IDENTIFICATION OF INDIGENOUS TECHNICAL KNOWLEDGES (ITKs) AS CLIMATE SMART AGRICULTURE (CSA) TECHNOLOGY

A Thesis

By

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DEDICATED
TO
MY
BELOVED PARENTS

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ABSTRACT

Indigenous Technical Knowledge (ITK) is the rural people's basic knowledge that provides sufficient information for the decision-making of the small and marginal farmers that helps in social upliftment. The focus of the study was to identify Indigenous Technical Knowledges (ITKs) as Climate Smart Agriculture (CSA) technology. The study was conducted in three unions of Chitalmari upazila under Bagerhat district with purposively selected 110 respondents and data were collected from the sampled respondents through personal interview using an interview schedule from 9th March, 2023 to 18th March, 2023. Majority (53.6%) of the respondents were in the medium use category of ITKs. The respondent farmers of the study used fifty-one ITKs to different extent. However, 'Soaking vegetable seeds in water for better germination' was used to the highest extent (90.30%) followed by 'Feeding molasses and table salt to cattle. On the other hand, 'A mixture of catechu and *haritaki* extract in the water to protect fertilized eggs from damage' was used to the lowest extent (1.82%). The articulation of the selected ITKs clearly indicated their benefits scientifically and suitability of used as CSA technology. Knowledge of ITKs' had a significant positive correlation with the use of ITKs. Farmers had severe problems regarding use of ITKs (79.1%) and 'Preference of farmers for sophistication with reliance on readymade inputs' ranked 1st among the identified 15 problems. Farmers perceived that the suitability of ITK-related solutions was medium and 1st position was ranked by the solution against ITK related problems 'ITKs should be used combined with environment-friendly modern techniques to get solutions of almost all situations.' So, the adoption of ITKs as CSA technology is very crucial to overcome the challenges of the climate-changing world.

Keywords: Adoption, articulation, constraints, CSA technology, indigenous practices.

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CHAPTER I

INTRODUCTION

1.1 Background of the Study

Agriculture is a vital sector for the livelihood of many communities around the world. It not only provides food and income for farmers but it also plays a crucial role in preserving cultural heritage and promoting sustainable development. Like other developing countries in this subcontinent, Bangladesh is regarded as one of the richest in terms of Indigenous Technical Knowledge (ITK) due to a range of ethnic communities, multiplicity of cultures, history and values. The country primarily consists of agrarian land with 47.50 percent of the labor force dependent on agriculture which contributes to 16.33 percent of the GDP of the country's total economy (BER, 2014). All these rapid changes in economic, technological and demographic conditions along with the creation of new market opportunities, promotion of chemical inputs and financial constraints have led or forced the farmers of Bangladesh to seek short-term profits and pay less attention to keeping their agriculture in balance with the ecological conditions. In modern farming practices, the environment has been treated in an unfriendly manner (Rahman, 2012). In recent years, there has been a renewed interest in traditional or indigenous farming methods which are based on the knowledge and practices passed down from previous generations. These methods are often well-adapted to the local environment and can be more sustainable and resilient than modern and industrial farming techniques (Altieri, 1999).

Indigenous technical knowledge is the fundamental knowledge of rural individuals that offers ample guidance for small and marginal farmers to make correct decisions and ultimately contributes to the betterment of society. Louise Grenier (1998) specified indigenous knowledge as "the unique, historic, local knowledge existing within and developed around the specific condition of women and men indigenous to a particular geographic area". ITKs help in maintaining the organic matter content of the soil, gene pools and conservation of indigenous varieties thus balancing biodiversity (Sharma et al., 2020). Such technical knowledge is passed down through daily life from generation to generation. Indigenous technical knowledge is valuable for the culture in which it develops as well as for researchers and urban planners working to improve living standards in rural areas (Warren, 1991). Currently, many ITKs are in danger of going extinct because of the excessive adoption of modern scientific knowledge. Many uneducated and underprivileged farmers are unable to use modern technologies. Modern technology benefits farmers in the short term but at the expense of long-term environmental degradation.

The research institutions and experimental farms in better-off parts of Bangladesh produce technologies and efforts are frequently made to transmit these ready-made, expensive technology packages to farmers. As a result, the majority of smallholders profit little from these technologies which occasionally make their situation worse by forcing them to cultivate more marginal land as capital-intensive farming spreads across better land. ITKs must be reinvented in order to be used to their fullest potential for future applications.

Recently, the general public has begun to understand the terrible consequences of pesticide use. Additionally, the poor socioeconomic conditions and rising landlessness of rural farmers are driving them to select low-input agriculture as an alternative. In order to achieve sustainable development, it is crucial to use a variety of indigenous agricultural technologies, including intercropping, seed germination, weed and pest control, variety of crops, seed preservation, fish and animal production, breeding, soil conservation, irrigation and water conservation. Experts in extension, researchers, policymakers and international organizations should pay particular attention to this realization.

In fact, the use of modern technology in Bangladesh's agriculture has given rise to troubling sustainability concerns (Farouk and Salam, 1996). In the past year, it has become increasingly clear that high-external-input agriculture has negative environmental and social effects. At the same time, numerous disadvantaged communities of smallholders have been forced to use the resources that are available to them so intensively that environmental degradation is now becoming a great problem.

Besides, climate change also creates a great disaster for agriculture and poor farmers. In many parts of the world, millions of people's livelihoods, food security and agriculture are now seriously threatened by climate change (Field et al., 2014). According to a number of studies, changes in rainfall patterns (Lobell et al., 2012; Aggarwal et al., 2009; Prasanna, 2014; Mall et al., 2006); temperature changes; and variations in the frequency and intensity of extreme climatic events like floods and droughts (Brida and Owiyo, 2013; Singh et al., 2013) could all have a significant impact on agriculture production. According to estimates of the effects of past and future climate change on cereal crop yields in various regions, the yield loss can range from 35% for rice to 60% for maize depending on the location, future climate scenarios and projected year (Porter et al., 2014). Some of the main causes of climate change impacts on agriculture include changes in crop cultivation appropriateness and associated agricultural biodiversity, a decline in input usage efficiency and an increase in the incidence of pests and diseases (Zabel et al., 2014; Norton, 2014). To ensure the food and livelihood security of farming communities, agricultural production systems must be adapted to these changes.

There are a number of potential adaptation solutions, to lessen the moderate to severe climatic hazards to agriculture. Climate-smart agriculture (CSA) technology, practices and services are adaptation choices that sustainably boost productivity, improve resistance to climatic shocks and lower greenhouse gas emissions (FAO, 2010). According to Vermeulen et al. (2012) and Lipper et al. (2014), the main objective of CSA is to build resilient food production systems that ensure both food and financial security in the face of ongoing climate change and variability. Numerous agricultural techniques and technologies including minimum tillage, various crop establishment techniques, nutrient and irrigation management and residue incorporation, can increase crop yields, increase the efficiency of the use of water and nutrients and lower greenhouse gas (GHG) emissions from agricultural activities (Branca et al., 2011, Jat et al., 2014, Sapkota et al., 2015). The use of better seeds, ICT-based agro-advisories, crop/livestock insurance and rainwater harvesting can all assist farmers in lessening the effects of climate change and variability (Mittal, 2012; Altieri and Nicholls, 2013). The CSA alternatives generally include conventional and cutting-edge methods, tools and services that are pertinent for a specific place to adapt to climate change and variability (CIAT, 2014). In this study, technology or practice is deemed to be climate smart if it can assist in achieving at least one pillar of CSA (either by increasing production, increasing resilience, or lowering GHG emissions). Farmers must choose adaptation strategies ex-ante under climate risk and make short- and long-term investments based on the magnitude of the existing climate variability and the anticipated climate change in the future (Callaway, 2004).

The application of CSA technologies (hereinafter referred to as CSA technologies) singly or in combination has a significant potential to lessen the effects of climate change on agriculture. For instance, Finger and Schmid (2007) predicted that straightforward adaptation strategies like shifting agricultural planting dates and implementing irrigation technology might lead to higher yields with fewer fluctuations than those achieved without adaptation. According to a meta-analysis of agricultural simulations conducted under various climatic scenarios (Challinor et al., 2014), farm level modifications can boost crop yields by an average of 7–15% when compared to those without adaptation. According to numerous research, the advantages of adaptation depend on the crop as well as on variations in temperature and rainfall (Easterling et al., 2007). Similar to this, multiple farm level studies (Khatri-Chhetri et al., 2016, Sapkota et al., 2014, Gathala et al., 2011) indicate that adoption of CSA technology can improve crop yields, boost input usage efficiency, raise net income and reduce GHG emissions.

Despite the many advantages of CSA technology, farmers are currently adopting them at a rather low rate (Palanisami et al., 2015). The socioeconomic makeup of farmers, the biophysical context of a specific place and the characteristics of new technology are only a few of the many variables that affect how widely CSA technologies are adopted (Campbell et al., 2012; Below et al., 2012; Deressa et al., 2011). Major obstacles to scaling out CSA in various agroecological regions include the discovery, prioritization and promotion of existing CSA technologies while taking into account regional climate concerns and technology demand.

ITKs can be used as CSA technology. ITKs have significant benefits if explored, they are alternatives that can be widely adapted, they are simpler, safer and less expensive to adopt than those of modern technology, they are a safer alternative to harmful chemicals and they are environmentally friendly and play a momentous role in sustainable development (Kanak Pervez et al., 2015). In Bangladesh, rural farmers play a vital role in developing, preserving and reinjecting ITKs into the livelihood system. To increase the production of farm inputs, it is crucial to conduct research and preserve local expertise. These priorities are necessary because there is an increasing need to record these ITKs and inform researchers, development professionals and funding organizations about the benefits of maintaining and enhancing them to increase productivity. On this topic, very little research has been conducted in Bangladesh.

Hence the study was undertaken to identify the ITKs as CSA technology, farmers' extent of adoption of those ITKs and address the problems and solutions behind the non-adoption.

1.2 Statement of the Problems

A lot of challenges are being faced in agriculture due to climate change impacts. Many of the farmers are utilizing ITKs to overcome the faced challenges. However proper enlistment of those ITKs is not yet done. Besides those ITKs validity need to be assessed as CSA technology.

The present study was undertaken with the title 'Identification of Indigenous Technical Knowledges (ITKs) as Climate Smart Agriculture (CSA) Technology' in view of the above background and facts. The aim of the study was to provide information under the following queries

i. What are the ITKs used by rural farmers in agriculture?
ii. How aware are the rural farmers regarding ITKs and the purpose behind their use?
iii. How suitable are the identified ITKs as CSA technology?
iv. How is the relationship between selected demographic characteristics of farmers and ITKs?
v. What are the problems and solutions to adopting ITKs?

1.3 Objectives of the Study

Considering the facts this study was conducted to identify Indigenous Technical Knowledges (ITKs) as an indicator of Climate Smart Agriculture (CSA) Technology. The following specific objectives were formulated to give proper direction to the study

i. To identify the ITKs used by rural farmers and the adoption level of ITKs in agriculture
ii. To articulate the suitability of identified ITKs as CSA technology through literature review and scientific explanation
iii. To explore the relationship between selected demographic characteristics of farmers and use of ITKs
iv. To identify the constraints and solutions for the adoption of ITKs in agriculture

1.4 Scope of the Study

Indigenous technical knowledge (ITK) is a suitable set of technology for farming activities that is most cost-effective and environmentally safe. The majority of Bangladeshi farmers are extremely impoverished, making it difficult for them to accept modern technology. ITK is very effective and applicable for farm management for researchers, extension personnel and crop producers which are more economical, less hazardous and can cope with the climate change impacts.

The researcher considers a scientific analysis to be a valuable document for various government, autonomous and non-government organizations to plan, organize and generate appropriate technologies for sustainable agricultural development and to successfully identify the ITKs and understand the phenomena related to the study's objectives. The scopes of the study are as follows

i. The study was conducted in Chitalmari Upazila of Bagerhat district. It is hoped that the findings may also be applicable to other parts of Bangladesh where the physical, socioeconomic and other cultural conditions are similar to those of the study area.
ii. The research findings may also be useful for agricultural extension service providers to develop strategic actions for conserving a welcoming farm environment for rural farmers.
iii. The researcher also thinks that developing extension programs to lower production, health and environmental risk will benefit from the study's findings and suggestions.
iv. According to the relationships between the personal characteristics of farmers and the use of ITKs by the farmers, more specified plans can be undertaken to select adequate and proper ITKs to improve the condition of ITK adoption.
v. The researcher's knowledge and expertise obtained during the study's execution will be useful to him in conducting future research.

1.5 Assumptions of the Study

According to Goode (1945), an assumption is a supposition that an apparent fact or principle is true in the light of available evidence. While conducting the investigation, the researchers held the following assumptions in their heads

i. The sampled respondents were capable of furnishing suitable responses to the questions contained in the interview schedule.
ii. The researcher was well conscious of the social and cultural environment of the study area.
iii. The collected data were free from bias.
iv. The views and opinions expressed by the respondents who made up the sample were the representative views and concepts of the entire population of the research area.

v. The responses that the respondents provided were reliable and truly expressed.
vi. The responses might be rated by the researchers with adequate precision.
vii. The information searched by the researcher reveals the real situation to satisfy the objectives of the study.

1.6 Limitations

i. The study was confined to three unions namely Charbaniari, Shibpur and Chitalmari under Chitalmari upazila of Bagerhat district. The findings may not accurately reflect the overall situation of the country due to the vast range of natural variation and differences amongst social systems.
ii. Only a few selected characteristics of respondents were taken into account for the investigation.
iii. There is numerous indigenous farming technology that farmers develop, but only fifty-one of these were chosen for measuring the extent of their use.
iv. The population for the present study was confined to just the heads of farm families in the study region because they were the ones who made decisions for their respective families about the use of ITKs in farming activities,
v. There were no scientific explanations or literature about some of the ITKs that the farmers used.
vi. The efficacy of the selected ITKs was not assessed.
vii. The interview schedule was prepared in English but was translated into the mother tongue Bangla while interviewing data.

1.7 Definition of Key Terms

Certain key terms were used throughout this study which are defined here for clear understanding.

Indigenous Technical Knowledge (ITK): In the current study, ITK is used to refer to the totality of knowledge and practices that are unique to a particular culture and are based on people's accumulated experiences in dealing with situations and problems in various aspects of life. ITK is surrounded by numerous areas including agriculture, resource management, food and nutrition and education. Due to financial and time constraints, the author limited his research to ITKs relevant to the agriculture sector she chooses (crop production, livestock production and fish production) in order to stay within her area of expertise and interest.

Climate Smart Agriculture (CSA): An integrated method of managing landscapes including crops, livestock, forests and fisheries known as climate-smart agriculture (CSA) which tackles the interlinked challenges of food security and accelerating climate change. CSA aims to simultaneously achieve the outcomes of increased productivity, enhanced resilience and reduced emissions.

Technology: Technology is a plan for practical action that reduces the degree of uncertainty in the cause-and-effect relationship necessary to bring about a desired outcome.

CSA Technologies: CSA technologies offer opportunities for addressing climate change challenges as well as for economic growth and development of agriculture.

Climate Change: Long-term changes (30 years) in temperature and weather patterns are referred to as climate change.

Green House Gas (GHG): A gas that absorbs infrared light and hence contributes to the greenhouse effect is called a greenhouse gas. Examples of greenhouse gases are chlorofluorocarbons and carbon dioxide, etc.

Knowledge of ITKs: It refers to the farmers' empirical or practical knowledge of the actions of the indigenous practices.

Attitude: It refers to the positive or negative reaction of a respondent towards implementing ITK and the outcome of ITK.

Innovators: These individuals who adopt new technology or ideas simply because they are new, tend to take risks more readily and are the most venturesome are known as innovators.

Early Adopters: Early adopters tend to create opinions that propel trends. They are not unlike innovators in how quickly they take on new technologies and ideas but are more concerned about their reputation as being ahead of the curve.

Early Majority: If an idea or other innovation reaches this group, it usually adopts it quickly. This group makes decisions based on utility and practical benefits of that thing. These group are known as early majority.

Late Majority: While the late majority exhibits certain characteristics of the early majority, they are less willing to commit and require more encouragement as they adopt.

Laggards: This group takes time to adopt new concepts or technologies. They frequently only adopt when they are forced to or when it already belongs to everyone.

***Hukkah*:** *Hukkah* is a water pipe that is used to smoke specially made tobacco.

CHAPTER II

REVIEW OF LITERATURE

Reviews of the literature related to the main study are presented in this chapter. Several research projects on farmers' indigenous technical knowledge have been conducted in a variety of nations which may be important to highlight here. The literature was organized into sections. However, this chapter just briefly discusses the literature of the research that is currently available.

2.1 Review of Indigenous Technical Knowledges (ITKs) and CSA Technology

2.1.1 Definition and concept of ITK in agriculture

Indigenous knowledge encompasses much more than just technical methods. It encompasses a wide range of understandings, perceptions and intuitive understandings of the environment, including things like lunar and solar cycles, astrology, meteorological and geological conditions and more. This type of knowledge often referred to as "folk wisdom," is typically intertwined with cultural beliefs and norms and is expressed through traditions and myths. Additionally, traditional forms of communication, such as songs and proverbs and traditional social structures and forms of cooperation are also part of the local knowledge system. However, it may be difficult for those trained in Western science to fully grasp and understand these knowledge systems (Thrupp, 1989).

As stated by Warren (1991), indigenous knowledge refers to knowledge that is specific to a particular culture or society. It serves as the foundation for communication and decision-making within that society. Furthermore, this knowledge is constantly evolving both through the creativity and innovation of the indigenous people, as well as through interactions with other knowledge systems.

The indigenous knowledge of farming communities living in a certain region is derived from their past farming experiences, both from previous generations and from the present generation. When farmers adopt technologies developed elsewhere, it becomes a part of their indigenous knowledge as much as their self-developed technologies. The farmers' practical understanding of the local ecosystem and how to interact with it is evident in their farming techniques and their ability to use natural resources to sustain their livelihoods (Reijntjes et al.,2002).

According to Chowdhury et al. (1996), indigenous traditional knowledge (ITK) is developed over time by indigenous people and farmers who have built up a wealth of knowledge and practices specific to their location, including in areas such as agriculture, natural resource management, human and animal health care and more. This collection of knowledge, traditional beliefs and practices is often referred to as indigenous or traditional knowledge.

2.1.2 Significance of ITK in agriculture

Scientists, development workers and policy planners around the world now agree that focusing on and evaluating local technologies is essential for sustainable agricultural development. The following reviews highlight the importance of indigenous technical knowledge (ITK) in achieving sustainability in agriculture.

Verma and Singh (1969) emphasized that ITK is the result of an evolutionary process, developed over thousands of years of experience. They assert that traditional wisdom is tested over time and understanding the dimension of the technology that the local farmers use can help researchers determine the degree and direction of change through formal research.

Talawar and Singh (1992) suggested that understanding the science behind indigenous knowledge systems would aid in comprehending the concepts and practices that promote sustainability, which can be integrated with modern information systems for the efficient management of resources.

Reijntjes et al. (2002) reported that in recent years, there has been a growing scientific interest in locally-developed farming systems and technologies. These are seen as a source of sound ideas, locally adapted cultivars and practices that could lead to sustainable use of resources of nature.

Sharland (1991) referred to the statements of Warren (1991) and pointed out that agricultural scientists accept that indigenous technical knowledge must be reassessed for introducing new agricultural technology, as farmers have a wealth of information about their environment that should be taken into account. The author also opined that indigenous technologies used by one society to solve problems can also be used to solve problems faced by another society in a similar agroecosystem in another part of the world. As knowledge is a valuable national resource, its systems are dynamic and continually influenced by internal creativity and experimentation as well as by contact with external systems. It helps ensure that the end-users of agricultural development projects are involved in developing technologies appropriate to their needs. It is cost-effective as well as it builds development efforts, enhancing sustainability and capacity building.

Thrupp (1989) informed that today some researchers and development workers have recognized that rural people have a great richness of knowledge about their resources, environments and farming practices and are often experimenters, risk-takers, innovators, intensifiers, diversifiers and practitioners of great common sense, who have remarkable capacities to adapt to change and constraints of evolving their technologies over time. This technical knowledge of the farmers has been ignored by researchers, planners and development workers. Rather top-down approaches are being tried with the least success and quite often displacing or neglecting societies' resource-poor rural people.

