agriculture workforce, farm size, annual income, training exposure, knowledge on pesticide application, awareness about environmental pollution, attitude towards harmful effects of chemical pesticide, contact with pesticide dealers, cost of pesticide and contact with IPM club/FFS, while the adoption of commonly used IPM practices in boro rice cultivation was dependent variable of the study.

Results of correlation have been shown in Table 4.16. Correlation co-efficient among all the variables might be seen in the correlation matrix in appendix-B.

Table 4.16 Relationship between adoption of commonly used IPM practices by the Boro rice growers and their selected characteristics

Dependent variable	Independent variables	Computed value of co-efficient of correlation 'r'	Tabulated value at 128 df	
			0.05 level	0.01 level
Adoption of commonly used IPM practices by the boro rice growers	Age	-0.009 ^{NS}	0.172	0.225
	Education	0.167 ^{NS}		
	Family agriculture workforce	-0.113 ^{NS}		
	Training exposure	0.329**		
	Annual income	-0.034 ^{NS}		
	Farm size	0.026 ^{NS}		
	Cost of pesticide	-0.012 ^{NS}		
	Knowledge on pesticide application	0.066 ^{NS}		
	Awareness about environmental pollution	0.145 ^{NS}		
	Attitude towards harmful effects of chemical pesticide	0.203*		
	Contact with pesticide dealer	0.139 ^{NS}		
	Contact with IPM club	0.324**		

** Significant at the 0.01 level * Significant at the 0.05 level ^{NS} Not significant

4.4.1 Relationship between adoption of commonly used IPM practices by the boro rice growers and age

Relationship between age and adoption of commonly used IPM practices by the boro rice growers was determined by Pearson's product moment correlation coefficient. The coefficient of correlation between age and adoption of commonly used IPM practices by the boro rice growers was presented in Table 4.16. The coefficient of correlation (r) between the concerned variables was found -0.009. The following observations were made on the basis of the value of correlation coefficient between the two concerned variables of the study under consideration:

a. *The relationship showed a negative trend between the concerned variables.*

b. *The observed value of "r" (-0.009) between the concerned variables was found to be smaller than the tabulated value (r = 0.172) with 128 degrees of freedom at 0.05 level of probability.*

c. *The null hypothesis could not be rejected.*

d. *The relationship between the concerned variables was not statistically significant at 0.05 level of probability.*

Based on the above finding, it can be concluded that age of the farmers had no significant relationship with the adoption of commonly used IPM practices by the boro rice growers. That is, farmers of all age categories can adopt commonly used IPM practices. Similar findings were also found by Gogoi and Gogoi (1989) and Kashem (2003) in their studies.

4.4.2 Relationship between adoption of commonly used IPM practices by the boro rice growers and education

Relationship between education and adoption of commonly used IPM practices by the boro rice growers was determined by Pearson's product moment correlation coefficient. The coefficient of correlation between adoption of commonly used IPM practices by the boro rice growers and education was presented in Table 4.16. The

coefficient (r) of correlation between the concerned variables was found 0.167. The following observations were made on the basis of the value of correlation coefficient between the two concerned variables of the study under consideration:

a. *The relationship showed a positive trend between the concerned variables.*

b. *The observed value of "r" (0.167) between the concerned variables was found to be smaller than the tabulated value (r = 0.172) with 128 degrees of freedom at 0.05 level of probability.*

c. *The null hypothesis could not be rejected.*

d. *The relationship between the concerned variables was not statistically significant at 0.05 level of probability.*

Based on the above finding, it can be concluded that education of the farmers had no significant relationship with the adoption of commonly used IPM practices by the boro rice growers. Aurangozeb (2002) also found similar findings in his studies.

4.4.3 Relationship between adoption of commonly used IPM practices by the boro rice growers and family agriculture workforce

Relationship between family agriculture workforce and adoption of commonly used IPM practices by the boro rice growers was determined by Pearson's product moment correlation coefficient. The coefficient of correlation between age and adoption of commonly used IPM practices by the boro rice growers was presented in Table 4.16. The coefficient of correlation (r) between the concerned variables was found -0.113. The following observations were made on the basis of the value of correlation coefficient between the two concerned variables of the study under consideration:

a. The relationship showed a negative trend between the concerned variables.

b. The observed value of "r" (-0.113) between the concerned variables was found to be smaller than the tabulated value (r = 0.172) with 128 degrees of freedom at 0.05 level of probability.

c. The null hypothesis could not be rejected.

d. *The relationship between the concerned variables was not statistically significant at 0.05 level of probability.*

Based on the above finding, it can be concluded that family agriculture workforce of the farmers had no significant relationship with the adoption of commonly used IPM practices by the boro rice growers. That is, farmers of all family agricultural workforce categories can adopt commonly used IPM practices. Talukder (2006) also found similar findings in his study.

