ADOPTION OF BRRI DHAN29 PRODUCTION TECHNOLOGIES BY THE FARMERS IN SHARIAKANDI, BOGRA

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CERTIFICATE

This is to certify that the thesis entitled, **"ADOPTION OF BRRI DHAN29 PRODUCTION TECHNOLOGIES BY THE FARMERS IN SHARIAKANDI, BOGRA"** 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 **Fatema-Tuz-Zohra**, Registration No. 10-03771, under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.

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

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DEDICATION

LOVINGLY DEDICATED TO MY BELOVED PARENTS

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LIST OF ABBREVIATIONS AND GLOSSARY

Abbreviation	Full word
APS	Adoption Period Score
AQ	Adoption Quotient
Ag. Ext. Ed.	Agricultural Extension Education
Ag. Ext. and Info. Sys.	Agricultural Extension and Information System
B	Multiple regression
BBS	Bangladesh Bureau of Statistics
BEC	Bangladesh Economic Census
BRRI	Bangladesh Rice Research Institute
DAE	Department of Agricultural Extension
et. al	All Others
GDP	Gross Domestic Product
INGER	International Network for Genetic Evaluation of Rice
IRRI	International Rice Research Institute
NGO	Non-government organization
σ	Standard Deviation
$\bar{x}$	Mean

ADOPTION OF BRRI DHAN29 PRODUCTION TECHNOLOGIES BY THE FARMERS IN SHARIAKANDI, BOGRA

ABSTRACT

The study examined the extent of adoption of BRRI dhan29 production technologies and estimated the contribution of the selected characteristics of the farmers to the adoption of production technologies. A structured questionnaire was used for data collection from 117 BRRI dhan29 growers of Sonatala and Dohopara villages of Sariakandi upazila in Bogra district. Data were gathered from January 06 to February 05, 2017. Descriptive statistics, multiple regression were used for data analysis. Results show that most of the farmers (67.5 %) belong to medium adoption followed by high adoption (18.8 %) of BRRI dhan29 production technologies. Among the variables- age, level of education, farming experience, annual family income, attitude towards rice cultivation, usage of ICT in agriculture, organizational participation and knowledge on rice production were significant contributor and accounted for 59.3 percent of the variation in adoption of BRRI dhan29 production technologies. It was also found that 4.2 percent, 15.3 percent, 41.1 percent, 31.5 percent and 6.9 percent farmers were innovators, early adopters, early majority, late majority and laggards respectively regarding to BRRI dhan29 adoption. It was concluded that (i) the majority of the farmers adopted BRRI dhan29 production technologies, (ii) annual family income was derived as a vital contributor of adoption of these technologies, and (iii) one-third of these farmers were classified as 'late majority' adopters. Based on the findings, it was recommended that DAE and other extension services providers (e.g., NGOs) should take pragmatic initiatives for more adoption of BRRI dhan29 production technologies and increasing growers income so that they can adopt new production technologies to increase rice production to alleviate poverty and achieve food security in Bangladesh.

Key words: Technologies, rice cultivation, adopters, adoption;

CHAPTER I

INTRODUCTION

1.1 General Background

Bangladesh is an agrarian country. About 76% of the people live in rural areas, and 47.5% of the total manpower is involved in agriculture. In Bangladesh, agriculture contributes 18.82% of the gross domestic product (GDP) of the country in the year of 2014-2015 (BEC, 2016). Bangladesh has a long history of rice cultivation. Rice is grown throughout the country except in the southeastern hilly areas. The agroclimatic conditions of the country are suitable for growing rice year-round. However, the national average of rice yield is much lower (2.94 t/ha) than that of other rice-growing countries (BBS, 2012). Rice is the staple food for about 156 million people of the country. The population growth rate is 2 million per year, and if the population increases at this rate, the total population will reach 238 million by 2050. An increase in total rice production is required to feed this ever-increasing population. At the same time, the total cultivable land is decreasing more than 1% per year owing to the construction of industries, factories, houses, and highways. On the other hand, due to urbanization, food habits tend to be changed, demanding the cultivation of new crops that should share land used for rice cultivation. Therefore, the modern varieties of rice have the capacity to contribution to increase the yield per unit area. Among the modern varieties, BRRI dhan29 is tend to have the capacity to increase rice production in a sustainable manner for the food and nutritional security of this highly populated country.

There are three rice-growing seasons in Bangladesh: Aus, Aman, and Boro. Aus is the pre-monsoon upland rice growing season under rain fed conditions. Boro is the dry-season irrigated rice planted from December to early February and harvested between April and June. Earlier, Boro was grown in the very low-lying areas with residual water from the wet season and irrigated manually

using surface water in times of water shortage (Fujita, 2010). Such traditional boro rice was transplanted after the recession of floodwater in November and harvested from April to May. In the mid-1960s, the modern high yielding rice variety IR-8 was introduced in Bangladesh agriculture, primarily for Boro using irrigation. Then, beginning in 1970, another International Rice Research Institute (IRRI) bred variety IR-20 was introduced to farmers for the Aman season. Since 1973, the Bangladesh Rice Research Institute (BRRI), in partnership with IRRI, has been engaged in adaptive research to evaluate elite genetic lines under the IRRI-managed International Network for Genetic Evaluation of Rice (INGER). Under the brand name BR, and later BRRI dhan, it has released varieties that suit the agro-ecological conditions in Bangladesh (Hossain *et al.*, 2013). Many IRRI lines were well suited in Bangladesh for the Boro season, such as BR1, BR3, BR14, BRRI dhan28, and BRRI dhan29.

The development of groundwater irrigation system by tube wells accelerated, the rapid installation of shallow tube wells throughout the 1980s boosted the cropped area and yield of dry-season Boro rice dramatically (Fujita, 2010). With the introduction of ground water irrigation systems and the incorporation of modern high-yielding varieties, dry-season Boro rice gained popularity. The rice cropping pattern of Bangladesh has changed-areas once occupied by the rainfed Aus gradually shifted to Boro cultivation. As a result, the contribution from each season also changed-Aman rice previously contributed a major portion of total rice, but Boro is now the major contributor to total rice production in the country, despite Aman coverage area being greater. Aus, Aman, and Boro rice were recently reported to account for 7%, 38%, and 55%, respectively, of the total rice production in Bangladesh (Risingbd, 2014). In the year 2013-2014, rice production was 34.3 million ton (BBS, 2014). Bangladesh has made notable progress in sustaining commendable growth in rice production, and this growth in production has originated mostly from the shift from low-yielding traditional to high-yielding modern varieties when irrigation facilities were developed (Hossain *et al.*, 2006). Another factor contributing to

the increase total rice production by irrigation and modern rice varieties such as BRRI dhan29 is the key to change the rural economy.

Although Bangladesh has an agrarian economy, about 89% of total farm-holdings are below 2.49 acres in size (Kashem, 2013). Socioeconomic factors, such as the predominance of small and marginal farmers and tenancy cultivation in agrarian structure, did not impede the adoption of modern rice varieties in Bangladesh (Asaduzzaman, 1979; Mandal, 1980; Alauddin and Tisdell, 1996). Moreover, the major constraints to the adoption of modern rice varieties were in fact logistic factors (Hossain *et al.*, 2006).

History prove that the logical development (when rehearsed by expansive number of rice cultivators) decisively affect rice generation in nations like Japan, the Philippines and Indonesia. It is likely that the farmers of Bangladesh will create comparable outcomes on the off chance that they receive modem innovations and utilize sufficient and gainful info on their territories. It is, along these lines, vital that the idea and advantages of modem advances ought to be scattered to the farmers in persuading and appealing way, so that agriculturist reaction rapidly to receive those advances. This is without a doubt an educative process and, concerned for the most part with expanding farming generation and enhancing expectations for everyday comforts of farmers. The legislature has taken another rural augmentation strategy to achieve the craved objective. An individual more often doesn't receive another innovation unless he finds the advantage of it by himself. Regardless of the possibility that he is persuaded about its advantage still he may not utilize the same due to absence of money related capacity. Now and again he may have intended to utilize the innovation however his social standards and conventions does not urge him to utilize the same for prestigious elements. All these identity socio-economy and mental elements take a shot at a person when he is gone up against with another circumstance or with a changed program.

Bogra locale is considered as surplus rice growing zone of the nation, where BRRI dhan29 was a noteworthy endeavor. Shariakandi upazila range, in this manner, considered a most reasonable area to concentrate the marvels of selection of BRRI dhan29 innovations by the rice cultivators. Contemplates on individual, gathering and society uncovered that acknowledgment of modem innovations is restrictive upon many variables. Some of these are social, individual, practical and situational components. While directing any review on the reception of modem advancements, these elements should be considered. An extremely couple of past research work attempted to discover the above certainties. Subsequently, the present examine felt need to lead an exploration entitled "Adoption of BRRI dhan29 production technologies by the farmers in Shariakandi, Bogra."

1.2 Statement of the Problem

The achievement of any innovation relies on its dissemination among the potential clients, which eventually is measured by the level of selection of that innovation. Whenever advancement is acquainted with the farmer, it might be promptly or somewhat or completely acknowledged and it might likewise happen that the reception of advancement is stopped or completely ceased.

These happenings are unquestionably because of various variables. Selection of BRRI dhan29 innovations are impacted by the farmer's statistic and financial position. A comprehension about a similar will be helpful to the specialists, organizers and augmentation specialists in doing exploration, arranging and execution of expansion projects for upgrading adoption of BRRI dhan29 technologies in rice cultivation. The motivation behind this review along these lines was to investigate the connections between various qualities of the farmers and their selection of BRRI dhan29 in rice production. This was finished by looking for answers to the accompanying queries:

i. What are the attributes of BRRI dhan29 producers?
ii. To what extent the BRRI dhan29 cultivation technologies were adopted by the farmers?

iii. What personal and socio-economic characteristics influence farmers to adopt BRRI dhan29 cultivation?

iv. To what extent the selected characteristics of farmers contribute to the adoption of BRRI dhan29 production technologies?

The above-mentioned questions obviously impel the researcher for conducting the present research entitled "Adoption of BRRI dhan29 production technologies by the farmers in Shariakandi upazila, Bogra".

1.3 Objectives of the Study

The aim of the study was to explore the extent of adoption of BRRI dhan29 production technologies by the farmers. The following objectives were considered to conduct the research work:

i. To assess the extent of adoption of BRRI dhan29 production technologies by the farmers;

ii. To describe the selected socio-economic characteristics of farmers:
   - Age
   - Level of education
   - Farm size
   - Family size
   - Annual family income
   - Farming experience
   - Attitude towards rice cultivation
   - Training exposure
   - Usage of ICT in agriculture
   - Extension media contact
   - Organizational participation
   - Knowledge on rice production

iii. To estimate the level of contribution of the selected characteristics of farmers in adoption of BRRI dhan29 production technologies;

iv. To categorize the adopters of BRRI dhan29;

1.4 Scope of the Study

The present study was designed to have an understanding of adoption of BRRI dhan29 production technologies by the farmers and to explore its relationship with their selected characteristics.

i. The findings of the study will, in particular, be applicable to the study area at Sariakandi upazila under Bogra district. The findings may also be applicable to other locale of Bangladesh where socio-cultural, psychological and economic condition do not differ much than those of the study areas.

ii. The findings of the study may also be subsidiary to the field worker of extension service to enhance their action strategies for adoption.

iii. The findings of the study will be conducive to accelerate the improvement in agriculture, farmers' logistic supports, information needs and the way of dissemination especially tuned to key role players in the society as well as adoption of BRRI dhan29 production technologies by the farmers. The outcomes might also be helpful to the planners and policy makers, extension workers and beneficiaries of the agriculture.

iv. To the academicians, it may help in the further conceptualization of the systems model for analyzing the adoption of BRRI dhan29 production technologies by the farmers. In addition, the findings of this study may have other empirical evidence to all aspects of adoption of BRRI dhan29 production technologies by the farmers which may be used to build theory of adoption.

1.5. Justification of the Study

Rice cultivation plays a vital role towards achieving food security in Bangladesh. Presently impressive exertion is being made through research and extension delivery system to increase rice production. But the actual increase in production will depend on the activities of the rice cultivators and also the adoption of modern varieties in rice cultivation in our country. For that to

enhance rice production efficiency, modern varieties play a great role. The concept and benefits of the rice cultivation should be disseminated to the farmers in a convincing and attractive manner, so that farmers respond quickly to adopt modern varieties of rice cultivation. This is indisputably an educative process and is possible through extension education system, concerned mainly with increasing agricultural production and promoting living standards of the farmers.

The productive efficiency in agricultural production is a vital issue from the standpoint of agricultural improvement in developing countries since it provides pertinent information useful for drawing sound management decisions in resource allocations for developing agricultural policies and institutional improvements. Several adaptive exercises are regularly envisaged by the farmers in the local agriculture but the relative success to overcome these situation and primary variations gradually making them more vincible. In this condition, the adaptive/adjustments capacities of the targeted people need to be gradually improved to comprehend the probabilistic vulnerabilities and its consequences over agriculture and agriculturally based livelihoods. The demeanor of rice producer is dominated by his/her personal, economic, social and psychological characteristics (Hossain, 1991). Bogra district was considered as a suitable area to study the process of adoption of BRRI dhan29 production technologies by the rice cultivators. Keeping the above facts in view, a study entitled ‘Adoption of BRRI dhan29 production technologies by the farmers in Shariakandi, Bogra’.

1.6. Assumptions of the Study

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

i. The respondents were efficient of furnishing proper answers to the questions contained in the interview schedule.

ii. The data collected by the researcher were free from favor and errors were normally distributed.

iii. The responses given by the respondents were valid and reliable.

iv. Information sought by the researcher revealed the real condition and was the representative of the whole population of the study area to gratify the objectives of the study.

v. The researcher was well adjusted to herself with the social surroundings of the study area. Hence, the collected data from the respondents were free from bias.

1.7 Limitations of the Study

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

i. The study was confined to two villages namely Sonatala and Dohopara villages of Sariakandi Upazila under Bogra district.

ii. It is difficult to get accurate information regarding adoption indicator from the farmers as many of them are illiterate.

iii. Characteristics of the farmers were many and varied, but only twelve characteristics were selected for the research study.

iv. There were embarrassing situations at the time of data collection. So, the researcher had to develop proper rapport with the respondents to collect information with greater accuracy.

CHAPTER II

REVIEW OF LITERTURE

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

Section 1: Concept of adoption, technology adoption, adoption process and levels of adoption of agricultural innovation

Section 2: Factors related to the adoption of agriculture technology

Section 3: Conceptual framework of the study

2.1 Concept of Adoption, Technology Adoption, Adoption Process and Levels of Adoption of Agricultural Innovation

2.1.1 The concept of adoption

According to Feder *et al.* (1985), adoption is "the degree of use of new innovation in long run equilibrium when a farmer has full information about the new technology and its potential". However, the equilibrium level of adoption will not be achieved if the technology is still being experimented by the farmers. Rogers (1995) defines innovation as an idea, practice, or object that is perceived as new by an individual or other unit of adoption. This wide definition captures any idea or process that is perceived to have utility. Lionberger (1968) and Van den Ban and Hawkins (1996) contended that,

adoption is a process, which the decision to adopt usually takes time. People do not adopt new practice or idea as soon as they hear about it; they may wait several years before trying it. Therefore, the adoption and diffusion of innovation process has been characterized as the acceptance overtime of some specific items by individuals (or adoption unit) linked to specific channels of communication. In this study the word innovation, technology and recommended practices will be used interchangeably.