Many experts argue that indigenous knowledge is a valuable source for sustainable development and resource management. Gupta (1989) suggests that knowledge generated by communities such as peasants, pastoralists and artisans, as well as women in the household, can be used to create new technologies for sustainable development.

Chowdhury et al. (1996) argued that this knowledge which is a storehouse of accumulated experience in natural resource management, should be valued and integrated into agricultural development.

Altieri (1996) notes that scientists are increasingly looking to traditional agriculture as a way to address the deficiencies of modern agricultural development, recognizing that indigenous farmers may hold solutions for the future of Andean agriculture.

Shah (1994) argues that while indigenous systems may not work in every situation, the integration of local and external technologies can lead to appropriate solutions in the farming practices.

Rist (1991) notes that indigenous techniques, while traditional, can also be considered modern in the context of sustainable agriculture. Multiple studies have demonstrated the significance of utilizing the existing knowledge and decision-making abilities of farmers in development projects.

2.1.3 Scope of ITK research in Bangladesh

The use of Indigenous Technical Knowledges (ITKs) is considered a crucial aspect of agricultural extension systems and natural resource management processes. Research on ITKs is deemed essential in order to fully utilize its potential as an alternative to chemical agriculture and as a means of providing economic benefits and easy adaptation for poor and illiterate farmers. The National Environment Management Action Plan (NEMAP 1995) and the New Agricultural Extension Policy (NAEP 1996) have both emphasized the importance of ITKs and have recommended their use as an environmentally friendly technology. Despite its significance, research on ITKs in Bangladesh has been limited, with early work on the subject starting in the late 1990s such as the methodology for ITKs documentation by Sillitoe et al. (1998) and Quddus (2000) who provided a framework for indigenous knowledge-based research and development programs.

The National Environment Management Action Plan (NEMAP 1995) and the New Agricultural Extension Policy (NAEP 1996) both recommend the use of ITKs as a means of maximizing land use efficiency and promoting environmentally friendly agriculture. Despite the importance of ITKs, research on this topic in Bangladesh has been limited.

ITKs have a wide range of uses in Bangladesh such as the use of plants and plant parts for human and livestock health. Researchers have conducted studies on these aspects, documenting traditional medicine and the sustainable use of biodiversity. The use of ITKs in medicinal treatments for various diseases, including skin diseases and fungal and bacterial infections, is common. Additionally, ITKs are utilized for other purposes such as Disaster Risk Reduction (DRR) and Natural Resource Management (NRM). The use of ITKs in DRR has a long history in the country and it plays a vital role in management activity during emergency situations. The community-based disaster risk reduction project also uses ITKs as a programmatic tool to strengthen community-based disaster mitigation initiatives. ITKs are also used to predict the occurrence of natural hazards and to avoid loss of life and assets. In NRM, ITKs are used to protect forest plants from insects and borer attacks, which sustain vegetation in catchment areas and the economy, livelihood and culture of the tribal people are closely interlinked with the natural resources. Rahman (2000b) discussed the traditional method of agroforestry, known as "jhum," that is commonly used in Bangladesh, where both long-term tree crops and short-term vegetable crops are cultivated simultaneously.

Beside agriculture, the use of traditional knowledge (ITKs) in fishery and livestock rearing is very common. Fishermen and fish traders use various technologies to make their work easier. For example, Shah and Townsley (2000) found that traditional fish traders and fishermen in central Bangladesh developed a system of carp polyculture using existing water bodies, without the need for outside assistance. Hasan et al. (2009) studied the extent of ITKs used in fisheries and livestock, identifying nine ITKs commonly used in fisheries and 25 ITKs in livestock. Chadwick et al. (1998) conducted research on water resource management and indigenous knowledge in Bangladesh and found that farmers and fishermen have a deep understanding of their environment and have developed appropriate management systems. Ghosh (2002) looked at how floodplain farmers use their traditional knowledge in making farm-related decisions. He found that farmers often need to look for alternatives due to various constraints, as the floodplain is a risky area. Rahman (2012) studied the extent of ITKs used by farmers in crop fields and found 50 ITKs utilized by farmers in their agricultural practices.

So, there is a great scope for the researchers to research on ITKs in Bangladesh.

2.1.4 Awareness of Indigenous Technical Knowledge

Kanak Pervez et al. (2015) observed that the majority of the respondents were considered to have moderate awareness of ITKs. A small percentage were considered to have low awareness than high awareness of ITKs. The farmers are well aware of every aspect of agriculture. Even while their understanding is beneficial to sustainable agriculture, many times they are genuinely ignorant of environmental problems. ITKs have a specific manner of modifying the material and economic demands because of their low-cost characteristics which are related to the livelihoods of disadvantaged people. The majority of household resources are better utilized by rural women for constructive purposes that would otherwise go to waste. ITKs are typically regarded as outdated. ITKs are not seen as a contemporary component of agriculture. According to the most recent studies, involvement in organizations and education cosmopolitism and rural women's awareness of global issues are negatively correlated with the rural farmers' awareness of ITKs. The educational system of Bangladesh is far away from ethnic and traditional knowledge. ITKs are consequently acquired informally from family and the community. Similarly, organizational participation and cosmopolitism have a negative impact on ITK awareness. The political and professional leaders' ignorance of the significance of ITKs is the primary cause. When individuals become objectively aware of their own indigenous knowledge base, sustainable agriculture is achievable.

2.1.5 Knowledge and attitude of farmers on ITKs

The research of Khatri et al. (2021) found that knowledge, as a collection of understood information held by an individual, plays a crucial role in adoption behavior and is often considered a necessary prerequisite for adoption by various authors. He also found that the maximum surveyed farmers had an average level of knowledge of ITK while the lowest percentage were found to have limited knowledge. The descriptive findings also showed that the majority of farmers in the sampled region had a positive attitude toward the usage of ITKs in agriculture. Parents or relatives were the main source of information for the majority of respondents followed by farmers and elders from the community. Various industries, including fertilizer management, plant protection, plant storage, animal husbandry and weather forecasting were reported to apply this knowledge.

2.1.6 Use of ITK

The literature review in this section focuses on the application of Indigenous Technical Knowledge (ITK) to many aspects of crop, fisheries and livestock production. Information regarding the local fanning system, experiences, institutions, culture, etc. can be found in great detail on ITK. Above all, farmers' knowledge and needs serve as the foundation for transformation (Reijntjes et al.,2002).

2.1.6.1 Crop production

According to research from 1994 by an anonymous source, applying moist sand to crop fields lowers soil pH. Sorghum and cowpea grow particularly well at termite mound locations according to Schlippe (1956).

Wilken (1987) discovered that high-value crops including tomatoes, chiles and onions were fertilized with ant waste in Zaachilla and Mexico. In India, ash put in onion fields and seedbeds prior to sowing and planting aids in bulb development and quality improvement. According to farmers, this aids in soil reclamation (Anonymous, 1994).

Traditional crop selection, planting dates and cultivation techniques according to Altieri (1989) and Thurston (1990) frequently reflect efforts to reduce insect damage.

According to Anonymous (1994), the following indigenous insect management methods are particularly effective:

a. Mint leaves emit a pungent smell that repels insects.
b. Chilies and other hot peppers can be used on vegetables against the caterpillars, aphids, flies and other pests.
c. Neem is effective against caterpillars and weevils or soybeans.
d. Pyrethrum acts as a botanical insecticide against caterpillars, aphids, flies and other pests.
e. Wood ash sprinkled on seedlings helps repel cutworms.

Many have reported the usage of diluted cow urine as an insecticide. According to Lohar (1952) diluted urine is extremely good at preventing powdery mildew on broad-leaf mustard. In China, citrus growers have been known to place nests of the predatory ant (*Oecophylla smaragdmi F.*) for over a century according to DeBach (1964) to lessen the impact of insects on orange trees. Even bamboo rods that join one another are installed by citrus farmers so that ants can cross them to get from tree to tree.

According to Gupta et al., (1996), the noxious weed *Cyperus rotundus* can be controlled by using the empty shells of cotton balls.

According to Gomathinayagam, a progressive ecological farmer from Tamil Nadu's Puliyanagudi village, the potent scent of Cycas sp. cones keeps earthen bugs away from rice crops when they are in the milky stage (Anonymous, 1994).

According to Hossain and Alam (1993), the farmers in the Kazirshimla district of Mymensingh. Bangladesh employs the following traditional approaches to crop pest management:

a. Haphazard planting of crops to reduce the infestation of certain weeds.
b. Criss-cross hanging of banana leaf thread above brinjal plot to prevent bird attack.
c. Digging deep rings around cabbage, cauliflower and tomato seedlings to inhibit cutworm attack.
d. Spreading sawdust over banana beetle.
e. Using powdered seeds of *'peetraj'* (*Amoora rohutica*) as an insecticide.

2.1.6.2 Fish production

One of the main elements of agricultural activity is fishing, which is important for Bangladesh's economy in general as well as for nutrition, employment, revenue generation and foreign exchange profits. Currently, it produces 4% of the entire Gross Domestic Product (GDP), 9% of the revenues from foreign exchange and 75% of the daily animal protein intake per person (Ali, 1997).

There are numerous indigenous varieties of fish, in addition to the primary cultivated species, that are crucial to the population's diet. Despite the fact that not all fish in this categorization are very small, some fish are categorized as small indigenous species. Out of the 260 species of freshwater fish that may be found locally, more than 140 species are categorized as Small Indigenous Species (SIS) and make up more than 80% of the total catch, which is consumed mostly by the poor people.

According to Chowdhury et al. (1996), farmers in Lalmonirhat and Rajshahi cultivate fish using the following methods:

a. The intestines of beef cattle, goats, ducks and poultry are grinned and fed to the fish rearing in the pond.

b. After cleaning the poultry den, the stools are given to the fish.

c. For increasing fish production, cow dung is applied in the ponds and stirring is done with the help of a fishing net.

d. Lime, banana plant and branches of neem are thrown in the pond to prevent fish diseases.

e. Kerosene is spread over aquatic weeds to destroy them.

Farmers in Sunamganj provide paddy husk to the pond as fish food. Termite mounds in the Joydebpur region expand swiftly and do significant damage. These mounds are collected by women and children, who then break them up into little pieces and drop them into ponds (Chowdhury et al., 1996).

In many regions of the world, rice cultivation has traditionally used ducks, fish, frogs and snakes to control insects (Reijntjes et al.,2002).

2.1.6.3 Livestock production

Women use a lot of ethnoveterinary concepts and practices in Peru, many of which have significant therapeutic and preventative benefits. For instance, many medicines work well to treat diarrhea or shield against parasitic infections (McCorckle et al., 1988).

Feeding fresh wood apple leaves will help a sick cow or goat that has loose stools and indigestion. To treat indigestion, raw turmeric combined with a small amount of lime and wrapped in a banana leaf is fed to cows (Chowdhury et al., 1996).

Cattle in Sunamganj are fed warm, boiling rice mixed with paddy husk to treat their dyspepsia. Raw turmeric, zinger and "*shati*" (*Cercuma amada*) leaf juice extracts are offered to cattle to treat indigestion and gas production. For immediate control, this is quite effective (Chowdhury et al., 1996).

Ointment consisting of "*motiharitobacco*" and "*pathar chun*" is applied and bandaged to treat infection of wounds created on a draft animal's shoulder (Chowdhury et al.,1996).

The goat is given water from a local hookah (a smoking pipe) to treat gas buildup and indigestion. Depending on the size and age of the goat, the dose ranges from 1/4 to 1/2 liter (Chowdhury et al., 1996).

According to Chowdhury et al. (1996), rural women hatch eggs of enhanced exotic varieties under local hens to breed better-quality chickens. He also discovered that heated boiled rice combined with a few drops of kerosene is fed to the poultry as a preventative for various ailments.

According to Chowdhury et al. (1996), farmers gather snails from crop fields, break the shells and then cut the flesh into small pieces to feed to baby ducklings. This high-quality protein promotes the duckling's rapid growth.

2.1.7 CSA (Climate Smart Agriculture) technology

Many regions of the world have low agricultural productivity, which makes them less able to react to unfavorable circumstances. Productivity is predicted to drop even further as a result of climate change (CC) and production has become more erratic. Many nations throughout the world intend to use the climate-smart agriculture (CSA) approach to enhance agriculture. The term "CSA" denotes an integrated collection of technology and practices that concurrently increase agricultural productivity and financial return, improve adaptability to CC and lower greenhouse gas (GHG) emissions. The CSA is a concept that combines the requirement for CC adaptation with mitigation techniques in agriculture to ensure food security. For instance, techniques like using renewable energy for agriculture, such as pyrolysis units, solar panels, windmills and water pumps, are crucial for food production. Productivity, adaptability and mitigation are the three main stakes that the CSA idea takes into account, although the literature has not adequately integrated these issues. For impoverished and developing nations, production and adaptation were of utmost importance, whereas industrialized nations focused mostly on mitigation. The discovery, evaluation (cost-benefit ratio) and subsequent ordering of CSA choices and portfolios for investment pose the greatest difficulty for policymakers and stakeholders in operationalizing CSA. The objectives of CSA are to raise farmer resilience in a sustainable manner, enhance agricultural output, accomplish food security and sustainable development goals, as well as lower greenhouse gas emissions (Hussain et al.,2022).

The degree to which farmers in a specific place adopt the CSA method depends on a variety of factors. In order to determine farmers' preferences and readiness to pay for particular CSA techniques and technology in various rainfall zones, many studies used a participatory evaluation method. According to their socioeconomic traits and rainfall zones, the study indicated that farmers' preferences for CSA technology are distinguished by some commonalities as well as variances. Crop insurance, weather-based crop agro-advisories, rainwater collecting, site-specific integrated nutrient management, contingency crop planning and laser land leveling were the technologies that local farmers appreciated the most. The findings also show that the cost of implementing new technologies has an impact on farmers' choices and willingness to pay (Khatri-Chhetri et al.,2017).

2.1.8 Problems Regarding ITKs

ITK adoption by farmers is hindered by a number of factors including sociocultural limitations and farmers' preference for sophistication with reliance on ready-made inputs. These factors are followed by the length of time needed to implement ITKs and achieve the desired outcomes. In order to improve the agricultural sector, it is necessary to validate ITK, change the negative societal view of farmers, increase awareness among the younger generation and receive financial and technical help from the government (Khatri et al.,2021).

2.2 Conceptual Framework of the Study

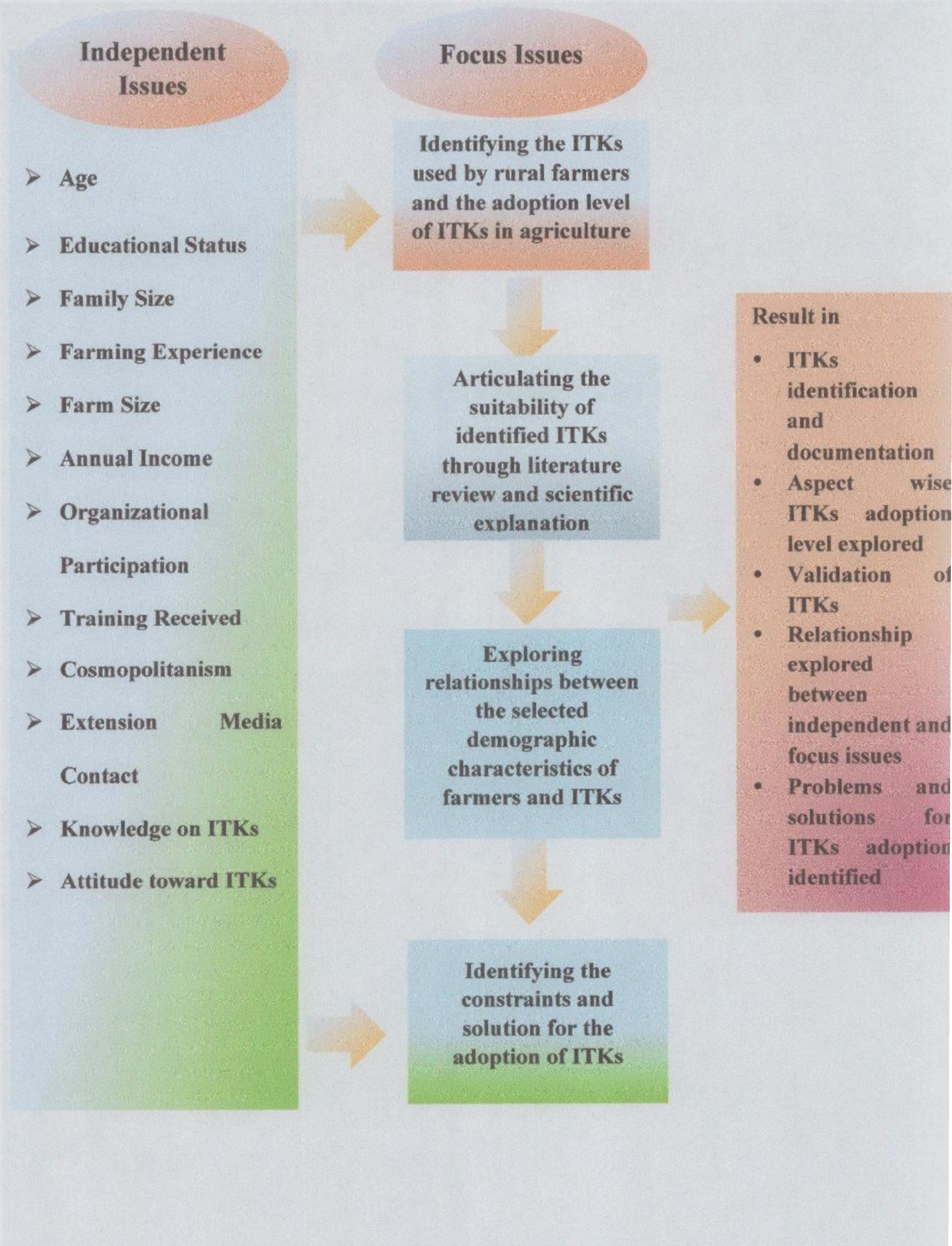

Figure 2.1 Conceptual Framework

CHAPTER III

METHODOLOGY

Materials and methods provide comprehensive information on the steps that were taken to conduct the study. Here, the term "materials" refers to the raw materials, tools, equipment, etc. utilized in an experiment and "method" refers to the procedure for carrying out the work. Research methodology refers to the particular processes or strategies used to identify, select, process and analyze data regarding a topic. In a research paper, the methodology section enables the reader to assess a study's overall validity and reliability (Morrison et al., 2021). Research methodology is a methodical approach to solving a research problem. It can be viewed as a science that examines the methods used in research (Kothari, 1990). The goal of the current study was to identify Indigenous Technical Knowledges (ITKs) as CSA Technology. In order to get a structured summary, the researchers had to observe and collect tenable, effective and reliable data. To achieve the goals, accurate data was collected from reliable sources. This chapter has covered the methodology and procedures used to carry out the study.

3.1 Research Design

The study employed an ex-post facto explanatory cross-sectional research design. The nature of the study was quasi-experimental. The study tried to predict the relationship of the selected demographic characteristics of the farmers with their ITK use.

3.2 Locale of the Study

The study was carried out in several villages in the Chitalmari upazila of Bagerhat district. The unique characteristics of the study area include the fact that farming is the main source of income for the local population. Farmers in the Chitalmari upazila were engaged in crop cultivation, fisheries and livestock rearing. Chitalmari Upazila has a total area of 192 square kilometers. Figure 3.1 shows a map of the upazila of Chitalmari.