4.4.4 Relationship between adoption of commonly used IPM practices by the boro rice growers and farm size

Relationship between farm size and adoption of commonly used IPM practices by the boro rice growers was determined by Pearson's product moment correlation coefficient. The coefficient of correlation between adoption of commonly used IPM practices by the boro rice growers and education was presented in Table 4.16. The coefficient (r) of correlation between the concerned variables was found 0.026. The following observations were made on the basis of the value of correlation coefficient between the two concerned variables of the study under consideration:

a. *The relationship showed a positive trend between the concerned variables.*

b. *The observed value of "r" (0.026) between the concerned variables was found to be smaller than the tabulated value (r = 0.172) with 128 degrees of freedom at 0.05 level of probability.*

c. *The null hypothesis could not be rejected.*

d. *The relationship between the concerned variables was not statistically significant at 0.05 level of probability.*

Based on the above finding, it can be concluded that farm size of the farmers had no significant relationship with the adoption of commonly used IPM practices by the boro rice growers. Hossain (2004) also found similar findings in his study.

4.4.5 Relationship between adoption of commonly used IPM practices by the boro rice growers and annual family income

Relationship between annual income and adoption of commonly used IPM practices by the boro rice growers was determined by Pearson's product moment correlation coefficient. The coefficient of correlation between annual income and adoption of commonly used IPM practices by the boro rice growers was presented in Table 4.16. The coefficient of correlation (r) between the concerned variables was found -0.034. The following observations were made on the basis of the value of correlation coefficient between the two concerned variables of the study under consideration:

a. *The relationship showed a negative trend between the concerned variables.*

b. *The observed value of "r" (-0.034) between the concerned variables was found to be smaller than the tabulated value (r = 0.172) with 128 degrees of freedom at 0.05 level of probability.*

c. *The null hypothesis could not be rejected.*

d. *The relationship between the concerned variables was not statistically significant at 0.05 level of probability.*

Based on the above finding, it can be concluded that annual income of the farmers had no significant relationship with the adoption of commonly used IPM practices by the boro rice growers. That is, farmers of all annual income categories can adopt commonly used IPM practices. Hanif (2000) also found similar findings in his study. Farmers generally having large farm size have high annual income. IPM is a holistic approach which requires intensive care. Intensive care require more time and labour which ultimately decreases adoption of IPM practices in large form. These may be causes of finding negative relationship between commonly used IPM practices by the boro rice growers and their annual family income.

4.4.6 Relationship between adoption of commonly used IPM practices by the boro rice growers and training exposure

Relationship between training exposure and adoption of commonly used IPM practices by the boro rice growers was determined by Pearson's product moment correlation coefficient. The coefficient of correlation between training exposure and adoption of commonly used IPM practices by the boro rice growers was presented in Table 4.16. The coefficient (r) of correlation between the concerned variables was found 0.329. The following observations were made on the basis of the value of correlation coefficient between the two concerned variables of the study under consideration:

a. *The relationship showed a positive trend between the concerned variables.*

b. *The observed value of "r" (0.329) between the concerned variables was found to be greater than the tabulated value (r = 0.225) with 128 degrees of freedom at 0.01 level of probability.*

c. *The null hypothesis was rejected.*

d. *The relationship between the concerned variables was statistically significant at 0.01 level of probability.*

Based on the above finding, it can be concluded that training exposure had highly significant positive relationship with the adoption of commonly used IPM practices by the boro rice growers. Training increases courage and enable the farmers to do new or complicated farming activities. As the first use of integrated pest management practices may be complicated to the farming community, the finding of the study revealed the truth that training exposure is a significant attribute for adoption of commonly used IPM practices by the boro rice growers. Rahman (2010) and Rahman (2001) also found similar findings in their studies.

4.4.7 Relationship between adoption of commonly used IPM practices by the boro rice growers and Knowledge on pesticide application

Relationship between knowledge on pesticide application and adoption of commonly used IPM practices by the boro rice growers was determined by Pearson's product moment correlation coefficient. The coefficient of correlation between adoption of commonly used IPM practices by the boro rice growers and knowledge on pesticide application was presented in Table 4.16. The coefficient (r) of correlation between the concerned variables was found 0.066. The following observations were made on the basis of the value of correlation coefficient between the two concerned variables of the study under consideration:

a. *The relationship showed a positive trend between the concerned variables.*

b. *The observed value of "r" (0.066) between the concerned variables was found to be smaller than the tabulated value (r = 0.172) with 128 degrees of freedom at 0.05 level of probability.*

c. *The null hypothesis could not be rejected.*

d. *The relationship between the concerned variables was not statistically significant at 0.05 level of probability.*

Based on the above finding, it can be concluded that knowledge on pesticide application of the farmers had no significant relationship with the adoption of commonly used IPM practices by the boro rice growers.