2.1.2 Technology adoption

The term technology 'has been defined in different ways by various authors. Rogers (1995) defined technology as, the design for instrumental action that reduces the uncertainty in the cause-effect relationship involved in achieving a desired outcome. According to Guerin and Guerin (1994), and Rogers (1995), technology is usually comprised of hardware (the object component) and software (idea component) but it can also be made up entirely of information, which is the software component. In contrast, however, Ison and Rusell (2002) defined technology as the application of scientific knowledge to practical tasks. Abara and Singh (1993) in their work on the ethics and biases of technology adoption supported this view. They argued that it is the actual application of knowledge that is termed - technology. According to Phiri (2011), this definition by Ison and Rusell (2002), and Abara and Singh (1993) can be best used to describe those technologies that are comprised of entirely new ideas or information. Feder and Just (1985) on the other hand, described technology as an agricultural practice that is considered new to an area. These agricultural practices (technology) may take the form of new machinery, a high yielding crop, a recommendation for a new method of fertiliser use, or new methods of controlling pests and diseases (Guerin and Guerin, 1994). The word technology and innovation are used synonymously (Rogers, 2003). Various definitions are used in the literature to refer to the ideas, practices or objects perceived to be new by a potential adopter. Guerin and Guerin (1994) support Rogers (2003) definition of innovation as an-idea, practice or object perceived as new by an

individual or other unit of adoption. They defined innovation in terms of how it is viewed by farmers whilst making a decision to adopt or reject it. Therefore, a technology can be a new idea, technique or object. For this study, the term technology will be used from this point onward to also mean innovation. In the following section, the adoption process is reviewed.

2.1.3 Adoption process

Rogers (2003) described adoption as the decision by an individual to use the introduced technology as the best available alternative. Feder *et al.*, (1985) on the other hand defined adoption as-the degree of use of a new technology in the long-run equilibrium when farmers have the full information about the new technology. According to Spence (1994), adoption is not a one-off decision but a process in which the individual finally decides to use the introduced ideas or techniques, after a thorough assessment has been carried out. On the other hand, Guerin and Guerin (1994) defined technology adoption as - the implementation of the already transferred knowledge about a technological innovation and is the end product of the technology transfer is the process. According to Rogers (2003), technology adoption involves a mental process that individual goes through when he or she becomes aware of information regarding the idea that is perceived to be new. The adoption process continues until decisions are made to use or reject the new idea (Rogers, 2003). The five steps in the adoption decision process are conceptualized as knowledge, persuasion, decision, implementation, and confirmation (Rogers, 2003). Spence (1994) on the other hand, indicated awareness, interest, evaluation, trial and adoption, as the stages involved in the adoption process. Although these authors term the adoption process differently, the steps described by them although have some minor differences, are very similar. These two models are compared in the following paragraphs.

The knowledge stage of the model is when an individual becomes aware of the existence of a technology as he/she receives information about it and understands how it works (Rogers, 2003). However, Spence (1994) described

this stage as the awareness stage. Spence further pointed out that the individual may obtain the information through mass media, or from written, spoken or visual material which the individual farmer can access.

The second stage of Rogers (2003) model is persuasion. At this stage, an individual may change his/her attitude towards the technology being introduced. Spence (1994) described this as the interest stage, whilst Pannell *et al.*, (2006) referred to it as the non-trial evaluation phase. During the interest stage, an individual will typically attempt to gain more factual data in order to enable an examination of the innovation at a closer level and to explore it in the context of personal circumstances, past experiences, and prevailing beliefs (Spence, 1994).

The third stage of Rogers (2003) model is decision. During this stage, the individual farmer engages in the activities that will consequently lead to the adoption (or rejection) of the new idea or technique. Spence (1994) considered this to be the evaluation of an innovation. Furthermore, during this process, an individual is attempting to assess whether the advantages will outweigh any perceived disadvantages. Pannell *et al.*, (2006) however, described this stage as the trial evaluation. They stressed that trials contribute substantially to both the decision-making and skill development aspects of the learning process. If small-scale trials are not possible (or not enlightening) for some reason, the opportunities for widespread adoption are greatly diminished. Farmers will be cautious about leaping into full-scale adoption due to the risk that the innovation may prove to be a full-scale failure. Practices which are not trial able may still be adopted, but generally the adoption occurs only after substantial information-seeking, discussion, analysis, and reflection (Pannell *et al.*, 2006).

The fourth stage of Rogers (2003) model is implementation. At this stage, the individual begins to completely apply or use the new idea (Rogers, 1995, 2003). Also, at this stage, farmers often look for more information to find out

whether they have made the correct decision by adopting the technology (Van den Ban and Hawkins, 1996). Spence (1994) considered this stage as a trial stage, since the implementation of the new idea is undertaken on a smaller scale. Duncan (1969) confirmed Spence's argument by stating that adoption is not an all-or-nothing decision. He suggested that there is a grey area between small-scale trialing and the eventual scale of adoption. Adoption is often a continuous process and it may occur within a gradual or stepwise manner, which sometimes results in only a partial adoption (Wilkinson, 2011). Farmers often change and modify their practices or technology, in order to adapt it to their own circumstances. However, Rogers (1995, 2003) argued that this is a full implementation stage, since the decision has already been made.

The fifth stage of Rogers (2003) model is confirmation. This stage is reached when the individual seeks more information towards supporting and reinforcing the decision he or she has made or when he or she discontinues the use of the new idea because of resultant difficulties (Rogers, 2003). Adopters, who are sometimes confronted with conflicting messages from change agents or peers, regarding the new practices, tend to discontinue using the new practice (Van den Ban and Hawkins, 1996). Some adopters may discontinue the use of a new idea or practice after adoption (Rogers, 2003). The discontinuation of a technology may be a result of the individual adopter being dissatisfied with the performance of the new idea or practice. It may also due to the fact that the individual has found a new practice that surpasses the existing one and as such they would like to replace it (Rogers, 2003). Spence (1994) on the other hand indicated that such a rejection could happen immediately after the acceptance of a technology, if there is a better alternative. The adoption of technology is influenced by a range of factors. In the following sections, the factors that influence the adoption decision of a new technology are examined.

2.1.4 Levels of adoption of agricultural innovation

Agriculture is a way of life to many subsistence farmers and other farmers are in constant search of ways in which to improve upon their lives. In agriculture context, adoption is decision made by an individual to start using new agricultural innovations with the aim to increase productivity. This might be a new crop variety or management practices adopted by an individual, family or corporation. Adoption of agricultural technologies is considered as one of the ways that offer opportunities for improved agricultural production and hence improved life (Niyegela, 2007).

The technology must be widely adopted in order to self-sustain. Within the rate of adoption, there is a point at which agricultural technology reaches critical mass. The categories of adopters are: innovators, early adopters, early majority, late majority, and laggard. Innovators (2.5%) - had larger farms, were more educated, more prosperous and more risk-oriented, early adopters (13.5%) - younger, more educated, tended to be community leaders, less prosperous, early majority (34%) - more conservative but open to new ideas, active in community and influence to neighbors, late majority (34%) - older, less educated, fairly conservative and less socially active, laggards (16%) - very conservative, had small farms, oldest and least educated. Level of adoption of technology manifests itself in different ways in various cultures and fields and is highly subject to the type of adopters and innovation-decision process (Rogers, 1983).

2.2 Factors Related to the Adoption of Agriculture Technology

There were a number of factors identified in the literature, which have influenced the adoption of agricultural technology. Drawing on several studies on technology adoption such as Adesina and Zinnah (1992); Aguila-Obra and Melendez (2006); Chau and Tam (1997); Doorman (1991); Feder, Just and Zilberman (1985); Rogers (1985). It can be ascertained that the factors, which influence the farmers' decision to either adopt or not to adopt a technology can

be grouped under three major headings: 1) the characteristics of the technology; 2) internal factors; and 3) external factors. These factors are discussed in the following section.

2.2.1 Characteristic of technology

Rogers (1995) identified five characteristics of a technology that influenced adoption. These are: 1) relative advantage; 2) compatibility; 3) complexity; 4) trialability; and 5) observability. Feder *et al.*, (1985) identified three others and classified these technologies in relation to resource use. These characteristics included: 1) capital-saving or capital intensive; 2) land-saving or land-using; and 3) labor-saving or labor using. Feder and Umali (1993), Leathers and Smale (1991), and Pannell *et al.*, (2006) also identified associated risks with a new technology as an important factor that influenced adoption decisions of individuals. The following sections draw on the relevant literature to describe in detail each of these factors and their impacts on the adoption decisions of individuals.

a) Relative advantage

Relative advantage is the degree to which an innovation is perceived to be better than the idea it supersedes (Rogers, 1995). Relative advantage can also be described as the advantage of an innovation to achieve goals better (or at a lower cost) than previously (Van Den Ban and Hawkins, 1996). The degree of relative advantage is commonly expressed as economic profit, social prestige or other benefits (Rogers, 1995). It has been found that agricultural practices, which are believed to be profitable, have an increased likelihood of adoption, whilst those that are believed to provide less return are less likely to be adopted (Barr and Cary, 1992; Webb, 2004).

b) Compatibility

Compatibility refers to the degree to which an innovation is perceived as consistent with existing values, past experience, and the needs of the potential

adopter (Roger, 1995; 2003). The more compatible an innovation is to a potential farmer's life experiences and situation, the more familiar they will be with the innovation and the less uncertain they will be about adopting the innovation (Deressa *et al*., 2009). Ogunlana (2004) also defined compatibility as being the ease by which the farmers can integrate the new practices into their farming system and access other relevant inputs that would help in its adoption.

c) Complexity

The complexity factor is the degree to which a technology is perceived to be difficult to understand and use (Rogers, 2003). The greater the complexity of an innovation the more negatively a new farmer may view the technology. For example, the discontinuation of a system of rice intensification program, which was introduced in Madagascar for rice farmers, was largely due to the difficulties faced by farmers in understanding the application of the new practices and methods (Moser and Barrett, 2002). Gibson (1994) shared a similar view and reported that farmers in Papua New Guinea rejected growing rice because rice cultivation was seen as complex and difficult to manage.

d) Trialability

Trialability is the degree to which the technology can be tested on a small scale (Rogers, 2003). Ogunlana (2004) pointed out that farmers are always keen to adopt technologies which they have first trialed on a limited basis on their farm, compared to one they have to adopt on a larger scale - which might fail. Floyd *et al.*, (2003) and Rogers (2003) added that a technology, which can be gradually implemented without a large capital investment from outside, is important, since it will certainly enhance the farmers' decision to adopt the technology.

e) Observability

Observability is the degree to which the results of a technology can be visible to others (Rogers, 1995). *Cary et al.*, (2002) argued that a profitable outcome is

an important factor that influences the adoption decision. A lack of observable profit, as result of adopting a technology would inhibit the adoption of the technology by others. The more observable the outcomes of an innovation offers and is perceived as being suitable by the farmer, the rate of adoption will become more positive (Rogers, 2003). For example, in a study on mangrove swamp rice varieties in Sierra Leone, Adesina and Zinnah (1992) found that farmers adopted a new variety of rice introduced to the area because they observed that the results were highly visible.

2.2.2 Internal factors

Several authors (Bantel and Jackson, 1989; Deressa *et al.*, 2009; Knowler and Bradshar, 2006; Pannell *et al.*, 2006; Staal *et al.*, 2002) suggested that there are four key internal factors that influence the adoption of technology. These factors include: 1) characteristics of the farmer; 2) on-farm factors; 3) cultural factors; and 4) leadership characteristics. The following sections draw on the relevant literature to describe in detail each internal factor that can influence a farmer's adoption decision.

2.2.2.1 Characteristics of the farmer

2.2.2.1.1 Age

The personal characteristics that may influence the adoption decision of a farmer include age, gender, education, and level of farming experience (Deressa *et al.*, 2009; Doss and Morris, 2000). These personal factors can affect the innovativeness of an individual and thus contribute to determining the rate at which farmers' will adopt new technology (Adesina and Zinnah, 1992; Deressa *et al.*, 2009; Spence, 1994). The age of the farmer is often considered to be one of the factors responsible for influencing his or her decision to adopt a technology (Souza *et al.*, 1993). Tiamiyu *et al.*, (2009) argued that younger farmers are more likely to adopt new technologies if they are not constrained by limited cash resources, whilst older farmers are less likely to adopt new

technologies if they require extra physical labor. Older farmers may be less interested because they have less need for extra income. However, there is conflicting evidence on this relationship with some researchers finding no significant evidence between age and adoption (Curtis *et al.*, 2005; Guerin and Guerin, 1994; Shiferaw and Holden, 1998). For example, Adesina and Zinnah (1992), in their study on the factors affecting the adoption of rice farming in Sierra Leone found that the age of farmers had no significant relationship to their adoption decision of rice farming. The education level of farmers also or could also affect their decision to adopt or reject a technology. Evidence from various sources has indicated that a positive relationship exists between the educational level of a farmer and the adoption of improved technologies (Doss and Morris, 2000; Moser and Barrett, 2003; Tiamiyu *et al.*, 2009). Moser and Barret (2003) in their study on factors affecting non-adoption of a system of rice intensification in Madagascar found that adopters and non-adopters who had more years of schooling adopted the rice intensification system at a higher rate than those with less education. They also found that farmers with more years of schooling were more likely to belong to a farmer association than farmers with low level of education. Experience is also positively related to technology adoption, through an increase in the decision maker's ability to assess whether a new technology would be profitable (Hassan and Nhemachena, 2008; Khanna, 2001; Maddison, 2006). However, variables relating to experience are found in many studies, with mixed results. For example, Lin (1991) found that experience related positively to the adoption of hybrid rice in China. On the other hand, experience may be related to age, which has often been shown to be negatively related to adoption (Polson and Spencer, 1991; Zepeda, 1990). The other important aspect of experience, which is rarely investigated but is equally important, is the past experience of the farmer with the proponents of change (the government, their agents and policies advocated) (Agarwal, 1983; Stanley *et al.*, 2000). For example, Agarwal (1983) stated that the past experience of a farmer with the technology and its proponents can positively influence his/her decision to adopt the

technology. However, in contrast, Stanley *et al.* (2000) found this relationship to be negative. They found that the previous experience of the potential adopters (with a previous government's failed program) was seen as a barrier to adoption. Finlay *et al.*, (2004), in a study examining land managers' attitude towards land management in Australia, supported this view. He found that the past experience of the land managers with government agents and their failed program only contributed to a general feeling of distrust and animosity towards government policies and their agents (such as the extension officers). Byron *et al.* (2005) reports that, elderly farmers seem to be somewhat less inclined to adopt new practices than younger farmers. It is also well known that, in general, the older the farmers the less their willingness to try new innovations or take risks. Older farmers may have more experience, resources, or authority that can allow them more possibilities for trying recommended production practices (CIMMYT, 1993). Some studies indicate that the number of farming years has a positive and significant relationship with the use of recommended production practices at least in early years (Mattee, 2009). Furthermore, some of the studies found there are no relationship between age and the use of recommended production practices (Mattee, 2009). Still other studies show that younger farmers are more likely to adopt recommended production practices (Van den Ban and Hawkins, 1996). A study conducted at Dhamrai upazila under Dhaka district in Bangladesh that showed a non-significant relationship of age on adoption of BRRI dhan29 production technologies (Islam, 2007).