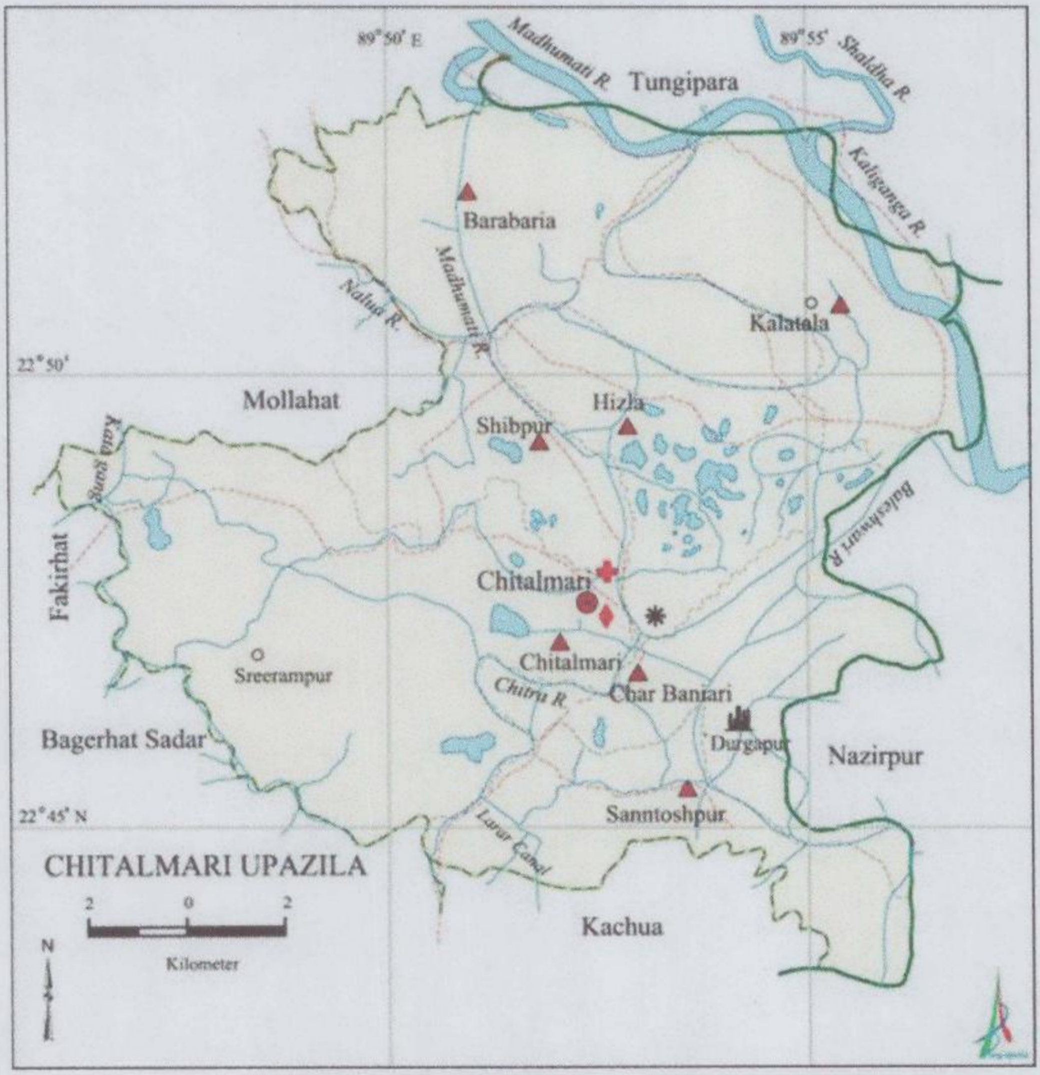

Figure 3.1 Chitalmari upazila of Bagerhat district

3.3 Population and Sampling Technique

The population of the study were consisted of all the rural farmers, women, local leaders and the stakeholders of the Chitalmari upazila, Bagerhat. One hundred and ten of them were purposefully selected to make up the study's sample.

3.4 Preparation of Interview Schedule

An interview schedule was prepared in order to collect relevant information from the respondents. The interview schedule was carefully designed with a view to meeting the requirements of the objectives of the study. Both open and close-ended questions were contained in the interview schedule and all the questions were in a direct and simple form. An initial interview was taken from 5 graduates of Khulna University before final data collection for checking the suitability of the ITK related statements added to it. Corrections, addition, alteration and rearrangements were added to the interview schedule according to the directions of the supervisor of the researcher. After preparing the final interview schedule, data were collected and checked properly. Multiple copies of the final interview schedule were then prepared for the collection of data. The interview schedule's English version has been included in Appendix A.

3.5 Data Collection

Data were collected by the researcher through the face-to-face interview of the respondents in the chosen area using the interview schedule. The researchers made all possible efforts to explain the purpose of the study to the respondents to get valid and reliable information. The researcher took every precaution to build rapport with each respondent before the interview began so that they would feel comfortable providing accurate responses. In addition, the opinions of a few key informants were used to supplement and validate some of the data gathered through the interview program. The respondents of the selected areas helped and cooperated with the researchers in data collection. The respondents' information was collected between March 9 and March 18, 2023.

3.6 Study Variables Selection

The selection and measurement of variables are important tasks in survey research. When relationships are involved, it is crucial to define the problem and decide the variables because relationships are the fundamental building blocks on which all sciences are based. Two different types of variables are found in every relationship; one is the independent variable and the other is the dependent variable. The factor that the experimenter manipulates in an effort to understand its connection to an observed phenomenon is known as an independent variable. On the other hand, a dependent variable is a variable that changes as the experimenter adds, eliminates, or modifies the independent variables (Townsend, 1953).

Table 3.1 Selected characteristics of respondents

Selected characteristics of farmers	ITKs related issues
i. Age	i. Farmers' knowledge on ITKs
ii. Educational status	ii. Farmers' attitude toward ITKs

Selected characteristics of farmers		ITKs related issues	
iii.	Family size	iii.	ITKs' use
iv.	Main occupation	iv.	ITKs' adoption
v.	Farming experience	v.	Problems regarding ITKs
vi.	Farming system	vi.	Solutions regarding ITKs
vii.	Farm size		
viii.	Annual income		
ix.	Organizational participation		
x.	Training received		
xi.	Cosmopolitanism		
xii.	Extension media contact		

3.7 Data Processing and Analysis

All of the information in the interview schedule were edited after the data had been collected. For interpretation and discussion, all personal characteristics were categorized and arranged in simple tables. When applicable, Local units were converted into standard units and qualitative data were converted into quantitative ones by means of suitable scoring. SPSS and MS Excel were used on a microcomputer for the data analysis. Descriptive data were interpreted using basic statistics including frequency counts, percentages, ranges, means and standard deviations. The respondents' attitudes regarding ITKs were measured using a five-point Likert scale. Throughout the analysis, Spearman rank correlation was employed to investigate the associations between the relevant variables.

3.8 Measurements of Demographic Characteristics of Respondents or Independent Issues

3.8.1 Age

The age of the respondents refers to the period of time from his/her birth to the time of the interview. However, one score was assigned for each and every complete year of the respondent's age based on available information of respondents. The first item on the interview schedule (Appendix A) is the age of the respondents. The respondents were categorized into the following categories based on age as shown in Table 3.2.

Table 3.2 Categories of respondents based on their age

Categories	Score
Young	≤35
Middle	36-55
Old	>55

Source: Mim and Islam, 2022

3.8.2 Educational status

A respondent's educational status was assessed using the number of years spent in school. Respondents who are illiterate that is unable to read and write received a score of zero (0). If a respondent received education outside of school, his or her education equivalent score was calculated based on the formal education level that the respondent had. For every year of schooling successfully completed, a score of "one" was given. The minimum and highest values are "0" and unknown, respectively. The second item on the interview schedule (Appendix A) is educational status. The respondents were divided into the following categories based on their educational status as indicated in Table 3.3.

Table 3.3 Categories of respondents according to their educational status

Categories	Score
Illiterate	0
Can sign only	0.5
Primary	1-5
Secondary	6-10
Higher secondary	11-12
Undergraduate	13-16
Postgraduate	>16

Source: Mim and Islam, 2022

3.8.3 Family size

The total number of family members of a respondent including himself/herself and the others' dependents is known as family size. The actual number of respondents' family members indicates a score on family size. The third item on the interview schedule (Appendix A) is family size. According to the categories in Table 3.4, respondents were divided according to the size of their families.

Table 3.4 Categories of respondents according to their family size

Categories	Number of family members
Small	≤4
Medium	5-6
Large	>6

Source: Mim and Islam, 2022

3.8.4 Main occupation

The main occupation of a respondent refers to the kind of work that the person does for pay most of the time. It is also known as a primary job. The fourth item on the interview schedule (Appendix A) is the main occupation of a respondent. According to the categories below, respondents were divided according to their main occupation.

i. Agriculture
ii. Business
iii. Service
iv. Day laborer
v. Fisheries
vi. Other (if any)

3.8.5 Farming experience

A respondent's experience in farming was determined by the time span from his or her first year of farming to the interview based on statement number 5 in the interview schedule (Appendix A). The maximum and minimum score of the respondents is unknown. As stated in Table 3.5, they are divided into the following categories based on their farming experience.

Table 3.5 Categories of respondents according to their farming experience

Categories	Score
Low	≤10
Medium	11-20
High	>20

Source: Mim and Islam, 2022

3.8.6 Farming system

The farming system refers to the mixture of farm enterprises such as crops, livestock, fisheries, agroforestry and fruit crops that a farmer cultivates. The sixth item on the interview schedule (Appendix A) is the farming system of a respondent. According to the categories below, respondents were divided according to their farming system.

i. Crop
ii. Livestock
iii. Fisheries
iv. Crop + Fish
v. Crop + Livestock
vi. Livestock + Fish
vii. Crop + Livestock + Fish

3.8.7 Farm size

The total area of land owned by a respondent including homestead area refers to as farm size. It also includes the land taken from others on borga or taken from others on lease. The area was estimated in terms of full of benefits to the respondent. The following formula was used to determine the size of the farm.

$FS = A1+A2+1/2\ (A3+A4)\ +A5$

Where, FS= Farm size

A1= Homestead

A2= Own land under cultivation

A3= Land given to others on borga

A4= Land taken from others on borga

A5= Land taken from others on lease

A6= Others

The farm's size was initially measured in local units before being changed to hectares. The seventh question on the interview schedule (Appendix A) deals with farm size. Farmers were divided into five categories according to the size of their farms as indicated in Table 3.6.

Table 3.6 Categories of respondents according to their farm size

Categories	Score (ha)
Landless	≤0.02
Marginal	0.021-0.2
Small	0.21-1.0
Medium	1-3
Large	>3

Source: BBS, 2016

3.8.8 Annual income

A farmer's annual family income was calculated by taking into account their annual earnings from all sources, including agriculture, business, services and others. The eighth item on the interview schedule (Appendix A) is a question on family income. The maximum and minimum score of the respondents is unknown.

Table 3.7 Categories of respondents according to their annual family income

Categories	Taka ('000' BDT $year^{-1}$)
Low	<180
Medium	180-300
High	>300

Source: Mim and Islam, 2022

3.8.9 Organizational participation

A respondent's organizational participation was assessed based on how actively involved they were at the time of the interview in various organizations within the research area. The interview schedule (Appendix A) item number 9 includes a list of many organizations.

No involvement received a score of 0, general members received a score of 1, executive committee members a score of 2 and executive committee officers a score of 3. A respondent's organizational participation score was summed up and farmers are categorized into the following groups as indicated in Table 3.8.

Table 3.8 Categories of respondents according to their organizational participation

Categories	Score
Low	≤6
Medium	7-12
High	>12

Source: Mim and Islam, 2022

3.8.10 Training received

Depending on how much training the respondent had gotten, his or her training score was calculated. For calculating the training score, (1) was given receiving each day of the training. A score of 1, 2, or 3 was given to respondents based on how many days of training sessions they had, respectively. If they do not participate in any training, a score of 0 was given. The interview schedule lists the training obtained as item No. 10 (Appendix A). In Table 3.9, the respondents were divided into the following categories.

Table 3.9 Categories of respondents according to their training received

Categories	Score
Low	≤15
High	>15

3.8.11 Cosmopolitanism

A respondent's level of cosmopolitanism was measured using the frequency of his or her travels to locations outside of their own social system to determine their cosmopolitanism score. The scores were 3, 2, 1 and 0, respectively and were calculated by counting the number of trips made to five different locations that represent the frequency of visitation as frequently, occasionally, rarely and not at all. The score might be between 0 and 15, with "0" denoting no cosmopolitanism and "15" denoting extremely high cosmopolitanism. Item 11 of the interview schedule (Appendix A) lists the respondents' cosmopolitanism. The respondents were classified into the following categories in Table 3.10.

Table 3.10 Categories of respondents according to their cosmopolitanism

Categories	Score
Low	≤5
Medium	6-10
High	>10

Source: Mim and Islam, 2022

3.8.12 Extension media contact

A respondent's degree of exposure to various extension media and individuals who served as information sources to inspire him or her and extend his outlook to new practices was used to determine the extent of that respondent's extension media contact. The score might be anything from 0 to 96 with "0" denoting no extension media contact and "96" denoting extremely significant extension media contact. The respondents were classified into the following categories according to extension media contact as shown in Table 3.11.

Table 3.11 Categories of respondents according to their extension media contact

Categories	Score
No	0
Rare	1-24
Occasional	25-48
Often	49-72
Regular	>72

Source: Mim and Islam, 2022

3.8.13 Knowledge on ITKs

Knowledge of Indigenous Technical Knowledge (ITKs) of the farmers indicates their practical knowledge of ITKs. To determine knowledge of ITKs of farmers 12 questions were asked to each farmer. The questions addressed several facets of ITKs. Each question was assigned 2 marks. If a farmer can answer all of those questions, he/she will get 24 marks. If he/she could not answer any of the questions he/she will get 0. The range is therefore from 0 to 24.

Table 3.12 Categories of respondents according to their knowledge of ITKs

Categories	Score
Low	≤8
Good	9-16
Excellent	>16

3.8.14 Attitude towards ITKs

Respondents' attitude towards ITKs refers to their reactions, positive as well as negative reaction to ITKs. The possible scores are between 10 and 50. A five point Likert scale was used to measure attitude and the results are shown below for each positive opinion.

Opinion	Score
Strongly agree	5
Agree	4
Undecided	3
Disagree	2
Strongly disagree	1

The following scores were given to each opinion in case of negative statements

Opinion	Score
Strongly agree	1
Agree	2
Undecided	3
Disagree	4
Strongly disagree	5

Table 3.13 Categories of respondents according to their attitude towards ITKs

Categories	Score
Highly unfavorable	≤10
Unfavorable	11-20

Categories	Score
Neutral	21-30
Favorable	31-40
Highly favorable	41-50

3.9 ITK Related Focus Issues

3.9.1 Identification of the ITKs used by rural farmers and the adoption level of ITKs in agriculture

ITKs were identified from secondary sources like available literature, articles, relevant books, proceedings, reports, publications, web sites and farmers experience. After collecting all the ITKs, they were sorted and suitable fifty-one ITKs were selected for the completion of the study.

Farmers use of ITKs, adoption index of ITKs, adopter categories and extent of adoption of ITKs were then analyzed to identify the adoption level of ITKs in agriculture.

3.9.1.1 ITKs' use

ITKs' use of the respondents indicates the total score of the respondents according to how frequently the use the 51 selected ITKs. For each ITK, the highest score is 3 and the lowest score is 0. The minimum and maximum scores of a respondent could be 0 and 153. The respondents were classified into the following categories according to their use of ITKs Table 3.14.

Table 3.14 Distribution of respondents on the basis of their ITKs use

Categories	Score
Low use of ITKs	≤51
Medium use of ITKs	52-102
High use of ITKs	103-153

3.9.1.2 Adoption index of ITKs

Farmers were interviewed to collect data on whether they adopted each of the selected ITKs or not. The extent of adopting an ITK was determined based on the adoption index. The adoption score was determined by using the following formula,

$AS = N1\times3+N2\times2+N3\times1+N4\times0$

Where,

AS= Adoption score

N1= Number of respondents who did the practice regularly

N2= Number of respondents who did the practice occasionally

N3= Number of respondents who did the practice rarely

N4= Number of respondents who did the practice not at all

The possible range of practice scores was 0 to 330.

For example, among 100 respondents 55, 11, 9 and 8 respondents indicate the extent of a practice as regularly, occasionally, rarely and not at all respectively. Thus, the AS for that practice is

$$AS = 55\times3+11\times2+9\times1+8\times0$$

$$= 165+22+9+0 =196$$

After determining of AS, the adoption index was determined by the following formula

$$(\%) \text{ Adoption Index} = \frac{\text{Observe adoption score}}{\text{Possible highest adoption score}}\times100$$

3.9.1.3 Adopter categories

There are five adopter categories. Adopter categories of farmers are identified on the basis of their time required to adopt ITKs by asking questions orally during interviewing. Then they were assigned to different adopter categories on the basis of the statements of Table 3.15.

Table 3.15 Adopter categories of respondents

Categories	Score	Statement
Innovators	1	This group adopt ITKs quickly
Early adopters	2	This group creates opinions before adoption of ITKs which propel trends.
Early majority	3	This group adopt ITKs after a varying degree of time

Categories	Score	Statement
Late majority	4	This group adopt ITKs after the majority member of the society
Laggards	5	This group do not adopt or last to adopt ITKs

Source: Rogers, 1995

3.9.1.4 Extent of adoption of ITKs

The percentage of each adopter categories (Innovators, early adopters, early majority, late majority and laggards) of crop related ITKs were calculated by the following formula

$$(\%)\ \text{Innovators} = \frac{\text{Total number of innovators in crop related ITKs}}{\text{Total number of respondents adopted crop related ITKs}} \times 100$$

$$(\%)\ \text{Early adopters} = \frac{\text{Total number of early adopters in crop related ITKs}}{\text{Total number of respondents adopted crop related ITKs}} \times 100$$

$$(\%)\ \text{Early majority} = \frac{\text{Total number of early majority in crop related ITKs}}{\text{Total number of respondents adopted crop related ITKs}} \times 100$$

$$(\%)\ \text{Late majority} = \frac{\text{Total number of Late majority in crop related ITKs}}{\text{Total number of respondents adopted crop related ITKs}} \times 100$$

$$(\%)\ \text{Laggards} = \frac{\text{Total number of laggards in crop related ITKs}}{\text{Total number of respondents adopted crop related ITKs}} \times 100$$

The percentage of each adopter categories in case of fisheries, livestock and weather forecasting related ITKs were calculated using the same type of formula.

After calculating all the percentages of each adopter categories, a graph had been formed using Microsoft excel to show the extent of adoption of ITKs by the farmers.

3.9.2 Articulation on the suitability of identified ITKs as CSA technology through literature review and scientific explanation

This section had been prepared by collecting and reviewing key information about the selected ITKs from various journals, proceedings, reports, publications, online resources and MS thesis, etc. available on internet websites. The researcher got valuable suggestions and information from the course instructors, thesis supervisor and other resource personnel. Farmers point of view were also taken into consideration. After collecting all the necessary information, it was compiled and arranged chronologically for the fulfillment of the objectives.

3.9.3 Relationship between the selected demographic characteristics of farmers and use of ITKs

The correlation coefficient was computed using the scores of each demographic characteristics of farmers and their use of ITKs. As all the scores were rank data, Spearman rank correlation was employed to investigate the association between the selected variables.

3.9.4 Identification of the constraints and solutions for the adoption of ITKs in agriculture

The researcher identified the constraints and solutions of ITK adoption from various literatures, her own thought and also from the key farmers opinion.

This section is discussed under the following headings

3.9.4.1 Problems regarding ITKs

Problems against ITKs were listed as number 16 in the interview schedule (Appendix A). The severity magnitude of the problems was scored in Table 3.16.

Table 3.16 Problem score

Severity magnitude	Score
Highly severe	4
Severe	3
Moderately severe	2
Less severe	1
Not at all	0

After calculating the total score, the respondents were then distributed into the following categories on the basis of their perception of the severity of ITK-related problems in Table 3.17.

Table 3.17 Distribution of respondents on the basis of their perception of the severity of ITKs-related problems

Categories	Score
Less severe	≤20

3.9.4.3 Solutions regarding ITKs

Solutions against ITK-related problems were listed as number 17 in the interview schedule (Appendix A). The suitability magnitude of the solutions was scored in Table 3.18.

Table 3.18 Score of solution

Suitability magnitude	Score
Highly suitable	4
Suitable	3
Moderately suitable	2
Less suitable	1
Not at all	0

After calculating the total score, the respondents were then distributed into the following categories on the basis of their perception of the suitability of ITK-related solutions in Table 3.19.

Table 3.19 Distribution of respondents on the basis of their perception of the suitability of ITKs-related solutions

Categories	Score
Less suitable	≤ 20
Suitable	21-40
Highly suitable	>40

3.9.4.4 Solution suitability index (SSI)

The suitability of a solution was determined based on the solution suitability index (SSI). The SSI was determined by using the following formula,

$$SSS = N1\times4+N2\times3+N3\times2+N4\times1+N5\times0$$

Where,

SSS= Solution suitability score

N1= Number of respondents who marked the solution as highly suitable

N2= Number of respondents who marked the solution as suitable

N3= Number of respondents who marked the solution as moderately suitable

N4= Number of respondents who marked the solution as less suitable

N5= Number of respondents who did not mark the solution at all

The possible range of solution suitability score (SSS) was 0 to 440.