4.4.8 Relationship between adoption of commonly used IPM practices by the boro rice growers and awareness about environmental pollution

Relationship between awareness about environmental pollution and adoption of commonly used IPM practices by the boro rice growers was determined by Pearson's product moment correlation coefficient. The coefficient of correlation between adoption of commonly used IPM practices by the boro rice growers and awareness

about environmental pollution was presented in Table 4.16. The coefficient (r) of correlation between the concerned variables was found 0.145. The following observations were made on the basis of the value of correlation coefficient between the two concerned variables of the study under consideration:

a. *The relationship showed a positive trend between the concerned variables.*

b. *The observed value of "r" (0.145) between the concerned variables was found to be smaller than the tabulated value (r = 0.172) with 128 degrees of freedom at 0.05 level of probability.*

c. *The null hypothesis could not be rejected.*

d. *The relationship between the concerned variables was not statistically significant at 0.05 level of probability.*

Based on the above finding, it can be concluded that awareness about environmental pollution of the farmers had no significant relationship with the adoption of commonly used IPM practices by the boro rice growers. Rahman (2010) also found similar findings in his study.

4.4.9 Relationship between adoption of commonly used IPM practices by the boro rice growers and attitude towards harmful effects of chemical pesticide

Relationship between attitude towards harmful effects of chemical pesticide and adoption of commonly used IPM practices by the boro rice growers was determined by Pearson's product moment correlation coefficient. The coefficient of correlation between attitude towards harmful effects of chemical pesticide and adoption of integrated pest management (IPM) practices was presented in Table 4.16. The coefficient (r) of correlation between the concerned variables was found 0.203. The following observations were made on the basis of the value of correlation coefficient between the two concerned variables of the study under consideration:

a. *The relationship showed a positive trend between the concerned variables.*

b. *The observed value of "r" (0.203) between the concerned variables was found to be greater than the tabulated value (r = 0.172) with 128 degrees of freedom at 0.05 level of probability.*

c. *The null hypothesis was rejected.*

d. *The relationship between the concerned variables was statistically significant at 0.05 level of probability*.

Based on the above finding, it can be concluded that attitude towards harmful effects of chemical pesticide of the farmers had significant relationship with the adoption of commonly used IPM practices by the boro rice growers. Farmers' unfavourable attitude towards chemical pesticide indicates that, they know the harmful effects of chemical pesticides. To reduce harmful effect of chemical pesticide they adopt IPM practices.

4.4.10 Relationship between adoption of commonly used IPM practices by the boro rice growers and contact with pesticide dealers

Relationship between contact with pesticide dealers and adoption of commonly used IPM practices by the boro rice growers was determined by Pearson's product moment correlation coefficient. The coefficient of correlation between adoption of commonly used IPM practices by the boro rice growers and contact with pesticide dealers was presented in Table 4.16. The coefficient (r) of correlation between the concerned variables was found 0.139. The following observations were made on the basis of the value of correlation coefficient between the two concerned variables of the study under consideration:

a. *The relationship showed a positive trend between the concerned variables.*

b. *The observed value of "r" (0.139) between the concerned variables was found to be smaller than the tabulated value (r = 0.172) with 128 degrees of freedom at 0.05 level of probability.*

c. *The null hypothesis could not be rejected.*

d. *The relationship between the concerned variables was not statistically significant at 0.05 level of probability.*

Based on the above finding, it can be concluded that contact with pesticide dealers of the farmers had no significant relationship with the adoption of commonly used IPM practices by the boro rice growers.

4.4.11 Relationship between adoption of commonly used IPM practices by the boro rice growers and cost of pesticide

Relationship between cost of pesticide and adoption of commonly used IPM practices by the boro rice growers was determined by Pearson's product moment correlation coefficient. The coefficient of correlation between cost of pesticide and adoption of commonly used IPM practices by the boro rice growers was presented in Table 4.16. The coefficient of correlation (r) between the concerned variables was found -0.012. The following observations were made on the basis of the value of correlation coefficient between the two concerned variables of the study under consideration:

a. The relationship showed a negative trend between the concerned variables.

b. The observed value of "r" (-0.012) between the concerned variables was found to be smaller than the tabulated value (r = 0.172) with 128 degrees of freedom at 0.05 level of probability.

c. The null hypothesis could not be rejected.

d. The relationship between the concerned variables was not statistically significant at 0.05 level of probability.

