ADOPTION OF INTEGRATED PEST MANAGEMENT (IPM) PRACTICES IN RICE CULTIVATION BY THE FARMERS OF SHAHJADPUR UPAZILLA UNDER SIRAJGANJ DISTRICT

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CERTIFICATE

This is to certify that the thesis entitled, **"Adoption of Integrated Pest Management (IPM) Practices in Rice Cultivation by the Farmers of Shahjadpur Upazilla under Sirajganj District."** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **Master of Science (MS) in Agricultural Extension,** embodies the result of a piece of bona fide research work carried out by **Md. Masum Kabir,** Registration No. 09-03408, under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.

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

Dated: June, 2015
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DEDICATION

THIS THESIS IS LOVINGLY DEDICATED

TO

MY PARENTS

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June, 2015 **The Researcher**

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ABSTRACT

The purpose of this study was to determine the adoption of IPM practices by rice growers and to explore the contributing characteristics of the farmers to their adoption of IPM practices. Data were gathered from 120 farmers of two villages namely Chakhoripur and Chinadhukuria, Kayempur Union of Shahjadpur upazila under Sirajgong by using a pretested interview schedule during the period from 10 April to 30 July, 2015. Descriptive statistics, multiple regression were used for data analysis. The findings reveal that 44.4% respondents had medium adoption where 24.1 percent had low adoption and 31.5 percent had high adoption of commonly used IPM practices in rice cultivation. Among the influential variables respondents' age, farm size, training exposure, Cosmopoliteness, knowledge on pesticide application and attitude towards harmful effects of chemical pesticide were significant contributor and provided 82.1 percent contribution to adoption of IPM practices in rice cultivation.

Chapter 1

INTRODUCTION

1.1. General Background

Bangladesh is an economically agriculture based developing country. 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.

On the basis of land area compared to other countries in the world, Bangladesh is a small country but its population density is probably the highest in the world. To meet up the food consuming demand for 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. Pesticide consumption increased to 9.8 kg per ha in 2009 in Bangladesh which is 0.7 kg per ha in the year 2000 (Statistical Data Book for Agricultural Research and Development in SAARC Countries 2012).In the year of 2007 37,712.20 tons of pesticide sold in Bangladesh at different trade name and 22,118 tons which is nearly 86.81% is used in rice (Pesticide information of SAARC Countries, SAARC Agricultural center).

Many studies have examined the effects of pesticide exposure on the risk of cancer. Associations have been found with: leukemia, lymphoma, brain, kidney, breast, prostate, pancreas, liver, lung, and skin cancers. This increased risk occurs with both residential and occupational exposures. Increased rates of cancer have been found among farm workers who apply these chemicals. A mother's occupational exposure to pesticides during pregnancy is associated with an increase in her child's risk of leukemia, Wilms' tumor, and brain cancer. Application of pesticides to crops that are in bloom can kill honeybees, which act as pollinators .Fish and other aquatic biota may be harmed by pesticide-contaminated water (Helfrich) .To avoid such consequences Integrated Pest Management (IPM) is the best alternative strategy. Integrated Pest Management (IPM) is a broad ecological approach to pest control using various pest control tactics in a compatible manner.

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 introduce IPM in Bangladesh in the year of 1981 in rice cultivation, but it gains its popularity in the year 1987. Government establishes 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 a project named DAE-DANIDA SPPS Project. Second phase of this project started in 2002. Of this consequence Bangladesh Government took 3 years project from 2006 to 2009. It was started in 58 district of 244 upazila (Krishibid Magazine, special edition, March-April 2014).

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. This practice will help to increase the overall condition of the country. Some farmers realized the benefits of the practices and responded positively to adopt this practice. Some farmers in contrast, showed totally reverse attitude. Few researches have been conducted to measure the extent of adoption of IPM in rice cultivation.

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 metric tons rice in the year 2014 (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 metric tons of pesticide sold in Bangladesh at different trade name and among them 22,118 metric tons which is nearly 86.81% was used in rice production (Rahman, 2011) though the Department of Agricultural Extension (DAE) started disseminating IPM practices in rice cultivation since 1981 through different IPM projects. Among all other agricultural practices IPM is the best practice to increase the crop production by reducing the effect of harmfulness of human body and environmental pollution. Some farmers realized the benefits of the practices and responded positively to adopt this practice. Some farmers in contrast, showed totally reverse attitude.

The present study aims to provide information regarding the following research questions:

1. What is the extent of adoption of IPM practices by the farmers in rice cultivation?

2. What are the farmers' preferences in adoption of different IPM practices in rice cultivation?
3. What are the farmers selected characteristics that contributed to the extent of adoption of IPM practices in rice cultivation?

So, findings of the extent of adoption in IPM can be helpful in determining the effectiveness of program implemented by DAE. On the above considerations, the researcher of this study felt necessity to conduct the research on **"Adoption of IPM Practices by the Farmers in Rice Cultivation".** It is assumed that if the extent of adoption could be identified than the DAE can be able to take appropriate steps to implement the technology.

1.3. Objectives of the Study

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

1. To determine the extent of adoption of IPM practices by the farmers in rice cultivation;
2. To determine and describe some selected personal and socio-economic characteristics of the farmers, the selected characteristics are:
    a. Age
    b. Education
    c. Farm size
    d. Family Size
    e. Annual family income
    f. Training Exposure
    g. Innovativeness
    h. Cosmopoliteness
    i. Knowledge on IPM Practices
    j. Knowledge on pesticide application
    k. Attitude towards harmful effects of chemical pesticide
    l. Contact with IPM club and/or FFS;

3. To compare the extent of adoption of different IPM practices in rice cultivation; and

4. To explore the contributory factors related to the extent of adoption of IPM practices by the farmers in rice cultivation and their selected characteristics;

1.4. Justification of the Study

The integrated pest management, which has an important role in sustainable agriculture, is described as the integrative use of all available pest control methods to control the pests. In IPM, especially biological and biotechnological control methods have a vital importance as the alternatives to chemical control. Since the chemical control is not solely effective on some pests. Besides it has unwanted side effects such as health threat, environmental pollution and pest resistance factors give an alternative opportunity to growers to use biological and biotechnological control methods. In Bangladesh, biological control and pheromone traps are used to manage some pests. Most of the farmers in our country are poor. They are not able to use chemical pesticide that will readily kill the pest. But these pesticides are toxic in nature and are hazardous to environment and human health. Biological pesticides act slowly but safe in nature and ecofriendly. On the basis of the findings of the present study specific recommendation would be made for realistic policy formulation which would help the farmers to become aware about using IPM practices instead of chemical pesticides.

1.5 Assumptions of the Study

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

- The respondents included in the sample were capable of furnishing proper responses to the questions set up in the interview schedule.

- Views and opinions furnished by the respondents included in the sample were the representative views and opinions of the whole population of the study area.
- The responses furnished by the respondents were reliable. They expressed the truth about their convictions and awareness.
- The researcher acted as interviewer was very well adjusted to the social and cultural environment of the study area. Hence, the respondents furnished their correct opinions without any kind of hesitation.
- The data collected by the researcher were free from bias and they were normally and independently distributed.
- The items included in the interview schedule for measuring use of IPM practices were adequate to reflect the extent of use of IPM practices by the farmers of that locality.

1.6 Scope and Limitations of the Study

The present study was undertaken with a view to know the extent of using IPM practices by the farmers. In order to conduct the research in a meaningful and manageable way, it became necessary to impose some limitations in certain aspects of the study. Considering the time, money, labor and other necessary resources available to the researcher, the following limitations have been observed throughout the study:

- The study was confined to two villages namely Chakhoripur and Chinadhukuria of Kayempur union under Shahjadpur upazila of Sirajgang district**.**
- Characteristics of the farmers were many and varied but only twelve characteristics were selected for investigation in this study.
- The extent of using IPM practices of farmers was measured on the basis of their response to the selected statements.
- The findings could be applicable for the study area and similar situations in physical, socio-economic cultural and geographic conditions only.

- Finally, for collection of information, the researcher had to depend on the data furnished by the respondents during their interview with him. As none of the farmers kept records of their farming activities, they furnished information to the different questions by recall.
- In some cases, the researcher faced unexpected interference from the over interested side talkers while collecting data from target respondents. However, the researcher tried to overcome the problems as far as possible with sufficient tact and skill.

1.7. Definition of Terms

A concept is an abstract of observed thing, events or phenomenon or in other words, it is a short hand representation of variety of facts (Wilkinson and Bhandarkar, 1977). A researcher needs to know the meaning and contents of every term that he uses. It should clarify the issue as well as explain the fact to the investigator and readers. However, for clarity of understanding, a number of key concepts/terms frequently used throughout the study defined are interpreted as follows:

1.7.1. Age

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

1.7.2. Education

Education referred to the development of desirable knowledge, skill, attitudes, etc. of an individual through the experiences of reading, writing, observation and related matters

1.7.3. Family size

Family size o f a respondent referred to the total members in his/her family including him/her, children and other dependents, who live and eat together in a family unit.

1.7.4. Farm size

Farm size referred to the total area on which a farmer's family carries on farming operations, the area being estimated in terms of full benefit to the farmer's family.

1.7.5. Annual family income

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

1.7.6. Training exposure

It referred to the total number of days that a respondent had exposure training from DAE, NGOs or other organizations under different training program.

1.7.6. Innovativeness

Innovativeness is the degree to which an individual is relatively earlier in adopting an innovation with respect to other members of a social system (Rogers, 1995). This was comprehensive by the quickness of accepting innovation by an individual in relation to others a n d was measured on the basis of time dimension.

1.7.7. Cosmopoliteness

Cosmopoliteness of a farmer referred to the degree to which an individual's orientation is both inside and outside of his/her social system.

1.7.8. Knowledge on IPM practices

Literally knowledge means knowing or what one knows about a subject, fact, person etc. Knowledge on IPM practices referred to farmers' understanding of the facts, phenomena and methods in different aspects of IPM practices.

1.7.9. 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.

1.7.10. Attitude towards harmful effects of chemical pesticide

Attitude is an enduring tendency to perceive or act towards persons or situations in 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 an attitude scale, following Likert method of summated rating.

1.7.11. Contact with IPM club and/or FFS

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

1.7.12. 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. In this study, adoption of commonly used IPM practices by the rice growers means percentages of average mean area adoption of 10 commonly used IPM practices in rice cultivation.