For example, among 100 respondents 64, 17, 11, 5 and 8 respondents indicate the extent of solution regarding solution number as highly suitable, suitable, moderately suitable, less suitable and not at all respectively. Thus, the SSS for that solution is

$$SSS = 64\times4+17\times3+11\times2+5\times1+8\times0$$

$$= 256+51+22+5+0 = 334$$

After determining SSS, the suitability index of the solution was determined by the following formula

$$(\%)\ \text{Suitability index of the solution} = \frac{\text{Observed solution score}}{\text{Possible highest solution score}}\times100$$

3.9.5 Rank

Based on the (%) severity of the issues, a rank was assigned. The issue with the highest (%) severity received the 1st rank, followed by the issue with the second-highest (%) severity and so forth. If two or more issues obtain the same score, the same rank was assigned to them.

CHAPTER IV

RESULTS AND DISCUSSION

The purpose of this chapter is to discuss the findings of the study. The study was done to identify the Indigenous Technical Knowledges (ITKs) as Climate Smart Agriculture (CSA) technology which is used by the rural farmers, local leaders and stakeholders of Chitalmari upazila of Bagerhat district. Presentations of the findings have been made in this chapter in the following sections in accordance with the objectives

i. Identification of the ITKs used by rural farmers and the adoption level of ITKs in agriculture
ii. Articulation on the suitability of identified ITKs as CSA technology through literature review and scientific explanation
iii. Relationships between the selected demographic characteristics of farmers and use of ITKs
iv. Identification of the constraints and solutions for the adoption of ITKs in agriculture

4.1 Identification of the ITKs Used by Rural Farmers and the Adoption Level of ITKs in Agriculture

4.1.1 ITKs' use

The rural farmers' score on ITKs' use varies from 25 to 89 against a possible range of 0 to 153. The mean and standard deviation are 54.25 and 12.90, respectively. Based on the mean and standard deviation, farmers' use of ITKs was categorized into three (Table 4.1). Majority of the respondents (53.6%) were in the medium-use category of ITKs followed by the low-use category (46.4%).

Table 4.1 Distribution of respondents on the basis of their ITKs use

Categories	Score	N=110		Mean ± SD ($\bar{x} \pm \sigma$)	Range	
		Frequency	Percentage		Min.	Max.
Low use of ITKs	≤51	51	46.4	54.25±12.90	25	89
Medium use of ITKs	52-102	59	53.6			
High use of ITKs	103-153	0	0			

No respondents were found in the high-use category of ITKs because of their preference for readymade inputs and the low productivity of ITKs.

4.1.2 Adoption index of ITKs

Table 4.2 Adoption index of ITKs

Serial	ITKs	Score of ITK use				ITK score	ITK index (%)	Rank
		Regularly (3)	Occasionally (2)	Rarely (1)	Not at all (0)			
	Crop related ITKs							
i.	Soaking vegetable seeds in water for better germination	83	24	1	2	298	90.30	1st
ii.	Burning crop residues	55	25	6	24	221	66.97	11th
iii.	Garlic-potato intercropping to reduce pest attack	4	4	14	88	34	10.30	35th
iv.	Use of fish cleaning water at the base of bottle gourd vine	3	7	3	97	26	7.88	36th =
v.	Application of ash in leafy vegetables to control aphid	13	42	9	46	132	40	20th
vi.	Erecting scare-crow in standing crops to scare birds	29	13	8	60	121	36.67	23rd
vii.	Hand pollination in cucurbit vegetable	60	17	11	22	225	68.18	8th
viii.	Use of neem extract as a pesticide	7	11	11	81	54	16.36	32nd
ix.	Watering/ fumigating of rodent holes to control them	16	12	22	60	94	24.48	27th=
x.	Coarse grain rice varieties generally do not lodge	69	25	1	15	258	78.18	3rd

Serial	ITKs	Score of ITK use				ITK score	ITK index (%)	Rank
		Regularly (3)	Occasionally (2)	Rarely (1)	Not at all (0)			
xi.	Weed growth is faster in upland areas	52	34	10	14	234	70.91	6th
xii.	Greenish tillering during active tillering is an indication of poor yield in rice	20	23	16	51	122	36.97	22nd
xiii.	Clayey soil is suitable for rice variety	64	16	6	24	230	69.70	7th
xiv.	Application of casuarina or neem leaves or sand will correct soil alkalinity	1	6	3	100	18	5.45	37th
xv.	Intercropping cereals with legumes to increase N content in the soil	15	24	13	58	106	32.12	26th
xvi.	Setting up bamboo sticks or branches of trees to control insect	62	11	5	32	213	64.55	12th
xvii.	Using *neem* (*Azadirachta indica*) leaves to store food grains like paddy and wheat	65	21	5	19	242	73.33	5th
	Fisheries related ITKs							
xviii.	Application of cow dung in the pond as fish feed	12	22	7	69	87	26.36	29th
xix.	Use of rice husk as fish feed	44	54	4	8	244	73.94	4th

Serial	ITKs	Score of ITK use				ITK score	ITK index (%)	Rank
		Regularly (3)	Occasionally (2)	Rarely (1)	Not at all (0)			
xx.	Application of segmented banana plants for cleaning the pond water	18	29	13	50	125	37.88	21^{st}
xxi.	Use of banana leaves as a feed for carp fish	40	48	8	14	224	67.88	9^{th}
xxii.	Application of poultry litter in the pond as fish feed	1	5	2	102	15	4.55	39^{th} =
xxiii.	Drying of excess fish for the lean period	6	16	2	86	52	15.76	33^{rd}
xxiv.	Planting *mehogany* tree beside the pond to control fish disease	14	17	12	57	88	26.67	28^{th}
xxv.	Application of food wastage in the pond as feed	20	54	17	19	185	56.06	15^{th}
xxvi.	Dragging fishing net for aeration	10	31	16	53	108	32.73	25^{th}
xxvii.	Use of oil cakes in the pond for the rapid growth of fish	18	31	13	38	139	42.12	18^{th}=
xxviii.	Use of termites as feed for fish in ponds	0	5	6	99	16	4.85	38^{th}=
xxix.	Use of common carp for natural seed rearing	0	0	0	110	0	0	43^{rd} ≡
xxx.	Use of salt and turmeric solution in a pond after the	1	16	14	79	49	14.85	34^{th}

Serial	ITKs	Score of ITK use				ITK score	ITK index (%)	Rank
		Regularly (3)	Occasionally (2)	Rarely (1)	Not at all (0)			
	rainy season to have protection from disease infestation							
xxxi.	Using dried *kacchu patta*(*Colocasia sp.*) as fish feed	0	3	4	103	10	3.03	40th
xxii.	Sowing *dhaincha* (green manure) during summer to enhance nutritional content for fish in the reservoir	10	15	10	75	70	21.21	31st
xxiii.	A mixture of catechu and *haritaki* extract in the water to protect fertilized eggs from damage	1	0	3	106	6	1.82	42nd
	Livestock related ITKs							
xxiv.	Feeding the flesh of oysters and snails to duck	32	48	7	23	199	60.30	14th
xxv.	Feeding contraceptive pill for controlling Newcastle of poultry	0	0	0	110	0	0	43rd ≡
xxvi.	Feeding molasses and table salts to cattle	68	27	7	8	265	80.30	2nd

Serial	ITKs	Score of ITK use				ITK score	ITK index (%)	Rank
		Regularly (3)	Occasionally (2)	Rarely (1)	Not at all (0)			
xvii.	Feeding the *katanate* grass to livestock for improving lactation	24	30	7	49	139	42.12	18th=
xviii.	Use of bamboo case to protect ducklings from snatched birds	60	8	7	35	203	61.52	13th
xxix.	Deeping eggs in water for assessing the hatching quality	3	5	7	95	26	7.88	36th=
xl.	Feeding seeded bananas to cattle for curing loose motion	19	20	17	54	114	34.55	24th
xli.	Using an earthen pot for laying and hatching eggs of poultry	41	15	8	46	161	48.79	17th
xlii.	Use of *biscatali* grass as a repellent of body lice of cattle	1	4	4	101	15	4.55	39th=
xliii.	Feeding *hukkah* water to control worms of goat	2	1	8	99	16	4.85	38th=
xliv.	Feeding *Sali* (raw paddy) to cows to remove retained placenta	0	2	4	104	8	2.42	41st
xlv.	Drenching mixture of jaggery and onion to cure constipation	26	6	4	74	94	28.48	27th=
xlvi.	Moving FMD-infected animals through mud or hot dust to cure FMD infection	57	21	10	22	223	67.58	10th

Serial	ITKs	Score of ITK use				ITK score	ITK index (%)	Rank
		Regularly (3)	Occasionally (2)	Rarely (1)	Not at all (0)			
klvii.	Drenching castor oils to animals to cure tympany	0	0	0	110	0	0	43rd ≡
	Weather forecasting related ITKs							
lviii.	If the wind is blowing east to west, it confirms that heavy rainfall will occur after a few days	23	23	22	32	137	41.52	19th
xlix.	If grasshopper is in a group of 10–12 then, it is supposed that rain will occur in the next 24 hour	31	32	19	28	176	53.33	16th
l.	If the rainbow is seen in the western sky, heavy rainfall will occur.	6	14	27	63	73	22.12	30th
li.	When the rain is about to begin, the spider makes its web in the opposite direction i.e., vertically to the earth and sky and after rain, the direction of the web is horizontal to the earth and sky	0	0	0	110	0	0	43rd ≡

The respondent farmers of the study used the selected (51) ITKs to different extent. Data presented in Table 4.2 showed that the 1st position was ranked by 'Soaking vegetable seeds in water for better germination' on the basis of obtained highest score (298) which was followed by 'Feeding molasses and table salts to cattle' (2nd, score 265), 'Coarse grain rice varieties generally do not lodge' (3rd, score 258), 'Use of rice husk as fish feed' (4th, score 244) and 'Using *neem* (*Azadirachta indica*) leaves to store food grains like paddy and wheat'(5th, score 242). On the other hand, least score was obtained by the ITKs of 'A mixture of catechu and *haritaki* extract in the water to protect fertilized eggs from damage' (42nd, score 6) followed by 'Feeding *Sali* (raw paddy) to cows to remove retained placenta' (41st, score 8), 'Using dried *kacchu patta* (*Colocasia sp.*) as fish feed' (40th, score10), 'Application of poultry litter in the pond as fish feed' and 'Use of *biscatali* grass as a repellent of body lice of cattle' (39th, score 15) among all the ITKs adopted by the respondents.

Most of the marginal and small farmers are not economically solvent enough to adopt high-cost modern technology. So, they try to utilize the available household waste and farm by-products using their traditional knowledge properly. Additionally, the use of ITKs is independent of outside costs and depends on the community's own self-sufficient knowledge base therefore it has been practiced by the rural people for centuries.

4.1.3 Adopter category of ITKs

For each of the fifty-one selected ITKs. frequency and percentage of the adopter categories of the respondents using ITKs are shown in Table 4.3.

Table 4.3 Distribution of respondents on the basis of their ITKs' adoption category

Serial	ITKs	ITK adopter categories									
		Innovators		Early adopters		Early majority		Late majority		Laggards	
		F.	%	F.	%	F.	%	F.	%	F.	%
	Crop related ITKs										
i.	Soaking vegetable seeds in water for better germination	0	0	92	83.64	16	14.55	0	0	0	0
ii.	Burning crop residues	0	0	62	56.36	21	19.09	3	2.73	0	0
iii.	Garlic-potato intercropping to reduce pest attack	0	0	5	4.55	5	4.55	12	10.91	0	0
iv.	Use of fish cleaning water at the base of bottle gourd vine	0	0	2	1.82	9	8.18	2	1.82	0	0
v.	Application of ash in leafy vegetables to control aphid	0	0	16	14.55	32	29.09	16	14.55	0	0
vi.	Erecting scare-crow in standing crops to scare birds	0	0	33	30	13	11.82	4	3.64	0	0
vii.	Hand pollination in cucurbit vegetable	0	0	42	38.18	33	30	12	10.91	1	0.91
viii.	Use of neem extract as a pesticide	0	0	8	7.27	12	10.91	9	8.18	0	0
ix.	Watering/ fumigating of rodent holes to control them	0	0	21	19.09	12	10.91	15	13.64	2	1.82
x.	Coarse grain rice varieties generally do not lodge	0	0	56	50.91	31	28.18	8	7.27	0	0
xi.	Weed growth is faster in upland areas	0	0	47	42.73	35	31.82	13	11.82	1	0.91
xii.	Greenish tillering during active tillering is an indication of poor yield in rice	0	0	13	11.82	30	27.27	15	13.64	1	0.91
xiii.	Clayey soil is suitable for rice variety	0	0	71	64.55	12	10.91	3	2.73	0	0

Serial	ITKs	ITK adopter categories									
		Innovators		Early adopters		Early majority		Late majority		Laggards	
		F.	%	F.	%	F.	%	F.	%	F.	%
xiv.	Application of casuarina or neem leaves or sand will correct soil alkalinity	0	0	3	2.73	3	2.73	4	3.64	0	0
xv.	Intercropping cereals with legumes to increase N content in the soil	0	0	20	18.18	16	14.55	14	12.73	2	1.82
xvi.	Setting up bamboo sticks or branches of trees to control insect	0	0	64	58.18	13	11.82	1	0.91	0	0
xvii.	Using *neem* (*Azadirachta indica*) leaves to store food grains like paddy and wheat	0	0	76	69.09	11	10	4	3.64	0	0
	Fisheries related ITKs										
xviii.	Application of cow dung in the pond as fish feed	0	0	12	10.91	18	16.36	11	10	0	0
xix.	Use of rice husk as fish feed	0	0	57	51.82	40	36.36	5	4.55	0	0
xx.	Application of segmented banana plants for cleaning the pond water	0	0	22	20	27	24.55	11	10	0	0
xxi.	Use of banana leaves as a feed for carp fish	0	0	40	36.36	47	42.73	9	8.18	0	0
xxii.	Application of poultry litter in the pond as fish feed	0	0	2	1.82	3	2.73	3	2.73	0	0
xxiii.	Drying of excess fish for the lean period	0	0	7	6.36	11	10	6	5.45	0	0
xxiv.	Planting *mehogany* tree beside the pond to control fish disease	0	0	15	13.64	20	18.18	18	16.36	0	0
xxv.	Application of food wastage in the pond as feed	0	0	43	39.09	31	28.18	17	15.45	0	0
xxvi.	Dragging fishing net for aeration	0	0	25	22.73	22	20	10	9.09	0	0
xxvii.	Use of oil cakes in the pond for the rapid growth of fish	0	0	24	21.82	33	30	13	11.82	2	1.82
xxviii.	Use of termites as feed for fish in ponds	0	0	2	1.82	2	1.82	7	6.36	0	0
xxix.	Use of common carp for natural seed rearing	0	0	0	0	0	0	0	0	0	0

Serial	ITKs	ITK adopter categories									
		Innovators		Early adopters		Early majority		Late majority		Laggards	
		F.	%	F.	%	F.	%	F.	%	F.	%
xxx.	Use of salt and turmeric solution in a pond after the rainy season to have protection from disease infestation	0	0	8	7.27	9	8.18	13	11.82	1	0.91
xxxi.	Using dried *kacchu patta* (*Colocasia sp.*) as fish feed	0	0	1	0.91	3	2.73	3	2.73	0	0
xxii.	Sowing *dhaincha* (green manure) during summer to enhance nutritional content for fish in the reservoir	0	0	18	16.36	8	7.27	9	8.18	0	0
xxiii.	A mixture of catechu and *haritaki* extract in the water to protect fertilized eggs from damage	0	0	0	0	1	0.91	2	1.82	1	0.91
	Livestock related ITKs										
xxiv.	Feeding the flesh of oysters and snails to duck	0	0	48	43.64	36	32.73	3	2.73	0	0
xxv.	Feeding contraceptive pill for controlling Newcastle of poultry	0	0	0	0	0	0	0	0	0	0
xxvi.	Feeding molasses and table salts to cattle	0	0	70	63.64	29	26.36	3	2.73	0	0
xvii.	Feeding the *katanate* grass to livestock for improving lactation	0	0	20	18.18	25	22.73	16	14.55	0	0
xviii.	Use of bamboo case to protect ducklings from snatched birds	0	0	57	51.82	11	10	7	6.36	0	0
xxix.	Deeping eggs in water for assessing the hatching quality	0	0	4	3.64	5	4.55	6	5.45	0	0
xl.	Feeding seeded bananas to cattle for curing loose motion	0	0	18	16.36	18	16.36	20	18.18	0	0
xli.	Using an earthen pot for laying and hatching eggs of poultry	0	0	44	40	16	14.55	4	3.64	1	0.91
xlii.	Use of *biscatali* grass as a repellent of body lice of cattle	0	0	2	1.82	2	1.82	4	3.64	1	0.91
xliii.	Feeding *hukkah* water to control worms of goat	0	0	4	3.64	0	0	6	5.45	1	0.91

Serial	ITKs	ITK adopter categories									
		Innovators		Early adopters		Early majority		Late majority		Laggards	
		F.	%	F.	%	F.	%	F.	%	F.	%
xliv.	Feeding *Sali* (raw paddy) to cows to remove retained placenta	0	0	2	1.82	0	0	3	2.73	0	0
xlv.	Drenching mixture of jaggery and onion to cure constipation	0	0	29	26.36	5	4.55	2	1.82	1	0.91
xlvi.	Moving FMD-infected animals through mud or hot dust to cure FMD infection	0	0	49	44.55	23	20.91	15	13.64	0	0
xlvii.	Drenching castor oils to animals to cure tympany	0	0	0	0	0	0	0	0	0	0
	Weather forecasting related ITKs										
lviii.	If the wind is blowing east to west, it confirms that heavy rainfall will occur after a few days	0	0	24	21.82	35	31.82	19	17.27	0	0
xlix.	If grasshopper is in a group of 10–12 then, it is supposed that rain will occur in the next 24 hour	0	0	34	30.91	31	28.18	17	15.45	0	0
l.	If the rainbow is seen in the western sky, heavy rainfall will occur.	0	0	15	13.64	16	14.55	16	14.55	0	0
li.	When the rain is about to begin, the spider makes its web in the opposite direction i.e., vertically to the earth and sky and after rain, the direction of the web is horizontal to the earth and sky	0	0	0	0	0	0	0	0	0	0

[F. = Frequency, %= Percentage]

Table 4.3 showed that the adopter categories of the respondents using ITKs are divided into five parts. They are- innovators, early adopters, early majority, late majority and laggards. In the case of early adopters, most of the respondents (83.64%) adopted the ITK of 'Soaking vegetable seeds in water for better germination'. In the case of early majority, the highest portion of the respondents (42.73%) adopted the ITK of 'Use of banana leaves as a feed for carp fish'. In the case of late majority, the highest portion of the respondents (18.18%) adopted the ITK of 'Feeding seeded bananas to cattle for curing loose motion'. In the case of laggards, 1.82% of the respondents adopted both 'Intercropping cereals with legumes to increase N content in the soil' and 'Use of oil cakes in the pond for the rapid growth of fish' as ITKs. There were no innovators of ITKs among the respondents.

4.1.4 Extent of adoption of ITKs

It is evident from Figure 4.1 that majority (58.43%) of the respondents were early adopters, followed by early majority (28.43%), late majority (12.5%) and laggards (0.65%) of crop-related ITKs. In case of fisheries-related ITKs, highest portion of the respondents were early adopters (39.88%) followed by early majority (39.74%), late majority (19.8%) and laggards (0.58%), respectively. ITKs in livestock, majority (56.89%) of the respondents were early adopters, followed by early majority (27.87%), late majority (14.59%) and laggards (0.66%), respectively. Highest portion (39.61%) of the respondents were early majority in case of ITKs in weather forecasting followed by early adopters (35.27%) and late majority (25.12%), respectively.