Based on the above finding, it can be concluded that cost of pesticide of the farmers had no significant relationship with the adoption of commonly used IPM practices by the boro rice growers. That is, farmers of all cost of pesticide categories can adopt commonly used IPM practices.

4.4.12 Relationship between adoption of commonly used IPM practices by the boro rice growers and contact with IPM Club/FFS

Relationship between contact with IPM club/FFS and adoption of commonly used IPM practices by the boro rice growers was determined by Pearson's product moment correlation coefficient. The coefficient of correlation between contact with IPM club/FFS and adoption of commonly used IPM practices by the boro rice growers was presented in Table 4.16. The coefficient (r) of correlation between the concerned variables was found 0.324. The following observations were made on the basis of the value of correlation coefficient between the two concerned variables of the study under consideration:

a. *The relationship showed a positive trend between the concerned variables.*

b. *The observed value of "r" (0.324) between the concerned variables was found to be greater than the tabulated value (r = 0.225) with 128 degrees of freedom at 0.01 level of probability.*

c. *The null hypothesis was rejected.*

d. *The relationship between the concerned variables was statistically significant at 0.01 level of probability.*

Based on the above finding, it can be concluded that contact with IPM club had highly significant positive relationship with the adoption of commonly used IPM practices by the boro rice growers. The farmers who have contact with IPM club will aware of the benefit of IPM practices. They know the elaborate use of IPM technology. So the farmers who had contact with IPM club will adopt more IPM practices.

CHAPTER 5
SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of findings

The findings of the study and interpretation of the results have been presented elaborately in chapter 4. The findings of the study are now summarized below.

5.1.1 Characteristics of the boro rice growers

Age:

Age of the fanners ranged from 24 to 78 years, with an average of 44.94. Among 130 respondents, 47.70 percent were middle aged, 26.92 percent were old and 25.38 percent were young aged.

Education:

Education scores of the farmers ranged from 0 to 15, with an average of 5.87. Among the 130 respondents, the highest proportion (38.46 %) had secondary education, 33.85 percent had primary education, 20.77 percent was illiterate and 6.92 percent had above secondary education.

Family Agriculture Workforce:

Family agriculture workforce size of the respondents ranged from 2 to 12. Among the 130 respondents, the average family agriculture workforce size of the respondents was 4.65. The highest proportion (54.61%) of the respondents had medium families compared to 23.08 percent had large agriculture workforce and 22.31 percent had small agriculture workforce.

Farm Size:

The farm size scores of the respondents ranged from 0.1 hectares to 4.8 hectares with an average of 1.03 hectares. Among the 130 respondents, 3.07 percent had marginal farm size, 52.31 percent had small farm size, 40.77 had medium and 5 percent had large farm size.

Annual Family Income:

The annual income of the farmers ranged from Tk 10 to 348 thousands, the average being of Tk. 74.87 thousands. Among the 130 respondents, 56.92 percent had low, 33.85 percent had medium and 9.23 percent had high annual family income.

Training Exposure:

Training exposure of the farmers ranged from 0 to 20, with an average being of 1.88. Among the 130 respondents, the highest proportion (80.0 %) had no training compared to 11.54 percent had medium training and 8.46 percent had low training exposure.

Knowledge on Pesticides Application:

The knowledge on pesticides scores ranged from 8 to 15, and the average being 11.13. Among the 130 respondents, 75.38 percent had medium knowledge, 11.54 percent had low knowledge and 13.08 percent had high knowledge on pesticides application.

Awareness about Environmental Pollution

The awareness about environmental pollution scores ranged from 6 to 14, the average being of 9.12. The highest proportion of respondents had (80.0 %) medium awareness about environmental pollution, while 10.76 percent had low awareness and 9.24 percent had high awareness about environmental pollution.

Attitude towards Harmful Effects of Chemical Pesticides

The attitude towards harmful effects of chemical pesticides scores ranged from 31 to 51, average of 41.04.The highest proportion of respondents had (71.54 %) moderate

unfavorable attitude, while 15.39 percent had low unfavorable attitude and 13.07 percent had high unfavorable attitude towards harmful effects of chemical pesticides.

Contact with Pesticide Dealers

The contact with pesticide dealers' scores ranged from 4 to 19, the average being of 12.82. The highest proportion of the respondent had (66.92%) low contact, while 24.62 percent had medium contact and 8.46 percent had very low contact with pesticide dealers.