1.7.13. Respondents

Respondents mean people who have answered questions asked by an interviewer for a social survey. They are the people from whom a social research worker usually gets most data required for his research.

1.7.14. Variable

A general indication in statistical research of characteristic that occurs in a number of individuals, objects, groups etc. and that can take on various values, for example the age of an individual.

1.7.15. 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, 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.

Chapter 2

REVIEW OF LITERATURE

The goal of this Chapter is to represent the findings of previous researchers related to the investigation. The reviews are accessibly existed here based on the major objectives of the study. This Chapter consists of three sections. The first section deals with the extent of use of integrated pest management practices by the rice cultivators; second section is dedicated to an observation on the findings related to the relationship between the selected characteristics of the rice cultivators and their trend of use and third section approach the conceptual framework of the study.

2.1 Adoption of IPM practices by the rice farmers

Ghimire and Kafle (2014) conducted a study on Integrated Pest Management Practice and its Adoption by the farmers in Nepal. The study revealed that about 53 percent of farmers were satisfied with the practice.

Hossain (2009) conducted a study on adoption of integrated pest management practices by the farmers of Brahmanbaria district. The study revealed that 57 percent of the farmers were medium users while 22 percent were low users and 21 percent were high users of IPM practices.

Hossain (2006) showed in a study on adoption of integrated pest management practices in rice field by the farmers in Tapodhan union under Rangpur District. The study revealed that 82 percent of the farmers were high users while 10 percent were medium users and 8 percent were low users of IPM practices.

Kauser (2006) reported in a study on adoption of integrated pest management practices by the farmers in crop cultivation. The study revealed that 57 percent of the farmers were medium users while 39 percent were high users and 4 percent were low users of IPM practices.

Sardar (2002) studied on "adoption of IPM practices by the farmers under PETRRA Project of RDRS". He observed that majority (45.9 %) of the farmers had medium, 38.3 % had low and 15.8 % 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 %) of farmers fell under the medium adoption category, while 21 percent had high adoption and 19 percent had low adoption.

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

Islam (2002) conducted a study on adoption of modern agricultural technologies by the farmers of Sandwip. The study revealed that 69 percent of the farmers had medium adoption while 13 percent had low adoption and 18 percent had high adoption of modern agricultural technologies.

Haider *et al.,* (200l) observed that one-third (37 percent) of the farmers fell in low adopter category compared to 32.5 percent in optimum adopter 23.5 percent above optimum adopter and only 7 percent had non-adopter on Nitrogenous fertilizer. In respect of extent of phosphoric fertilizer two thirds (68 percent) of the farmers belonged to non-adopter category compared to 23 percent having above optimum adopter, 5 percent optimum adopter and only 4 percent had below optimum adopter of phosphoric (P) fertilizer. In respect of extent of potassic fertilizer three quarters categories compared to 10 percent falling below optimum adopter, 8 percent optimum adopter and only 3 percent above optimum adopter of potassic (K) fertilizer.

Podder (1999) concluded a research study on the adoption of Mehersagar banana by the farmers. He found 47 percent of the respondent had medium adoption compared to 14 percent having low and 39 percent having high 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.

Bembridge and Wiliams (1990) studied the personal, sociological, socio-psychological and communication characteristics that influence the adoption of maize practice in farmer support programme in South Africa. The study revealed that less than 50% of the farmers who adopted practices were implementing them according to recommendation and man y did not have a clear concept that the practices were interrelated.

2.2 Findings related to the Relationship between the Selected Characteristics of the farmers and their use of IPM Practices:

2.2.1 Age and adoption of IPM Practices

Hossain (2009) found that age of the farmers had positive significant relationship with their use of IPM practices.

Hossain (2006) conducted a study on use of integrated pest management practices in Rice field by the farmers in Tapodhan union under Rangpur District. He found that age of the farmers had no significant relationship with their use of IPM practices.

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

An investigation was carried out by Kauser (2006) on use of integrated pest management practices in rice field by the farmers in crop cultivation. He found that age of the farmers had negative significant relationship with their use of IPMpractices.

Mia (2005) conducted a study on adoption of integrated pest management practices in Rice field by the vegetable growers' of Magura district. He found that age of the vegetable growers' had no significant relationship with their adoption of IPM practices.

Khan (2013), Rahman (2004) and Singh and Rajendra (2005) observed that there was significant and positive relationship between age of the farmers and their adoption of IPM Practices.

Sadar (2002) conducted a study on adoption of IPM practices by the farmers under PETRRA project of RDRS. He found that age of the farmers had a negatively significant relationship with their adoption of IPM practices.

Islam (2002) conducted a study on adoption of modern agricultural technologies by the farmers of Sandwip. He found that age of the farmers was not related to their adoption of modern agricultural technologies.

Rahman (2001) observed that there was no significant relationship between age and adoption of Aalok-6201 hybrid rice cultivation practices. Podder (1999) and Hossain (1999) are found similar results in their respective studies.

Hussen (2001) conducted a study which concluded that age of the sugarcane growers had a significant negative relationship with their adoption of modern sugarcane cultivation practices. Rahman (1995) also found similar result in his study.

Hossain (1999) conducted a study to determine the farmer's perception on the effects of agro-chemical on environment. He found that age of the farmers had no relationship with their adoption of fertilizer.

Sarkar (1997) observed that there was no significant relationship between ages of the farmers and their adoption of improved potato cultivation practices. Similar findings were observed by Rahman (1986), Singh (1989) and Kher (1992) in their respective studies.

Chowdhury (1997) observed that the age of the farmers had no significant relationship with their adoption of selected BINA technologies.

Islam (1996) conducted a study on farmer's use of indigenous technical knowledge (ITK) in the context of sustainable agricultural development. He found that age of the farmers had significant negative relationship with their extent of use of ITK.

Pal (1995) conducted a study on adoption of recommended sugarcane cultivation practices by the farmers. He found that age had significant and negative relationship with the adoption of recommended sugarcane cultivation practices. Similar findings were found by Hasan (1996) and many others.

Khan (1993) in his study found that age of the farmers was significantly related with their adoption of insecticides. He also found that with the increase of age of the farmers, the adoption of insecticides reduce i.e., age was negatively related with adoption.

Hoque (1993) observed that age had a negative relationship with the adoption of insecticides. Kashem (1987) observed similar relationship.

Singh (1991) conducted a study to determine the extent of adoption of selected recommended practices by kinnow growers of Ferozepur and Faridkot districts of Punjab. He found no relationship between age of the farmers and their level of adoption of plant protection measures.

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

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

2.2.2 Education and adoption of IPM practices

Patil (2001), Haque(2003), Islam (2002), Okoro & Bibuaka (2003), Khan and Kashem (2003) and Singh and Rajendra (2005) observed that there were significant and positive relationship between education of the fanners 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 1PM practices.

2.2.3. Family size and adoption of IPM practices

Hossain (2009) observed in a study that family size of the farmers had no significant relationship with their use of IPM practices.

Hossain (2006) found that family size of the farmers had no significant relationship with their use of IPM practices.

Kauser (2006) revealed on a study on use of integrated pest management practices in Rice field by the farmers in crop cultivation. He found that family size of the farmers had no significant relationship with their use of IPM practices.

Mia (2005) showed a study on adoption of integrated pest management practices by the vegetable growers' of Magura district. He found that family size of the vegetable growers' had positive significant relationship with their adoption of IPM practices.

Hossain (2003) found that number of family members had significantly negativerelationship with their adoption of modern Boro rice cultivation practices.

Rahman (2001) in his study found that family size of the farmers had no significant relationship with their adoption of Aalok 6201 hybrid.

Hossain (1999) conducted a study to determine the farmer's perception on the effects of agrochemicals on environment. He found no relationship between the farmer's family size and their adoption of fertilizer.

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 with the adoption of selected BINA Technologies. Similar findings were observed by Barkatullah (1985), Okoro and Obibuaka (1992), Pathak and Sasmal (1992) and Sarkar (1997).

Alam (1997) in his study found that family size of the farmers had positive and significant relationship with their use of farm practices in rice cultivation.

Islam (1996) observed the family of the farmers had significantly negative relationship with their extent of use of ITK.

Ullah (1995) observed that family size had positive significant relationship with adoption of livestock and green revolution technologies.

2.2.4. Farm size and adoption of IPM practices

Hossain (2009) showed a study on use of integrated pest management practices by the farmers of Brahmanbaria district. He found that farm size of the farmers had positive significant relationship with their use of IPM practices.

Hossain (2006) conducted a study on use of integrated pest management practices in Rice field by the farmers in Tapodhan union under Rangpur District. He found that farm size of the farmers had no significant relationship with their use of IPM practices.

Kauser (2006) found in a study on use of integrated pest management practices by the farmers in crop cultivation. He found that farm size of the farmers had positive significant relationship with their use of IPM practices.

Mia (2005) showed in a study on adoption of integrated pest management practices in Rice field by the vegetable growers' of Magura district. He found that farm size of the vegetable growers' had positive significant relationship with their adoption of IPM practices.

Hossain (2003) conducted a research study on farmer's knowledge and adoption of modern Boro rice cultivation practices. He found that farm size of the farmers had significant positive relationship within their adoption of modern Boro rice cultivation practices.

Sardar (2002) conducted a study on adoption of IPM practices by the farmers under PETRRA project of RDRS. He found that farm size of the farmers had a positive significant relationship with their adoption of IPM practices.

Islam (2002) conducted a study on adoption of modern agricultural technologies by the farmers of Sandwip. He observed that farm size of the farmers had a positive significant relationship with their adoption of modern agricultural technologies.

Rahman (2001) conducted an investigation on knowledge, attitude and adoption of Aalok-6201 hybrid rice by the farmers of sadar upazila in Mymensingh district. He observed that there was a significant positive relationship between farm size of the farmers and their adoption of Aalok-6201 hybrid rice.

Hussen (2001) conducted an investigation on adoption of modern sugarcane cultivation practices by the farmers of Dewangonjupzila in Jamalpur district. He observed that there was a significant positive relationship between farm size of the farmers and their adoption of modern sugarcane cultivation practices.

Gogoi & Gogoi (1989), Hossain (2001), Islam (2002) and Khan (2003) found a strong negative relationship between farm size and adoption of IPM practices of the fanners.