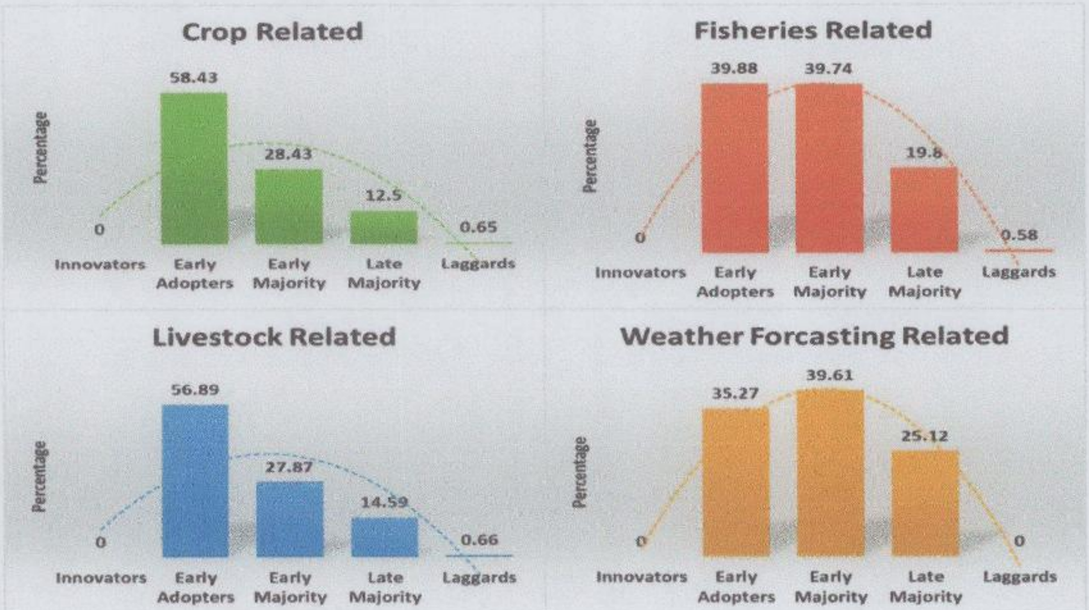

Figure 4.1 Extent of adoption of ITKs

Rogers (1995) stated in his theory of diffusion of innovation that the innovators, early adopters, early majority, late majority and laggards occupied 2.5%, 13.5%, 34%, 34% and 16% of the total population of a social system which is very different from the findings of this study.

Khatri et al. (2021) found that in the case of nutrient management, majority (83.07%) of the respondents were medium adopters. Majority (67.4%) of the respondents were medium adopters in the case of ITKs of plant protection. Maximum respondents (66.77%) were medium adopters in the case of ITKs of plant storage. ITKs in animal husbandry, majority (82.04%) of the respondents had medium adoption. Majority (79.86%) of the farmers were medium adopters in case of ITKs in weather forecasting

4.2 Articulation on the Suitability of the Identified ITKs through Literature Review and Scientific Explanation

Crop related ITKs

4.2.1 Soaking vegetable seeds in water for better germination

Some of the seed germination-related metabolic activities can take place without germination such as priming. Seeds are immersed in various high osmotic potential solutions (water) during priming which shortens the interval between seed germination and seedling emergence and to synchronize emergence, seed priming has frequently been employed (Parera and Cantliffe, 1994). There have been several developments in seed priming methods, such as hydropriming (soaking in water). Hydropriming-treated seeds exhibit rapid germination because it allows sufficient hydration and advancement of metabolic processes (Ashraf and Foolad, 2005).

So, it is scientifically proven that soaking vegetable seeds in water exhibits better germination.

4.2.2 Burning crop residues

Some farmers burn crop residues left in the field after crop harvest if the level of pest infestation is too high. This procedure aids in the destruction of insect eggs, larvae, pupae and fungus spores that have persisted in crop debris after crop harvest. The ash produced by field burning serves to increase soil fertility (Khatri et al.,2021).

4.2.3 Garlic-potato intercropping to reduce pest attack

Intercropping with plants that produce repellent chemicals was established in several crop and related plant models in order to create biological control of different insect vectors like aphids. Garlic intercropping and associated volatiles are anticipated to help advance integrated pest management systems and possibly reduce the amount of conventional synthetic pesticides used in crop fields like potatoes due to their potential alternatives as a biological control agent against aphids (Ninkovic et al., 2013).

4.2.4 Use of fish cleaning water at the base of bottle gourd vine

Fish cleaning water causes environmental pollution if they are not properly managed. Again, the waters of fish farms are prone to rapid fouling development because feed waste, fish excretion and fecal formation enhance nutrient and organic loading. This wastewater can become useful if they are used as fertilizer for bottle gourd vines.

4.2.5 Application of ash in leafy vegetables to control aphid

Wood ash forms a coating on plant surfaces, reducing insects' access to feeding sites and making them less attractive (Elwell and Mass, 1995). Additionally, wood ash acts as a fertilizer and adding additional nutrients to the soil. Wood ash, on the other hand, might not adhere to or be effective on the lower portions of plants and the abaxial surfaces of the leaves. Therefore, it is effective to use wood ash in field experiments for the management of aphids, white flies and termites (Saha et al., 2021).

4.2.6 Erecting scare-crow in standing crops to scare birds

A scarecrow is a straw object erected in gardens and fields to frighten birds away from crops. The same idea as the scarecrow was employed in a variety of ways in ancient Egypt to protect the harvest from bird attack. It is also used to scare herbivores. This reduces crop loss prior to the harvesting period (Abdelhakim, 2020).

4.2.7 Hand pollination in cucurbit vegetable

Hand pollination involved identifying healthy flowers, picking a male flower and gently rubbing (pollens) at the center (stigma) of a female flower. It ensures maximum pollination and fruit set. Pollens can also be applied by mixing with water with the help of a sprayer.

4.2.8 Use of neem extract as a pesticide

The main active ingredient in neem has been determined to be azadirachtin. It works to repel insects, prevent them from feeding and impede their growth, metamorphosis and reproduction. Although neem-based formulations rarely directly kill insects, they can significantly alter their behavior to reduce pest damage to crops and decrease their reproductive capacity. Azadirachtin mimics a natural hormone to have an impact on insect physiology. It has been proven to have an impact on hatching rates and egg production. Azadirachtin inhibits molting in larvae, preventing them from changing into pupae. Neem limits the growth of insects. Usually, treated insects are unable to transition to their next life stage and die. It prevents egg-laying as well. So, the pest can be easily controlled by it (Dimetry, 2012).

4.2.9 Watering/ fumigating of rodent holes to control them

It is very difficult to control rodents in field conditions. In some circumstances, flushing rats out of their burrows using water or smoke can be quite effective and suitable.

4.2.10 Coarse grain rice varieties generally do not lodge

Coarse grain rice varieties are generally thick-stemmed. The key factor determining the stem's resistance to lodging according to some studies (Vakhnenko and Kurchiy, 1990) is the thickness of the straw walls. Its increase boosts the stem's mechanical strength and the plant shows resistance to lodging. However, because of unique donor-acceptor relationships, thick-stemmed plants frequently exhibit lower production of the generative organs. So, coarse-grain rice varieties generally do not lodge (Dzhamirze, 2021).

4.2.11 Weed growth is faster in upland areas

Weed competition in upland crops is a significant economic issue since it can reduce crop output by 50–91%. Many different kinds of grasses, sedges and broad-leaved weeds are a problem for upland crops. In uplands, weeds typically appear in a number of flushes throughout the crops' growing season. The manner of crop establishment and tillage practices have a significant impact on the kind of weed infestation in upland crops (Singh, 2012).

4.2.12 Greenish tillering during active tillering is an indication of poor yield in rice

Due to low soil fertility, insufficient water, imbalanced use of fertilizer and other causes, the physiological balance in the rice plant become changed. Greenish tillering occurs during active tillering. It is an indication of poor yield in rice.

4.2.13 Clayey soil is suitable for rice variety

Rice cultivation is best suited to clay or clay loams soil. Such soils can support crop growth and water holding capacity is very high. Being a semi-aquatic crop, rice grows well in submerged conditions.

4.2.14 Application of casuarina or neem leaves or sand will correct soil alkalinity

There are many indigenous soil health care practices that can improve soil fertility as well as correct soil alkalinity. Casuarina trees can increase soil fertility by fixing nitrogen from the air. Neem leaf extract has the potential to increase soil P, K, Ca and Mg concentrations while also acting as a natural nitrification inhibitor (Sriraj et al., 2022). Sandy soils' poorer buffering capacity causes them to acidify more quickly. Thus, casuarina or neem leaves or sand can correct soil alkalinity naturally (Rajasekaran and Warren, 1995).

4.2.15 Intercropping cereals with legumes to increase N content in the soil

Cereal-legume intercropping is a crop production technique that boosts the soil's enzyme activity to increase soil quality and fertility. Legume plants produce nodules in their root zone through which they can fix atmospheric nitrogen. The majority of the soil's plant nutrients are made available to the plants by intercropping legumes with cereals. So, additional nutrient requirements (especially nitrogen) for the crop reduces (Dugassa, 2023).

4.2.16 Setting up bamboo sticks or branches of trees to control insect

Bamboo sticks or branches of trees can be used as bird perches. Predatory birds use bird perches as resting spots while hunting for prey such as insect pests of cotton, peanuts and cowpeas. Generally, predatory birds prefer to hunt their prey among field crops where they have locations to rest.

4.2.17 Using *neem* (*Azadirachta indica*) leaves to store food grains like paddy and wheat

Food grains and pulses can easily store by combining them with neem products like dried leaf powder, dried kernel powder or neem oil. Neem oil is simpler to use than leaves. Neem plant seed and kernels contain the majority of the active substance. Neem fumigation does not harm the land or aquatic environment and is non-toxic and environmentally benign. This fumigant impacts growth, development and life cycles in addition to killing insect pests. This fumigant's key benefit is that pests cannot adapt to it and become resistant (Gupta, 2022).

Fisheries related ITKs

4.2.18 Application of cow dung in the pond as fish feed

Fermented cow manure can be used as a fish feed substrate in stagnant water ponds. Cow dung is also useful for the growth of phytoplankton which fish use as their feed (Barash and Schroeder, 1984).

4.2.19 Use of rice husk as fish feed

The nutritional composition of paddy rice husks is suitable for fish feed requirements. It is more cost-effective than factory feed and easily available (Selvi et al., 2022).

4.2.20 Application of segmented banana plants for cleaning the pond water

Banana plants are easy to grow next to ponds. Segmented banana plants work as pond wetland filters that will help fish or duck ponds naturally filter their water. This contributes to maintaining the water's cleanliness for any aquatic life that might inhabit the pond or drink from it.

4.2.21 Use of banana leaves as feed for carp fish

Fish farmers have been using fresh banana leaves as a supplement to their feed and it has been suggested that these leaves may have phyto-prophylactic properties. To find out if banana leaves were ingested and digested by grass carp (*Ctenopharyngodon idella*) and to find out if this intake led to increased growth performance, a feeding trial was carried out by Mayrhofer et al. (2017). The results of the study showed that the overall feed conversion ratio (FCR) was greatly enhanced with the addition of banana leaves. The addition of the banana leaves was linked to a significant reduction in the severity of the skin lesions which might increase the fish's market value.

4.2.22 Application of poultry litter in the pond as fish feed

Compared to other livestock wastes, poultry wastes have a higher nutritional density. They often contain less moisture, fiber and substances like tannins that cause water to become color when used as pond fertilizers. Poultry litter is also a great substitute for fish feed which is cost-effective. In this case, poultry cum fish culture is very effective (Little and Satapornvanit, 1996).

4.2.23 Drying of excess fish for the lean period

Fish is processed and preserved using the standard and well-liked technique of drying which prevents microbial development and stops chemical and enzymatic reactions by removing moisture. These dried fish can meet up the protein need of people during the lean period (Sroy, 2023).

4.2.24 Planting *mehogany* tree beside the pond to control fish disease

Tannins and other organic substances released by *mehogany* leaves can aid in fostering a natural habitat for fish and other aquatic life. The leaves can soften the water and assist lower the pH, bringing it closer to the natural conditions seen in the wild. The seeds have naturally antibacterial, anti-inflammatory and antioxidant properties. When they dropouts on pond water, they help to control different fish diseases.

4.2.25 Application of food wastage in the pond as feed

Food wastage in households can serve as a major source of carbohydrates and protein when they are applied to ponds. These can replace the fish feed meal to produce quality fish (Wong et al., 2016).

4.2.26 Dragging fishing net for aeration

The process of pond aeration involves raising or maintaining the concentration of dissolved oxygen in a body of water. In order to bring the water into touch with the air, dragging a fishing net involves the mechanical movement of water that cracks the surface layer of the pond.

2.2.27 Use of oil cakes in the pond for the rapid growth of fish

In feed, fish meal and mustard oil cake were the primary sources of protein. Mustard oil cake is high in protein and oil content. It is mostly utilized as an addition to feed in aquaculture (Mazid et al., 1997).

4.2.28 Use of termites as feed for fish in ponds

Fish eats live termites that fall into the ponds. It has a lot of protein. Due to its high nutritious content, termite meal can replace up to 40% of the fish meal in the diet. Because of this, termite meals can support better growth and profit maximization (Olaniyi et al., 2016).

4.2.29 Use of common carp for natural seed rearing

The minimal input costs made carp seed farming and rearing extremely profitable at any scale (Shivakumar et al., 2013).

4.2.30 Use of salt and turmeric solution in a pond after the rainy season to have protection from disease infestation

Ichthyosporidiosis in fish can be controlled by bathing in a 3% salt solution. Gyrodaclylosis in fish can be controlled by bathing in a NaCl salt solution at a concentration of 2–5%. Turmeric-enriched fish pellets are very effective in enhancing fish immunity to the illness caused by mobile *Aeromonas septicemia* (Riauwaty et al., 2021).

4.2.31 Using dried *kacchu patta* (*Colocasia sp.)* as fish feed

Because the roots (or corms) and foliage have such large yields, *kacchu patta* (*Colocasia sp.*) is a tropical food crop with great promise. The leaves are easy to ensile, have a high protein content and have been shown to significantly lower calcium oxalate concentrations which appears to be a limiting factor in the consumption of fresh leaves according to Tiep et al. (2006). In the research by Buntha et al (2008), it was shown that taro leaf silage could replace up to 70-75% of the fish meal protein with higher feed intakes and N retention than with 100% of the protein from fish meal or from taro leaf silage.

4.2.32 Sowing *dhaincha* (green manure) during summer to enhance nutritional content for fish in the reservoir

Dhaincha is a green manuring crop that enhances organic matter content in the soil, supplies nitrogen and other nutrients and prevents soluble nutrient leaching. It supports the growth of phytoplankton in the reservoir which is very effective for the fish community.

4.2.33 A mixture of catechu and haritaki extract in the water to protect fertilized eggs from damage

A mixture of catechu and *haritaki* extract significantly reduces oxidative damage and removes free radicals from the body. Applying a mixture of catechu and haritaki extract in the water of the fish reservoir protects the fertilized eggs from damage.

Livestock related ITKs

4.2.34 Feeding the flesh of oysters and snails to duck

In addition to being a significant source of vitamin E and minerals, snail flesh is high in carbohydrates, low in fat and high in protein. For fish and other animals, oysters are a crucial supply of calcium. So, feeding the flesh of oysters and snails to ducks can support better growth and development of ducks (Nkansah et al., 2021)

4.2.35 Feeding contraceptive pill for controlling Newcastle of poultry

Only birds, especially poultry like chickens, are impacted by the sickness known as Newcastle. Numerous birds can become unwell and die soon as a result. Loss of appetite, coughing, gasping, nasal discharge, watery eyes, bright green diarrhea and neurological indicators including paralysis and convulsions are just a few of the symptoms that infected birds may exhibit. When poultry breeders in Egypt feed chicken's oral contraceptive drugs at the level they do, more estrogen residues accumulate in their bodies which can reduce the risk of Newcastle disease (Sadek,1995).

4.2.36 Feeding molasses and table salts to cattle

Feeding molasses to cattle improves digestion of pastures, increases milk production, helps maintain body condition and appetite and results in less feed waste. Salt is also a crucial component in animal feed. Salt keeps cattle healthy by preserving the proper mineral balance in the body. It is suggested to choose sea salt because it also includes extra necessary minerals and trace elements (Mordenti et al., 2021).

4.2.37 Feeding the *katanate* grass to livestock for improving lactation

In comparison to natural pasture hay, enhanced grass hays (containing *katanate* and other grass species) and treated teff straw silage diet feeding boosted milk output, nutritional digestibility and nitrogen use efficiency. Additionally, the cows fed with enhanced grass hays and treated teff straw changed the pathway by which nitrogen is excreted from urine to feces and reduced the amount of methane produced per daily milk yield. These findings therefore offer a novel feeding strategy that involves feeding nutritionally improved forages as a base diet. This strategy increases milk yield, nutrient utilization effectiveness and methane emission reduction for sustainable dairy production in tropical areas (Mekuriaw et al., 2020).

4.2.38 Use of bamboo case to protect ducklings from snatched birds

Ducklings can be easily snatched by crows and other birds. They can be protected by keeping them in a case made up of bamboo. The bamboo case is good for aeration and they can get a natural feeding environment.

4.2.39 Deeping eggs in water for assessing the hatching quality

Indigenous people assess the hatching quality of eggs by dipping eggs in a bowl of water. If the eggs float, they become viable and vice versa for those which do not float.

4.2.40 Feeding seeded bananas to cattle for curing loose motion

Indigenous people feed their cattle seeded bananas for curing loose motion. Seeded bananas are rich in carbohydrates, potassium and dietary fiber. The vitamins A and B are also abundant in them. It is very helpful for curing the loose motion of cattle.

4.2.41 Using earthen pot for laying and hatching eggs of poultry

The earthen pot is porous in nature. It keeps the temperature cool inside it. So, indigenous people use it for laying and hatching eggs of poultry because of its several benefits.

4.2.42 Use of *biscatali* grass as a repellent of body lice of cattle

Biskatali grass or oriental pepper is a medicinal plant and has been used in traditional medicine for the treatment of various diseases. Rural people control the body lice of cattle by bathing the animal with a mixture of water and oriental pepper. The plant has a toxic chemical which kills the body lice of cattle.

4.2.43 Feeding *hukkah* water to control worms of goat

Feeding *hukkah* water to goats for controlling worms is a traditional practice. The rural people used this practice before the invention of modern medicines.

4.2.44 Feeding *Sali* (raw paddy) to cows to remove retained placenta

It is also a traditional practice before the availability of veterinarians in rural areas.

4.2.45 Drenching mixture of jaggery and onion to cure constipation

There are some foods that encourage good gut bacteria. There are known as prebiotics. They contain a soluble fiber called inulin. Some of these foods are jaggery, onions, garlic, asparagus, etc. So, the mixture of jaggery and onion is very helpful to cure constipation.

4.2.46 Moving FMD-infected animals through mud or hot dust to cure FMD infection

Moving FMD-infected animals through mud or hot dust can help in the healing process of the disease of FMD infection. This practice is based on the concept of immunomodulation which is the process of modifying the immune response to a pathogen. Mud can act as a natural barrier against the FMD virus by preventing it from spreading to other part of the animal's body. Hot dust can also help to dry out blisters caused by FMD which can promote healing process.

4.2.47 Drenching castor oils to animals to cure tympany

Tympany refers to the accumulation of excessive gas in the rumen. Castor oil is known as a stimulant laxative. It increases the movement of the intestines and helps the stool to come out. It is a great indigenous medicine to cure tympany in animals.

Weather forecasting related ITKs

4.2.48 If the wind is blowing east to west, it confirms that heavy rainfall will occur after a few days

The direction of the wind can provide an indication of the weather pattern in a particular area. In Northern Hemisphere, the prevailing winds blow from west to east due to the rotation of the earth. When the wind shifts direction and blows from east to west, it can indicate a change in the atmospheric condition. In general, a shift in wind direction from east to west can be associated with atmospheric low pressure and typically associated with cloudy and rainy weather. It is a indication of heavy rainfall.

4.2.49 If grasshopper is in a group of 10–12 then, it is supposed that rain will occur in the next 24 hour

Grasshoppers are sensitive to changes in temperature and humidity. When the atmospheric conditions become favorable for rainfall, grasshoppers may gather in large groups as seek to shelter and food. Therefore, the presence of a large group of grasshoppers could be an indirect indicator of impending rainfall.

4.2.50 If the rainbow is seen in the western sky, heavy rainfall will occur

Rainbows are created by the reflection of light in water droplets in the atmosphere. Rainbows are typically seen in the opposite direction of the sun and they often associated with rainfall or the clearing of rain clouds.