2.2.2.1.2 Level of education

Education improves human capital, farm management capacity, the ability to understand and adopt recommended agricultural practices (Bezuayehu *et al.*, 2002). It is expected that better educated farmers are more likely to adopt recommended agricultural practices than less educated farmers (Cary *et al.*, 2002 and Nina, 1993). Mwaseba *et al.* (2006) reported that, education of household head has influence on adoption of recommended agricultural practices especially when the recommended agricultural practices require

managerial skills. A study conducted at Dhamrai upazila under Dhaka district in Bangladesh that showed a significant relationship of education on adoption of BRRI dhan29 production technologies (Islam, 2007). Amin (2015) conducted a study at Rajapur upazila under Jhalokathi district in Bangladesh that showed a significant contribution of education on adoption of modern technologies by the rice cultivators

2.2.2.1.3 The family size

The number of people in a household is another factor that can influence the adoption of recommended agricultural practices. Fivawo (1976) noted that the bigger the size of a family in a household the higher the chance of adopting recommended agricultural practices. Mussei *et al.* (2001) adds that large household sizes are able to provide the necessary labor required to adopt the recommended practice. Amin (2015) conducted a study at Rajapur upazila under Jhalokathi district in Bangladesh that showed a non-significant contribution of family size on adoption of modern technologies by the rice cultivators. Islam (2007) conducted a study at Dhamrai upazila under Dhaka district in Bangladesh that showed a non-significant relationship of family size on adoption of BRRI dhan29 production technologies.

2.2.2.1.4 Family income

Income may enhance labor and ability to purchase and therefore low level of income implies difficulties in buying farm inputs like improved seed, fertilizers and herbicides (Msuya, 2005). Many studies report positive contribution of income to household's adoption of recommended agricultural practices like use of improved seed varieties, fertilizers application, spacing, weeding, and pest management. For instance, different recommended agricultural practices adoption studies conducted by Kidane (2001) indicated positive relationship between income and adoption of recommended agricultural practices. Amin (2015) conducted a study at Rajapur upazila under Jhalokathi district in Bangladesh that showed a significant contribution of annual family income on

adoption of modern technologies by the rice cultivators. Islam (2007) conducted a study at Dhamrai upazila under Dhaka district in Bangladesh that showed a significant relationship of annual family income on adoption of BRRI dhan29 production technologies.

2.2.2.1.5 Farming experiences

Amin (2015) conducted a study at Rajapur upazila under Jhalokathi district in Bangladesh that showed a non-significant contribution of training exposure on adoption of modern technologies by the rice cultivators. Hossain *et. al.* (2006) concluded that the farming experiences of the farmers had positive significant relationship with their adoption of selected HYV rice. Haque (2003) concluded that farming experiences of the farmers had significant positive relationship with their adoption of modern maize cultivation technologies. Hossain (2003) revealed that farming experiences of the farmers had a significant relationship with their adoption at modern Boro rice cultivation practices. Aurangozeb (2002) conducted a study on adoption of integrated homestead farming technologies by the rural women in RDRS. He found that there was a positive significant relationship between farming experiences of the respondents and their adoption of integrated homestead farming technologies. Rahman (2001) conducted a study on knowledge attitude and adoption of the farmers regarding Aalok 6201 hybrid rice in Sadar upazila of Mymensingh district. He found that farming experiences of the farmers had a significant and positive relationship with their adoption regarding Aalok 6201 hybrid rice. Sarker (1997) conducted a study on correlates of selected characteristics of potato growers with their adoption of improved potato cultivation practices in five village of Comilla district. He observed that farming experiences of the potato growers had significant relationship with their adoption of improved potato cultivation.

2.2.2.1.6 Farmers' attitude

Attitude is the process by which a person receives information or stimuli from the environment and transforms it into psychological awareness (Van de Ban and Hawkin, 1988). According to Duvel (1991) perception is understood to be of more specific nature and is analyzed based on attribute of innovation. The attributes that can be directly associated with field forces are; prominence and relative advantages.

2.2.2.1.7 Training exposure and adoption

Amin (2015) conducted a study at Rajapur upazila under Jhalokathi district in Bangladesh that showed a significant contribution of training exposure on adoption of modern technologies by the rice cultivators. Haque (2003) concluded that training exposure of the farmers had significant positive relationship with their 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. Sardar (2002) conducted a study on adoption of IPM practices by the farmers under PETRRA project of RDRS and observed that training exposure of the farmers had a positive significant relationship with their adoption of IPM 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. Mostafa (1999) conducted a study on adoption of recommended mango cultivation practices by the mango growers of Nawabganj Sadar thana. He found that training exposure of mango growers had a significant positive relationship with their adoption of recommended mango cultivation practices. Chowdhury (1997) conducted a research on adoption of selected BINA technologies by the farmers. He indicated that training exposure of the farmers had a strongly positive

significant relationship with their adoption of selected BINA technologies. Kher (1992) carried out a research study on the adoption of improved wheat cultivation practices by the farmers in selected village Rajouri block, India. He observed that there was significant relationship between the farmers' training exposure and their adoption of improved wheat cultivation practices.

2.2.2.1.8 Usage of ICT in agriculture

A study on 'Adoption and usage of ICT in developing countries: Case of Ugandan firms' examined the extent of adoption and usage of ICT on one hundred and ten firms in Uganda; and established benchmarks that can be utilized in future research and comparison between firms. The results revealed that the adoption and usage of ICT by firms in developing countries follow the same pattern as in developed countries, and they only differ in the level of usage and adoption (Ssewanyana and Busler, 2007).

2.2.2.1.9 Extension media contact

Hossain (2006) concluded that the extension contact of the farmers had positive significant relationship with their adoption of selected HYV rice. Hossain (2003) concluded that communication exposure of the farmers had a significant and positive relationship with their adoption of modem Boro rice cultivation. Haque (2003) concluded that extension contact of the farmers had a significant positive relationship with their adoption of modem maize cultivation technologies. Sardar (2002) concluded that the extension contact had positively significant relationship with their adoption of IPM practices. Rahman (2001) conducted a study on knowledge, attitude and adoption of the fanners regarding Aalok 6201 hybrid rice in Sadar upazila of Mymensingh district. He found that extension contact of the farmers had a significant and positive relationship with their adoption of Aalok 6201 hybrid rice. Alam (1997) studied the use of improved farm practices of rice cultivation by the farmers of Anwara Thana of Chittagong district. The study indicated no significant relationship of extension contact of the farmers with their use of improved farm practices in rice

cultivation. Singh (1991) observed in his study that mass contact of the farmers had significant relationship with their level of adoption of plant protection.

2.2.2.1.10 Organizational participation

Amin (2015) conducted a study at Rajapur upazila under Jhalokathi district in Bangladesh that showed a non-significant contribution of organizational participation on adoption of modern technologies by the rice cultivators. Hossain (2006) revealed that organizational participation of the farmers had no significant relationship with their adoption of HYV rice. Sardar (2002) conducted a study on adoption of IPM practices by the farmers under PETRRA project of RDRS. He observed that organizational participation of the farmers had no significant relationship with their adoption of IPM practices. Rahman (2001) conducted a study on knowledge attitude and adoption of the farmers regarding Aalok 6201 hybrid rice in Sadar upazila of Mymensingh district. He found that organizational participation of the farmers had a significant and positive relationship with their adoption regarding Aalok 6201 hybrid rice. Mostafa (1999) conducted a study on adoption of recommended mango cultivation practices by the mango growers of Nawabganj sadar thana. He found that organizational participation of mango growers had a significant positive relationship with their adoption of recommended mango cultivation practices. Sarker (1997) conducted a study on correlates of selected characteristics of potato growers with their adoption of improved potato cultivation practices in five village of Comilla district. He observed that organizational participation of the potato growers had no relationship with their adoption of improved potato cultivation practices. Kher (1992) carried out a research study on the adoption of improved wheat cultivation practices by the farmers in selected village Rajouri block, India. He observed that there was no significant relationship between the farmers' social participation and their adoption of improved wheat cultivation practices. Islam (2007) conducted a study at Dhamrai upazila under Dhaka

district in Bangladesh that showed a significant relationship of organizational participation on adoption of BRRI dhan29 production technologies.

2.2.2.1.11 Farmers' knowledge

In this study knowledge refers to as an awareness of recommended practices or the optimum that is achievable in terms of efficiency. In this case refer to as awareness of recommended rice production practices in the study area. A lack of understanding or knowledge about the recommended practices is often cited as a strong barrier to the adoption of recommended practices or innovations (Duvel, 1991). Amin (2015) conducted a study at Rajapur upazila under Jhalokathi district in Bangladesh that showed a significant contribution of knowledge on modern technologies on adoption of modern technologies by the rice cultivators. Hossain (2009) showed that knowledge on IPM of the farmers had positive significant relationship with their use of IPM practices. Aurangozeb (2002) conducted a study on adoption of integrated homestead farming technologies by the rural women in RDRS. He found that there was a positive significant relationship between knowledge of the respondents and their adoption of integrated homestead farming technologies. Islam (2002) conducted a study on adoption of modern agricultural technologies by the farmers of Sandwip. He found that agricultural knowledge of the farmers had significant relationship with their adoption of modern agricultural technologies. Chowdhury (1997) conducted a research on adoption of selected BINA technologies by the farmers. He indicated that knowledge of the farmers had a strongly positive significant relationship with their adoption of selected BINA technologies. Sarkar (1997) found that potato production knowledge of potato growers had a positive and significant relationship with their adoption of improved potato cultivation practices

2.2.2.2 On-farm factors

On-farm factors include farm size, location, and land tenure (Daberkow and Mcbride, 2003; Knowler and Bradshar, 2007; Staal *et al.*, 2002). These factors

exist within the farm environment in which farmers carry out their daily activities (Spence, 1994). The effect of farm size on adoption has been frequently analysed in many adoption studies (Erenstein and Faroog, 2009; Daku, 2002; Doss andMorris, 2001). Evidence from various sources has indicated that there is a positive relationship between farm size and adoption (Erenstein and Faroog, 2009; Deressa *et al.,* 2009; Kasenge, 1998). In a number of studies, it was found that those with larger farms have a greater probability of adopting an innovation than owners of smaller sized farms (Azilah, 2007; Deressa *et al.,* 2009). Farmers operating larger farms tend to have greater financial resources and their opportunities to obtain credit are higher compared with those with smaller farms. In Kenya for example, a study by Gabre-Madhin and Haggblade (2001) found that large commercial farmers adopted new high-yielding maize varieties more rapidly than smallholders did. However, in contrast, Hossain (1988) pointed out that smallholder farmers are more willing to adopt labor intensive technologies than larger farmers did because smallholder farmers can use family labor, which is relatively cheap compared to larger commercial farms. The location of the farm is also an important factor, which influences the adoption of a technology. For example, Zeller *et al.,* (1998), in a study on market access in Malawi found that farmers who had their farms located close to major markets adopted maize faster than those whose farms were located far from the market. In a developed country's context, Khanna (2001) found in the American Midwest that the farmers who had their farm's located in proximity to soil research centers adopted new soil testing technology faster than those whose farms were located far away from the research Centre. Similarly, a study on the adoption of conservation tillage in Australia by D'Emden *et al.,* (2006), found that the proximity of the farm to the adopter's home was positively related to adoption. They further stated that farms that are located closer to locations that provide the service are more likely to adopt a new technology than farms located further away. Land ownership is widely believed to encourage the adoption of technologies linked to land (Kassie *et al.*, 2009). For example, in the Philippines, Neil and Lee

(2001) found that land ownership was positively associated with hedgerow adoption. Whilst empirical studies have supported this hypothesis, the results are not unanimous and the subject has been widely debated (Feder *et al.*, 1985; Rodriguez *et al.*, 2009). For example, Smucker *et al.*, (2000) found no definitive relationship between land ownership and technology adoption by peasant farmers in Haiti. Similarly, Rodriguez *et al.*, (2009), in a study on barriers to the adoption of sustainable agricultural practices in the 13 Southern States of the USA found the relationship between land ownership and the adoption of sustainable agricultural practices to be negative. This is because the landlords who lease their land to farmers dictated what crops would be grown on this land and this led farmers to be reluctant to adopt the new technology (Rodriguez *et al.*, 2009). This suggests that farmers working on leased land are less likely to adopt long-term technology practices because they perceive that the benefits of the adoption will not be necessary accrue to them. According to CIMMYT, (1993) farm size is a common variable in determining the adoption of an innovation. It has been recognized that, small and large farm operators differ in the speed of adoption of innovations (Polson and Spencer, 1991). Rogers (1983) averts that those farmers who own large farms enjoy a high socio economic status. They also have ample mass communication opportunities, and are more innovative in adopting new agricultural technologies. Amin (2015) conducted a study at Rajapur upazila under Jhalokathi district in Bangladesh that showed a non-significant contribution of farm size on adoption of modern technologies by the rice cultivators. Islam (2007) conducted a study at Dhamrai upazila under Dhaka district in Bangladesh that showed a significant relationship of farm size on adoption of BRRI dhan29 production technologies. In following section, the cultural factors that influenced adoption decision are reviewed.

2.2.2.3 Cultural factors

Cultural factors have also been identified as having influenced adoption decisions by farmers. These factors include: 1) norms and 2) the traditions of a

society (Herbig and Miller, 1991; Pannell *et al.*, 2006; Roger, 1995; Sommers and Napier, 1993; Straub, 1994; Tiraieyar, 2009; Twati and Tripoli, 2008; Wejnert, 2002). The cultural norms of a society are also an important factor that influences an adoption decision. Wejnert (2002) argued that technologies, which are not compatible with cultural norms, are adopted only by a relatively small percentage of potential, individual adopters. For example, Rogers (1995) found that the residents of Los Molino in Peru did not adopt the practice of boiling drinkable water because it conflicted with their norm of serving such water only to sick people. Similarly, in Costa Rica, the rate of adoption of fertility-control practices by married couples was low because they conflicted with their cultural values relating to optimum family size (Rosero-Bixby and Casterline, 1993; 1994). The traditions of a society are one of the factors that play an important role in affecting farmers' decision-making, which includes the likelihood of them adopting new practices (Stanley *et al.*, 2000). For example, Sommer and Napier (1993) found that the adoption of sustainable agriculture practices by farmers in Amish communities was influenced by their cultural traditions towards land and soil protection. However, in contrast, Wejnert (2002) stated that the cultural traditionalism associated with social inertia when adopting new practices and ideas can negatively affect the adoption of technology. Lawrence *et al.*, (2004) argued that society's resistance to discarding long-held traditions would lead to a strong resistance (within that society) to change the adoption of new technology. In the following section, the leadership characteristics that influenced adoption decision are discussed.