Muttalab et al. (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

Chowdhury (1997) conducted a research on adoption of selected BINA technologies by the farmers. He indicated that farm size of the farmers had a strongly positive significant relationship with their adoption of selected BINA technologies. Rahman (1986), Khan (1993), Hoque (1993) and Sarkar (1997) observed similar results in their respective studies.

Alam (1997) studied the use of improved farm practices in rice cultivation by the farmers. The findings of the study showed that the farm size had a significant relationship with their use of improved farm practices in rice cultivation.

Islam (1996) found that the farm size of the respondents had a significant negative relationship with their extent of use of indigenous technical knowledge (ITK).

Okoro and Obibuaka (1992) studied adoption of recommended management practices among small holders in IMO state, Nigeria. The findings of the study indicated a positive relationship between the farm size and adoption of recommended management practices.

2.2.5 Annual family income and adoption of IPM practices

Hossain (2009) conducted a study on use of integrated pest management practices by the farmers of Brahmanbaria district. He found that annual income of the farmers had no significant relationship with their use of IPM practices.

Hossain (2006) showed a study on use of integrated pest management practices in Rice field by the farmers in Tapodhan union under Rangpur District. He

found that annual income of the farmers had positive significant relationship with their use of IPM practices.

Kauser (2006) conducted a study on use of integrated pest management practices in Rice field by the farmers in crop cultivation. He found that annual income of the farmers had positive significant relationship with their use of IPM practices.

Mia (2005) showed a study on adoption of integrated pest management practices in Rice field by the vegetable growers' of Magura district. He found that annual income of the vegetable growers' had positive significant relationship with their adoption of IPM practices.

Hossain (2003) observed that annual income of the farmers had significant positive relationship with their adoption of modern Boro rice cultivation practices.

Haque(2003) and 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.

Sarder (2002) found that the farmers' belief had significant relationships with their adoption of IPM practices.

Sardar (2002) conducted a study on adoption of IPM practices by the farmers under PETRRA project of RDRS. He found that the annual income of the farmers had no relationship with their adoption of IPM practices.

Islam (2002) conducted a study on adoption of modern agricultural technologies by the farmers of Sandwip. He observed that the annual income of

the farmers had no relationship with their adoption of modern agricultural technologies.

Rahman (2001) conducted an investigation on knowledge, attitude and adoption of Aalok-6201 hybrid rice by the farmers of sadar upazila in Mymensingh district. He observed that there was a significant positive relationship between annual income of the farmers and their adoption of Aalok-6201 hybrid rice.

Hussen (2001) conducted an investigation on adoption of modern sugarcane cultivation practices by the farmers of Dewangonj upazila in Jamalpur district. He observed that there was a significant positive relationship between annual income of the farmers and their adoption of modern sugarcane cultivation practices.

Chowdhury (1997) found a significant and positive relationship between annual income and adoption of selected BINA technologies. Rahman (1986), Okoro *et al.* (1992), Islam (1993) and Sarker (1997) observed similar result in their respective studies.

Khan (1993) found significant relationship between annual incomes of the farmers and their adoption of insecticides. Similar findings obtained by Alam (1997), Pal(1995), Hossain and Crouch (1992).

Hoque (1993) observed a negative trend in his study but no relationship between the annual income of the cane growers and their use of recommended dose of fertilizer in sugarcane cultivation.

2.2.6. Training exposure and adoption of IPM practices

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

Haque (2003) found that training exposure of the respondent had positive significant relationship with their practices in farmer’s adoption of modern maize cultivation technologies.

Islam (2002) conducted a study on farmers' knowledge and adoption of ecological agricultural practices under the supervision of proshika. He found that agricultural training exposure of the farmers had no significant relationship with their adoption of ecological agricultural practices.

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).

2.2.7. Innovativeness and adoption of IPM practices

Hossain (2009) revealed a study on use of integrated pest management practices by the farmers of Brahmanbaria district. He found that innovativeness of the farmers had no significant relationship with their use of IPM practices.

Hossain (2006) observed a study on use of integrated pest management practices in Rice field by the farmers in Tapodhan union under Rangpur District. He found that innovativeness of the farmers had positive significant relationship with their use of IPM practices.

Kauser (2006) conducted a study on use of integrated pest management practices in Rice field by the farmers in crop cultivation. He found that innovativeness of the farmers had positive significant relationship with their use of IPM practices.

Mia (2005) reported a study on adoption of integrated pest management practices by the vegetable growers' of Magura district. He found that innovativeness of the vegetable growers' had positive significant relationship with their adoption of IPM practices.

Islam (2002) in his study revealed that innovativeness of the farmers had significant positive relationship with their adoption of modern agricultural technology.

Hossain (1999) found a positive significant relationship between innovativeness of the farmer's and their adoption of fertilizer and also observed no relationship with adoption of pesticides.

Rahman (1973) found a positive relationship between modernism and adoption of farm practices. He defined modernism as leading for new experience or opener to innovation. So, modernism as used by him is synonymous with the innovativeness of the present study.

2.2.8. Cosmopoliteness and adoption of IPM practices

Rahman (2001) in his study found that cosmopoliteness of the farmers had a significant and positive relationship with their adoption of Aalok - 6201 hybrid.

Hussen (2001) conducted an investigation on adoption of modem sugarcane cultivation practices by the farmers of Dewangonj upazila in Jamalpur district. He observed that there was a significant positive relationship between cosmopoliteness of the farmers and their adoption of modem sugarcane cultivation practices.

Pal (1995) conducted a research study on the adoption of recommended sugarcane cultivation practices by the farmers, he observed that the cosmopoliteness of the farmers had significant positive relationship with their adoption of recommended sugarcane cultivation practices. Similar results were found by Khan (1993), Hoque (1993) and Islam (1996).

Akanda (1994) found that non-locality behavior or cosmopoliteness of rural women was negatively correlated with their participation in homestead vegetables cultivation, cultivation of fruit trees and non-farm household activities.

Islam (1993) found a significant relationship between cosmopoliteness of the farmers and their adoption of recommended doses of fertilizer and plant protection measures in potato cultivation.

Khan (1993) observed in his study on adoption of insecticides and related issues by the farmers, a positive relationship between cosmopoliteness of the farmers and their adoption of insecticides.

Hoque (1993) observed in his study, a strong positive relationship between cosmopoliteness of the cane growers and their adoption of improved practices insugarcane cultivation.

2.2.9. Knowledge of IPM and practices of IPM

Hossain (2009) showed that knowledge on IPM of the farmers had positive significant relationship with their use of IPM practices.

Hossain (2006) conducted a study on use of integrated pest management practices in Rice field by the farmers in Tapodhan union under Rangpur District. He found that knowledge on IPM of the farmers had positive significant relationship with their use of IPM practices.

Kauser (2006) found in a study on use of integrated pest management practices in Rice field by the farmers in crop cultivation. He found that knowledge on IPM of the farmers had positive significant relationship with their use of IPM practices.

Mia (2005) conducted a study on adoption of integrated pest management practices by the vegetable growers' of Magura district. He found that knowledge on IPM of the vegetable growers' had positive significant relationship with their adoption of IPM practices.

Sardar (2002) in his study revealed that agricultural knowledge of the farmers had positively significant with their adoption at Integrated Pest Management practices.

Alam (1997) observed that agricultural Knowledge on rice growers has significant relationship with their use of farm practices in rice cultivation.

Rahman (1995) in his study observed no significant relationship between adoption of improved practices and farmer's knowledge on improved practices of potato cultivation.

Hoque (1993) in his study found that extent of adoption of BR-14 during Boro season had positive relationship with the agricultural knowledge level of the farmers. The findings indicate that the farmers with higher level of agricultural knowledge could provide crop production practices better than those of the farmer's with lower level of agricultural knowledge.

Kashem and Islam (1990) studied adoption of agricultural practices by the contact and non-contact farmers under T and V system. The study indicated a positive relationship between agricultural knowledge and adoption of agricultural practices.

2.2.10. 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.

2.2.11. Attitude toward IPM practice and adoption of IPM practices

Gani (1997) reported that use of' pesticides kills beneficial creatures and insect's that make the land fertile. Besides, 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.

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 are very much drought for two major reasons. One is the rapid evolution or new breed pests, resistant to the pesticides applied, and another in the increasing pesticide hazards.

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

Zul-Ekram (2014) in his study revealed that contact with IPM club and/or FFS had highly significant positive relationship with the adoption of IPM practices by the rice growers. The Farmers who have contacted with IPM club will aware of the benefit of IPM practices. They know the elaborate use of IPM technology. So, the farmers who have contact with IPM club will adopt more IPM practices.

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.