4.2.51 When the rain is about to begin, the spider makes its web in the opposite direction i.e., vertically to the earth and sky and after rain, the direction of the web is horizontal to the earth and sky

Spiders are known to be sensitive to changes in humidity, temperature and air pressure which are all factors that can precede rainfall. Before a rainstorm, the humidity in the air increases and this can affect the tension and stickiness of the spider's web. To compensate of these changes, spiders may adjust the orientation and shape of their webs to ensure that they are most effective at capturing prey.

The key aspects of CSA technology are they ensure productivity, sustainability, capacity building of rural communities, reduction of GHG emission, vulnerability reduction, conservation of natural resources, profit growth and food security. The selected ITKs can also be used as CSA technology as they fulfill the key aspects of CSA technology.

4.3 Relationships between the selected demographic characteristics of farmers and use of ITKs

4.3.1 Selected Demographic Characteristics of Farmers

The selected demographic characteristics include age, educational status, family size, main occupation, farming experience, farm size, annual family income, organizational participation, training received, cosmopolitanism, extension media contact, knowledge of ITKs and attitude toward ITKs of an individual. The distribution of respondents is shown in Table 4.5 on the basis of selected characteristics.

Table 4.4 Distribution of respondents according to their personal characteristics

Characteristics	Categories	Score	N=110		($\bar{x} \pm \sigma$)	Range	
			F.	%		Min.	Max.
Age (years)	Young	≤35	36	32.7	44.45±13.03	23	72
	Middle-aged	36-55	54	49.1			

Characteristics	Categories	Score	N=110		($\bar{x} \pm \sigma$)	Range	
			F.	%		Min.	Max.
	Old	>55	20	18.2			
Educational status (schooling years)	Illiterate	0	1	0.9	7.95±5.43	0	17
	Can sign only	0.5	25	22.7			
	Primary	1-5	13	11.9			
	Secondary	6-10	40	36.4			
	Higher Secondary	11-12	11	10.0			
	Undergraduate	13-16	13	11.7			
	Postgraduate	>16	7	6.4			
Family size (number of family members)	Small	≤4	55	50.0	4.73±1.62	2	12
	Medium	5-6	45	40.9			
	Large	>6	10	9.1			
Main occupation	Agriculture		93	84.5			
	Business		5	4.5			
	Service		4	3.6			
	Day laborer		0	0			
	Fisheries		8	7.3			
	Other (If any)		0	0			
Farming experience (years)	Low	≤10	33	30.0	24.57±15.19	2	60
	Medium	11-20	11	10.0			
	High	>20	66	60.0			
Farming system	Crop		0	0			
	Livestock		0	0			
	Fisheries		1	0.9			
	Crop + Fish		27	24.5			
	Crop + Livestock		5	4.5			
	Livestock + Fish		1	0.9			
	Crop + Livestock + Fish		76	69.1			
Farm size (ha.)	Landless	≤0.02	0	0	0.55±0.39	0.05	2.68
	Marginal	0.021-0.2	16	14.5			
	Small	0.21-1.0	82	74.5			
	Medium	1-3	12	10.9			
	Large	>3	0	0			
Income	Low	<180	47	42.7	320.1±450.9	20.3	3527

Characteristics	Categories	Score	N=110		$(\bar{x} \pm \sigma)$	Range	
			F.	%		Min.	Max.
('000' BDT year^{-1})	Medium	180-300	30	27.3			
	High	>300	33	30.0			
Organizational involvement	Yes		68	61.8			
	No		42	38.2			
Organizational participation (score)	Low	≤6	66	97.1	1.38±0.49	1	2
	Medium	7-12	2	2.9			
	High	>12	0	0			
Training received	Yes		45	40.9			
	No		65	59.1			
Duration of training received (days)	Low	≤15	34	75.6	4.05±17.78	1	180
	High	>15	11	24.4			
Cosmopolitanism (score)	Low	≤5	55	50.0	5.88±2.57	2	14
	Medium	6-10	48	43.6			
	High	>10	7	6.4			
Extension media contact (score)	No	0	0	0	30.42±8.54	10	57
	Rare	1-24	31	28.2			
	Occasional	25-48	71	64.5			
	Often	49-72	8	7.3			
	Regular	>72	0	0			
Farmers' knowledge on ITKs (score)	Low	≤8	2	1.8	14.75±2.83	7	22
	Good	9-16	71	64.5			
	Excellent	>16	37	33.6			
Farmers' attitude towards ITKs (score)	Highly unfavorable	0-10	0	0	39.16±6.90	19	50
	Unfavorable	11-20	1	0.9			
	Neutral	21-30	15	13.6			
	Favorable	31-40	58	52.7			
	Highly favorable	41-50	36	32.7			

[F. = Frequency, %= Percentage, $\bar{x}$= Mean, σ = Standard Deviation, Min.= Minimum and Max.= Maximum]

Data presented in Table 4.4 showed that the majority (54%) of the respondents were middle-aged. Young farmers were 36% and old farmers were 20%. The farmers' age ranged from 23 to 72 with a mean of 44.45 and a standard deviation of 13.03.

Mostly middle-aged farmers were involved in agricultural practices. The involvement of young and old farmers was less. The reasons behind the less involvement of young farmers in agriculture can be their preference for higher education, eagerness for getting government jobs and uncertainties of profit in agriculture.

Mim and Islam (2022) found major proportion (52%) of respondents were middle-aged highly involved in agriculture followed by young (26%) and old farmers (22%) respectively.

Highest portion of the farmers (36.4%) belong to a secondary level of education followed by 22.7%, 11.9%, 11.7%, 10.0%, 6.4% and 0.9% of the farmers who belong to can sign only, primary, undergraduate, higher secondary, postgraduate and illiterate level of education. The score of educational status ranged from 0 to 17 with a mean of 7.95 and a standard deviation of 5.43.

Mim and Islam (2022) found 34% of the respondents had a secondary educational level followed by primary (29%), can sign only (22%), higher secondary (13%), undergraduate (1%) and postgraduate (1%) level of education.

Majority of the family sizes of the respondents were small (50%). 40.9% of the respondents had medium families and 9.1% of the respondents had large families. The data of family size ranged from 2 to 12 with a mean of 4.73 and a standard deviation of 1.62.

Large families are decreasing day by day in urban as well as rural areas. The number of children also decreases within the families.

Mim and Islam (2022) found the highest portion of the respondents (46%) had medium families followed by small (38%) and large families (16%) respectively.

The main occupation of most of the respondents was agriculture (84.5%). About 7.3% of the respondents were engaged with fisheries followed by business (4.5%) and service (3.6%) respectively.

It is evident from Table 4.4 that maximum respondent (60%) had high farming experience. About 30% of the respondents had low farming experience. Only 10% of the respondents had medium farming experience. The rural farmers' score on farming experience varies from 2 to 60. The mean and standard deviation are 24.57 and 15.19 respectively.

High farming experiences indicates the farmers were well aware about ITKs and there is a great possibility of their maximum use of ITKs.

Mim and Islam (2022) found that highest portion of the respondents (44%) had high farming experience followed by medium (35%) and low (21%) farming experience.

The farming system of majority of the farmers (69.1%) were Crop + Livestock + Fish compared to 24.5%, 4.5%, 0.9% and 0.9% of the farmers were engaged with Crop + Fish, Crop + Livestock, Livestock + Fish and Fish cultivation.

The farm size of majority of the farmers was small (74.5%). About 14.5% farmers were marginal and 10.9% were medium farmers. The farm size of the farmers ranged from 0.05 to 2.68 ha with a mean of 0.55 and a standard deviation 0.39.

Farmers cannot make the expected amount of money if their farms are small, despite their best efforts. Growing the size of the farm is also crucial for improving the status of the farmers. Small farms may facilitate ITKs adoption, but they will obstruct efforts to reap financial rewards from them. since implementing ITKs practice roughly raises the cost of productivity. However, if the farm is small, the input expenditure might not produce the desired results.

Mim and Islam (2022) found that more than half 56%) of the farmers had small farm size followed by marginal (26%), medium (15%) and large (3%) farm size.

Data presented in table 4.4 showed that the annual income of maximum respondents (42.7%) was low. 42.7% of the respondents had medium income and 30% of the respondents had high income. The annual income of the respondents varies from 20300 BDT to 3527000 BDT. The mean and standard deviation are 320121.82 and 450923 respectively.

There was an exclusively high-income respondent who earned 3527000 BDT in a year by commercial fish farming. The respondents' mean income is only 320121.82 BDT, which is quite low. These days, it is really challenging to provide for a family with that wage. As a result, many are becoming less interested in farming and searching for alternative sources of income. Contrarily, low-income farmers are more likely to refrain from practices that would cost them money or cause a delay in the outcome of their input.

Mim and Islam (2022) found that highest portion of the farmers (45%) had low income followed by medium income (32%) and high income (23%) respectively.

Majority of the respondents (61.8%) involved in different organization. Among them 97.1% had low level of organizational involvement and only 2.9% had medium level of organizational involvement.

Mim and Islam (2022) found that only 44% of the total respondents participated in different organization.

According to Table 4.5, only 40.9% of the respondents received agricultural training. Among them 75.6% received short duration training and 24.4% received long duration training. Training duration ranged from 1 to 180 days with a mean of 4.05 and a standard deviation of 17.78.

Table 4.5 Types of agricultural training that the respondents received

Serial	Topic of training	Frequency	Percentage
i.	Rice cultivation	17	20.99
ii.	Jute cultivation	1	1.23
iii.	Vegetable cultivation	14	17.28
iv.	Coconut trees plantation	1	1.23
v.	Mushroom cultivation	1	1.23
vi.	Field crop cultivation	7	8.64
vii.	Tuber crop cultivation	3	3.70
viii.	Vermicompost production	1	1.23
ix.	Green manuring	1	1.23
x.	Seed production and storage	1	1.23
xi.	Cutting and grafting of horticultural crop	1	1.23
xii.	*"Ekti bari ekti khamar"* (The family homestead garden)	2	2.47
xiii.	*"Paribarik Pushti bagan"* (The family nutrition garden)	2	2.47
xiv.	Fish cultivation	22	27.16
xv.	Poultry farming	1	1.23
xvi.	Line, logo, perching	6	7.41

Table 4.5 showed that highest portion of the respondents (27.16%) received training related to fish cultivation followed by rice cultivation (20.99%) and vegetable cultivation (17.28%).

Mim and Islam (2022) found that only 46% of the total respondents received training. Among them, majority (60.9%) had low level of training followed by medium (39.1%) level of training.

Table 4.4 showed that cosmopolitanism of majority of the respondents (50%) is low. 43.6% of the respondents had medium and only 6.4% of the respondents had high cosmopolitanism. The score of cosmopolitanism ranged from 2 to 14 with a mean of 5.88 and a standard deviation of 2.57.

Higher level of cosmopolitanism serves to extend farmers' perspectives, whereas a lower level of cosmopolitanism restricts their viewpoint. Low levels of cosmopolitanism can also be a factor in farm operations not adopting high-quality environment friendly techniques as well as ITKs.

Mim and Islam (2022) found that majority of the respondents (58%) had low level of cosmopolitanism followed by medium (40%) and high (2%) level of cosmopolitanism respectively.

According to statistics from Table 4.4, the majority of respondents (64.5%) had only occasional level of extension media contact, while 28.2% had rare level of extension media contact and 3% contacted with the extension media often. The score of extension media contact ranged from 10 to 57 with a mean of 30.42 and a standard deviation of 8.54.

Mim and Islam (2022) found that majority of respondents (66%) had occasional level of extension media contact followed by often (31%) and rare (3%) level of extension media contact.

The data presented in Table 4.4 indicated that 64.5% of the surveyed farmers had a good knowledge of ITKs while approximately 1.8% were found to have limited knowledge. Additionally, 33.6% of farmers were found to possess an excellent level of knowledge about ITKs. The knowledge score ranged from 7 to 22 with a mean of 14.75 and a standard deviation of 2.83.

Here the knowledge of farmers is mainly on the selected questions related to ITKs. Respondents' good knowledge cannot guarantee the high use of ITKs. According to the respondents' knowledge level, farmers have a lot of information gaps about ITKs. It might be because of the proper identification, documentation and validation of ITKs and also extension workers provide less information about the benefits of ITKs. Farmers' knowledge of ITKs can be considerably increased by training.

Khatri et al. (2021) found that 64.89% of the respondent had medium level of knowledge and 9.27% of them had low level of knowledge about ITKs. He also found that 25.84% of the farmers were having high knowledge of ITKs.

It is evident from Table 4.4 that the majority of the respondents (52.7%) had a favorable attitude toward ITKs. 32.7% of the respondents had a highly favorable attitude followed by a neutral attitude (13.6%) and an unfavorable attitude (0.9%), respectively. The attitude score ranged from 19 to 50 with a mean of 39.16 and a standard deviation of 6.90.

The favorable attitude of respondents towards ITKs indicates that they are able to understand the benefits of ITKs' use in agricultural practices. They also understood that agricultural practices using ITKs are simple, cost-effective, beneficial for the health of humans and the environment, can cope with climate change and ensures sustainable agricultural development.

Khatri et al. (2021) found that majority of the majority of the respondents (53.93%) had a favorable attitude toward ITKs. 20.79% of the respondents had a highly favorable attitude followed by highly unfavorable attitude (9.55%), neutral attitude (8.99%) and unfavorable attitude (6.74%), respectively.

4.3.2 Relationships between the selected demographic characteristics of farmers and use of ITKs

Table 4.6 Relationships between the selected demographic characteristics of farmers and use of ITKs

Selected Characteristics	Use of ITKs
Age	.174
Educational status	.038
Family size	.081
Farming experience	.160
Farm size	-.041
Annual income	.206*
Organizational participation	-.030

Selected Characteristics	Use of ITKs
Duration of training received	.050
Cosmopolitanism	.241*
Extension media contact	.231*
Knowledge of ITKs	.493**
Attitude towards ITKs	-.021

** Correlation is significant at the 0.01 level * Correlation is significant at the 0.05 level

Table 4.6 showed that farm size had negative correlation with the use of ITKs. That means with the increase of farm size, the use of ITKs decreased and vice versa. The causes may be due to increased number of laborers, shortage of infrastructure related to practice, unwillingness of farmers to maintain every detail in large scale.

From table 4.6 it is found that annual income, cosmopolitanism, extension media contact had a positive correlation with the use of ITKs at 5% level of significance. This may occur due to young peoples' high literacy rate as their family income is more to afford higher education, their cosmopolitanism also increased and they had more extension media contact. That's why the knowledge of ITKs also increased among the respondents and they became more interested to practice ITKs for their betterment.

Results of Table 4.6 show that knowledge of ITKs had significant positive correlation with use of ITKs at 1% level of significance. This indicated that with the increase of "knowledge of ITKs', practicing rate also increased among the respondents.

Here 'knowledge of ITKs' is farmers' knowledge on the standard form of practices. A farmer is more or less likely to practice them in his farm for better production if the farmer is aware of the standard practices.

4.4 Identification of the Constraints and Solutions for the Adoption of ITKs in Agriculture

Table 4.7 Distribution of respondents on the basis of their perception of the severity of ITKs-related problems

Categories	Score	N=110		Mean ± SD ($\bar{x} \pm \sigma$)	Range	
		Frequency	Percentage		Min.	Max.
Less severe	≤20	0	0	36.96±4.50	23	48

Categories	Score	N=110		Mean ± SD ($\bar{x} \pm \sigma$)	Range	
		Frequency	Percentage		Min.	Max.
Severe	21-40	87	79.1			
Highly severe	>40	23	20.9			

The data presented in Table 4.7 indicated that 79.1% of the surveyed farmers perceived that the severity of ITK related problems was medium while approximately 20.9% perceived that the severity of ITK related problems was high. The severity score of ITK related problems ranged from 23 to 48 with a mean of 39.96 and a standard deviation of 4.50.

Table 4.8 Problems regarding ITK index

Serial	Problems of ITKs adoption	Score of problems					Problem score	Problem index (%)	Rank
		Highly severe (4)	Severe (3)	Moderately severe (2)	Less severe (1)	Not at all (0)			
1.	ITK has no written document	45	37	27	1	0	346	78.64	3rd
2.	Lack of knowledge of ITK practices	27	44	29	10	0	308	70	5th
3.	Lack of interest among young farmers	15	32	52	11	0	271	61.59	8th
4.	More time is required to get the desired results	29	37	32	12	0	303	68.86	6th
5.	Labor intensive nature of ITKs	40	34	16	19	1	313	71.14	4th
6.	Ambiguous in treatment	19	23	32	33	3	242	55	9th
7.	Unavailability of medicinal plants/ ingredients used for ITKs in the local market	21	21	30	34	4	241	54.77	10th
8.	Low productivity	62	28	14	6	0	366	83.18	2nd
9.	ITK is not a complete solution in all situations	25	33	31	14	7	275	62.50	7th
10.	Preference of farmers for sophistication with reliance on readymade inputs	70	26	11	3	0	383	87.05	1st
11.	Lack of expert guidance/ extension support for the adoption of ITKs	11	12	47	33	7	207	47.05	13th

Serial	Problems of ITKs adoption	Score of problems					Problem score	Problem index (%)	Rank
		Highly severe (4)	Severe (3)	Moderately severe (2)	Less severe (1)	Not at all (0)			
12.	Weak coordination between Research and Development Organizations	7	9	49	35	10	188	42.73	15th
13.	Many new problems have no traditional cure	9	17	51	28	5	217	49.32	11th
14.	Lack of full confidence of applying ITKs as Govt. officials and educated people give less recognition to this knowledge	7	13	44	39	7	194	44.09	14th
15.	Experienced farmers do not transfer their knowledge to any person except their family member	8	25	36	33	8	212	48.18	12th

From Table 4.8 it is found that the 1st position was ranked by the ITK related problem 'Preference of farmers for sophistication with reliance on readymade inputs' on the basis of obtained highest score (383) which was followed by 'Low productivity' (2nd, score 366) and 'ITK has no written document' (3rd, score 346). The least scores were obtained by the ITK related problems 'Weak coordination between Research and Development Organizations' (15th, score 188), 'Lack of full confidence of applying ITKs as Govt. officials and educated people give less recognition to this knowledge' (14th, score 194) and 'Lack of expert guidance/ extension support for the adoption of ITKs' (13th, score 207). Most of the farmers knew about the importance of using ITKs and the severity ITK related problems.

Khatri et al. (2021) found that the major constraints for the adoption of ITKs were 'Preference of farmers for sophistication with reliance on readymade inputs' followed by 'More time required to get the desired results from adoption of ITKs', 'Sociological constraints', 'Labor-intensive nature of ITKs', 'Lack of expert guidance/ extension support for adoption of ITKs' and 'Weak coordination between Research and Development Organizations'.

Table 4.9 Distribution of respondents on the basis of their perception of the suitability of ITKs-related solutions

Categories	Score	N=110		Mean ± SD ($\bar{x} \pm \sigma$)	Range	
		Frequency	Percentage		Min.	Max.
Less suitable	≤20	0	0	34.77±5.57	21	47
Medium suitable	21-40	90	81.8			
Highly suitable	>40	20	18.2			

The data presented in Table 4.9 indicated that 81.8% of the surveyed farmers perceived that the suitability of ITK related solutions was medium while approximately 18.2% perceived that the suitability of ITK related solutions was high. The suitability score of ITK related solutions ranged from 21 to 47 with a mean of 34.77 and a standard deviation of 5.57.