2.2.2.4 Leadership characteristics

Leadership characteristic is another internal factor, which has been found to influence the decision to adopt new technology (Bantel and Jackson, 1989; Damanpour and Schneider, 2009; Howell and Higgins, 1990; Levi and Litwin, 1986; Scott and Bruce, 1994; West and Anderson, 1996). Ross and Lappin (1967) referred to leadership characteristics as attitudes and behaviors of those individuals who perform leadership roles. They believe that good leaders need

to possess a positive identification with their people and also with others outside their community. Based on their work on community and cooperatives in participatory development Levi and Witwin (1986), supported this view. They found that good leaders are those who know their people intimately, who share with them their problems, and who lead their people towards common goals. Onyx and Leonard (2010) further support this view, in their study on complex systems leadership in emergent community projects in Australia, Uruguay, Sweden, and Peru. They found that the five community projects studied in five different countries were successful because the leadership of these community projects was open to their members in relation to shared decision making with members, honesty with members, and committed to their communities. The other important characteristics of leaders, which influence adoption decisions, are skills and knowledge (Cernea and Meinzen-Dick, 1995). According to Cernea and Meinzen-Dick (1995), these characteristics can be further divided into two types: 1) those that are required in an organizational role; and 2) those that are required in a technical role.

2.2.3 External factors

Apart from the internal factors, the adoption decision of farmers is also influenced by external factors. Several authors such as Akpabio and Inyang (2007); Anderson and Feder (2007); Caswell *et al.,* (2001); Cornejo *et al.,* (2001); D'Emden *et al.,* (2008); Doss (2006); Fliegel (1993); Grarner and Sharp (2004); Kurlalova *et al.,* (2006); Mansuri and Rao (2003); Saltiel *et al.,* (1994); Sunding and Zilberman (2001); and Zeller *et al.,* (1998) identified five main external factors to have influenced the adoption decision of farmers. These were: 1) government policy; 2) infrastructure development; 3) agro-climatic condition; 4) extension support; and 5) market access.

2.3 Conceptual Framework of the Study

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

This study is concerned with the 'Adoption of BRRI dhan29 Production Technologies in Sariakandi, Bogra'. Thus, the adoption of modern technologies by the BRRI dhan29 cultivators in the selected area of Bogra district was the dependent variable and 12 selected characteristics of the rice cultivators were considered as the independent variables under the study. Adoption of BRRI dhan29 production technologies may be affected through interacting forces of many independent variables. It is not possible to deal with all of the independent variables in a single study. It was therefore, necessary to limit the independent variables, which include age, level of education, farm size, family size, annual family income, farming experience, attitude towards rice cultivation, training exposure, usage of ICT in agriculture, extension media contact, organizational participation and knowledge on rice production for this study. Considering the above-mentioned situation and discussion, a conceptual framework has been developed for this study, which is diagrammatically presented in the following Figure 2.1.

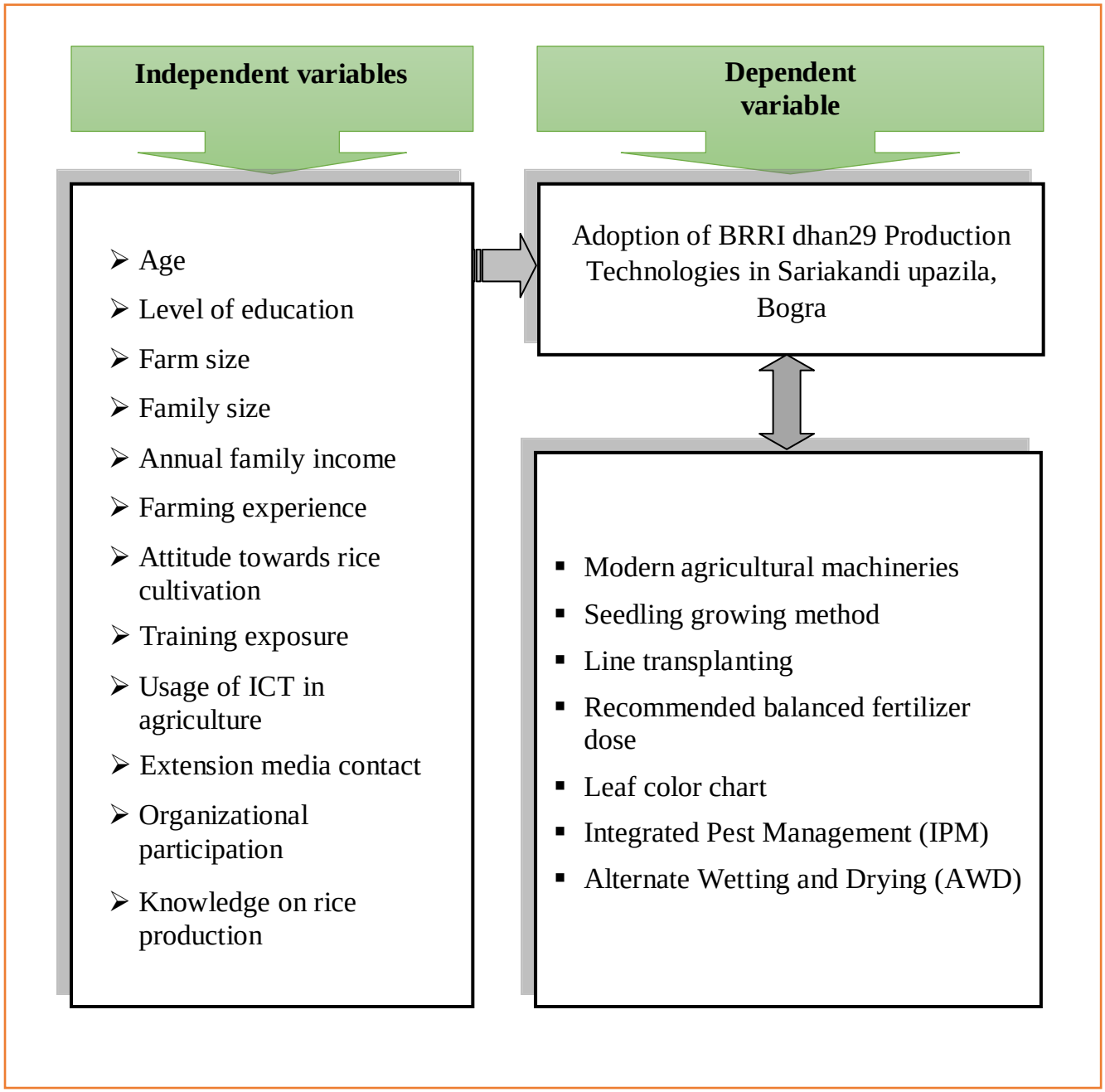

Figure 2.1 The conceptual framework of the study

CHAPTER III

MATERIALS AND METHODS

Methods play an important role in a scientific research. To achieve the objectives of the study, a researcher should be very careful while formulating methods and procedures in conducting the research. According to Mingers (2001), research methods are a structured set of guidelines or activities to generate valid and reliable research results. This chapter of the thesis illustrates the research methods and procedures used to collect and analyze the data for answering the research questions and attaining the purposes. The methods and operational procedures followed in conducting the study e.g. selection of study area, sampling procedures, instrumentation, categorization of variables, collection of data, measurement of the variables and statistical measurements. A chronological description of the methodology followed in conducting this research work has been presented in this chapter.

3.1 Research Design

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

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3.2 Locale of the Study

The study was conducted in the Sariakandi upazila under Bogra district. Sariakandi upazila (Bogra district) is bounded by Saghatta and Sonatala upazilas on the north, Dhunat and Kazipur upazilas on the south; Islampur, Madarganj and Sarishabari upazilas on the east and Gabtali upazila on the west. The features of the farmers and agriculture at Sariakandi upazila are like- Ownership of agricultural land: Landowner 56.61%, landless 43.39%; agricultural landowner: urban 33.41% and rural 58.41%; Main crops: Paddy, jute, wheat, mustard, vegetables; Extinct or nearly extinct crops: Sesame, linseed, arahar, khesari, black gram, kaun, sweet potato; Main fruits: Mango, jackfruit, guava, banana, papaya; Fishery farms:1232; Dairy farms: 110; Poultry farms: 85 etc. Sariakandi upazila has 12 unions; out of these Fulbari union was selected purposively as the study area. Among 22 villages of Fulbari union, the two villages namely Sonatala and Dohopara villages were selected purposively for the study.

The present study was conducted at Sonatala and Dohopara villages of Fulbari union based on the population size in the selected area. These areas is located in between 24°44' and 25°04' north latitudes and in between 89°31' and 89°45' east longitudes. The population of the villages had almost eagerness to cultivate the rice var. BRRI dhan29. The total population of the study area is 2618 where male and female were 1365 and 1253 respectively. The farm families are 525.

The map of the Bogra district has been presented in Figure 3.1. and the specific study locations of Fulbari union under Sariakandi upazila of Bogra district have also been shown in Figure 3.2.

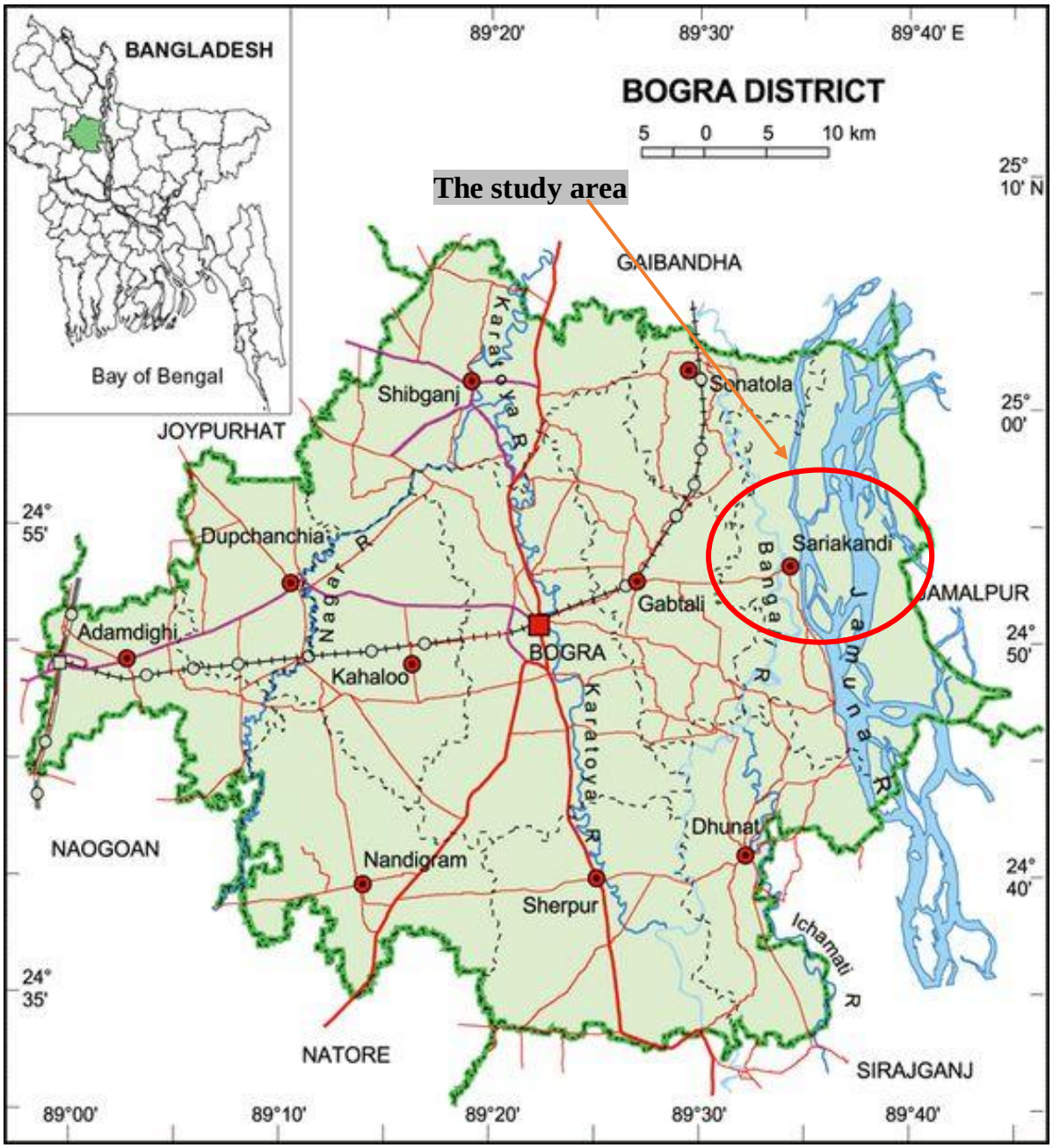

Figure 3.1 Map of Bogra district showing the study area of Sariakandi upazila

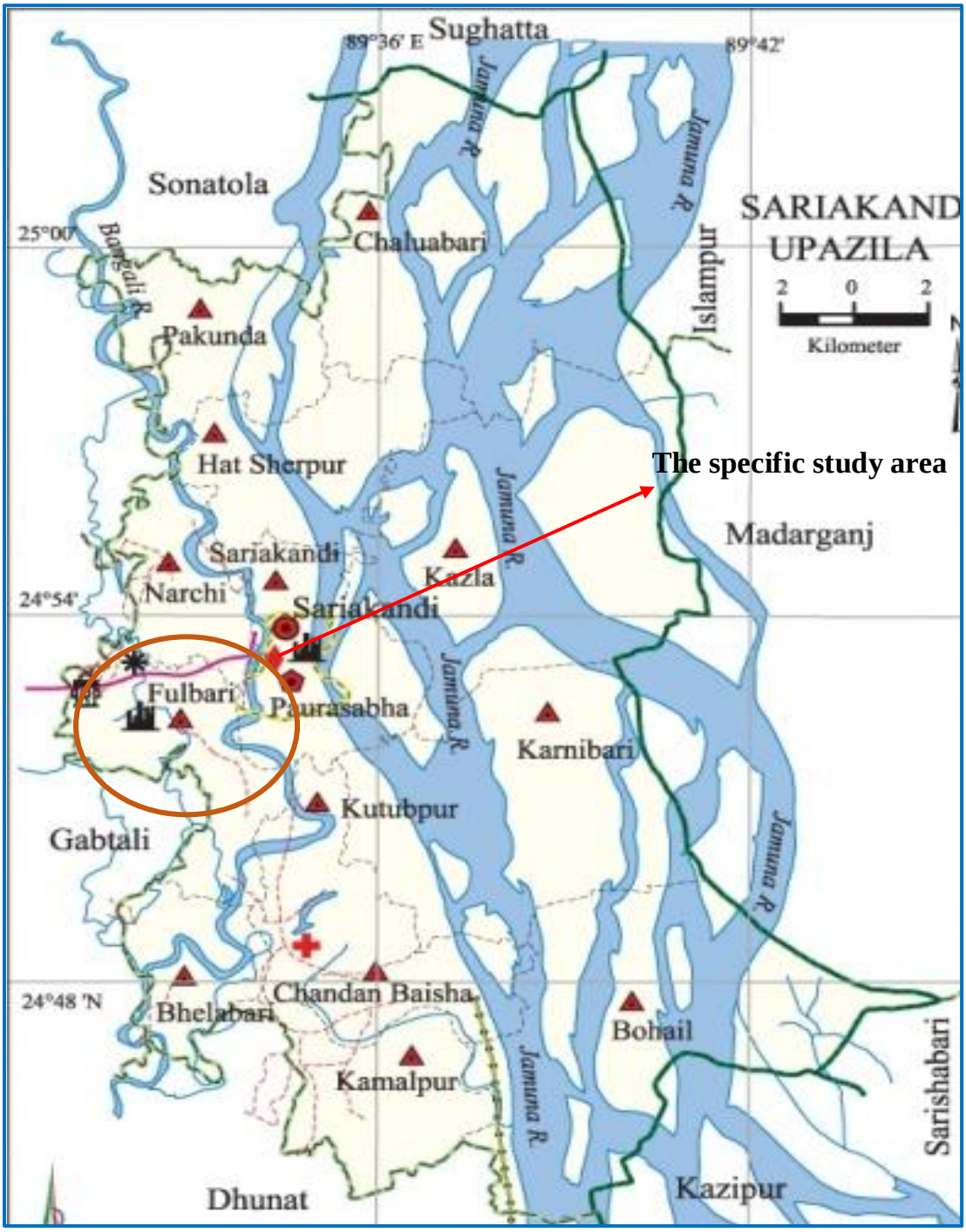

Figure 3.2 Map of Sariakandi upazila showing the study area of Fulbari union

3.3 Population and Sample of the Study

People who permanently reside in the selected villages constituted the active population of this study. As all population of the study area could not be possible to measure, head of the farm families of Sonatala and Dohopara villages of Fulbaria union of Sariakandi upazila under Bogra district constituted the population of the study. However, representative sample from the population was taken for collection of data following purposive sampling technique. One farmer (who mainly operated the farming activities of the family) from each of the farm families was considered as the respondent. Updated lists of all farm families who cultivated rice var. BRRI dhan29 of the selected villages were prepared with the help of SAAO and local leader (Matobbor). A purposive sampling procedure was followed to select one district from the whole of Bangladesh, and the same method was used to select the upazila as well as the villages as the study group. The total number of rice cultivators in these villages was 525; where 270 farm family heads from Sonatala village and 255 from Dohopara village under the union of Fulbari, constituted the population of the study. Thus, 525 rice cultivators constituted the population of the study which is shown in the following Table 3.1

Table 3.1 Population of the study area

Name of the selected upazila	Name of the selected union	Name of the selected villages	Number of the respondents
Sariakandi	Fulbaria	Sonatala	270
		Dohopara	255
		Total	525

3.3.1 Determination of the sample size

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

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

Where,

n = Sample size;

N, Population size = 525;

e, The level of precision = 8%;

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%;

The sample size (n) is = 117.