Conceptual Framework of the Study

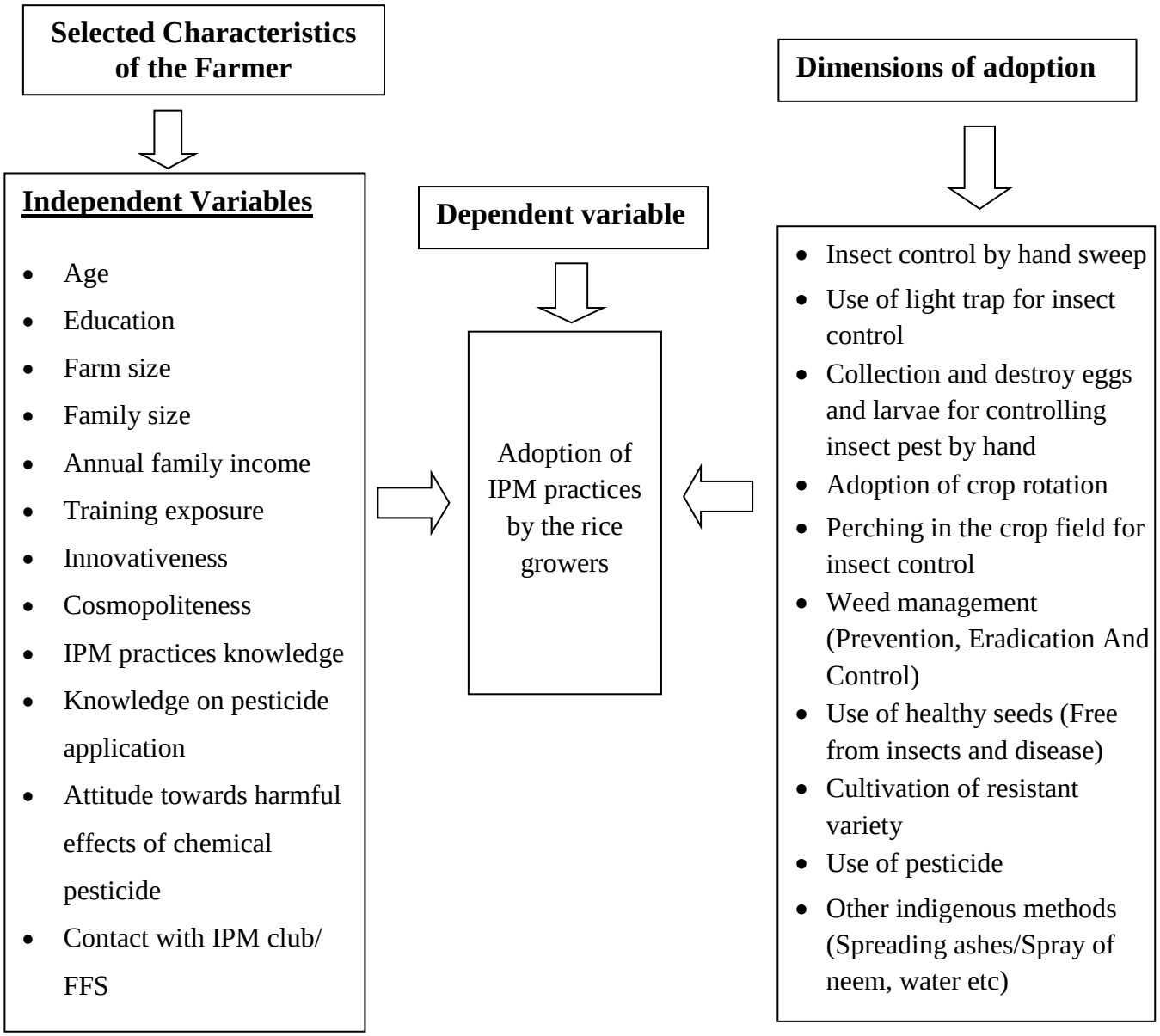

Figure 2.1 Conceptual framework of the study

Chapter 3

METHODOLOGY

Methods and procedures maintained for collection and analysis of data are essential for any kind of scientific research. It is one of the most important parts before conducting a research work. The researcher has great responsibility to describe clearly as to what sorts of research design, methods and procedures he would follow in collecting valid and reliable data and to analyze and interpret those to arrive at correct summery and conclusion.

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

Shahjadpur upazila under Sirajgong district was selected purposively for the study as this is a typical upazila of Bangladesh. Out of 9 unions Kayempur was selected for the study. Then two villages namely Chakhoripur and Chinadhukuria were selected as the locale of the study. A map of Bangladesh showing Sirajgong district and a map of Sirajgang district showing Shahjadpurupazilla and that considered as study have been shown in figure 3.1 and 3.2 respectively.

Figure 3.1 Map of Bangladesh showing Sirajgang district

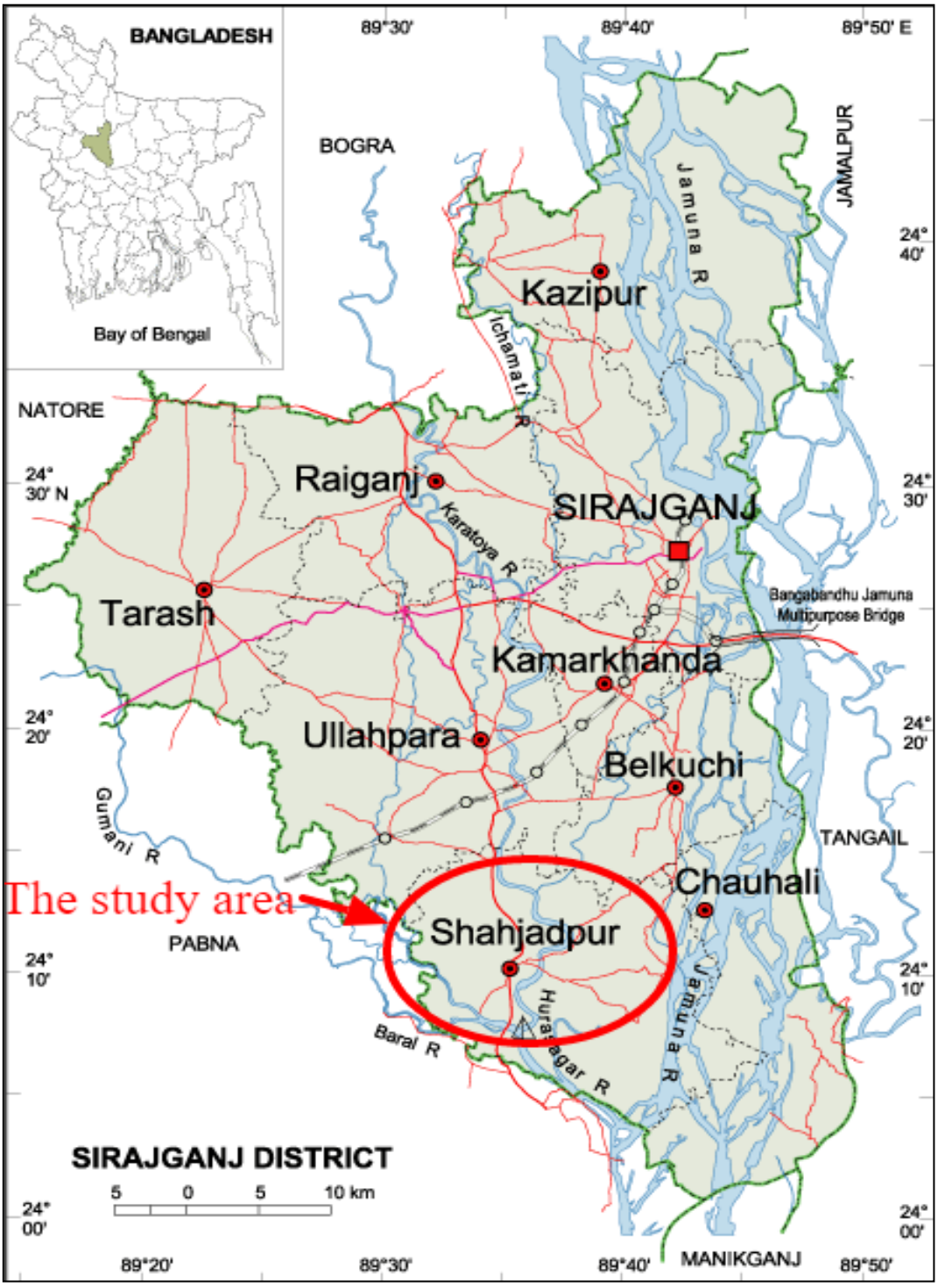

Figure 3.2 Map of Sirajgang district showing the Shajadpur upazila

3.2. Population and Sample of the Study

The researcher himself with the cooperation of local leaders and concerned Sub- Assistant Agriculture Officer (SAAO) collected an updated list of all the rice cultivators of the selected villages of respective union. The total number of farm families (rice growers) in these villages was 1208; where 665 farm family heads from Chakhoripur village and 543 from Chinadhukuria village under the union of Kayempur which constituted the population of the study.

3.2.1. Study Group (SG) Sampling

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

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

Where,

n = Sample size;

N, Population size = 1208;

e, The level of precision = 9% ;

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

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

So, the sample size (n) is = 108.

3.2.2. Distribution of the Population and Sample Size

According to Yamane's formula, 108 rice growers constituted the sample of the study.

A reserve list of 10 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 rice growers according to population and sample size

Name of villages	Population of rice growers	Number of rice growers included in the sample	Number of rice growers included in the reserve list
Chakhoripur	665	108	6
Chinadhukuria	543		4
Total	1208		10

3.3 Instruments for Data Collection

Data were collected using a previously selected interview schedule. Both open and closed forms of questions were included in the schedule. Before finalization, the interview schedule was pre-tested with 24 farmers of the study area which were excluded from the sample. On the basis of the pre-test experiences necessary corrections, modifications and alterations were made before finalizing the interview schedule for final data collection. During modification of the schedule, valuable suggestions were received from the research supervisor and relevant experts. The interview schedule was prepared in Bengali version then printed in its final form and multiplied. A copy of interview schedule in English version is placed in Appendix.

3.4 Variables of the Study

In the present study, the respondents' selected characteristics *viz* age, education, farm size, family size, annual family income, training exposure, innovativeness, cosmopoliteness, IPM practices knowledge, knowledge on pesticide application, attitude towards harmful effects of chemical pesticide and contact with IPM club and/or FFS were independent variables and their adoption of IPM practices in rice cultivation constituted dependent variable.

3.5 Measurement of Variables

The different level of knowledge and various characteristics of the rice growers might have affect on their use of integrated pest management (IPM) practices. These characteristics were age, education, family size, farm Size, annual income, training exposure, innovativeness, cosmopoliteness, knowledge on IPM Practices, knowledge on pesticide application, attitude towards harmful effects of chemical pesticide, contact with IPM club/FFS and adoption of IPM practices. Use of IPM practices was the main key point of the study.

3.5.1 Selected characteristics of the farmers

Measurement of all the factors of the farmers and their adoption of IPM practices are discussed in the following sub sections:

3.5.1.1 Age

Actual age of a farmer was measured by counting the actual years from his/her birth to the time of collecting data with an interview schedule. It was expressed in terms of complete years. According to age range the farmers are categorized in different steps. The age range up to 35, 36 to 50 and above 50 years mentioned here according to the category of young, middle and old aged farmers (Appendix I).

3.5.1.2 Education

Education of a farmer was measured by the number of years of schooling completed in an educational institution. A score of one (1) was given for each year of schooling completed. If a farmer didn't t know how to read and write, his education score was zero, while a score of 0.5 was given to a farmer who could sign his name only. If a farmer completes primary level of education his/her score was considered as 5 as well as 10 for secondary level of education and above 10 means higher education (Appendix I).

3.5.1.3 Family size

Family size of a respondent was determined by the total number of members in his/her family including him/her, children and other dependents. The scoring was made by the actual number of family members expressed by the respondents. For example, if a respondent had five members in his/her family, his/her score was given as 5.