Table 4.10 Solutions regarding ITK index

Serial	Solutions to ITKs adoption	Suitability score of the solution					Solution Score	Solution index (%)	Rank
		Highly suitable (4)	Suitable (3)	Moderately suitable (2)	Less suitable (1)	Not at all (0)			
1.	Proper identification and documentation of ITKs	35	48	26	1	0	337	76.59	3rd
2.	Building upon local people's knowledge	20	40	30	19	1	279	63.41	5th
3.	Increase awareness among the younger generation and develop an appreciation of an indigenous system	7	24	56	22	1	234	53.18	10th
4.	Using ITKs in a scientific way to get desired results within a short time	15	26	41	25	3	245	55.68	8th
5.	Using updated tools and implements to reduce the labor-intensive nature of ITKs	14	41	32	21	2	264	60	6th
6.	Validation of the ITKs/Assessment of the ITK for scientific logic	4	19	31	50	6	185	42.05	13th
7.	Making the ingredients used for ITKs available in the local market by different agencies	18	30	24	30	8	240	54.55	9th
8.	Discovering the ways to increase the productivity of ITKs by the researchers	46	40	17	7	0	345	78.41	2nd

Serial	Solutions to ITKs adoption	Suitability score of the solution					Solution Score	Solution index (%)	Rank
		Highly suitable (4)	Suitable (3)	Moderately suitable (2)	Less suitable (1)	Not at all (0)			
9.	ITKs should be used combined with environment-friendly modern techniques to get solutions of almost all situations.	59	36	11	4	0	370	84.09	1st
10.	Changing the poor social perception of farmers	5	6	43	50	6	174	39.55	14th
11.	Focus on future research on the adoption of ITK	0	13	40	45	12	164	37.27	15th
12.	Financial support from Government and other agencies	33	41	21	13	2	310	70.45	4th
13.	Experts should provide solutions to new problems using ITKs	20	32	30	23	5	259	58.86	7th
14.	Govt. officials and educated people should give more importance to ITK using	9	13	40	42	6	197	44.77	12th
15.	Experienced farmers should transfer their knowledge to others during different social gatherings	16	22	27	36	9	220	50	11th

It is evident from Table 4.10 that the 1st position was ranked by the solution against ITK related problem 'ITKs should be used combined with environment-friendly modern techniques to get solutions of almost all situations.' on the basis of obtained highest score (370) which was followed by 'Discovering the ways to increase the productivity of ITKs by the researchers' (2nd, score 345) and 'Proper identification and documentation of ITKs' (3rd, score 337). The least scores were obtained by the solution against ITK related problems 'Focus on future research on the adoption of ITK' (15th, score 164), 'Changing the poor social perception of farmers' (14th, score 174) and 'Validation of the ITKs/Assessment of the ITK for scientific logic' (13th, score 185).

Khatri et al. (2021) found that strategies to increase adoption of ITKs were 'Validate the ITKs/Assess the ITK for scientific logic', followed by 'Building upon local people's knowledge', 'Changing poor social perception of farmers', 'Increase awareness among the younger generation' and 'Develop appreciation of indigenous system', 'Financial support from Government and other agencies' and 'Focus on future research on adoption of ITK'.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

The respondent farmers of the study used the selected (51) ITKs to different extent. However, 'Soaking vegetable seeds in water for better germination' was used to highest extent (90.30%) on the basis of obtained highest score (298) which was followed by 'Feeding molasses and table salts to cattle' (2nd, score 265), 'Coarse grain rice varieties generally do not lodge' (3rd, score 258), 'Use of rice husk as fish feed' (4th, score 244) and 'Using *neem* (*Azadirachta indica*) leaves to store food grains like paddy and wheat'(5th, score 242). On the other hand, least score was obtained by the ITKs of 'A mixture of catechu and *haritaki* extract in the water to protect fertilized eggs from damage' (42nd, score 6) followed by 'Feeding *Sali* (raw paddy) to cows to remove retained placenta' (41st, score 8), 'Using dried *kacchu patta* (*Colocasia sp.*) as fish feed' (40th, score10), 'Application of poultry litter in the pond as fish feed' and 'Use of *biscatali* grass as a repellent of body lice of cattle' (39th, score 15) among all the ITKs adopted by the respondents.

In the case of early adopters, most of the respondents (83.64%) adopted the ITK of 'Soaking vegetable seeds in water for better germination'. In the case of early majority, the highest portion of the respondents (42.73%) adopted the ITK of 'Use of banana leaves as a feed for carp fish'. In the case of late majority, the highest portion of the respondents (18.18%) adopted the ITK of 'Feeding seeded bananas to cattle for curing loose motion'. In the case of laggards, 1.82% of the respondents adopted both 'Intercropping cereals with legumes to increase N content in the soil' and 'Use of oil cakes in the pond for the rapid growth of fish' as ITKs.

Majority (58.43%) of the respondents were early adopters, followed by early majority (28.43%), late majority (12.5%) and laggards (0.65%) of crop-related ITKs. In case of fisheries-related ITKs, majority of the respondents were early adopters (39.88%) followed by early majority (39.74%), late majority (19.8%) and laggards (0.58%), respectively. ITKs in livestock, majority (56.89%) of the respondents were early adopters, followed by early majority (27.87%), late majority (14.59%) and laggards (0.66%), respectively. Majority (39.61%) of the respondents were early majority in case of ITKs in weather forecasting followed by early adopters (35.27%) and late majority (25.12%), respectively.

Majority (54%) of the respondents were middle-aged. Young farmers were 36% and old farmers were 20%. Highest portion of the farmers (36.4%) belong to a secondary level of education followed by 22.7%, 11.9%, 11.7%, 10.0%, 6.4% and 0.9% of the farmers who belong to can sign only, primary, undergraduate, higher secondary, postgraduate and illiterate level of education. Majority of the family sizes of the respondents were small (50%). 40.9% of the respondents had medium families and 9.1% of the respondents had large families. The main occupation of most of the respondents was agriculture (84.5%). About 7.3% of the respondents were engaged with fisheries followed by business (4.5%) and service (3.6%) respectively. Maximum respondents (60%) had high farming experience. About 30% of the respondents had low farming experience. Only 10% of the respondents had medium farming experience. The farming system of maximum farmers (69.1%) was Crop + Livestock + Fish compared to 24.5%, 4.5%, 0.9% and 0.9% of the farmers were engaged with Crop + Fish, Crop + Livestock, Livestock + Fish and Fish cultivation. The farm size of majority of the farmers was small (74.5%). About 14.5% of farmers were marginal and 10.9% were medium farmers. The annual income of the maximum number of respondents (42.7%) was low. 42.7% of the respondents had medium income and 30% of the respondents had high income. Majority of the respondents (61.8%) were involved in different organizations. Among them 97.1% had a low level of organizational involvement and only 2.9% had medium level of organizational involvement. Only 40.9% of the respondents received agricultural training. Among them 75.6% received short duration training and 24.4% received long duration training. Highest portion of the respondents (27.16%) received training related to fish cultivation followed by rice cultivation (20.99%) and vegetable cultivation (17.28%). The cosmopolitanism of majority of the respondents (50%) is low. 43.6% of the respondents had medium and only 6.4% of the respondents had high cosmopolitanism. Majority of respondents (64.5%) had only an occasional level of extension media contact, while 28.2% had a rare level of extension media contact and 3% were contacted with the extension media often. Majority of the farmers (64.5%) had a good knowledge of ITKs while approximately 1.8% were found to have limited knowledge. Additionally, 33.6% of farmers were found to possess an excellent level of knowledge about ITKs. Majority of the respondents (52.7%) had a favorable attitude toward ITKs. 32.7% of the respondents had a highly favorable attitude followed by a neutral attitude (13.6%) and an unfavorable attitude (0.9%), respectively.

Annual income, cosmopolitanism and extension media contact had a positive correlation with the use of ITKs at 5% level of significance. 'Knowledge of ITKs' had a significant positive correlation with the use of ITKs at 1% level of significance. This indicated that with the increase of "knowledge of ITKs', practicing rate also increased among the respondents.

Majority of the surveyed farmers (79.1%) perceived that the severity of ITK-related problems was medium while approximately 20.9% perceived that the severity of ITK-related problems was high. The 1st position was ranked by the ITK-related problem 'Preference of farmers for sophistication with reliance on readymade inputs' on the basis of obtained highest score (383) which was followed by 'Low productivity' (2nd, score 366) and 'ITK has no written document' (3rd, score 346). The least scores were obtained by the ITK-related problems 'Weak coordination between Research and Development Organizations' (15th, score 188), 'Lack of full confidence of applying ITKs as Govt. officials and educated people give less recognition to this knowledge' (14th, score 194) and 'Lack of expert guidance/ extension support for the adoption of ITKs' (13th, score 207).

Most of the respondents (81.8%) perceived that the suitability of ITK-related solutions was medium while approximately 18.2% perceived that the suitability of ITK-related solutions was high. 1st position was ranked by the solution against ITK related problem 'ITKs should be used combined with environment-friendly modern techniques to get solutions of almost all situations' on the basis of obtained highest score (370) which was followed by 'Discovering the ways to increase the productivity of ITKs by the researchers' (2nd, score 345) and 'Proper identification and documentation of ITKs' (3rd, score 337). The least scores were obtained by the solution against ITK-related problems 'Focus on future research on the adoption of ITK' (15th, score 164), 'Changing the poor social perception of farmers' (14th, score 174) and 'Validation of the ITKs/Assessment of the ITK for scientific logic' (13th, score 185).

5.2 Conclusions

Highest portion of the respondents was in the medium-use category of ITKs followed by the low-use category. The respondent farmers of the study used the selected ITKs to different extent. However, 'Soaking vegetable seeds in water for better germination' was used to highest extent followed by 'Feeding molasses and table salt to cattle. On the other hand, 'A mixture of catechu and *haritaki* extract in the water to protect fertilized eggs from damage' was used to the lowest extent. Majority of the respondents were early adopters, followed by early majority, late majority and laggards of crop-related, fisheries-related and livestock-related ITKs. Majority of the respondents were early majority in case of ITKs in weather forecasting followed by early adopters and late majority, respectively. In the case of ITK practice,

The articulation of the selected ITKs clearly indicated their benefits scientifically and suitability of use as CSA technology.

Annual income, cosmopolitanism and extension media contact had a positive correlation with the use of ITKs. Knowledge of ITKs' had a significant positive correlation with use of ITKs.

Majority of the surveyed farmers perceived that the severity of ITK-related problems was medium. The 1st position was ranked by the ITK-related problem 'Preference of farmers for sophistication with reliance on readymade inputs' on the basis of obtained highest score which was followed by 'Low productivity' and 'ITK has no written document'. On the other hand, least score was obtained by the ITK-related problems 'Weak coordination between Research and Development Organizations'. Highest portion of the respondents perceived that the suitability of ITK-related solutions was medium. 1st position was ranked by the solution against ITK related problem 'ITKs should be used combined with environment-friendly modern techniques to get solutions of almost all situations' on the basis of obtained highest score which was followed by 'Discovering the ways to increase the productivity of ITKs by the researchers' and 'Proper identification and documentation of ITKs'. On the other hand, least score was obtained the solution against ITK-related problems 'Focus on future research on the adoption of ITK'.

5.3 Recommendations

5.3.1 Recommendations for policy implications

i. Farmers' knowledge of the use of ITKs in farming practices was not satisfactory. To raise farmers' knowledge of ITKs, various extension programs, like group discussions and farmer training need to be prioritized.

ii. Farmers' adoption of ITKs depends greatly on the availability of knowledge and the necessary collaboration and communication between scientists, extension agents and farmers. In this vital communication process, extension and education are crucial. Therefore, research on ITKs may be carried out at the local level of Bangladesh.

iii. In order to encourage farmers to embrace ITKs, GOs and NGOs should implement the appropriate incentive programs. It is necessary to establish an ITK identification program at the local level in Bangladesh.

iv. Rural farmers faced a difficult time in adopting ITKs for sustainable agricultural development due to a lack of information and experience. As a result, the concerned NGOs and DAE may take special care to inspire and educate the rural farmers.

5.3.1 Recommendations for future research

i. The study was conducted in one upazila under Bagerhat district so it will not be able to reflect the overall situation across the country. Further research is recommended in another area of Bangladesh.

ii. There are very few available studies about the scientific explanation of the ITKs. Future studies can cover this topic.

iii. Future researchers may assess the efficacy of the ITKs as CSA technology on productivity and sustainability.

CHAPTER VI

REFERENCES

Abdelhakim, W. M. (2020). Scaring Birds: The concept of the Scarecrow in Ancient Egypt. International Journal of Heritage, Tourism and Hospitality, 14(2), 42-51.

Aggarwal, P. K., Singh, A. K., Samra, J. S., Singh, G., Gogoi, A. K., Rao, G. G. S. N., & Ramakrishna, Y. S. (2009). Global climate change and Indian agriculture. Case studies from ICAR.

Ali, M. Y. (1997). Fish, Water and People: Reflections on Inland Openwater Fisheries Resources of Bangladesh. University Press Limited.

Altieri, M. A. (1989). Agroecology: A new research and development paradigm for world agriculture. Agriculture, Ecosystems & Environment, 27(1-4), 37-46.

Altieri, M. (1996). Indigenous knowledge re-valued in Andean agriculture. ILEIA newsletter, 12(1), 7-11.

Altieri, M. A. (1999). The ecological role of biodiversity in agroecosystems. In Invertebrate biodiversity as bioindicators of sustainable landscapes (pp. 19-31). Elsevier.

Altieri, M. A., & Nicholls, C. I. (2017). The adaptation and mitigation potential of traditional agriculture in a changing climate. Climatic Change, 140, 33-45.

Anonymous. (1994). Indigenous Techniques. Extension Digest. 2(1): 16-21.

Ashraf, M., & Foolad, M. R. (2005). Pre-sowing seed treatment—A shotgun approach to improve germination, plant growth and crop yield under saline and non-saline conditions. Advances in agronomy, 88, 223-271.

Barash, H., & Schroeder, G. L. (1984). Use of fermented cow manure as a feed substrate for fish polyculture in stagnant water ponds. Aquaculture, 36(1-2), 127-140.

Below, T. B., Mutabazi, K. D., Kirschke, D., Franke, C., Sieber, S., Siebert, R., & Tscherning, K. (2012). Can farmers' adaptation to climate change be explained by socio-economic household-level variables?. Global environmental change, 22(1), 223-235.

BER. (2014). Bangladesh Economic Review (BER). Ministry of Finance, Government of the Peoples' Republic of Bangladesh, Dhaka.

Branca, G., McCarthy, N., Lipper, L., & Jolejole, M. C. (2011). Climate-smart agriculture: a synthesis of empirical evidence of food security and mitigation benefits from improved cropland management.

Brida, A. B., Owiyo, T., & Sokona, Y. (2013). Loss and damage from the double blow of flood and drought in Mozambique. International Journal of Global Warming, 5(4), 514-531.

Buntha, P., Borin, K., Preston, T. R., & Ogle, B. (2008). Digestibility and nitrogen balance studies in pigs fed diets with ensiled taro (Colocasia esculenta) leaves as replacement for fish meal. Livestock Research for Rural Development, 20(sSupplement).

Callaway, J. M. (2004). Adaptation benefits and costs: are they important in the global policy picture and how can we estimate them?. Global Environ. Change-Human Policy Dimens., 14, 273-282.

Campbell, J., Cheong, S., McCormick, M., Pulwarty, S., Supratid, R. S., & Ziervogel, G. (2012). Managing the risks from climate extremes at the local level. Managing the risks of extreme events and disasters to advance climate change adaptation. A special report of working groups I and II of the IPCC. Cambridge University Press, Cambridge, UK and New York, USA.

Chadwick, M., Soussan, J., Mallick, D., & Alam, S. (1998). Understanding indigenous knowledge: Its role and potential in water resource management in Bangladesh. University of Leeds and Bangladesh Centre for Advanced Studies: Leeds, UK.

Challinor, A. J., Watson, J., Lobell, D. B., Howden, S. M., Smith, D. R., & Chhetri, N. (2014). A meta-analysis of crop yield under climate change and adaptation. Nature climate change, 4(4), 287-291.

Chowdhury, D. N., Elias, S. M., & Ahmed, N. U. (1996, May). Indigenous technologies used by women in Bangladesh. In A draft paper presented at the workshop on "Achievements of the Gender Research and Training Project.

CIAT. (2014). Climate-smart agriculture investment prioritization framework.

DeBach, P. (1964). Biological control of insect pests and weeds. Biological control of insect pests and weeds.

Deressa, T. T., Hassan, R. M., & Ringler, C. (2011). Perception of and adaptation to climate change by farmers in the Nile basin of Ethiopia. The Journal of Agricultural Science, 149(1), 23-31.

Dimetry, N. Z. (2012). Prospects of botanical pesticides for the future in integrated pest management programme (IPM) with special reference to neem uses in Egypt. Archives of Phytopathology and Plant Protection, 45(10), 1138-1161.

Dugassa, M. (2023). The Role of Cereal legume Intercropping in Soil Fertility Management: Review. Journal of Agriculture and Aquaculture, 5(1).

Dzhamirze, R. R., Ostapenko, N. N., & Chinchenko, N. N. (2021, March). Lodging resistance of modern domestic rice varieties. In IOP Conference Series: Earth and Environmental Science (Vol. 677, No. 5, p. 052097). IOP Publishing.

Easterling, W., Aggarwal, P., Batima, P., Brander, K., Erda, L., Howden, M., ... & Tubiello, F. (2007). Climate Change 2007: Impacts, Adaptation and Vulnerability. Cambridge University Press. UK, Cambridge, 273-313.

Elwell, H., & Maas, A. (1995). Natural pest and disease control, Natural Farming Network.

FAO, F. (2010). Climate smart agriculture: policies, practices and financing for food security, adaptation and mitigation. In Hague Conference on Agriculture, Food Security and Climate Change.

Farouk, S. M., & Salam, M. U. (1996). Sustainable agriculture in Bangladesh addressing issues through human resource development. The Journal of Rural Development, 26(1), 1-21.

Field, C. B., Van Aalst, M., Adger, W. N., Arent, D., Barnett, J., Betts, R., ... & Yoh, G. (2014). Part a: Global and sectoral aspects: Volume 1, global and sectoral aspects: Working group II contribution to the fifth assessment report of the intergovernmental panel on climate change. In Climate change 2014: impacts, adaptation and vulnerability (pp. 1-1101). IPCC.

Finger, R., & Schmid, S. (2007). Modelling agricultural production risk and the adaptation to climate change.

Gathala, M. K., Ladha, J. K., Kumar, V., Saharawat, Y. S., Kumar, V., Sharma, P. K., ... & Pathak, H. (2011). Tillage and crop establishment affects sustainability of South Asian rice–wheat system. Agronomy Journal, 103(4), 961-971.

Ghosh, G. P. (2002). Indigenous knowledge, livelihood and decision-making strategies of floodplain farmers in Bangladesh (Doctoral dissertation, Durham University).

Goode, W. J., & Hatt, P. K. (1945). Methods of Social Research. New York, McGraw Book Company.

Grenier, L. and International Development Research Centre (Canada). (1998). Working with Indigenous Knowledge: A guide for researchers. International Development Research Centre.

Gupta, A. K. (1989). Scientists view of farmers' practices in India: barriers to effective intention.

Gupta, A. K. (2022). Use of neem and neem based products in organic farming. Indian Farming, 72(1).

Gupta, A. K., Suthar, J., Patel, K., Koradia, D., Rawal, A., Pastakia, A., ... & Sherry Chand, V. (1996). Farmers innovations for sustainable resources management and conservation of biological diversity.

Hasan, S. S., Sultana, S., Khalil, M. I., & Mazumder, M. D. H. (2009). Identification and use of indigenous technologies (ITs) by the farmers in fisheries and livestock components. Bangladesh Res. Pub. J, 2(1), 351-360.

Hossain, S. M. A., & Alam, A. B. M. M. (1993). Farmers Ingenuity and Indigenous Knowledge in Developing Sustainable Farming Systems. Farming Systems Research: A Training Manual.

Hussain, S., Amin, A., Mubeen, M., Khaliq, T., Shahid, M., Hammad, H. M., ... & Nasim, W. (2022). Climate smart agriculture (CSA) technologies. Building Climate Resilience in Agriculture: Theory, Practice and Future Perspective, 319-33

Jat, R. K., Sapkota, T. B., Singh, R. G., Jat, M. L., Kumar, M., & Gupta, R. K. (2014). Seven years of conservation agriculture in a rice–wheat rotation of Eastern Gangetic Plains of South Asia: yield trends and economic profitability. Field Crops Research, 164, 199-210.

Kanak Pervez, A. K. M., Gao, Q., & Uddin, M. E. (2015). Rural women's awareness on indigenous technical knowledge: Case of northern Bangladesh. The Anthropologist, 21(3), 415-426.

Khatri, S., Khanal, S., & Kafle, S. (2021). Perceived attributes and adoption of Indigenous Technological Knowledge on agriculture-a case study from Bhirkot municipality of Syangja District, Nepal. Cogent Food & Agriculture, 7(1), 1914384.

Khatri-Chhetri, A., Aryal, J. P., Sapkota, T. B., & Khurana, R. (2016). Economic benefits of climate-smart agricultural practices to smallholder farmers in the Indo-Gangetic Plains of India. Current Science, 1251-1256.

Mittal, S. (2012). Modern ICT for agricultural development and risk management in smallholder agriculture in India. CIMMYT.

Mordenti, A. L., Giaretta, E., Campidonico, L., Parazza, P., & Formigoni, A. (2021). A review regarding the use of molasses in animal nutrition. Animals, 11(1), 115.