3.3.2 Distribution of the population, sample size and reserve list

According to Yamane's formula, the respondents comprised of 117 rice cultivators. A reserve list of 12 rice cultivators (ten percent of the sample size) were also prepared so that the rice cultivators of this list could be used for interview if the rice cultivators included in the original sample were not available at the time of conduction of interview. The farmers of the Sonatola and Dohopara villages of Fulbaria union were selected according to the proportionate on the total sample size (117) which was calculated using Yamane's (1967) formula. The distribution of the population, sample and reserve list is given in Table 3.2.

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

Name of union	Name of villages	Population of rice cultivators	Sample size	Farmers number in the reserve list
Fulbari	Sonatala	270	60	6
	Dohopara	255	57	6
Total		525	117	12

3.4 The Research Instrument

A well-structured interview schedule was developed based on objectives of the study for collecting information with containing direct and simple questions in open form and close form keeping in view the dependent and independent variables. Appropriate scales were developed to measure both independent and dependent variables.

The interview schedule was pre-tested with ten rice cultivators out of sample in the study area to finalize it for collection of research data. Necessary corrections, additions, alternations and adjustments were made in the interview schedule based on pretest experience. The interview schedule was then multiplied by printing in its final form. A copy of the interview schedule presented into Appendix-I.

3.5 Data Collection Procedure

The researcher herself collected the data from the BRRI dhan29 cultivators through personal contact. Whenever any rice cultivator faced difficulty in understanding questions, more attention was given to explain the same with a view to enabling the rice cultivators to answer properly. No serious problem was faced by the investigator during data collection but obtained cooperation from the BRRI dhan29 cultivators. Data collection was started in 06 January, 2017 and completed in 05 February, 2017.

3.6 Variables and Their Measurement Techniques

The variable is a characteristic, which can assume varying, or different values in successive individual cases. A research work usually contains at least two important variables viz. independent and dependent variables. An independent variable is that factor which is manipulated by the researcher in his attempt to ascertain its relationship to an observed phenomenon. A dependent variable is that factor which appears, disappears or varies as the researcher introduces, removes or varies the independent variable (Townsend, 1953). In the scientific research, the selection and measurement of variable constitute a significant task. Following this conception, the researcher reviewed literature to widen this understanding about the natures and scopes of the variables relevant to this research. At last he had selected 12 independent variables and one dependent variable. The independent variables were: age, level of education, farm size, family size, annual family income, farming experience, attitude towards rice cultivation, training exposure, usage of ICT in agriculture, extension media contact, organizational participation and knowledge on rice production. The dependent variable of this study was the 'adoption of BRRI dhan29 production technologies'. The methods and procedures in measuring the variables of this study are presented below:

3.6.1 Measurement of independent variables

The 12 characteristics of the rice cultivators mentioned above constitute the independent variables of this study. The following procedures were followed for measuring the independent variables.

3.6.1.1 Age

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

as presented in Appendix-I. Based on the available information cited by the farmers, they were classified into three categories.

Category	Years
Young age	≤ 35
Middle age	36 to 50
Old age	≥ 51

3.6.1.2 Level of education

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

For example, if a farmer passed the final examination of class five or equivalent examination, his/her education score has given five (5). A farmer can't read & write has given a score of zero (0). A person can't read or write but able to sign only has given a score of 0.5. If a farmer did not go to school but took non-formal education, his educational status was determined as the equivalent to a formal school student. This variable appears in item number 2 in the interview schedule as presented in Appendix-I. Based on the available information cited by the farmers, they were classified into five categories.

Category	Education (year of schooling)
Can't read & write	0
Can sign only	0.5
Primary education	1 to 5
Secondary education	6 to 10
Above secondary	> 10

3.6.1.3 Farm size

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

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

Where, FS = Farm size,

A = Homestead area including garden and pond,

B = Own land under own cultivation,

C = Land taken from others as borga

D = Land given to other as borga,

E = Land taken from others on lease,

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

Category	Area (hectare)
Landless	≤ 0.020
Marginal farmer	0.021 to 0.20
Small farmer	0.21 to 1.00
Medium farmer	1.01 to 3
Large farmer	> 3

3.6.1.4 Family size

Family size of a farmer 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 farmers. For example, if a farmer had five members in his/her family, his/her score was given as 5. This variable appears in item number 1.3 in the interview schedule as presented in Appendix-I. Based on the available information cited by the farmers, they were classified into three categories (Mean ± Standard Deviation) namely 'small', 'medium' and 'large' family.

3.6.1.5 Annual family income

The term annual income refers to the annual gross income of rice cultivators and the members of his family from different sources. It was expressed in taka. In measuring this variable, total earning taka of an individual rice cultivator was converted into score. A score of one was given for every one thousand taka. The method of ascertaining income involved three phases. Firstly, the income from agricultural crops in the preceding year was noted and converted into taka. Secondly, Income from animals and fish resources. Thirdly, other source income included earning form small business, service, other family members' income, day laborer, fishing and others if any. This variable appears in item number 5 in the interview schedule as presented in Appendix-I. Based on the available information cited by the farmers, they were classified into three categories (Mean ± Standard Deviation) namely 'low', 'medium' and 'high' annual family income.

3.6.1.6 Farming experience

Farming experience of rice cultivators was determined by the total number of year involved in farming activities. A score of one (1) was assigned for each year farming experiences. This variable appears in item number 6 in the interview schedule as presented in Appendix-I. Based on the information cited

by the farmers, they were classified into three categories (Mean ± Standard Deviation) namely ‘low’, ‘medium’ and ‘high’ farming experience.

3.6.1.7 Attitude towards rice cultivation

Attitude towards rice cultivation of a respondent implies to his/her beliefs, outlook, perception and action tendencies. To determine this criterion, a number of 8 statements (4 positive and 4 negative) were randomly presented before the interviewees. A five-point scale was used to measure the attitude of the beneficiaries. This scoring was done in the following manner:

Extent of agreement	Score
Strongly agreed	+2
Agreed	+1
Undecided	0
Disagreed	-1
Strongly disagreed	-2

All the scores for positive and negative statements were summed up and the final score was determined. This variable appears in item number seven (7) in the interview schedule as presented in Appendix-I. Based on the available information cited by the farmers, they were classified into three categories (Mean ± Standard Deviation) namely poorly favorable attitude, moderately favorable attitude and highly favorable attitude towards rice cultivation.

3.6.1.8 Training exposure

Training exposure of a rice cultivator was determined by the total number of day when he attended in different training programs in his life. A score of one (1) was assigned for each day of training attended. This variable appears in item number eight (8) in the interview schedule as presented in Appendix-I. Based on the available information cited by the farmers, they were classified into three categories (Mean ± Standard Deviation) namely ‘low’, ‘medium’ and ‘high’ training exposure.

3.6.1.9 Usage of ICT in agriculture

Usages of ICT in agriculture referred to the total usages for getting benefits from ICT services. It was expressed in score. In measuring this variable, a score of one was given for rare use of ICT in agriculture. This variable appears in item number nine (9) in the interview schedule (Appendix-I). The usages of ICT in agriculture scoring of the farmers were done in the following manner-

Category	Score
Regularly	4
Frequently	3
Occasionally	2
Rarely	1
Not at all	0

Based on the available information cited by the farmers, they were classified into three categories (Mean ± Standard Deviation) namely 'low', 'medium' and 'high' usages of ICT in agriculture.

3.6.1.10 Extension media contact

It was defined as one's extent of exposure to different communication media related to farming activities. Agricultural extension media contact of a farmer was measured by computing extension media contact score on the basis of their nature of contact with nine extension media. Each farmer was asked to indicate his nature of contact with four alternative responses, like regularly, frequently, sometimes, rarely and not at all basis to each of the seven media and score of four, three, two, one and zero were assigned for those alternative responses, respectively. These five options for each medium were defined specially to each medium considering the situation, rationality and result of pre-test. Logical frequencies were assigned for each of the four-alternative nature of contact. Extension media contact of the farmers was measured by adding the scores of seven selected source of information. Thus, extension media contact score of a farmer could range from 0 to 28, where zero indicated no extension

media contact and twenty-eight indicated highest level of extension media contact. This variable appears in item number 10 in the interview schedule as presented in Appendix-I. Based on the available information cited by the farmers, they were classified into three categories (Mean ± Standard Deviation) namely 'low', 'medium' and 'high' extension media contact.

3.6.1.11 Organizational participation

Organizational participation of a respondent was computed on the basis of his/her participation in different organizations. This variable appears in item number eleven (11) in the interview schedule as presented in Appendix-I. Scoring of the organizational participation was done using the following formula and in the following way-

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

Where, OP = Organizational participation score,

P_{om} = Participation as ordinary committee member,

P_{em} = Participation as executive committee member and

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

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

For example, if a respondent participated as an executive committee member of school committee, an ordinary member at NGO organized society and no participation in other organizations, that respondent would have a total score 3. Based on the available information cited by the farmers, they were classified into three categories (Mean ± Standard Deviation) namely 'low', 'medium' and 'high' organizational participation.

3.6.1.12 Knowledge on rice production

Rice production knowledge of a farmers was measured by asking him/her 10 questions related to different components of rice production e.g. mention 3 rice varieties, 3 diseases of rice, distinguish between local variety and HYV etc. It was measured assigning weightage three (3) for each question. So, the total assigned scores for all the questions became thirty. The score was given according to response at the time of interview. Answering a question correctly an individual could obtain full score. While for wrong answer or no answer he obtained zero (0) score. Partial score was assigned for partially correct answer. Thus, the agricultural knowledge score of a farmer could range from zero (0) to thirty (30), where zero indicates no knowledge and thirty indicates highest knowledge. This variable appears in item number 12 in the interview schedule as presented in Appendix-I. Based on the available information cited by the farmers, they were classified into three categories (Mean ± Standard Deviation) namely 'low', 'medium' and 'high' knowledge on rice production.

3.6.2 Measurement of dependent variable

Adoption of selected BRRI dhan29 production technologies was measured by computing Adoption Quotient (AQ). It was calculated by asking the farmers i) cultivated area for the technology ii) potential area for the technology iii) number of technologies used and iv) years of technology use. Adoption of selected BRRI dhan29 production technologies was measured by Adoption Quotient as the following formula suggested by Bhuiyan (2005):

$$\text{Adoption Quotient (AQ)} = \frac{\sum c/p}{y \times n} \times 100$$

Where, c = cultivated area

P = Potential area

y = Years of technology use

n = Number of technologies

Using above formula, adoption of selected BRRI dhan29 production technologies score of a respondent could range from 0-100, while 0 indicating no adoption and 100 indicating highest Adoption.

3.7 Measurement of Adopter Categories

Before measuring the adopter categories, the researcher calculated the Adoption Period Score (APS) of BRRI dhan29 by asking the question to the farmers "How many times did you take after hearing about the BRRI dhan29 qualities to cultivate in your land?'. The adopter categorization on the basis of APS diving the bell-shaped curve into five areas by using its two parameters (mean and standard deviation). After assigning APS for all farmers according to adoption Period of all the farmers were calculated as follows (Roger, 1995):

Innovator = $(\bar{x} - 2\sigma)$

Early adopter = $(\bar{x} - 2\sigma)$ to $(\bar{x} - \sigma)$

Early majority = $(x - \sigma)$ to $(\bar{x})$

Late majority = $(\bar{x})$ to $(\bar{x} + \sigma)$

Laggards & non-adopters = $(\bar{x} + \sigma)$ to $(\bar{x} + 2\sigma)$

The procedure followed to classify adopters where 1st group were innovator and then early adopter, early majority, late majority & last group considered as laggards. The majority of Indian researchers used this type of category

3.8 Hypothesis of the Study

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

3.8.1 Research hypothesis

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

"Each of the 12 selected characteristics (age, level of education, farm size, family size, annual family income, farming experience, attitude towards rice cultivation, training exposure, usage of ICT in agriculture, extension media contact, organizational participation and knowledge on rice production) of the farmers has significant contribution to the adoption of BRRI dhan29 production technologies."

3.8.2 Null hypothesis

A null hypothesis states that there is no contribution between the concerned variables. The following null hypothesis was formulated to explore the contribution of the selected characteristics on adoption of BRRI dhan29 production technologies. Hence, in order to conduct tests, the earlier research hypothesis was converted into null form as follows:

"There is no contribution of the selected characteristics (age, level of education, farm size, family size, annual family income, farming experience, attitude towards rice cultivation, training exposure, usage of ICT in agriculture, extension media contact, organizational participation and knowledge on rice production) of farmers on adoption of BRRI dhan29 production technologies."

3.9 Data Processing

For data processing and analysis, the following steps followed:

3.9.1 Compilation of data

After completion of field survey all the interview schedule were compiled, tabulated and analyzed according to the objectives of the study. In this process, all the responses in the interview schedule were given numerical coded values.

The responses to the question in the interview schedule were transferred to a master sheet to facilitate tabulation. Tabulation was done on the basis of categories developed by the investigator himself.

3.9.2 Categorization of BRRI dhan29 cultivators

For describing the various independent and dependent variables the BRRI dhan29 cultivators were classified into various categories. In developing categories, the researcher was guided by the nature of data and general consideration prevailing on the social system. The procedures have been discussed while describing variable in the sub-sequent sections of next chapter.