3.5.1.4 Farm size

Farm size of a respondent is referred to the total area of cultivable land on which his/her family carried out farming operations including homestead area, own land under own cultivation ,land taken from others on borga and land taken from others on lease. The farm size was measured in hectares for each farmer using the following formula:

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

Where, FS= Farm size

A_1 = Homestead area

A_2= Own land under own cultivation

A_3= Land given to others on borga

A_4= Land taken from others on borga

A_5= Land taken from others on lease

3.5.1.5 Annual family income

The income of a farmer is an important indicator that shows 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.

3.5.1.6 Training exposure on IPM practices

Training exposure of a respondent was identified on the basis of number of days of agriculture based training prgramme 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.

3.5.1.7 Innovativeness

According to Rogers (1995) it is the degree of adoption a new technology to which an individual or other unit of adoption is relatively earlier than the other member of the social system. Innovativeness of a respondent was measured on the basis of his/her extent of use of 10 selected modern agricultural practices.

Period of Adoption	Scores assigned
Do not use	0
Within 1 years	1
2 to 3 years	2
Above 3 years	3

The innovativeness score for a particular modern practice was calculated using the period of adoption as given below. Then all scores of the 10 selected practices were added together to get the innovativeness score of a respondent. Therefore, the possible innovativeness score of the respondents could range from 0 to 30, 0 indicating no innovativeness and 30 indicating very high innovativeness. Innovativeness is shown in item no.7 in the interview schedule.

3.5.1.8 Cosmopoliteness

Cosmopoliteness of a respondent was measured on the basis of frequency of visits to seven different places outside of his/her own social system. With four alternative responses, cosmopoliteness score was computed according to the following table:

Nature of participation	Assigned score
Regularly	0
Occasionally	1
Rarely	2
Not at all	3

3.5.1.9. Knowledge on IPM Practices

After thorough consultation with relevant experts and reviewing of related literature, 10 question regarding IPM practices were selected and those were asked to the respondent to determine their knowledge on IPM practices. Scores two (2), three (3) and four (4) scoring were assigned according to question type

for each correct answer and zero (0) for wrong or no answer. Partial score was also assigned for partially correct answer. Thus, possible scores for the knowledge on IPM practices of the respondents could range from 0 to 27, where 0 indicating very poor knowledge and 27 indicate the very high knowledge on IPM practices.

3.5.1.10. Knowledge on pesticide application

Knowledge is defined in this study included those behaviors 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 different possible answers. A score of '2' was given for each correct reply and '0' for incorrect or no reply for each item. The summation of scores of correct replies for all the 10 items of a particular respondent indicated his knowledge on pesticide application. Thus, the possible score for the knowledge on pesticide application of the respondents could range from 0 to 20, where 0 indicating very poor knowledge and 20 indicate very high knowledge on pesticide application.

3.5.1.11. Attitude towards harmful effects of chemical pesticide

Attitude of a respondent towards harmful effcts of chemical pesticide was measured by developing an attitude scale. Five-point Likert method of summated ratings was used to find out the farmers attitude towards harmful effcts of chemical insecticides. Nine statements including positive and negative attitude towards IPM practices were presented in the questionnaire item no. 11. If a statement was considered positive, it indicated a favorable attitude towards harmful effects of IPM practices for a respondent. If the case was reverse, it was considered as a negative statement. Out of these nine statements, five were positive and four were negative. Scoring was done by assigning 5, 4, 3, 2 and 1 scores to the five alternative responses as 'strongly agreed', 'agreed', 'no

opinion', 'disagreed', and 'strongly disagreed', respectively in case of a positive statement. Reverse score was assigned for a negative statement. However, attitude towards harmful effects of chemical pesticides of a farmer was obtained by summing up his/her scores for all the nine statements in item number 11 in the interview schedule. Attitude score, thus, obtained for a respondent could range from 9 to 45, where 9 indicates very low favorable attitude and 45 indicates very high favorable attitude towards harmful effect of chemical pesticides.

3.5.1.12. Contact with IPM club and/or FFS

The contact with IPM club and/orFFS was calculated for each farmer to identify the degree of his contact on the basis of his communication to the IPM club/FFS on different purposes. The following scale was used for computing the contact with IPM club and/or FFS scores:

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 and/or FFS.

3.5.1.13. Measurement of Dependent Variable

The extent of use of IPM practices used by the farmers was measured on the basis of 10 selected IPM practices. The respondents were asked to express their degree of use in the form of 'frequently', 'occasionally', 'rarely' and 'never',

while scores assigned to the above four responses were 3, 2, 1 and 0 respectively. Total range was 0- 30.

An IPM Practices Use Index (IPUI) was calculated to compare among use of different IPM practices.

$$IPUI = N \times F + N \times O + N \times R + N \times Ne$$

Where,

IPUI = IPM Practices Use Index

N= Number of farmers used IPM Practices

F= Frequently (3)

O = Occasionally (2)

R = Rarely (1)

Ne = Never (0)

3.6 Statement of Hypothesis

As defined by Goode and Hatt (1952) 'A hypothesis is a proposition, which can be put to a test to determine its validity.' It may prove valid or invalid of a proposition. In any event, however, it leads to a practical test. In studying contribution among variables, research hypotheses are formulated which state anticipated contribution among variables. However, for statistical test it becomes necessary to formulate null hypothesis.

A null hypothesis states that there is no contribution among the variables. If a null hypothesis is rejected on the basis of a statistical test, it is assumed that there is a contribution among the concerned variables.

The following null hypotheses were formulated for this study:

"*There is no contribution of the selected characteristics of the farmers on their use of IPM practices."*

3.7. Collection of Data

Data were collected personally by the researcher himself through face to face interview. To familiarize with the study area and for getting local support, the researcher took help from the local leaders and the field staffs of Upazila Agriculture Office. The researcher made all possible efforts to explain the purpose of the study to the farmers. Rapport was established with the farmers prior to interview and the objectives were clearly explained by using local language as far as possible. Data were collected during the period from 10 April to 30 July, 2015.

3.8. Data Processing

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

3.9. Statistical Analysis

The data were analyzed in accordance with the objectives of the proposed research work. Qualitative data were converted into quantitative data by means of suitable scoring technique wherever necessary. The statistical measures such as range, means, standard deviation, number and percentage distribution were used to describe the variables. The analysis of data was performed using statistical treatment with SPSS (Statistical Package for Social Sciences) computer program, version 20. In order to estimate the contribution of the selected characteristics of farmers on the adoption of IPM practices, multiple regression analysis (B) analysis was used. Throughout the study, five (.05)

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

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

$$Y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + b_9x_{9+} b_{10}x_{10+} b_{11}x_{11+}b_{12}x_{12+}e;$$

Where, Y= is the adoption of IPM practices,

Of the independent variables, x_1 is the respondent's age, x_2 is education, x_3 is farm size, x_4 is family size, x_5 is the annual family income, x_6 is training exposure, x_7 is Innovativeness, x_8 is Cosmopoliteness, x_9 is Knowledge on IPM Practices, x_{10} is knowledge on pesticide application, x_{11} is attitude towards harmful effects of chemical pesticide, x_{12} is contact with IPM club/FFS. b_1, b_2, b_3, b_4, b_5, b_6, b_7, b_8, b_9, b_{10}, b_{11} and b_{12} are regression coefficients of the corresponding independent variables, and e is random error, which is normally and independently distributed with zero mean and constant variance.

CHAPTER 4

RESULTS AND DISCUSSION

Results and discussion is a mirror of a research work. A consequential and detailed discussion on the findings of the scientific research study has been presented in this Chapter. This Chapter includes 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 rice growers and finally, the contribution of the independent variables have been discussed in the third section.

4.1 Selected Characteristics of the Rice Growers

Twelve characteristics of rice growing farmers were selected to describe and to find out their contribution on their adoption of commonly used IPM practices in rice cultivation. These selected characteristics were age, education, family size, farm size, annual family income, training exposure, innovativeness, cosmopoliteness, knowledge on IPM practices, knowledge on pesticide application, attitude towards harmful effects of chemical pesticide and contact with IPM club/FFS. The noticeable topographies of the twelve characteristics of the rice growing farmers, each of which constituted an independent variable.

4.1.1 Age

The age of the sample farmers ranged from 23 to 62 years with an average of 40.15 and standard deviation of 9.85. The respondents were classified into three categories on the basis of their age (Table 4.1) following Rashid (2014).

Table 4.1 Distribution of the rice growers according to their age

Category	Age range	Observed range	Respondents		Mean	SD
			Number	Percent (%)		
Young aged	Up to 35	23 - 62	37	34.3	40.15	9.85
Middle aged	36 - 50		56	51.9		
Old aged	> 50		15	13.8		
Total			108	100.00		

Data showing that the highest proportion 51.9% of the rice growers were middle aged compared to 13.8 percent old and 34.3 percent being young aged. According to Lion Berger (1960) elderly farmers seem to be somewhat less motivated to adopt new farm practices than younger ones. Young and middle aged people generally show more favorable 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 0-12, with an average of 4.78 and standard deviation of 4.012. The respondents were classified into five categories on the basis of their education (Table 4.2) following Rashid (2014).

Table 4.2. Distribution of the rice growers according to their education

Category	Score	Respondents		Mean	SD
		Number	Percent (%)		
Can't read or write	0	10	09.3	4.78	4.012
Can sign only	0.5	21	19.4		
Primary education	1 – 5	29	26.9		
Secondary education	6 – 10	36	33.3		
Higher secondary or above	> 10	12	11.1		
Total		108	100.00		

It is determined from the Table 4.2 that 33.3 percent comprised secondary education, 26.9 percent comprised of primary education, 19.4 percent of the respondents could sign only, 09.3% respondents couldn't read or write and 14 percent had above secondary education. Table 4.2 also shows that above 60 percent of the respondents got primary to secondary level of education. Jalal (2009) also found 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 Farm size

Farm size varied from 30 to 850 decimal with an average of 233.60 decimal and standard deviation of 189.66. The respondents were classified into five categories on the basis of their farm size (Table 4.3) following Hossain *et al.* (2011).