Cost of Pesticides:

The cost of pesticides of the farmers ranged from Tk 300 to 15000, the average being of 3596.92 Tk. Among the respondents, 45.39 percent had low pesticide cost, 27.69 percent had medium pesticide cost and 26.92 percent had high pesticide cost.

Contact with IPM club\FFS:

The contact with IPM club scores ranged from 0 to 14, the average being of 1.05. The highest proportion of the respondent had (87.69 %) no contact with IPM club, while 9.23 percent had very low contact and 3.07 percent had low contact with IPM club/FFS.

5.1.2 Adoption of commonly used IPM practices by the boro rice growers

Percentage of adoption of commonly used IPM practices by the boro rice growers ranged from 30 to 71, the average being of 40.85. More than half (57.69 %) of the respondents had medium adoption of commonly used IPM practices, while rest (42.31 %) of the respondent had low adoption of commonly used IPM practices in Boro rice cultivation.

5.1.3 Comparison among adoption of the different IPM practices by the boro rice growers

On the basis of Individual Practice Adoption Index (IPAI), use of healthy & disease free seed (383.6), use of weed management (381.5) and use of water management (378.0) were ranked 1st, 2nd and 3rd respectively. On the other hand, use of light trap

(23.3), use of trap to capture rat (13.1), and use of sweeping net (12.8) were ranked 8th, 9th and 10th respectively.

5.1.4 Relationship between adoption of commonly used IPM practices and the selected characteristics of the boro rice growers

Training exposure, attitude towards harmful effects of chemical pesticides, contact with IPM club had significant positive relationship. Education, farm size, knowledge on pesticides application, awareness about environmental pollution, and contact with pesticide dealer had non significant positive relationship with the adoption of commonly used IPM practices in boro rice cultivation. Age, family agriculture workforce, annual income, cost of pesticides had non significant negative relationship.

5.2 Conclusions

Conclusions drawn on the basis of the findings of this study and their logical interpretation in the light of the other relevant factors are furnished below:

1. The findings indicate that more than half (57.69%) of the respondents had medium adoption of commonly used IPM practices compared to 42.31 percent had low adoption of commonly used IPM practices in boro rice cultivation. This fact leads to the conclusion that overall adoption of commonly used IPM practices by the boro rice growers was not satisfactory. There is huge scope for increasing the extent of adoption of commonly used IPM practices in boro rice cultivation.

2. Training exposure of the respondents had positive significant relationship with their adoption of commonly used IPM practices by the Boro rice growers. But, overwhelming majority (88.46%) of the respondents had ‘no’ to ‘low’ training exposure. Therefore, it may be concluded that high training exposure of the farmers’ increase their adoption of commonly used IPM practices in boro rice cultivation.

3. Attitude towards harmful effects of chemical pesticide of the respondents had positive significant relationship with their adoption of commonly used IPM practices by the Boro rice growers. But, overwhelming majority (86.93%) of the farmers had low to moderate unfavorable attitude towards harmful effects of chemical pesticide. In the light of above findings, it may be concluded that formation of high unfavourable attitude towards harmful effects of chemical pesticides to the farmers increase their adoption of commonly used IPM practices in boro rice cultivation.

4. Contact with IPM club/FFS had significant positive relationship with their adoption of commonly used IPM practices by the Boro rice growers. But, overwhelming majority (87.69%) of the farmers had no contact with IPM club/FFS. Therefore, it may be concluded that high contact with IPM club/FFS of the farmers enhances their adoption of commonly used IPM practices in boro rice cultivation.

5. Environment friendly IPM practices like use of perching, use of pesticide as a last method of pest control, use of light trap, use of capture rat and use of sweeping net were least used IPM practices by the boro rice growers. Therefore, it may be concluded that unless or until these environment friendly practices are not popularize among the boro rice growers, the overall adoption of commonly used IPM practices would not be increased.

5.3 Recommendations

5.3.1 Recommendations for Policy Implication

Recommendations based on the findings and conclusions of the study are presented below:

1. An increased rate and extent of adoption of commonly used integrated pest management practices in boro rice cultivation are vital both for environment friendly rice production as well as increasing rice production. But, only a considerable proportion of the farmers had adopted few IPM practices in rice cultivation. It is, therefore, recommended that, the DAE may take effective steps for strengthening extension services in order to change adoption percentage of the boro rice growers regarding IPM practices.

2. Training had significant positive relationship with their adoption of integrated pest management practices. Therefore, it may be recommended that, DAE should conduct more training programs on commonly used IPM practices that would make the farmers more skilled to adopt integrated pest management in rice cultivation.