3.10 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 rice cultivators in the adoption of BRRI dhan29 cultivation technologies, multiple regression analysis (B) was used. Throughout the study, five (0.05) percent and one (0.01) percent level of significance were used as the basis for rejecting any null hypothesis. If the computed value of (B) was equal to or greater than the designated level of significance (*p*), the null hypothesis was rejected, then it was concluded that there was a significant relation between the concerned variable. Whenever the computed value of (B) was found to be smaller at the designated level of significance (*p*), the null hypothesis could not be rejected. Hence, it was concluded that there was no contribution of the concerned variables.

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

$$Y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + b_9x_9 + b_{10}x_{10} + b_{11}x_{11} + b_{12}x_{12} + e$$

Where,

Y= is the adoption of BRRI dhan29 cultivation technologies;

Of the independent variables, x_1 is the rice cultivators age, x_2 is level education, x_3 is farm size, x_4 is family size, x_5 is annual family income, x_6 is farming experience, x_7 is attitude towards rice cultivation, x_8 is training exposure, x_9 is usage of ICT in agriculture, x_{10} is extension media contact, x_{11} is organizational participation and x_{12} is knowledge on rice production. On the other hand, 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, and a is constant value of the regression equation.

CHAPTER IV

RESULTS AND DISCUSSION

The recorded observations in accordance with the objective of the study were presented and probable discussion was made of the findings with probable justifiable and relevant interpretation under this chapter. The findings of the study and their interpretation have been presented in this chapter. These are presented in four sections according to the objective of the study. The first section deals with the selected characteristics of the farmers, while the second section deals with the adoption of BRRI dhan29 production technologies. The third section deals with contribution of the farmers' selected characteristics on their adoption of BRRI dhan29 production technologies, while the fourth section deals with categorization of BRRI dhan29adopter.

4.1 Characteristics of the Farmers

Behavior of an individual is determined to a large extent by one's personal characteristics. There were various characteristics of the farmers that might have consequence to adoption of BRRI dhan29 production technologies. But in this study, twelve characteristics of them were selected as independent variables, which included their age, level of education, farm size, family size, annual family income, farming experience, attitude towards rice cultivation, training exposure, usage of ICT in agriculture, extension media contact, organizational participation and knowledge on rice production that might be greatly influenced the adoption of BRRI dhan29 production technologies of farmers are presented below:

4.1.1 Age

The age of the farmers has been varied from 22 to 66 years with a mean and standard deviation of 41.83 and 11.57, respectively. Considering the recorded age farmers were classified into three categories namely 'young', 'middle' and

'old' aged following Rashid (2014). The distributions of the farmers in accordance of their age are presented in Table 4.1.

Table 4.1 Distribution of the farmers according to their age

Category	Range (years)		Farmers		Mean ($\bar{x}$)	SD (σ)
	Score	Observed	Number	Percent		
Young aged	Up to 35	22-66	42	35.9	41.83	11.57
Middle aged	36-50		50	42.7		
Old aged	Above 50		25	21.4		
Total			117	100.0		

Table 4.1 reveals that the middle-aged farmers comprised the highest proportion (42.7 percent) followed by young aged category (35.9 percent) and the lowest proportion were made by the old aged category (21.4 percent). Data also indicated that the middle and young aged category constitute 78.6 percent of total farmers. The young and middle aged farmers were generally more involved in farm activities than the older.

4.1.2 Level of education

The level of educational scores of the farmers ranged from 0 to 12 with a mean and standard deviation of 6.37 and 3.88, respectively. Based on the educational scores, the farmers were classified into five categories. The distributions of farmers according to their level of education are presented in Table 4.2.

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

Category	Range (years)		Farmers		Mean ($\bar{x}$)	SD (σ)
	Score	Observed	Number	Percent		
Can't read and sign	0	0-12	9	7.7	6.37	3.88
Can sign only	0.5		12	10.3		
Primary education	1-5		28	23.9		
Secondary education	6-10		51	43.6		
Above secondary	>10		17	14.5		
Total			117	100.0		

Table 4.2 shows that farmers under secondary education category constituted the highest proportion (43.6 percent) followed by primary education (23.9 percent). On the other hand, the lowest 7.7 percent in can't read and sign category followed by can sign only category (10.3 percent) and 14.5 percent respondents were above secondary category. Education broadens the horizon of outlook of farmers and expands their capability to analyze any situation related to adopt the BRRI dhan29 production technologies. An educated farmer is likely to be more responsive to the modern facts, ideas, and information of BRRI dhan29 production technologies. To adjust with the same, they would be progressive minded to adopt production technologies of BRRI dhan29 as well as involve with modern cultural farm activities.

4.1.3 Farm size

The farm size of the farmers ranged from .14 ha to 2.75 ha with a mean and standard deviation of 0.91 and 0.56, respectively. Based on their farm size, the farmers were classified into five categories following the categorization according to DAE. The distribution of the farmers according to their farm size is presented in Table 4.3.

Table 4.3 Distribution of the farmers according to their farm size

Category	Range (ha)		Farmers		Mean ($\bar{x}$)	SD (σ)
	Score (ha)	Observed	Number	Percent		
Landless	≤0.02	0.14-2.75 (ha)	-	-	0.91	0.56
Marginal	0.021-0.20		5	4.3		
Small	0.21-1.00		67	57.3		
Medium	1.01-3.0		45	38.5		
Large	>3		-	-		
Total			117	100.0		

Table 4.3 indicates that the small farm holder constituted the highest proportion (57.3 percent) followed by medium farm holder (38.5 percent). The findings of the study revealed that majority of the farmers were small to medium sized farm holder. The average farm size of the farmers of the study area (0.91 ha)

was higher than that of national average (0.60 ha) of Bangladesh (BBS, 2014). The cultivator with marginal farm size has very little scope to experiment about new technologies as their earnings depend on agriculture.

4.1.4 Family size

Family size of the farmers ranged from 2 to 9 with the mean and standard deviation of 4.75 and 1.61, respectively. According to family size the farmers were classified into three categories (Mean ± Standard Deviation) namely 'small', 'medium' and 'large' family. The distribution of the cultivators according to their family size is presented in Table 4.4.

Table 4.4 Distribution of the farmers according to their family size

Category	Range (Number)		Farmers		Mean ($\bar{x}$)	SD (σ)
	Score	Observed	Number	Percent		
Small family	≤ 3	2-9	29	24.8	4.75	1.61
Medium family	4-7		78	66.7		
Large family	> 7		10	8.5		
Total			117	100.0		

Table 4.4 indicates that the medium size family constituted the highest proportion (66.7 percent) followed by the small size family (24.8 percent). Only 8.5 percent farmers had large family size. Such finding is quite normal as per situation of Bangladesh. The findings indicated that average family size of study area was smaller than the national average which is 4.85 (BBS, 2014).

4.1.5 Annual family income

The score of annual family income of the rice cultivators ranged from 62 to 230 with a mean and standard deviation of 108.692 and 37.25, respectively. On the basis of annual family income, the rice cultivators were classified into three categories (Mean ± Standard Deviation) namely 'low', 'medium' and 'high' annual family income. The distribution of the rice cultivators according to their annual family income is presented in Table 4.5.

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

Category	Range ('000' BDT)		Farmers		Mean ($\bar{x}$)	SD (σ)
	Score	Observed	Number	Percent		
Low income	≤71	62-230	17	14.5	108.69	37.25
Medium income	72-146		82	70.1		
High income	>146		18	15.4		
Total			117	100.0		

Data reveals that the rice cultivators having medium annual income constitute the highest proportion (70.10 percent), while the lowest proportion in low income (14.50 percent) followed by high income (15.40 percent). Overwhelming majority (84.60 percent) rice cultivators have low to medium annual income.

4.1.6 Farming experiences

Score of farming experiences of rice cultivators ranged from 6 to 50 with mean and standard deviation of 22.19 and 11.96, respectively. On the basis of faming experience scores, the rice cultivators were classified into three categories (Mean ± Standard Deviation) namely 'low, 'medium' and 'high' experience. The distribution of the rice cultivators according to their farming experiences is given in Table 4.6.

Table 4.6 Distribution of the farmers according to their farming experiences

Category	Range (year)		Farmers		Mean ($\bar{x}$)	SD (σ)
	Score	Observed	Number	Percent		
Low experience	≤ 10	6-50	16	13.7	22.19	11.96
Medium experience	11-35		82	70.1		
High experience	> 35		19	16.2		
Total			117	100.0		

Table 4.6 reveals that the majority (70.10 percent) of the cultivator fell in medium farming experience category, whereas only 13.7 percent in low experience category followed by 16.2 percent in high farming experience

category. The findings of the present study reveal that around 83.8 percent of the rice cultivators in the study area had low to medium farming experiences.

4.1.7 Attitude towards rice cultivation

Attitude towards rice cultivation of the farmers ranged from 3 to 13. The average and standard deviation were 8.58 and 2.49 respectively shown in the following Table 4.7. On the basis of attitude towards rice cultivation, the respondents were categorized into three classes' (Mean ± Standard Deviation) namely poorly favorable attitude, moderately favorable attitude and highly favorable attitude.

Table 4.7 Distribution of the farmers according to their attitude towards rice cultivation

Category	Range (score)		Farmers		Mean ($\bar{x}$)	SD (σ)
	Score	Observed	Number	Percent		
Poorly favorable attitude	≤ 6	3-13	29	24.8	8.58	2.49
Moderately favorable attitude	7-11		67	57.3		
Highly favorable attitude	>11		21	17.9		
Total			117	100.0		

The observed data shows that most of the farmers (57.3 percent) had a moderately favorable attitude towards rice cultivation while 24.8 and 17.9 percent of them had highly and poorly favorable attitude respectively. The attitude of the respondents expressed their perception about rice cultivation. It helped the researcher to judge or measure the acceptance/rejection of rice cultivation in the rural area.

4.1.8 Training exposure

Training exposure score of the rice cultivators ranged from 0 to 24 with a mean and standard deviation of 10.96 and 5.62, respectively. Based on the training exposure score, the rice cultivators were classified into three categories (Mean

± Standard Deviation) namely 'no training', 'low', 'medium' and 'high' training exposure. The distribution of the rice cultivators according to their training exposure is presented in Table 4.8.

Table 4.8 Distribution of the rice cultivators according to their training exposure

Category	Range (score)		Farmers		Mean ($\bar{x}$)	SD (σ)
	Score	Observed	Number	Percent		
No training	0	0-24	8	6.8	10.96	5.62
Low training	1- 5		19	16.2		
Medium training	6-16		64	54.7		
High training	>16		26	22.2		
Total			117	100.0		

Table 4.8 indicates that the highest proportion (54.7 percent) of the rice cultivators had medium training exposure compared to 22.2 percent in high training exposure and 16.20 percent in low training exposure category, respectively and the lowest proportion (6.8 percent) had no training. Training makes the rice cultivators skilled and helps them to acquire deep knowledge about the respected aspects. Trained rice cultivators can face any kind of challenges about the adverse situation in their cultivation. So, they show favorable attitude toward adoption of modern rice cultivation technologies.

4.1.9 Usage of ICT in agriculture

Usages of ICT in agriculture score of the farmers ranged from 2 to 12. The average and standard deviation were 8.14 and 2.31respectively. Bases on usages of ICT in agriculture, the respondents were categorized into three classes' (Mean ± Standard Deviation) namely low usages, medium usage and high usage. The distribution of the rice cultivators according to their usages of ICT in agriculture is presented in Table 4.9.

Table 4.9 Distribution of the farmers according to their usages of ICT in agriculture

Category	Range (score)		Farmers		Mean ($\bar{x}$)	SD (σ)
	Score	Observed	Number	Percent		
Low usages	≤5	2-12	30	25.6	8.14	2.31
Medium usages	6-10		78	66.7		
High usages	>10		9	7.7		
Total			117	100.0		

The observed data shows that most of the farmers (66.7 percent) had medium usage while 25.6 and 7.7 percent of them had low and high usage of ICT in agriculture respectively (Table-4.9).

4.1.10 Extension media contact

The observed score of agricultural extension contact of the farmers ranged from 8 to 24 against a possible range of 0 to 27. The average score of the farmers was 15.24 with a standard deviation 2.99 (Table 4.10). The farmers were classified into three categories on the basis of their exposure to farming information through communication exposure scores and distribution of the three categories (Mean ± Standard Deviation) namely 'low', 'medium' and 'high' agricultural extension media contact of the farmers. Data showed that the highest proportion (65.0%) of the farmers had medium agricultural extension contact as compared to 23.0 percent of them having low agricultural extension contact and 12.0 percent fell in high extension contact (Table 4.10).

Table 4.10 Distribution of the farmers according to their extension media contact

Category	Range (score)		Farmers		Mean ($\bar{x}$)	SD (σ)
	Score	Observed	Number	Percent		
Low contact	≤ 12	8-24	27	23.0	15.24	2.99
Medium contact	13-18		76	65.0		
High contact	>18		14	12.0		
Total			117	100.0		

From this table, it might be concluded that majority of the farmers had medium extension contact. It could be concluded that extension agent or media of the study area were available to the farmers. The finding was interesting but logical because in general the farmers in the rural areas of Bangladesh are less cosmopolite in nature and less exposed to different information sources. Finding revealed that 23.0 percent of the farmers had low extension contact which demands for strengthening and improving the communication strategy. Extension contact pertains to ones contact with multifarious sources of farming knowledge and information. This results in cognitive change of the users with an eventual change in behavior and also in skill. They receive information from their neighbors, relatives etc.

4.1.11 Organizational participation

Organizational participation score of the rice cultivators ranged from 6 to 19 with a mean and standard deviation of 13.95 and 3.39, respectively. Based on organizational participation score, the rice cultivators were classified into three categories (Mean ± Standard Deviation) namely low, medium and high participation. The distribution of the rice cultivators as per their organizational participation is presented in Table 4.11.

Table 4.11 Distribution of the farmers according to their organizational participation

Category	Range (score)		Farmers		Mean ($\bar{x}$)	SD (σ)
	Score	Observed	Number	Percent		
Low participation	≤ 12	6-19	17	14.5	13.95	3.39
Medium participation	13-18		79	67.5		
High participation	> 18		21	18.0		
Total			117	100.0		

Data reveals that the highest proportion (67.5 percent) of the rice cultivators had medium organizational participation, while 18.8 percent and 14.5 percent had high and less organizational participation respectively.

4.1.12 Knowledge on rice production

Rice production knowledge scores of the farmers ranged from 11 to 25 against possible score of 0 to 30. The average score and standard deviation were 16.76 and 3.94, respectively. Based on the rice production knowledge scores, the farmers were classified into three categories (Mean ± Standard Deviation) namely low knowledge, medium knowledge and high knowledge (Table 4.12).