Table 4.3. Distribution of the rice growers according to their farm size

Category	Score range (decimal)	Observed range (decimal)	Respondents		Mean	SD
			Number	Percent (%)		
Landless	0 - <50	30 - 850	15	13.9	233.60	189.67
Marginal	50 - <150		30	27.8		
Small	150 - <250		28	25.9		
Medium	250 - 749		28	25.9		
Large	> 750		7	6.5		
Total			108	100.00		

Data in the Table 4.3 reveal that more than one-fourth (25.9 %) of the respondent had small farm, 25.9 percent had medium farm, 27.8 percent had marginal farm and 6.5 percent had large farm. Table 4.3 also shows that overwhelming majority (79.6 %) of the respondents had marginal to medium size of farm. 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, 2014). The farmer with marginal 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 and they play the role of early adopters.

4.1.4 Family size

Family size of the respondents varied from 2 to 10 with a mean of 5.77 and standard deviation of 1.842. On the basis of family size, the respondents were classified into three categories as shown in Table 4.4.

Table 4.4 Distribution of the rice growers according to their family size

Category	Score range	Respondents		Mean	SD
		Number	Percent (%)		
Small	2 - 4	31	28.7	5.77	1.842
Medium	5 - 7	69	63.9		
Large	8 - 10	8	07.4		
Total	2 - 10	108	100.00		

Data shown in the Table 4.4 reveal that 63.9 percent of the respondents had medium family size followed by 28.7 percent had small family size while 07.4 percent had large family size. The findings indicate that average family size of the study area was greater than the national average which is 4.85 (BBS, 2014). The fact is that joint family mostly characterized the medium to large families.

4.1.5 Annual family income

The cultivation seasons including Aus, Amon and Boro, farmers cultivated different types of HYV rice variety and their annual income ranges were between 52 to 230 thousands taka with the mean and standard deviation of 119.70 and 42.653 respectively. According to their earning from rice cultivation and other sources, they were classified into three categories. The categories and distribution of the respondents were shown in Table 4.5.

Table 4.5 Distribution of the rice growers according to their annual family income

Category	Scoring (000 tk)	Observe range	Number of respondents		Mean	SD
			Number	Percent (%)		
Low	< 75	52 - 230	24	22.2	119.70	42..65
Medium	75 - 150		57	52.8		
High	> 150		27	25.0		
Total			108	100.00		

Data in the Table 4.5 show that 52.8 percent of the farmers had medium annual income, 22.2 percent of the respondents had low annual income and 25.0

percent had high annual income. Islam (2002) also found almost similar findings in his study.

The observations showed that the average income of the farmers was 119.70 that were a medium category income because the percent of medium income category farmers were higher than other two categories and more than half of the farmers belonged to medium income category farmers. The other reason might be due to the fact that most of the farmers of the study area were not only engaged in agriculture, but also they were engaged 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

In this study, the researcher finds out some field level data and knowledge about training exposure of the farmers. Their observed range about training exposure was from 0 to 18 with a mean and standard deviation of 7.31 and 5.92 respectively. According to their length of training, the respondents were classified into three categories. The distribution of the respondents according to their training exposure has been presented in Table 4.6.

Table 4.6 Distribution of the rice growers according to their training exposure

Category	Scoring (days)	Observed range	Respondents		Mean	SD
			Number	Percent (%)		
No training	0		19	17.6		
Low	1 - 5		31	28.7		
Medium	6 - 15	0 - 18	38	35.2	7.31	5.92
High	> 15		20	18.5		
Total			108	100.00		

The table showed that the percentage of no training, low training, medium training and high training were 17.6% , 28.7%, 35.2% and 18.5% respectively.

The surveyor found that, there almost 17.6% of total farmers had no any kind of training exposure, while 28.7% and 35.2% farmers had low and medium training exposure. Farmers of high training exposure were 18.5% compared to others categories. Training makes the farmers skilled and helps them to acquire deep knowledge about the respected aspects. Trained farmers can face any kind of challenges about the adverse situation in their cultivation. So, they show favorable attitude toward adoption of IPM practices. Ghimire and Kafle (2014) revealed that the adoption level of IPM practice would increase by 45.8 % if farmers are provided trainings in group.

4.1.7 Innovativeness

The observed innovativeness scores of the respondents ranged from 4 to 26 against the possible range of 0 to 30. The average and standard deviation were 14.94 and 6.07 respectively. Based on the innovativeness scores the respondents were classified into three categories as shown in Table 4.7.

Table 4.7 Distribution of the rice growers according to their innovativeness

Category	Scoring	Observed range	Respondents		Mean	SD
			Number	Percent (%)		
Low	1 - 10	4 - 26	37	34.3	14.94	6.07
Medium	11 - 20		44	40.7		
High	21 - 30		27	25.0		
Total	0 - 30		108	100.00		

Data presented in Table 4.7 indicate that 34.3 percent of the respondents had low innovativeness as compared to 40.7 percent medium and only 25.0 percent high innovativeness. Data also revealed that majority (75.00%) of the respondents were under low to medium innovativeness. The innovativeness also refers to proneness of an individual to accept new ideas and practices.

4.1.8 Cosmopoliteness

The observed cosmopoliteness scores of the respondents ranged from 4 to 18 against the possible range of 0 to 21. The mean score was 11.69 with the standard deviation of 4.39. Based on the observed cosmopoliteness scores, the respondents were classified into three categories as shown in Table 4.8,

Table 4.8 Distribution of the rice growers according to their cosmopoliteness

Category	Scoring	Observed range	Respondents		Mean	SD
			Number	Percent (%)		
No	0		0	0.00		
Low	1 – 7		31	28.7		
Medium	7 – 14	4 - 18	44	40.7	11.69	4.395
High	15 - 21		33	30.6		
Total	1 – 21		108	100		

Data contained in the Table 4.8 show that 40.7 percent of the total respondents had medium cosmopoliteness as compared to 28.7 percent having low and only 30.6 percent had high cosmopoliteness. Data also revealed that majority (71.3%) of the respondents were under medium to high cosmopoliteness where 69.4 percent of the respondents were under medium to low cosmopoliteness. Ghimire and Kafle (2014) resulted that the adoption level of IPM practice would increase by 3.3% if farmers are provided membership in farmers group.

4.1.9 Knowledge on IPM practices

Knowledge on IPM practices scores of the respondents ranged from 4 to 22 against the possible range of 0 – 27 having an average of 12.86 and standard deviation of 3.67. On the basis of knowledge scores, the respondents were classified into three categories namely, ‘low knowledge’, ‘medium knowledge’ and ‘high knowledge’. The distribution of the respondents according to their knowledge on IPM practices is given in Table 4.9.

Table 4.9 Distribution of the rice growers according to their IPM practices knowledge

Category	Scoring	Observed range	Respondents		Mean	SD
			Number	Percent (%)		
Poor	0 - 9	6 – 23	30	27.8	14.14	4.813
Medium	10 - 18		56	51.9		
High	19 - 27		22	20.4		
Total	0 - 27		108	100.00		

Data in the Table 4.9 show that more than half (51.9%) of the respondents fell in medium knowledge category followed by 27.8 percent in poor knowledge category and only 20.4 percent in high knowledge category. Knowledge is to be well thought-out as vision of an explanation in any aspect of the situation concerning practices. It is act or state of understanding; clear awareness of fact or truth, that helps an individual to foresee the consequence he may have to face in future. It makes individuals to become rational and conscious about related field. To perform optimum production, farmers should have adequate knowledge on different aspects of IPM practices.

4.1.10 Knowledge on pesticide application

Knowledge on pesticide application scores of the farmers ranged from 2 to 18 against the possible range from 0 to 20 with an average of 10.44 and standard deviation of 4.0. On the basis of knowledge on pesticide application scores, the respondents were classified into three categories that were shown in Table 4.10.

Table 4.10. Distribution of the rice growers according to their knowledge on pesticide application

Category	Scoring	Observed range	Respondents		Mean	SD
			Number	Percent (%)		
Poor	0 - 7	2 - 18	36	33.3	10.44	4.0
Medium	8 - 14		50	46.3		
High	15 - 20		22	20.4		
Total	0 - 20		108	100.00		

Data in the Table 4.10 show that the highest proportion (46.3%) of the respondents had the medium knowledge, 33.3 percent had poor knowledge and only 20.4 percent respondents had high 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 execute crop production and crop protection successfully, the respondents should have adequate knowledge on the application of pesticide. However, it is observed that majority (79.60%) of farmers in the study area had poor to medium knowledge on pesticide application.

Therefore, one may apprehend that due to poor 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.

4.1.11 Attitude towards harmful effects of chemical pesticide

Attitude towards harmful effects of chemical pesticide observed scores ranged from 0 to 38 against the possible range from 0 to 45 with an average of 20.65 and standard deviation of 8.39. On the basis of attitude towards harmful effects of chemical pesticide scores, the respondents were classified into three categories as shown in Table 4.11.

Table 4.11 Distribution of the rice growers according to their attitude towards harmful effects of chemical pesticide

Categories	Scoring	Observed score	Respondents		Mean	SD
			Number	Percent (%)		
Low attitude	0 - 15	6 - 38	37	34.3	20.65	8.398
Medium attitude	16 - 30		52	48.1		
High attitude	31 - 45		19	17.6		
Total	0 - 45		108	100		

Data in the Table 4.11 show that the highest proportion (48.1%) of the respondents had medium favorable attitude towards harmful effects of chemical pesticide, where 34.3 percent respondents had low favorable attitude and also 17.6 percent had high favorable attitude towards harmful effects of chemical pesticide.

High attitude towards harmful effects of chemical pesticide refrain farmers from injudicious application of pesticide which ultimately increase adoption of IPM practices in farming.

4.1.12 Contact with IPM club and/or FFS

Contact with IPM club and/or FFS observed scores ranged from 7 to 27 against the possible range from 0 to 27 with an average of 16.00 and standard deviation of 6.63. On the basis of contact with IPM club scores, the respondents were classified into three categories that were shown in Table 4.12.

Table 4.12. Distribution of the rice growers according to their contact with IPM club and/or FFS

Category	Scoring	Observed score	Number of respondents		Mean	SD
			Number	Percent (%)		
Low	0- 10	7-27	32	29.6	16.00	6.635
Medium	11 - 20		40	37.0		
High	21 - 27		36	33.4		
Total	0 - 27		108	100.00		

Data in the Table 4.12 show that the highest proportion (37.0%) of the respondents had medium contact, 29.6 percent respondents had low contact and only 33.4 percent had high contact with IPM club and/or FFS. The findings of the study indicate that all the respondents were any way connected with IPM club and/or FFS because of maximum respondents were under minimum education. Also the reason may be comparatively higher number of IPM club or FFS in the study area or high 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.