3. Attitude towards harmful effects of chemical pesticide had significant positive relationship with boro rice growers' adoption of commonly used IPM practices. Therefore, it may be recommended that, DAE and other extension agencies may campaign more about the harmful effects of chemical pesticide on human health and adjacent environment to change the attitude of the boro rice farmers.

4. Contact with IPM club had significant positive relationship with their adoption of commonly used IPM practices in boro rice cultivation. Therefore, it may be recommended that, DAE should open more IPM club in the remote area to acquire the farmers about commonly used integrated pest management (IPM) practices in rice cultivation.

5. It may be recommended that massive result and method demonstration programmes, training programmes, field trips etc. should be executed to make desirable changes in the farmers' attitude and supply necessary IPM (Integrated Pest Management) tools to increase overall adoption of commonly used IPM practices by the farmers.

6. The progressive farmers are playing a vital role in communicating information to the farmers. This necessitates updating the knowledge of progressive farmers with proper training to make them more useful in adoption of commonly used integrated pest management practices.

7. The Department of Agricultural Extension (DAE) needs to pay more attention to ensure the adoption of integrated pest management (IPM) practices through building confidence among the farmers about commonly used IPM practices in rice cultivation by showing clear difference between traditional and recommended practices.

5.3.2 Recommendations for Further Study

1. This study investigated the effects of twelve characteristics of the farmers on their adoption of commonly used integrated pest management practices in boro rice cultivation. Therefore, it is recommended that further studies should be conducted involving other variables in these regards. This study dealt with only ten commonly used IPM practices in boro rice cultivation. More studies should be undertaken including other IPM practices of boro rice cultivation.

2. The present study was conducted only in two villages of Baliadangi Upazila under Thakurgaon District. Findings of the study need further verification through similar research in other parts of the country.

3. It is difficult to determine the extent of adoption of commonly used IPM practices by the farmers. Measurement of adoption of the farmers is not free from questions. More reliable measurement of concerned variables is necessary for further study.

4. An exhaustive study on problems faced by the farmers in the adoption of integrated pest management practices in boro rice cultivation can also be undertaken.

5. The present study did not reveal the factors that affected the non-adoption of integrated pest management practices by the boro rice growers. It is, therefore, suggested that the factors responsible for non-adoption of each practice of integrated pest management should be ascertained in future studies.

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Appendix -A

English version of the interview schedule

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

An Interview Schedule on "**Adoption of Commonly Used Integrated Pest Management (IPM) Practices by the Boro Rice Growers**"

(This interview schedule is entitled for a research study)

Part-A

Serial no..... Date.....

Name of respondent.....

Village..... Union..... Thana.....

Contact number: ……..

Part-B

Please answer the following questions .Give tick (√) marks if necessary

1. Age.....years

2. **Education**

a) Illiterate

b) Can sign only

c) Studied up to class ……...

3. Family agriculture work force

Please mention the number of your family members in the following groups:

a) Male member _____person
b) Female member _____ person
c) Total member _____person
d) Family member involve in agriculture _____person

4. Gross annual income (Tk)

Please mention production and income of your family from different sectors in the last year

Sl no.	Source of income	Amount of production	Price per unit (Tk)	Total (Tk)
A	Agriculture			
1	Rice			
2	Jute			
3	Wheat			
4	Potato			
5	Pulse			
6	Oilseed			
7	Spices and condiments			
8	Vegetables			
9	Fruits			
10	Other crops			
11	Fish culture			
12	Poultry rearing			
13	Cattle rearing			
B	Business			
C	Service			
D	Labour			
E	Others			

Total annual income = A+B+C+D+E =

5. Farm size

Please mention the area of your land possession:

Sl. no.	**Types of land ownership**	**Land Area**	
		Local unit	Hectare
1	Homestead area (Including pond)		
2	Own land under own cultivation		
3	Land given to others as borga		
4	Land taken from others as borga		
5	Land taken from others as lease		
6	Fallow land		
	Total		

6. Training exposure

Do you attend any training on agriculture during last 5 years? Yes ☐ / No ☐ . If yes, Then please mention the training courses you have attended so far:

Subject	Place	Duration(day)	Organization

7. Knowledge on pesticide application

Sl no.	Questions	Correct Answer	Score	
			Correct Answer	Wrong Answer
1.	What quantity of insecticide suspension generally hold in a knapsack sprayer machine a) 5 liter d) 27 liter b) 16 liter c) 25 liter	b) 16 liter		
2.	What area of rice field can be sprayed by one tank solution of knapsack sprayer? a) 1 decimal d) 15 decimal b) 5 decimal c) 10 decimal	b) 5 decimal		
3.	What time is not suitable for spraying? a) In the morning b) In the noon's scorching sunshine c) After noon	b) In the noon's scorching sunshine		
4.	How much standing water is needed for applying granular insecticides in rice field? a) 0 cm d)20-25 cm b) 5-10 cm c) 15-20 cm	b) 5-10 cm		
5.	How much Furadan 5G (Carbofuran group) is needed to control stem borer in 1decimal of rice field? a) 10 gm/decimal d)70 gm/decimal b) 40 gm/decimal c) 80 gm/decimal	a)40 gm/decimal		
6.	What rodenticide is needed to control rats? a) Lanirat /Quickfume d) DDT b) Ripcord /chlorden c) Agrosun/Vitavex	a) Lanirat/Quickfume		

7.	What weedicide is needed for controlling weeds of rice field? a) Stem F-34 d) Ecofuran b) Shathi c) Ripcord	a) Shathi		
8.	In what direction of wind pesticide should be sprayed? a) Towards wind b) Against wind	a) toward wind		
9.	Mention the name of one granular insecticide? a) Ecofuran 5G b) Ripcrod c) Cix 10 EC d) Malathion 50EC	a) Ecofuran 5G		
10.	Which two factors are crucial during pesticide application? a) Recommended doses i)a,b b) Types of insect pest ii)b,c c) Nature of sprayer iii)c,d d) Time of pest attack	i)a,b		
11.	Application of pesticide higher than recommended doses are harmful for environment a) True b) False	a) True		
12.	Mention the name of one spray machine? a) Knapsack d)saboj b) provati c) Krisan	a)Knapsack		
13.	Application of pesticide lower than the recommended doses may cause resistant of insect to insecticide. a) Yes b) No	a) Yes		
14.	Mask use during pesticide application a) Essential d)strictly prohibited b) Not important c) Only for specific pesticide	a) Essential		
15.	After how many days of spraying you can harvest crops a) According to instruction given in labeling b) Immediately c) After one day	a) According to instruction given in labeling		
16.	Without spray how can you apply insecticide a) With seed treatment b) No such way	a)With seed treatment		

8. Awareness about environmental pollution

Mention true or false for the following statements

Sl no.	Statements	Opinion		Obtained score
		True	False	
1.	The ever-increasing population may cause environmental pollution			
2.	Indiscriminate use of agro-chemicals may cause e nvironmental pollution			
3.	Recurring outbreak of pest and diseases in crop field may cause environmental pollution			
4.	Indiscriminate cutting of plants and trees may cause environmental pollution			
5.	Indiscriminate defecation does not affect the environment			
6.	Increase of intensive cropping area does not affect the environment much			
7.	Lowering of water table and depletion of under ground aquifer may cause environmental pollution			
8.	Throwing of poly bag here and there may cause environmental pollution			
9	Black smoke emission from agricultural machines and oil engines may cause environmental pollution			
10.	Rapid unplanned and uncontrolled industrialization and urbanization may cause environmental pollution			
11.	Unhealthy housing, poor ventilation and high density may cause environmental pollution			
12.	Burning of cow dung, crop residues, grasses, leaves etc have no harmful effect on environment			
13.	Decrease in all forms of wild life may cause environmental pollution			
14.	Used bottles & packets left in the field don't affect the environment			
15.	Unregistered & unapproved insecticide may be used			

9. Attitude towards harmful effects of chemical pesticide

Sl. no	Statement about harmful effects of chemical pesticide	Extent of opinion				
		Strongly agree	Agree	No opinion	disagree	Strongly disagree
1. (+)	Persistent toxic pesticide like DDT, Heptachlor etc persist in the environment for many years					
2. (-)	Pesticides applied in crop fields being washed to pound, canals and rivers don't cause any problems in using					
3. (+)	Continuous pesticides application in crop fields increase resistance to insect-pest					
4. (-)	Application of pesticides in crop fields don't cause death of beneficial and pollinating insects					

5. (+)	Use of toxic pesticides in crop cause the death of beneficial organisms like earthworms, frogs, snakes etc.					
6. (-)	Careless use of insecticides don't cause death and health hazards to the domestic animals and poultry birds					
7. (+)	Pesticides create health hazards to users by skin and eye irritation if proper protection measures aren't taken					
8. (-)	Pesticides' residues don't exist in human body					
9. (+)	Application of toxic insecticide in irrigated crop fields cause pollution in canals, pond and rivers.					
10. (-)	Inhalation of toxic insecticides don't cause cancer and other diseases to human health					
11. (+)	Most of the soil pesticide is harmful for soil internally which makes the soil unproductive					
12. (-)	Toxic insecticides don't cause the reduction of some bird species					