Table 4.12 Distribution of the farmers according to their knowledge on rice production

Category	Range (score)		Farmers		Mean ($\bar{x}$)	SD (σ)
	Score	Observed	Number	Percent		
Low knowledge	≤ 12	11-25	23	19.7	16.76	3.94
Medium knowledge	13-20		68	58.1		
High knowledge	≥ 21		26	22.2		
Total			117	100.0		

Data presented in Table 4.12 reveals that 58.1 percent of the farmers had medium rice production knowledge, 19.7 percent had low knowledge and 22.2 percent had high knowledge on rice production. Thus, an overwhelming majority (58.1%) of the farmers had medium knowledge. This lead to understanding that rice production knowledge would be reflected more by the medium knowledge on agriculture group in the present study. Knowledge on rice production of the farmers is definitely affected by the education of the farmers because education helps to enhance the eagerness to be acquainted with new variety or technology. In addition, knowledge on rice production of the respondent is definitely affected by the extension contact because with the increase of the communication exposure to new thing. Knowledge on rice production is very important aspects for ensuring adoption of rice. Farmers lives on farming. Hence, they must require skill and modern knowledge to get more yield and profit to ensure adoption of BRRI dhan29.

4.2 Adoption of BRRI dhan29 Production Technologies

Adoption of BRRI dhan29 production technologies by the rice cultivators is the dependent variable of this study and it was measured by computing scores according to extent of adoption with each of 12 selected technologies. Adoption of rice cultivation technologies by the rice cultivators scored varied from 65.00 to 87.38 with the mean and standard deviation of 76.42 and 3.51 respectively. On the basis of adoption scores, the rice cultivators were classified into three categories (Mean ± Standard Deviation) namely low, medium and high adoption of BRRI dhan29 production technologies. The distribution of the cultivators according to their adoption of BRRI dhan29 production technologies score under the study is given in Table 4.13.

Table 4.13 Distribution of the rice cultivators according to their adoption of BRRI dhan29 production technologies

Category	Range		Farmers		Mean ($\bar{x}$)	SD (σ)
	Score	Observed	Number	Percent		
Low adoption	≤ 72	65-87.38	16	13.7	76.42	3.51
Medium adoption	73-80		79	67.5		
High adoption	≥ 81		22	18.8		
Total			117	100.0		

Table 4.13 indicates that among the respondents, the highest 67.5 percent rice cultivators belongs to the group of medium adoption and the lowest percentage 13.7 percent in low adoption followed by high adoption (18.8 percent) by the rice cultivators in adoption of BRRI dhan29 production technologies. Among the cultivators most of the rice cultivators (86.3 percent) have medium to high adoption in BRRI dhan29 production technologies.

4.3. Variables Related on the Adoption of BRRI Dhan29 Production Technologies

In order to estimate the adoption of BRRI dhan29 production technologies by the rice cultivators and contribution of the independent variables, multiple regression analysis was used. The results are shown in the Table 4.14.

Table 4.14 Multiple regression coefficients of contributing factors related to the farmers' adoption of BRRI dhan29 production technologies

Dependent variable	Independent variables	B	*p*	R^2	Adj. R^2	F	*p*
Farmers' adoption of BRRI dhan29 production technologies	Age	-0.17	0.020*	0.593	0.571	27.460	0.000**
	Level of education	0.280	0.000**				
	Farm size	0.300	0.514				
	Family size	0.151	0.333				
	Annual family income	1.024	0.163				
	Farming experience	0.149	0.039*				
	Attitude towards rice cultivation	0.097	0.001**				
	Training exposure	0.094	0.059				
	Usage of ICT in agriculture	0.945	0.013*				
	Extension media contact	0.054	0.083				
	Organizational participation	0.164	0.021*				
	knowledge on rice production	0.285	0.005**				

** Significant at $p < 0.01$;

* Significant at $p < 0.05$

Table 4.14 shows that there is a significant contribution of respondents' age, level of education, farming experience, attitude towards rice cultivation, usage of ICT in agriculture, organizational participation and knowledge on rice production. Of these, level of education, attitude towards rice cultivation, knowledge on rice production were the most important contributing factors (significant at the 1% level of significance). Age, farming experience, usage of ICT in agriculture, organizational participation had significant contribution at the 5% level of significance while coefficients of other selected variables don't have any contribution on adoption of BRRI dhan29 production technologies.

The value of R^2 is a measure of how of the variability in the dependent variable is accounted for by the independent variables. So, the value R^2 0.593 means that independent variables accounts for 59% of the variation in adoption of BRRI dhan29 production technologies.

The adjusted R^2 indicates the loss of predictive power or shrinkage. Therefore, the adjusted value (0.571) tells us how much variance in Y (adoption of BRRI dhan29 production technologies) would be accounted if the model has been deprived from the populations from which the sample was taken.

The F ratio is 27.46 which is highly significance ($p<.001$). This ratio indicates that the regression model significantly improved the ability to predict the outcome variable.

The b-values indicate the individual contribution of each predictor to the model. Almost all predictors have positive b-values indicates if scores/ values of predictors (e.g. level of education) increases so do the extent of adoption of BRRI dhan29 production technologies. Usages of ICT in agriculture (b=.945), this value indicates that as usages of ICT in agriculture increase by one unit, adoption of BRRI dhan29 production technologies increase by 0.945 units. This interpretation is true only if the effects of all other predictors are held constant.

However, each predictor may explain some of the variance in respondents' adoption of BRRI dhan29 production technologies conditions simply by chance. In summary, the models suggest that the respective authority should consider farmers' age, level of education, farming experience, attitude towards rice cultivation, usage of ICT in agriculture, organizational participation and knowledge on rice production.

4.3.1 Significant contribution of education on adoption of BRRI dhan29 production technologies

The contribution of education on adoption of BRRI dhan29 production technologies was measured by testing the following null hypothesis;

"There is no contribution of education on adoption of BRRI dhan29 production technologies".

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

i. The contribution of the education was significant at 1% significance level.

ii. So, the null hypothesis could be rejected.

iii. The b-value of level of education is 0.945. So, it can be stated that as level of education increase by one unit, adoption of BRRI dhan29 production technologies increase by 0.945 units. This interpretation is true only if the effects of all other predictors are held constant.

Based on the above finding, it can be said that a rice cultivators had more education increased the capabilities of adoption of BRRI dhan29 production technologies. Education enhances the abilities of the cultivators at a short time than others which transformed them to adopt of BRRI dhan29 production technologies. So, education has significantly contributed to the adoption of BRRI dhan29 production technologies.

4.3.2 Significant contribution of attitude towards rice cultivation on adoption of BRRI dhan29 production technologies

The contribution of attitude towards rice cultivation on adoption of BRRI dhan29 production technologies was measured by testing the following null hypothesis;

"There is no contribution of attitude towards rice cultivation on adoption of BRRI dhan29 production technologies."

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

i. The contribution of the attitude towards rice cultivation on BRRI dhan29 production technologies was significant at 1% significance level.
ii. So, the null hypothesis could be rejected.
iii. The b-value of attitude towards rice cultivation is 0.097. So, it can be stated that as attitude towards rice cultivation increase by one unit, adoption of BRRI dhan29 production technologies increase by 0.097 units. This interpretation is true only if the effects of all other predictors are held constant.

Based on the above finding, it can be said that attitude towards rice cultivation increases cultivators' willingness which helps him/her to adopt it for own benefit. So, attitude towards rice cultivation influenced significantly on the adoption of BRRI dhan29 production technologies.

4.3.3 Significant contribution of rice production knowledge on adoption of BRRI dhan29 production technologies

The contribution of rice production knowledge on adoption of BRRI dhan29 production technologies was measured by testing the following null hypothesis;

"There is no contribution of rice production knowledge on adoption of BRRI dhan29 production technologies."

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

i. The contribution of the rice production knowledge on BRRI dhan29 production technologies was significant at 1% significance level.
ii. So, the null hypothesis could be rejected.
iii. The b-value of rice production knowledge is 0.285. So, it can be stated that as rice production knowledge increase by one unit, adoption of BRRI dhan29 production technologies increase by 0.285 units. This interpretation is true only if the effects of all other predictors are held constant.

Based on the above finding, it can be said that clear understanding of the different aspects of an innovation increases cultivators' knowledge about a new technology which helps him/her to adopt it for own benefit. So, rice production knowledge influenced significantly on the adoption of BRRI dhan29 production technologies.

4.3.4 Significant contribution of age on adoption of BRRI dhan29 production technologies

The contribution of age on adoption of BRRI dhan29 production technologies was measured by testing the following null hypothesis;

"There is no contribution of age on adoption of BRRI dhan29 production technologies."

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

i. The contribution of the age on BRRI dhan29 production technologies was significant at 5% significance level.
ii. So, the null hypothesis could be rejected.

iii. The b-value of age is -0.17. So, it can be stated that as age decrease by one unit, adoption of BRRI dhan29 production technologies increase by 0.945 units. This interpretation is true only if the effects of all other predictors are held constant.

Based on the above finding, it can be said that final adoption of BRRI dhan29 production technologies involves risks. Cultivators who are young are mostly ready to accept risk associated with investment for the adoption of BRRI dhan29 production technologies in rice cultivation. So, the age significantly contributed to the adoption of BRRI dhan29 production technologies.

4.3.5 Significant contribution of farming experience on adoption of BRRI dhan29 production technologies

The contribution of farming experience on adoption of BRRI dhan29 production technologies was measured by testing the following null hypothesis;

"There is no contribution of farming experience on adoption of BRRI dhan29 production technologies."

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

i. The contribution of farming experience on adoption of BRRI dhan29 production technologies was significant at 5% significance level.

ii. So, the null hypothesis could be rejected.

iii. The b-value of farming experience is 0.149. So, it can be stated that as farming experience increase by one unit, adoption of BRRI dhan29 production technologies increase by 0.149 units. This interpretation is true only if the effects of all other predictors are held constant.

Based on the above finding, it can be stated that farming experience increases cultivators' skills on the application of technologies. A skilled rice cultivator can successfully use a technology in his field. So, the farming experience

significantly contributed to the adoption of BRRI dhan29 production technologies.

4.3.6 Significant contribution of usages of ICT in agriculture on adoption of BRRI dhan29 production technologies

The contribution of usage of ICT in agriculture on adoption of BRRI dhan29 production technologies was measured by testing the following null hypothesis;

"There is no contribution of usage of ICT in agriculture on adoption of BRRI dhan29 production technologies."

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

i. The contribution of usage of ICT in agriculture on adoption of BRRI dhan29 production technologies was significant at 5% significance level.
ii. So, the null hypothesis could be rejected.
iii. The b-value of usage of ICT in agriculture is 0.945. So, it can be stated that as usage of ICT in agriculture increase by one unit, adoption of BRRI dhan29 production technologies increase by 0.945 units. This interpretation is true only if the effects of all other predictors are held constant.

Based on the above finding, it can be said that usage of ICT in agriculture increases cultivators' capability on the application of technologies. A capable rice cultivator can successfully use a different production technologies regarding BRRI dhan29 cultivation in his field. So, the usage of ICT in agriculture significantly contributed to the adoption of BRRI dhan29 production technologies.

4.3.7 Significant contribution of organizational participation on adoption of BRRI dhan29 production technologies

The contribution of organizational participation on adoption of BRRI dhan29 production technologies was measured by testing the following null hypothesis;

"There is no contribution of organizational participation on adoption of BRRI dhan29 production technologies."

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

i. The contribution of the organizational participation on adoption of BRRI dhan29 production technologies was significant at 5% significance level.

ii. So, the null hypothesis could be rejected.

iii. The b-value of organizational participation is 0.164. So, it can be stated that as organizational participation increase by one unit, adoption of BRRI dhan29 production technologies increase by 0.164 units. This interpretation is true only if the effects of all other predictors are held constant.

Based on the above finding, it can be said that educated people usually keeps contact with different institutions for enhancing their knowledge about a new innovation. They receive detail information about a technology from different sources as well as different organization. More organizational participation means more adoption. So, the organizational participation significantly contributed to the adoption of BRRI dhan29 production technologies.

4.4 Categorization of BRRI dhan29 Adopters

The BRRI dhan29, as measured by the time in which an individual adopt BRRI dhan29, is continuous. Based on their adoption score, the adopters were classified into five categories following the categorization according to Roger (1995). The distribution of the adopters according to adoption is presented in following Table 4.15.

Table 4.15 Distribution of the BRRI dhan29 adopters according to adoption

Categories	Basis of Categories	Frequency of adopters	Mean of adoption period ($\bar{x}$)	Standard Deviation (σ)
Innovator	($\bar{x}$ - 2σ)	5	3.22	.938
Early adopter	($\bar{x}$ -2σ) to ($\bar{x}$ -σ)	18		
Early majority	(x - σ) to ($\bar{x}$)	48		
Late majority	($\bar{x}$) to ($\bar{x}$ + σ)	38		
Laggards	($\bar{x}$ + σ) to ($\bar{x}$ +2σ)	8		
Total		117		

This is, however, may be partitioned into five adopter categories by lying off standard deviation from the mean time of adoption in a bell-shaped curve in the figure 4.1.

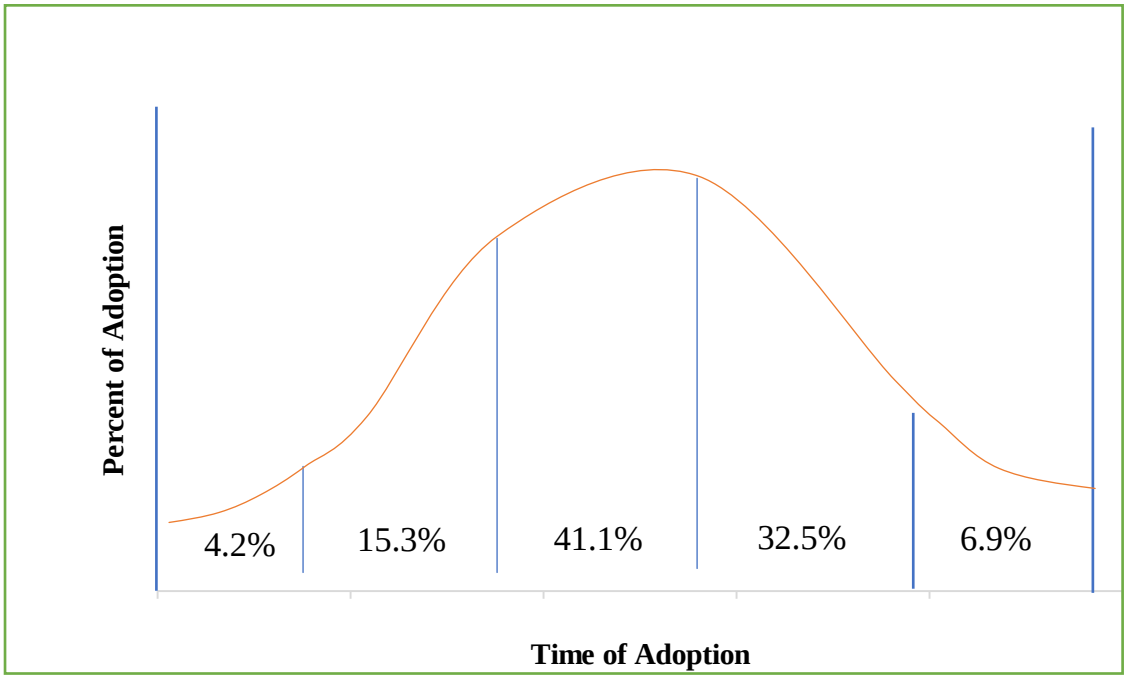

Figure 4.1 Categorization of farmers on the basis adoption of BRRI dhan29 in a bell-shaped curve.