4.2 Adoption of IPM Practices in rice cultivation

Adoption of IPM practices scores of the rice growers ranged from 5 to 27 against the possible range from 0 to 30 with an average of 16.17 and standard deviation of 6.45. On the basis adoption of IPM practices in rice cultivation, the respondents were classified into three categories that were shown in Table 4.13.

Table 4.13 Distribution of the rice growers according to their adoption of IPM Practice

Category	Scoring	Observed score	Respondents		Mean	SD
			Number	Percent (%)		
Low adoption	0 - 10	5 - 27	26	24.1	16.17	6.458
Medium adoption	11 - 20		48	44.4		
High adoption	21 - 30		34	31.5		
Total	0 - 30		108	100.00		

Data in the Table 4.13 show that near about half of the respondents (44.4%) had medium adoption where 24.1 percent had low adoption and 31.5 percent had high adoption of IPM practices in rice cultivation. Sardar (2002) also found almost similar findings in his study. The findings of the present study revealed

that adoption of IPM practices by the rice growers was little bit satisfactory. Maximum rice growers had medium to high adoption of commonly used IPM practices. The reasons may be most of the rice growers had low to medium training, most of the farmers had primary to secondary education level.

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

To compare the adoption of different used IPM practices in rice cultivation, IPM Practices Use Index (IPUI) was calculated. An IPM Practices Use Index (IPUI) for each of the practices could range from 0 to 324. The ten commonly used IPM practices have arranged in rank order in Table 4.14 on the basis of their IPUI. The observed IPUI ranged from 103 to 303.

Table 4.14 Rank order of the adoption of IPM practices by the rice growers

Sl. No.	Name of IPM practices	IPUI	Rank
1.	Use of pesticide	303	1
2.	Perching in the crop field for insect control	286	2
3.	Weed management (Prevention, Eradication and Control)	278	3
4.	Use of healthy seeds (Free from insects and disease)	275	4
5.	Adoption of crop rotation	245	5
6.	Cultivation of resistant variety	238	6
7.	Collection and destroy eggs and larvae For controlling insect pest by hand	221	7
8.	Other indigenous methods (Spreading ashes/Spray of neem water etc.)	134	8
9.	Use of light trap for insect control	129	9
10.	Insect Control by hand sweep	103	10

4.3.1 IPM Practices Use Index (IPUI)

On the basis of computed IPUI, it was observed that the Use of pesticide were adopted by the farmers to the highest extent (303) and it was closely followed by the use of perching in the crop field for insect control (286), use of weed management (Prevention, Eradication and Control) (278) and Use of healthy seeds (Free from insects and disease). On the other hand, practices like use of Insect Control by hand sweep (103), Use of light trap for insect control (129) and use of other indigenous methods (Spreading ashes/Spray of neem water etc.) (134) were adopted by the farmers to the lowest extent.

The findings indicate that insect pest control by pesticide is one of the basic treatments for successful agricultural production. There is no alternative of controlling insect pest to increase production. Almost all of the farmers in the study area collect related pesticide from local market or dealer. That is why farmers adopt these practices to the highest extent. Perching is an environment friendly 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. Moreover, use of this practice, synthetic insecticide use can be reduced. 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. 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 or from BADC. That is why farmers adopt these practices to the higher extent.

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. 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.Mechanical and biological methods of pest control are time consuming. So they adopt indigenous methods (Spreading

ashes/Spray of neem, water etc) for alternate use of pesticides as the last method of pest control to the lower extent.

4.4. Variables Contributed to the adoption of IPM practices by the Farmers

In order to estimate the adoption of IPM practices by the farmers from the independent variables, multiple regression analysis was used which is shown in the table 4.15.

Table 4.15 Multiple regression coefficients of contributing factors related to the adoption of IPM practices

Dependent variable	Independent variables	B	*p*	R^2	Adj. R^2	F	*p*
Adoption of IPM practices	Age	.007	.010**	.830	.821	103.782	.000***
	Education	.108	.066				
	Farm Size	-.034	.010**				
	Family Size	-.003	.102				
	Annual family income	.011	.073				
	Training exposure	.048	.045*				
	Innovativeness	.841	.787				
	Cosmopoliteness	.076	.052				
	Knowledge on IPM practices	-.170	.127				
	Knowledge on pesticide application	.030	.019*				
	Attitude towards harmful effects on chemical pesticide	.006	.008**				
	Contact with IPM club and/or FFS	.124	.128				

*** Significant at p<0.01. ** Significant at p<0.05.

The data in Table 4.15 test the final null hypothesis: There is no contribution of the selected characteristics (age, education, family size, farm size, annual

family income, training exposure, innovativeness, cosmopoliteness, knowledge on IPM practices, knowledge on pesticide application, attitude towards harmful effects of chemical pesticide , contact with IPM club/FFS) of farmers to their adoption of farmers' IPM practices.

In order to assess which factors contribute to the adoption of IPM practices by the farmers, multiple regression analysis was used. Table 4.15 shows that there is a significant contribution of respondents' age, farm size, training exposure, cosmopoliteness, knowledge on pesticide application, attitude towards harmful effects of chemical pesticide to change their adoption of IPM practices. Of these, age, farm size and attitude towards harmful effects of chemical pesticide were the most important contributing factors (significant at the 1% level of significance). Training exposure, cosmopoliteness, knowledge on pesticide application were also the important contributing factors (significant at the 5% level of significance).

83.0% (R^2 = 0.830) of the variation in the respondents' changed adoption of IPM practices can be attributed to their age, farm size, training exposure, cosmopoliteness, knowledge on pesticide application and attitude towards harmful effects of chemical pesticide, making this an excellent model (see 4.15). The F value indicates that the model is significant ($p<0.000$). However, each predictor may explain some of the variance in respondents' adoption of IPM practice conditions simply by chance. The adjusted R-square value penalizes the addition of extraneous predictors in the model, but values of 0.821 still show that the variance in respondents' adoption of IPM practice can be attributed to the predictor variables rather than by chance, and that both are suitable models (Table 4.15). In summary, the models suggest that the respective authority should consider the respondents' age, farm size, training exposure, cosmopoliteness, knowledge on pesticide application and attitude towards harmful effects of chemical pesticide in adoption of IPM practices by the farmers.

Chapter 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter presents summary of findings, conclusions and recommendations of the study.

5.1 Summary of Findings

The major findings of the study are summarized below:

5.1.1 Individual characteristics of the farmers

Findings in respect of the 12 selected characteristics of the farmers are summarized below:

Age: The highest proportion (51.9%) of the rice growers were middle aged compared to 13.8 percent old and 34.3 percent being young aged.

Education: Almost all of the farmers had different level of education. Among them 33.3 percent comprised secondary education, 26.9 percent comprised of primary education, 19.4 percent of the respondents could sign only, 09.3 respondents couldn't read or write and 11.1% had above secondary education.

Farm size: More than one-fourth (25.9 %) of the total respondent had small farm where, 13.9 percent had no own cultivable land, 25.9 percent had also medium farm, 27.8 percent had marginal farm and 6.5 percent had large farm.

Family size: The highest proportion(63.9%) of the respondents had medium family size followed by 28.7 percent had small family size while 07.4 percent had large family size.

Annual family income: It was found that 52.8 percent of the farmers had medium annual income, 22.2 percent of the respondents had low annual income and 25.0 percent had high annual income.

Training exposure: The percentage of no training, low training, medium training and high training were 17.6%, 28.7%, 35.2% and 18.5% respectively. The findings indicates that, there almost 17.6% of total farmers had no any kind of training exposure, while 28.7% and 35.2% farmers had low and medium training exposure. Farmers of high training exposure were 18.5% compared to others categories.

Innovativeness: More than one-third (34.3%) of the respondents had low innovativeness as compared to 40.7 percent medium and only 25.0 percent had high innovativeness. Data also revealed that majority (75.00 percent) of the respondents had low to medium innovativeness.

Cosmopoliteness: The highest proportion(40.7%) of the respondents had medium cosmopoliteness as compared to 28.7 percent having low and only 30.6 percent had high cosmopoliteness. No respondents showed any cosmopoliteness. Data also revealed that majority (71.3 percent) of the respondents were under medium to high cosmopoliteness where 69.4 percent of the respondents were under medium to low cosmopoliteness.

Knowledge on IPM practices: More than half (51.9%) of the respondents fell in medium knowledge category followed by 27.8 percent in poor knowledge category and only 20.4 percent in high knowledge category.

Knowledge on Pesticides Application: The highest proportion (46.3%) of the respondents had the medium knowledge, 33.3 percent had poor knowledge and only 20.4 percent respondents had high knowledge on pesticide application.

Attitude towards harmful effects of chemical pesticides: The highest proportion (48.1%) of the respondents had the medium favorable attitude towards harmful effects of chemical pesticide, where 34.3 percent had low favorable attitude and only 17.6 percent had high attitude towards harmful effects of chemical pesticide.

Contact with IPM club and/or FFS: The highest proportion (37.0%) of the respondents had medium contact, 29.6 percent respondents had low contact and only 33.4 percent had high contact with IPM club and FFS.

Adoption of IPM Practices in Rice Cultivation: On the basis of percent of adoption of commonly used IPM practices in rice cultivation, the highest proportion of the respondents (44.4%) had medium adoption where 24.1 percent had low adoption and 31.5 percent had high adoption of commonly used IPM practices in rice cultivation.

5.1.4 Variables contributed to the adoption of IPM practices

There was a significant contribution of respondents' age, farm size, training exposure, cosmopoliteness, knowledge on pesticide application, attitude towards harmful effects of chemical pesticide to change their adoption of IPM practices. Of these, age, farm size and attitude towards harmful effects of chemical pesticide were the most important contributing factors (significant at the 1% level of significance) where farm size showed the negative significant contribution. Training exposure, cosmopoliteness, knowledge on pesticide application were also the important contributing factors (significant at the 5% level of significance).

5.2 Conclusions

Findings of the present study and the logical interpretation of other relevant facts prompted the researcher to draw the following conclusions:

1. More than two third (75.9 %) of the farmers had medium to high adoption of IPM practices. The finding leads to the conclusion that there satisfying trends in increasing the use of IPM practices.

2. Almost two-thirds (65.7%) of the respondents were middle to old aged and regression coefficient revealed that age of the respondent had significant positive contribution to their use of IPM practices. Therefore, it may be concluded that IPM practices were used more by old aged farmers than young aged farmers.