10. Contact with pesticide dealers

Sl No.	**Purpose of contact**	**Extent of contact**			
		Regularly	Frequently	Rarely	Not at all
1.	To know the application procedure				
2	To know new technique of application				
3	To gather knowledge of new product				
4	To know update of any product				
5	To know appropriate time of application				
6	To know the residual effect of insecticide				
7	To get suggestion for appropriate insecticide for insect infestation				
8	To know the harvesting time after insecticide application				
9	For social gathering				
10	Personal interest				
11	To buy pesticide				
12	Others (specify please)				

11. Cost of pesticide (last season)

Categories of pesticide	Cost of pesticide (Tk)
Insecticide	
Fungicide	
Weedicide	
Total	

12. Contact with IPM club/ FFS

Sl No.	Purpose of contact	Extent of contact			
		Regularly	Frequently	Rarely	Not at all
1	To receive training				
2	For meeting				
3	To know the latest IPM techniques				
4	To get suggestion from other members experienced about IPM				
5	To know the modern cultivation techniques				
6	To contact with GOs and NGOs for their service				
7	To save money in saving scheme or collect loan				
8	To know the tolerant varieties				
9	To know the time to start chemical control measures				
10	Others (specify please)				

13. Adoption of commonly used IPM practices in boro rice cultivation

Name of Practices	Year of the adoption			$\sum \frac{l}{L}$	$\bar{x}$ adoption
	2013	2014	2015		
1. Use of healthy and disease free seeds					
Allotted area for cultivation(l)					
Potential area (L)					
Proportion of area coverage($\frac{l}{L}$)					
2. Use of light trap					
Allotted area for cultivation(l)					
Potential area (L)					
Proportion of area coverage($\frac{l}{L}$)					

3. Use of sweeping net					
Allotted area for cultivation(l)					
Potential area (L)					
Proportion of area coverage($\frac{l}{L}$)					
4. Use of perching					
Allotted area for cultivation(l)					
Potential area (L)					
Proportion of area coverage($\frac{l}{L}$)					
5. Use of water management					
Allotted area for cultivation(l)					
Potential area (L)					
Proportion of area coverage($\frac{l}{L}$)					
6. Use of weed management					
Allotted area for cultivation(l)					
Potential area (L)					
Proportion of area coverage($\frac{l}{L}$)					
7. Use of crop rotation					
Allotted area for cultivation(l)					
Potential area (L)					
Proportion of area coverage($\frac{l}{L}$)					
8. Destroy the crop residues					
Allotted area for cultivation(l)					
Potential area (L)					
Proportion of area coverage($\frac{l}{L}$)					
9. Use trap to capture Rat					
Allotted area for cultivation(l)					
Potential area (L)					
Proportion of area coverage($\frac{l}{L}$)					

10. Use of pesticide as a last method of pest control					
Allotted area for cultivation(*l*)					
Potential area (L)					
Proportion of area coverage($\frac{l}{L}$)					

Adoption quotient = $\frac{\Sigma \bar{x}}{No.of\ practices}$ X 100

= ——————————————————————————X 100

Thanks for your co-operation

Signature of Interviewer

Date:.....

.....

Appendix-B: Correlation Matrix

Characters	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	Y
X_1	1												
X_2	-.193*	1											
X_3	.311**	-.134	1										
X_4	-.081	.240*	-.002	1									
X_5	.064	.159	-.064	.315**	1								
X_6	.205*	.285**	.115	.290**	.701**	1							
X_7	.136	.182*	.034	.333**	.847**	.758**	1						
X_8	-.040	.247**	-.094	-.097	.125	.122	.074	1					
X_9	-.096	.208*	-.103	.058	.079	.033	.074	.344**	1				
X_{10}	-.117	.181*	-.124	.027	.108	.132	.143	.388**	.453**	1			
X_{11}	.098	.195*	.034	.080	.107	.196*	.092	.090	-.032	.124	1		
X_{12}	-.110	.258**	.016	.877**	.274**	.250**	.282**	-.066	.031	.030	.099	1	
Y	-.009	.167	-.113	.329**	-.034	.026	-.012	.066	.145	.203*	.139	.324**	1

X_1: Age
X_2: Education
X_3: Agriculture Workforce
X_4: Training Exposure
X_5: Annual income
X_6: Farm size
X_7: Cost of pesticide
X_8: Knowledge on pesticide application
X_9: Awareness about environmental pollution
X_{10}: Attitude towards harmful effects of chemical pesticide
X_{11}: Contact with pesticide dealer
X_{12}: Contact with IPM club
Y: Adoption of common IPM practices by boro rice growers