Data presented in figure 4.3.2 indicates that 4.2% of the respondent farmers were innovators, 15.3% early adopters, early majority 41.1%, 31.5% were late

majority & last category was laggards 6.9%. This category almost same as Roger's category and this type of category support Roger's category. From this figure, it may be said that BRRI dhan29 had been properly diffused by the diffusion channel and farmers got sufficient information about adoption of BRRI dhan29. It also says that Roger's findings regarding adopter category are almost similar to our environment.

CHAPTER V

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

The study was conducted in the Sonatala and Dohopara villages of Fulbaria union of Sariakandi upazila under Bogra district to find out the adoption of BRRI dhan29 production technologies. Total 525 rice cultivators were selected from the study area as the population. According to Yamane's formula, 117 BRRI dhan29 cultivators constituted the sample of the study. A well-structured interview schedule was developed based on objectives of the study for collecting information. The independent variables were: age, level of education, farm size, family size, annual family income, farming experience, attitude towards rice cultivation, training exposure, usage of ICT in agriculture, extension media contact, organizational participation and knowledge on rice production. The dependent variable of this study was the adoption of BRRI dhan29 production technologies. Data collection was started in 07 March, 2016 and completed in 26 April, 2016. Various statistical measures such as frequency counts, percentage distribution, average, and standard deviation were used in describing data. In order to estimate the contribution of the selected characteristics of BRRI dhan29 cultivators in the adoption of BRRI dhan29 production technologies, multiple regression analysis (B) was used. The major findings of the study are summarized below:

5.1 Summary of Findings

5.1.1 Selected characteristics of the rice cultivators

Age: The middle-aged rice cultivators comprised the highest proportion (42.7 percent) and the lowest proportion by the old aged category (21.4 percent).

Level of education: Secondary education constituted the highest proportion (43.6 percent) and the lowest 7.7 percent in can't read and sign category.

Farm size: The small farm holder constituted the highest proportion (57.3 percent), whereas the lowest 4.3 percent in marginal farm holder.

Family size: The medium size family constituted the highest proportion (66.7 percent) and only 8.5 percent cultivators had large family size.

Annual income: Medium annual income constituted the highest proportion (70.1 %), while the lowest proportion in low income (14.5 percent) category.

Farming experiences: The majority (70.1 percent) fell in medium farming experience category, whereas only 13.7 percent in low experience category.

Attitude towards rice cultivation: Most of the farmers (57.3 percent) had a moderately favorable attitude towards rice cultivation while 24.8 and 17.9 percent of them had highly and poorly favorable attitude respectively.

Training exposure: The highest proportion (54.7 percent) had medium training exposure category and the lowest proportion (6.8 percent) had no training.

Usage of ICT in agriculture: Most of the farmers (66.7 percent) had medium usage while 25.6 and 7.7 percent of them had low, high usage of ICT in agriculture respectively.

Extension media contact: The highest proportion (65.0%) of the farmers had medium agricultural extension contact as compared to 23.0 percent of them having less agricultural extension contact and 12.0 percent fell in high extension contact

Organizational participation: The highest proportion (67.5 percent) of the respondents had medium organizational participation and the lowest 14.5 percent had high organizational participation.

Knowledge on rice production: The majority (58.1 percent) of the rice cultivators fell in medium knowledge category, whereas and the lowest is 19.7 percent in high knowledge category.

5.1.2 Adoption of BRRI dhan29 production technologies

The highest 67.5 percent rice cultivators belong to the group of medium adoption and the lowest percentage 13.7 percent to low adoption followed by high adoption (18.8 percent).

5.1.3 Variables related on the adoption of BRRI dhan29 production technologies

There is a significant contribution of respondents' age, level of education, farming experience, attitude towards rice cultivation, usage of ICT in agriculture, organizational participation and knowledge on rice production. Of these, level of education, attitude towards rice cultivation, knowledge on rice production were the most important contributing factors (significant at the 1% level of significance). Age, farming experience, usage of ICT in agriculture, organizational participation had significant contribution at the 5% level of significance while coefficients of other selected variables don't show any contribution on adoption of BRRI dhan29 production technologies.

The value of R^2 is a measure of how of the variability in the dependent variable is accounted for by the independent variables. So, the value R^2 0.593 means that independent variables accounts for 59% of the variation in adoption of BRRI dhan29 production technologies. The adjusted R^2 indicates the loss of predictive power or shrinkage. Therefore, the adjusted value (.571) tells us how much variance in Y (adoption of BRRI dhan29 production technologies) would be accounted if the model has been deprived from the populations from which the sample was taken. The F ratio is 27.46 which is highly significance ($p<.001$). This ratio indicates that the regression model significantly improved the ability to predict the outcome variable.

The b-values indicate the individual contribution of each predictor to the model. Almost all predictors have positive b-values indicates if scores/ values of predictors (e.g. level of education) increases so do the extent of adoption of BRRI dhan29 production technologies. However, each predictor may explain

some of the variance in respondents' adoption of BRRI dhan29 production technologies conditions simply by chance. In summary, the models suggest that the respective authority should consider farmers' age, level of education, farming experience, attitude towards rice cultivation, usage of ICT in agriculture, organizational participation and knowledge on rice production.

5.2 Conclusions

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

i. It may be concluded that the composite adoption of BRRI dhan29 production technologies is moderate and needs further advancement.

ii. It may, therefore, be concluded that extension teaching should be given to all age categories of the farmers especially to the young and middle aged farmers by the extension workers in order to exhort adoption of BRRI dhan29 production technologies. However, envisaging the facts it would be wise to work with old aged farmers as they more than the others.

iii. Level of education of the farmers showed the most important contributing factor on adoption of BRRI dhan29 production technologies. This means that high literacy and educational level among the farmers might have influenced high BRRI dhan29 production technologies. Conclusion could be made that these farmers could be more ameliorated in all aspects of socio-economic life if government takes more educational project to make the farmers' more educated.

iv. It may be concluded that high farming experience encourage the farmers to adopt BRRI dhan29 production technologies.

v. Farmer's attitude towards rice cultivation had a significant contribution on adoption of BRRI dhan29 production technologies. It is, therefore, concluded that extension workers should vocation adequately with the farm

people through various teaching methods and correctly envisaging those characteristics of the farmers which have some bearing on these activities.

vi. The findings revealed that usages of ICT by the farmers had a significant contribution on adoption of BRRI dhan29 production technologies. Usages of ICT by the farmers increase the outlook of the farmers which lead them to adopt BRRI dhan29 production technologies.

vii. Conclusion could be drawn that if the farmers would be motivated to participate in organizational activities then the adoption of BRRI dhan29 production technologies would likely to enhance.

viii. Rice cultivation knowledge of the respondents had a significant contribution on adoption of BRRI dhan29 production technologies. The above facts lead to the conclusion that necessary arrangements should be made increase the knowledge of farmers which would ultimately increase the adoption of selected rice production practices.

5.3 Recommendations

5.3.1 Recommendations for policy implications

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

i. It is, therefore, recommended that an effective step should be taken by the Department of Agricultural Extension (DAE) and Non-Government Organizations (NGOs) for strengthening the farmers' qualities in favor of adoption of BRRI dhan29 production technologies to a higher degree.

ii. Age had a significant contribution on adoption of BRRI dhan29 production technologies in the study area. Therefore, it is recommended that the extension workers should work with the farmers of all age groups to enhance the adoption of BRRI dhan29 production technologies. However, they will have to collaborate more comparatively with middle aged farmers.

iii. Level of education of the farmers had a significant contribution on adoption of BRRI dhan29 production technologies. It indicates the importance of education of the BRRI dhan29 cultivators for rapid adoption of production technologies. It may be recommended that arrangements should be made for enhancing the education level of the BRRI dhan29 cultivator by the concerned authorities through the establishment of night school, adult education and other extension events as possible.

iv. Farming experience of the rice cultivators was important contributing factors on adoption of modern rice cultivation technologies. Therefore, it is recommended that the extension workers should work with the experienced farmers to enhance the adoption of BRRI dhan29 production technologies.

v. It was observed that higher (86 percent) number of the farmers had higher attitude score towards rice cultivation. It may be recommended that massive demonstration programs, training programs, field trips etc. should be implemented to bring about considerable changes in the farmers' attitude.

vi. The concerned authorities should take necessary steps to increase the usages of ICT in agriculture by the farmers. Therefore, it is recommended that the extension worker should provide supplementary supports to use ICT in agriculture so that farmers themselves could come in contact with ICT.

vii. Since organizational participation had significant contribution on adoption of BRRI dhan29 production technologies, it is recommended that the concerned authorities should take necessary steps to mobilize the farmers towards organizational activities.

viii. Farmers having medium to high knowledge about rice cultivation. It should be selected on priority basis for any motivational training by Department of Agricultural Extension (DAE) and Non-Government Organizations (NGOs) for running sustainable rice production.

5.3.2 Recommendations for further study

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

i. It is recommended that similar studies should be conducted in other areas of Bangladesh.

ii. It is recommended that further study should be conducted with other characteristics of the farmers with their adoption.

iii. Studies need to be undertaken to ascertain the principles and procedures for installation, patronization of nursing association in rural areas of Bangladesh.

iv. It is therefore suggested that future studies should be included more reliable measurement of concerned variable.

v. Further studies may be conducted in respect of adoption of other crop production technologies.

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APPENDIX-I

ENGLISH VERSION OF THE INTERVIEW SCHEDULE

Department of Agricultural Extension and Information System

Sher-e-Bangla Agricultural University
Dhaka-1207

An Interview Schedule for the Study Entitled

ADOPTION OF BRRI DHAN29 PRODUCTION TECHNOLOGIES BY THE FARMERS IN THE SELECTED AREAS OF SHARIAKANDI UPAZILA UNDER BOGRA DISTRICT

Name of the respondent: …… Serial No: ……

Union: …….

Village: ……..…..…

(Please provide following information. Your information will be kept confidential and will be used for research purpose only)

1. Age

How old are you? _____years.

2. Level of education

Please mention your level of education.

a) I can't read and write ☐

b) I can sign only ☐

c) I have passed…….class.

d) I took _____ years non-formal education.

3. Farm size

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

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

4. Family size

How many members are there in your household including you? .....

5. Annual family income

Please mention the amount of annual income from the following sources during last year:

a) Income from Agricultural Crops

SL. No.	Crop Name	Production (Kg or Maund)	Cost/Kg or Maund	Total Cost
1.	Rice			
2.	Wheat			
3.	Maize			
4.	Jute			
5.	Potato			
6.	Pulse crop			
7.	Oil crop			
8.	Spice crop			
9.	Vegetables			
10.	Fruits			
Total				

b) Income from animals and fish resources

Sl. No.	Income resources	Production (Kg or Maund/Number)	Cost/Unit (Tk)	Total Cost (Tk)
1.	Livestock			
2.	Poultry			
3.	Fish resources			
Total				

c) Income from other resources

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

6. Farming experience

What is your present age of farming experience? ..... Years

7. Attitude towards rice cultivation

Please indicate your agreement with the following statement:

SL. No.	Statement	Extent of agreement/disagreement				
		SA (2)	A (1)	UD (0)	DA (-1)	SDA (-2)
1 (+)	Chemical fertilizers increase rice production					
2 (-)	Modern varieties do not help to increase rice production					
3 (+)	Transplanting seedling with proper spacing increases rice production					
4 (-)	Organic manure does not improve soil quality					
5 (+)	Yield of crops decreases if we transplant modern variety seedling lately					
6 (-)	Disease and pest do not cause any harm for crop production					
7 (+)	It is necessary to aggregate plant and animal to balance environment					
8 (-)	Country plough is more effective than mould board plough					

Note: SA= Strongly Agreed; **A**=Agreed; **UD**=Undecided; **DA**=Disagreed; **SDA**= Strongly Disagreed;

8. Training exposure

Please mention about your training exposure on rice cultivation:

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

9. Usage of ICT in agriculture

Please indicate how often you use these e-Agriculture media:

Sl. No.	Name of ICT in Agriculture	Extent of uses				
		Regularly (4)	Frequently (3)	Occasion -ally (2)	Rarely (1)	Not at all (0)
1.	Mobile Phone- Call/ Tele-center					
2.	Video-audio documentary, agril. content digitization					
3.	Website or portal in Bangla and English					
4.	Television telecast/ Radio broadcast					

10. Extension media contact

Please state the extent of your contact with the following ones:

Sl. No.	Name of information sources	Extent of contact				
		Regularly (4)	Frequently (3)	Sometimes (2)	Rarely (1)	Not at all (0)
1.	Ideal farmer/ 3 months	8 or more times	6-7 times	4-5 times	1-3 times	
2.	Fertilizer dealer/3 months	≥ 10 times	8-9 times	4-7 times	1-3 times	
3.	Insecticide dealer/3 months	≥ 10 times	8-9 times	4-7 times	1-3 times	
4.	Seed dealer/3 months	≥ 10 times	8-9 times	4-7 times	1-3 times	
5.	Agricultural magazine, poster, leaflets/3 months	≥ 10 times	8-9 times	4-7 times/ 3 months	1-3 times	
6.	Sub Assistant Agricultural Officer/3 months	≥ 10 times	8-9 times	4-7 times	1-3 times	
7.	Upazila level Agricultural Officers/3 months	≥ 10 times	8-9 times	4-7 times	1-3 times	
Total						

11. Organizational participation

Please mention the nature and duration of your participation:

Sl. No.	Name of organizations	Not involved (0)	Nature of Participation		
			Ordinary Member (1)	Executive Member (2)	President/ Secretary (3)
1.	Religious committee				
2.	School committee				
3.	Farmers' association				
4.	Bazar Committee				
5.	Co-operative society				
6.	NGO organized society				
7.	Youth club				
8.	Union council				
9.	Social welfare organization				
10.	Others (please specify…….)				

12. Knowledge on rice production

Please answer the following question about rice cultivation

Sl. No.	Questions	Full marks	Marks obtain
1.	Mention 3 rice varieties.	3	
2.	Mention 3 diseases of rice	3	
3.	Mention 3 harmful insect of rice	3	
4.	What is soil fertility?	3	
5.	What is the Nitrogen deficiency symptom of rice?	3	
6	How many types of rice based on season?	3	
7.	Distinguish between local variety and HYV?	3	
8.	What is the control measure of rice borer?	3	
9.	What dissimilarities between manure and fertilizer?	3	
10.	What should be done for rice seed storage?	3	

ADOPTION

13. Please answer following questions:

When you heard about BRRI dhan29? ……

When you started cultivation? …….

Times required after listening BRRI dhan29 to cultivate: ……. years.

14. Adoption of BRRI dhan29 production technologies

Please answer the following questions:

Sl. No.	Name of the technology	Years	Potential area (p)	Effective area (e)	e/p
1.	Modern agricultural machineries	**2013-2014**			
		2014-2015			
		2015-2016			
2.	Seedling growing method	**2013-2014**			
		2014-2015			
		2015-2016			
3.	Line transplanting	**2013-2014**			
		2014-2015			
		2015-2016			
4.	Recommended balanced fertilizer dose	**2013-2014**			
		2014-2015			
		2015-2016			
5.	Leaf color chart	**2013-2014**			
		2014-2015			
		2015-2016			
6.	Integrated Pest Management (IPM)	**2013-2014**			
		2014-2015			
		2015-2016			
7.	Alternate Wetting and Drying (AWD)	**2013-2014**			
		2014-2015			
		2015-2016			

Thank you for your kind co-operation.

Date: ……

……..……..

(Signature of the interviewer)