3. Farm size had a significant negative contribution to their use of IPM practices. Therefore, it may be concluded that less the farm size of the farmers more the use of IPM practices.

4. Training exposure of the respondents had positive significant contribution to their adoption of IPM practices by the rice growers. But, overwhelming majority (81.50%) of the respondents had no training to medium training exposure. Therefore, it may be concluded that any arrangement to increase the training exposure of the farmers' would ultimately increase their adoption of IPM practices in rice cultivation.

5. The highest proportion (46.3%) of the respondents had the medium knowledge, 33.3 percent had poor knowledge and only 20.4 percent respondents had high knowledge on pesticide application. Therefore, it may be concluded that knowledge on pesticide application increase their adoption of IPM practices in rice cultivation which had a significant contribution.

6. Attitude towards harmful effects of chemical pesticide of the respondents had positive significant contribution to their adoption of

IPM practices by the rice growers. But, overwhelming majority (82.4%) of the farmers had low to medium favorable attitude towards harmful effects of chemical pesticide. In the light of above findings, it may be concluded that formation of high favorable attitude towards harmful effects of chemical pesticides of the farmers would increase their adoption of IPM practices in rice cultivation.

5.3 Recommendations

5.3.1 Recommendations for policy implications

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

1. Given that the urgent need for increasing IPM practices, it is recommended that the DAE may take effective steps for strengthening extension services in order to change using percentage of the farmers regarding IPM practices.

2. Age of the respondent had significant positive contribution to their use of IPM practices. Therefore it may be recommended that attempts should be taken by the concerned authorities to increase use of IPM practices especially for the young and middle aged farmers.

3. Farm Size of the respondent had significant negative contribution to their use of IPM practices. Therefore it may be recommended that awareness program for the large farmer should be taken.

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

5. There existed a positive significant contribution to knowledge on pesticide application in their adoption of IPM practices. Therefore, it may be recommended that attempts should be taken by Department of Agricultural Extension (DAE) and other extension providers to arrange training, result and method demonstration program on judicious pesticide application.

6. Attitude towards harmful effects of chemical pesticide had significant positive contribution to the adoption of 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 rice farmers.

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 use of IPM practices in rice cultivation by showing clear difference between traditional and recommended practices.

5.3.2 Recommendations for further study

A small and limited research work cannot provide unique and universal information related to adoption of IPM practices by the farmers. Further studies should be undertaken on related matters. On the basis of scope and limitations of the present study and observations made by the researcher, the following recommendations are made for further study:

1. The study was conducted in Shahjadpur upazila of Sirajgang District. Similar studies should be conducted in other parts of the country to get a clear picture of the whole country which will be helpful for effective policy formulation.

2. It is difficult to determine actual adoption of IPM practices by the farmers. Measurement of adoption of IPM practices by the farmers is not free from questions. More reliable measurement of concerned variable is necessary for further study.

3. To measure adoption of IPM practices by the farmers‟ the researcher developed a scale and the validity of the scale may be verified by further studies using the same scale.

4. The present study was undertaken to explore contribution of 12 selected characteristics of the farmers to their adoption of IPM practices. Therefore, it could be recommended that further studies should be designed considering other agricultural and non-agricultural activities and including other characteristics of the farmers that might affect the adoption of IPM practices.

5. In the present study family size, innovativeness, knowledge on IPM practices and contact with IPM club/FFS had no significant contribution to their adoption of IPM practices. In this connection, further verification is necessary.

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Appendix

An Interview Schedule on "Adoption of Integrated Pest Management (IPM) practices in rice cultivation by the farmers of Shahjadpur Upazilla under Sirajganj District"

(This interview schedule is entitled for a research study)

Part-A

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

Name of respondent: .....

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

Part-B

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

1. Age: ..... years

2. Education

a) Cannot read or write

b) Can sign only

c) Studied up to class ……...

3. Family size

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

5. Farm Size

Please mention the area of your land possession:

Sl. No.	Types ofland ownership	Land Area	
		Local unit	Hectare
1.	Homestead area (Including pond)		
2.	Own land under own cultivation		
3.	Land given to others as shared crop		
4.	Land taken from others as shared crop		
5.	Land given to others as lease		
6.	Land taken from others as lease		
7.	Fallow land		
	Total		

4. 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 = …….

6. Training Exposure

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

Subject	Place	Duration(day)	Organization

7. Innovativeness
Please mention extent of use of the following modern agricultural innovations.

Sl. No.	Name of Innovation	Used			Do not use
		Within 1 year (1)	Within 1-3 years (2)	Above 3 years (3)	(0)
1	Use of bio-fertilizer				
2	Use of green manure in crop production				
3	Use of gypsum				
4	Use of granular Urea				
5	Use of modern Agricultural Machineries(Power tiller/ Pump/ Seed Driller)				
6	Use of Seed Treater				
7	Use of bamboo buster				
8	Use of pheromone				
9	Use of hybrid rice Seed				
10	Use of Leaf color chart				

8.Cosmopoliteness

Please indicate how frequently you visit the following places within a specific period.

Sl.No.	Places of visit	Degree of Visit			
		Regularly (3)	**Occasionally (2)**	**Rarely (1)**	**Not at All (0)**
1.	Visit to market/relatives/friends outside of your own village but within your own union	7 or more times/month	3-6 times/ month	1-2 times/ month	No Visit
2.	Visit to other union	6 or more Times/month	4-5 times/ month	1-3times/ month	No Visit
3.	Visit to own thana headquarter	6 or more Times/month	4-5 times/ month	1-3times/ month	No Visit
4.	Visit to other Thana headquarter	4 or more Times/year	3-4 times/ year	once/ year	No Visit
5.	Visit to own town/head quarter	4 or more Times/year	3-4 times/ year	once/ year	No Visit
6.	Visit to other district town/headquarter	4 or more Times/year	2-3times/ year	once/ year	No Visit
7.	Visit to capital city or other metropolitan city	4 or more Times/year	2-3times/ year	once/ year	No Visit

9. Knowledge on IPM Practices

Kindly answer the following question:

Sl. No.	Question	Full Marks	Marks Obtained
1.	What do you mean by IPM(Integrated Pest Management)?	3	
2.	Mention two examples of biological control	2	
3.	Mention two examples of mechanical control	2	
4.	Mention two examples of cultural method	2	
5.	What is bamboo buster? What is done by it?	2	
6.	What is light trap?	2	
7.	What do you mean by resistant variety?	4	
8.	What are the advantages of weed management?	2	
9.	What are the characteristics of quality seed	4	
10.	In which condition of pest attack do you apply pesticide?	4	

Total marks =	**27**	

10. Knowledge on pesticide Application

Sl. No.	Questions	Correct Answer	Marks	Score	
				Correct Answer	Wrong Answer
1.	Do you know the water holding capacity of a knapsack sprayer machine a) 1liter b) 10 liter c) 15 liter d) 20 liter	b) 15 liter	2		
2.	Do you know the area coverage of a full tank solution of knapsack sprayer? a) 1 decimal b) 5 decimal c) 15 decimal d) 20 decimal	b) 5 decimal	2		
3.	Do you know the suitable time of spraying? a) In the morning b) In the noon's scorching sunshine c) After noon	b) In the morning	2		
4.	How much standing water is needed for applying insecticides in rice field? a) 0 cm c) 15-20 cm b) 5-10 cm d) 20-25 cm	b) 5-10 cm	2		
5.	Whatrodenticide is needed to control rats? a) Lanirat /Quickfume b) Ripcord /chlorden c) Agrosun/Vitavex d) DDT	a) Lanirat/ Quickfume	2		
6.	What weedicide is needed for controlling weeds in rice field? a) Stem F-34 c) Ripcord b) Shathi d) Ecofuran	a) Shathi	2		
7.	In what direction of wind pesticide should be sprayed? a) Towards wind b) Against wind	a) Toward wind	2		
8.	Application of pesticide higher than recommended doses are harmful for environment	a) True	2		

	a) True b) False				
9.	Mask use during pesticide application a) Essential b) Not important c) Only for specific pesticide d) Strictly prohibited	a) Essential	2		
10.	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	2		
Total marks =			**20**		

11. Attitude towards harmful effects of chemical pesticide

Sl. No.	**Statement about harmful effects of chemical pesticide**	**Extent of opinion**				
Positive extent		Strongly agree (5)	Agree (4)	No opinion (3)	Disagree (2)	Strongly disagree (1)
1. (+)	Non-stop pesticides application in crop fields increase resistance to insect-pest					
2. (+)	The use of pesticides is harmful than use of IPM					
3. (+)	Pesticide is the cause of death of aquatic living beings					
4. (+)	The use of pesticide increase crop yield					
5. (+)	Use of toxic insecticide in irrigated crop fields cause pollution in canals, ponds and rivers.					
Negative extent		Strongly agree (1)	Agree (2)	No opinion (3)	Disagree (4)	Strongly disagree (5)
6. (-)	Pesticides applied in crop fields being washed to ponds, canals and rivers don't cause any problems					
7. (-)	Pesticide do not reduce the soil fertility					

8. (-)	Pesticides' residues don't exist in human body					
9. (-)	Most of the soil pesticide is harmful for soil internally which makes the soil unproductive					

12. Contact with IPM club and/or FFS

Sl.No.	**Purpose of contact**	**Extent of contact**			
		Regularly	Frequently	Rarely	Not at all
		3	2	1	0
1.	For meeting				
2.	To receive training				
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 IPM Practices

(a) Do you control pests in rice cultivation? Yes/No

(b) If yes, please mention how frequently do you use the following IPM technologies in your crop field

Sl. No.	Technologies	Degree of adoption			
		Frequently (3)	Occasionally (2)	Rarely (1)	Never (0)
1.	Insect Control by hand sweep				
2.	Use of light trap for insect control				
3.	Collection and destroy eggs and larvae For controlling insect pest by hand				
4.	Adoption of crop rotation				
5.	Perching in the crop field for insect control				
6.	Weed management (Prevention, Eradication And Control)				
7.	Use of healthy seeds (Free from insects and disease)				
8.	Cultivation of resistant variety				
9.	Use of pesticide				
10.	Other indigenous methods (Spreading ashes/Spray of neem water etc.)				

Thanks for your co-operation .....

Date:..... Signature of Interviewer