Morrison, G. S., Enzinger, E., Hughes, V., Jessen, M., Meuwly, D., Neumann, C., ... & Anonymous, B. (2021). Consensus on validation of forensic voice comparison. Science & Justice, 61(3), 299-309.

NAEP 1996. New Agricultural Extension Policy. Ministry of Agriculture. Dhaka: Government of the People's Republic of Bangladesh.

NEMAP 1995. National Environment Management Action Plan. Ministry of Environment and Forest. Dhaka: Government of the People's Republic of Bangladesh.

Ninkovic, V., Ahmed, E., Glinwood, R., & Pettersson, J. (2003). Effects of two types of semiochemical on population development of the bird cherry oat aphid Rhopalosiphum padi in a barley crop. Agricultural and Forest Entomology, 5(1), 27-34.

Nkansah, M. A., Agyei, E. A., & Opoku, F. (2021). Mineral and proximate composition of the meat and shell of three snail species. Heliyon, 7(10), e08149.

Norton, R. (2014). Combating climate change through improved agronomic practices and input-use efficiency. Journal of Crop Improvement, 28(5), 575-618.

Olaniyi, C. O., Olabomi, F. T., & Ajayi, O. M. (2016). Performance characteristics and nutrients utilization of African catfish fed termite based diets. International Journal of Science, Environment and Technology, 5(5), 2679-2688.

Palanisami, K., Kumar, D. S., Malik, R. P. S., Raman, S., Kar, G., & MOHAN, K. (2015). Managing water management research: analysis of four decades of research and outreach programmes in India. Economic and Political Weekly, 33-43.

Parera, C. A., & Cantliffe, D. J. (1994). Presowing seed priming. Horticultural reviews, 16(16), 109-141.

Porter, J. R., Xie, L., Challinor, A. J., Cochrane, K., Howden, S. M., Iqbal, M. M., ... & Travasso, M. I. (2014). Food security and food production systems.

Prasanna, V. (2014). Impact of monsoon rainfall on the total foodgrain yield over India. Journal of earth system science, 123(5), 1129-1145.

Quddus, M. A. (2000). Use of indigenous knowledge in the sustainable development of Bangladeshi farm forestry. Indigenous knowledge development in Bangladesh: Present and future, 57-64.

Rahman, MA. (2000b). Tree pathology and Bangladeshi agro-forestry In: P Sillitoe (Ed.): Indigenous Knowledge Development in Bangladesh: Present and Future. Dhaka: University Press Limited, pp. 55-62.

Rahman, M. (2012). Practice of indigenous knowledge system by the farmers in maintaining ecosystem in Bangladesh. Journal of Agricultural Sciences, Belgrade, 57(3), 155-168.

Rajasekaran, B., & Warren, D. M. (1995). Role of indigenous soil health care practices in improving soil fertility: Evidence from South India. Journal of soil and water conservation, 50(2), 146-149.

Reijntjes, C. (2002). Farming for the future: an introduction to low-external-input and sustainable agricultura. Londres, Mc.

Riauwaty, M., Siregar, Y. I., & Mulyani, I. (2021). Effectiveness of turmeric-enriched pellets to improve the immunity of Clarias batrachus toward motile Aeromonas septicemia disease. F1000Research, 10.

Rist, S. (1991). Revitalising Indigenous Knowledge. ILEA Neusletter. 3/91:22.

Rogers, E. (1995). Diffusion of Innovations,. The Free Press, 263-266

Sadek, I. A. (1995). Some aspects of the use of oral contraceptives as growth-promoting agents in poultry. EMHJ-Eastern Mediterranean Health Journal, 1 (2), 241-247, 1995.

Saha, B., Rahman, M. M., Uddin, M. M., Shahjahan, M., & Roy, B. (2021). Management of mustard aphids using eco-friendly control approaches. Fundamental and Applied Agriculture, 6(4), 395-402.

Sapkota, T. B., Majumdar, K., Jat, M. L., Kumar, A., Bishnoi, D. K., McDonald, A. J., & Pampolino, M. (2014). Precision nutrient management in conservation agriculture based wheat production of Northwest India: Profitability, nutrient use efficiency and environmental footprint. Field Crops Research, 155, 233-244.

Sapkota, T. B., Jat, M. L., Aryal, J. P., Jat, R. K., & Khatri-Chhetri, A. (2015). Climate change adaptation, greenhouse gas mitigation and economic profitability of conservation agriculture: Some examples from cereal systems of Indo-Gangetic Plains. Journal of Integrative Agriculture, 14(8), 1524-1533.

Schlippe, P. D. (1956). Shifting cultivation in Africa: the Zande system of agriculture. Shifting cultivation in Africa: the Zande system of agriculture.

Selvi, E., Ekawaty, N., & Fitrilia, E. (2022). Waste management of rice husk and paddy field snails (Pila ampullacea) for alternative feed in fish farming: a case study in Karawang Regency, Indonesia. Aquaculture, Aquarium, Conservation & Legislation, 15(1), 377-383.

Shah, P. (1994). Local Institutions and Para-Professionals in Watershed Management. ILEIA Newsletter, 10(2), 17-19.

Shah, W. A., & Townsley, P. (2000). An indigenously developed pond aquaculture system. Indigenous knowledge development in Bangladesh: present and future, 131-136.

Sharland, R. W. (1991). Using indigenous knowledge in a subsistence society. Warren et al.

Sharma, I., Kanta, C., Dwivedi, T. and Rani, R. (2020). Indigenous agricultural practices: A supreme key to maintaining biodiversity. Microbiological Advancements for Higher Altitude Agro-Ecosystems and Sustainability, 91–112. https://doi.org/10.1007/978-981-15-1902-4_6

Shivakumar, M., Bala, S., Rajanna, C., & Naveenkumar, B. T. (2013). Economics of seed rearing and farming of carps. Labour, 1, 08-750.

Sillitoe, P., Dixon, P., & Barr, J. J. F. (1998). Indigenous knowledge research on the floodplains of Bangladesh: The search for a methodology. Grassroots Voice, 1(1), 5-15.

Singh, M. K. (2012). Weed management in upland rice. ORYZA-An International Journal on Rice, 49(1), 1-9.

Singh, G., Mishra, D., Singh, K., & Parmar, R. (2013). Effects of rainwater harvesting on plant growth, soil water dynamics and herbaceous biomass during rehabilitation of degraded hills in Rajasthan, India. Forest ecology and management, 310, 612-622.

Sriraj, P., Toomsan, B., & Butnan, S. (2022). Effects of Neem Leaf Extract on the Soil Properties, Growth, Yield and Inorganic Nitrogen Contents of Lettuce. Horticulturae, 8(12), 1104.

Sroy, S., Avallone, S., Servent, A., In, S., & Arnaud, E. (2023). Does drying preserve the nutritional quality of small freshwater fish without excessive concentrations of heavy metals?. Current Research in Food Science, 6, 100489.

Talawar, S., & Singh, Y. P. (1992). Indigenous knowledge system: Climate and crop-pest climate interactions. Indian Journal of Extension Education, 28(1&2), 1-7.

Thrupp, L. A. (1989). Legitimizing local knowledge: From displacement to empowerment for Third World people. Agriculture and Human Values, 6, 13-24.

Tiep, P. S., Van Luc, N., Tuyen, T. Q., Hung, N. M., & Van Tu, T. (2006, August). Study on the use of Alocasia macrorrhiza (roots and leaves) in diets for crossbred growing pigs under mountainous village conditions in northern Vietnam. In Workshop-seminar" Forages for Pigs and Rabbits" MEKARN-CelAgrid, Phnom Penh, Cambodia (pp. 22-24).

Townsend, J.N. (1953). Introduction of Experimental Methods. International Student Edition. Me. Grow-Hill Book Company. Inc.. New York.

Thurston, H. D. (1990). Plant disease management practices of traditional farmers. Plant disease, 74(2), 96-102.

Vakhnenko, V. A., & Kurchiy, B. A. (1990). A resonance model of lodging of cereals. Fiziologiya i Biokhimiya Kul'turnykh Rasteniĭ, 22(3), 245-252.

Verma, M. R., & Singh, Y. P. (1969). plea for studies in traditional animal husbandry. Allahabad farmer.

Vermeulen, S. J., Campbell, B. M., & Ingram, J. S. (2012). Climate change and food systems. Annual review of environment and resources, 37, 195-222.

Warren, D. M. (1991). Using indigenous knowledge in agricultural development (No. 127). World Bank.

Zabel, F., Putzenlechner, B., & Mauser, W. (2014). Global agricultural land resources– a high resolution suitability evaluation and its perspectives until 2100 under climate change conditions. PloS one, 9(9), e107522.

Wilken, G.C. (1987). Good Farmers: Traditional Agricultural Resource Management in Mexico and Central America Berkeley: University of California Press.

Wong, M. H., Mo, W. Y., Choi, W. M., Cheng, Z., & Man, Y. B. (2016). Recycle food wastes into high quality fish feeds for safe and quality fish production. Environmental pollution, 219, 631-638.

Appendix A

Interview schedule of this thesis

Agrotechnology Discipline

Life Science School

Khulna University, Khulna-9208

Survey on

Identification of Indigenous Technical Knowledges (ITKs) as Climate Smart Agriculture (CSA) Technology

(Confidentiality will be maintained and all information will be used only for study purposes)

Respondent No.:

Date:

Personal information of the respondent:

Name:
Fathers Name:
Address:
Contract No:

1. Age (year):

2. Educational status: a) Illiterate, b) Can sign only, c) Actual schooling years ......

3. Family size:

Family type (put √): ☐ Nuclear ☐ Joint ☐ Extended

Number of family members: a) Male.............. b) Female..............

4. Main occupation

Please furnish your main occupation (put √)

☐ Agriculture ☐ Business ☐ Service

☐ Day laborer ☐ Fisheries ☐ Others

5. Experience in farming (years):

6. Farming system (put √)

☐ Crop ☐ Livestock ☐ Fisheries

☐ Crop + Fish ☐ Crop + Livestock ☐ Livestock + Fish

☐ Crop + Livestock + Fish

7. Farm size (ha): ....

Please Furnish information about your lands according to use.

Serial	Use of land	Area of land	
		Local unit	Hectare
A1	Homestead area		
A2	Own land under cultivation		
A3	Land given to others on borga		
A4	Land taken from others on borga		
A5	Land taken from others on lease		
A6	Others		

$FS = A1+A2+1/2(A3+A4) + A5 \pm A6$

8. Annual family income (BDT): Please mention information about your family income (Annual) from different sources:

A. Income from agricultural sectors: How much money did you receive from the following agricultural sectors in the preceding year?

Serial	Sources of income	Sources	Total production (Local unit)	Price/ unit (Taka)	Amount of income (taka)
1.	Agriculture	Crops			
		Vegetables			
		Fruits			
2.	Livestock	Cattle			
		Goat			
		Sheep			
		Poultry			
3.	Fisheries				
5.	Social forestry				
6.	Homestead gardening				
7.	Others				
Total					

B. Income from non-agricultural sectors: How much money did you receive from the following non-agricultural sectors in the preceding year?

Serial	Income sources	Income (Taka)
1.	Service	
2.	Business	
3.	Day laborer	
Total		

Total income = (A + B) =.............................. Taka

9. Organizational participation:

Are you involved in any organization? ☐ Yes ☐ No

If yes, then answer the following question

Serial	Name of the No. Serial organization (Non-political)	Extent of involvement				Duration (year)
		No Involvement (0)	General Member (1)	Executive Member (2)	Executive Officer (3)	
1.	Youth organization					
2.	Farmer club					
3.	Committee (mosque/Temple /church/Mandir/madrasa)					
4.	NGO maintained					
5.	GO maintained associations					
6.	Other (specify)					

10. Training: Have you received any agricultural training? ☐ Yes ☐ No

If yes, Please mention the name of the training with the duration you have received from different organization

Serial	Name of the training	Duration (Days)	Organized by
1.			
2.			
3.			
4.			

11. Cosmopolitanism:

Please indicate the number of times you have visited the following places within the specified period:

Serial	Place of visit	Nature of visit			
		Frequently (3)	Occasionally (2)	Rarely (1)	Not at all (0)
1.	Relative or other known persons	5-6 times/month	3-4 times/month	1-2 times/month	0 times/month

Serial	Place of visit	Nature of visit			
		Frequently (3)	Occasionally (2)	Rarely (1)	Not at all (0)
	located outside of your own village.				
2.	Union parishad office.	8-10 times/month	5-6 times/month	2-3 times/month	0 times/month
3.	Own Upazilla.	5-6 times/month	3-4 times/month	1-2 times/month	0 times/month
4.	Other district Upazilla/ Sadar.	4 times/year	3 times/year	1-2 times/year	0 times/year
5.	Capital and other cities.	3 times/year	2 times/year	1 times/year	0 times/year

12. Extension media contact:

Categories		Regularly (4)	Often (3)	Occasionally (2)	Rarely (1)	Not at all (0)
a. Mass media	1. Radio					
	2. Television					
	3. Poster					
	4. Leaflets					
	5. Newspaper					
	6. Exhibition/ Agriculture fair					
	7. Magazine					
	8. Online Agricultural Apps					
b. Group Contact	1. Farmers' field					
	2. School					
	3.1PM/1CM club					
	4. Tours					
	5. Lecture					
c. Personal cosmopolite	1.0ffice call (SAAO)					
	2.0ffice call (AEO/UAO)					
	3. Email					
	4. Personal letter					
	5. Mobile					
	6.Farm & home visit by SAAO					
d. Personal localite	1. Friends					
	2.Relatives					
	3.Neighbor					
	4. Dealer (pesticide)					

Categories		Regularly (4)	Often (3)	Occasionally (2)	Rarely (1)	Not at all (0)
	5. Model farmer					

13. Rural farmers' knowledge of ITKs:

Serial	Question	Correct (2)	Partially Correct (1)	Wrong (0)
1.	Name two ingredients used to store grains.			
2.	Name two procedures useful for better germination of seeds.			
3.	Name two ingredients applied to correct soil alkalinity.			
4.	Name two measures of rodent control.			
5	Name the soil type suitable for rice variety.			
6.	Name two ingredients used as fish feed.			
7	Mention the plants used in cleaning pond water.			
8	Mention two methods of controlling fish disease			
9	Name two ingredients used as duck or poultry feed.			
10	Mention two uses of earthen pots in poultry.			
11	Mention two ingredients to cure constipation of livestock.			
12	Mention two indigenous weather forecasting methods.			

14. Attitude of rural farmers about ITKs:

Serial	Attitude parameters	Attitude about the statement				
		Strongly Agree (5)	Agree (4)	Undecided (3)	Disagree (2)	Strongly Disagree (1)
1	ITKs that you have heard of are completely familiar.					
2	ITKs are easy to operate.					
3	ITKs are safe for health.					
4	ITKs are inexpensive.					
5	ITKs are environment-friendly.					
Serial	**Attitude parameters**	**Strongly Agree (1)**	**Agree (2)**	**Undecided (3)**	**Disagree (4)**	**Strongly Disagree (5)**
6	The use of ITKs requires more time to get desired results.					
7	ITKs operating procedure is complex.					

8	ITKs might create health and environmental hazard.					
9	The risk of adopting ITKs is large due to possibility of production failure.					
10	The impact of adopting ITKs on income improvement is less.					

15. Rural farmers' adoption level of ITKs:

Serial	Crop related ITKs	Do you use this ITK?		Adopter categories					How often do you use this ITK?			
		Yes	No	1	2	3	4	5	Regularly (3)	Occasionally (2)	Rarely (1)	Not at all (0)
1	Soaking vegetable seeds in water for better germination											
2	Burning crop residues											
3	Garlic-potato intercropping to reduce pest attack											
4	Use of fish cleaning water at the base of bottle gourd vine											
5	Application of ash in leafy vegetables to control aphid											
6	Erecting scare-crow in standing crops to scare birds											
7	Hand pollination in cucurbit vegetable											
8	Use of *neem* extract as a pesticide											
9	Watering/ fumigating of rodent holes to control them											
10	Coarse grain rice varieties generally do not lodge											
11	Weed growth is faster in upland areas											

Serial	Crop related ITKs	Do you use this ITK?		Adopter categories					How often do you use this ITK?			
		Yes	No	1	2	3	4	5	Regularly (3)	Occasionally (2)	Rarely (1)	Not at all (0)
12	Greenish tillering during active tillering is an indication of poor yield in rice											
13	Clayey soil is suitable for rice variety											
14	Application of casuarina or neem leaves or sand will correct soil alkalinity											
15	Intercropping cereals with legumes to increase N content in the soil											
16	Setting up bamboo sticks or branches of trees to control insect											
17	Using *neem* (*Azadirachta indica*) leaves to store food grains like paddy and wheat											

Serial	Fisheries Related ITKs	Do you use this ITK?		Adopter categories					How often do you use this ITK?			
		Yes	No	1	2	3	4	5	Regularly (3)	Occasionally (2)	Rarely (1)	Not at all (0)
18	Application of cow dung in the pond as fish feed											
19	Use of rice husk as fish feed											
20	Application of segmented banana plants for cleaning the pond water											
21	Use of banana leaves as a feed for carp fish											

Serial	Fisheries Related ITKs	Do you use this ITK?		Adopter categories					How often do you use this ITK?			
		Yes	No	1	2	3	4	5	Regularly (3)	Occasionally (2)	Rarely (1)	Not at all (0)
22	Application of poultry litter in the pond as fish feed											
23	Drying of excess fish for the lean period											
24	Planting *mehogany* tree beside the pond to control fish disease											
25	Application of food wastage in the pond as feed											
26	Dragging fishing net for aeration											
27	Use of oil cakes in the pond for the rapid growth of fish											
28	Use of termites as feed for fish in ponds											
29	Use of common carp for natural seed rearing											
30	Use of salt and turmeric solution in a pond after the rainy season to have protection from disease infestation											
31	Using dried *kacchu patta* (Colocasia sp.) as fish feed											
32	Sowing *dhaincha* (green manure) during summer to enhance nutritional content for fish in the reservoir											
33	A mixture of catechu and *haritaki* extract in the water to protect the fertilized eggs from damage											

Serial	Livestock Related ITKs	Do you use this ITK?		Adopter categories					How often do you use this ITK?			
		Yes	No	1	2	3	4	5	Regularly (3)	Occasionally (2)	Rarely (1)	Not at all (0)
34	Feeding the flesh of oysters and snails to duck											
35	Feeding contraceptive pill for controlling Newcastle of poultry											
36	Feeding molasses and table salts to cattle											
37	Feeding the *katanate* grass to livestock for improving lactation											
38	Use of bamboo case to protect ducklings from snatched birds											
39	Deeping eggs in water for assessing the hatching quality											
40	Feeding seeded bananas to cattle for curing loose motion											
41	Using an earthen pot for laying and hatching eggs of poultry											
42	Use of *biscatali* grass as a repellent of body lice of cattle											
43	Feeding *hukkah* water to control worms of goat											
44	Feeding *Sali* (raw paddy) to cows to remove retained placenta											
45	Drenching mixture of jaggery and onion to cure constipation											
46	Moving FMD-infected animals through mud or hot dust to cure FMD infection											
47	Drenching castor oils to animals to cure tympany											

Serial	Indigenous Weather Forecasting Related ITKs	Do you use this ITK?		Adopter categories					How often do you use this ITK?			
		Yes	No	1	2	3	4	5	Regularly (3)	Occasionally (2)	Rarely (1)	Not at all (0)
48	If the wind is blowing east to west, it confirms that heavy rainfall will occur after a few days											
49	If grasshopper is in a group of 10–12 then, it is supposed that rain will occur in the next 24 hour											
50	If the rainbow is seen in the western sky, heavy rainfall will occur.											
51	When the rain is about to begin, the spider makes its web in opposite direction i.e., vertically to the earth and sky and after rain, the direction of the web is horizontal to the earth and sky											

**** Adopter categories:**

1 = Innovators, 2 = Early adopters, 3 = Early majority, 4 = Late majority and 5 = Laggards

16. Constraints for the adoption of ITKs in agriculture:

Serial	Problems of ITKs adoption	Extend of problems				
		Highly severe (4)	Severe (3)	Moderately severe (2)	Less severe (1)	Not at all (0)
1.	ITK has no written document					
2.	Lack of knowledge of ITK practices					
3.	Lack of interest among young farmers					
4.	More time is required to get the desired results					
5.	Labor intensive nature of ITKs					
6.	Ambiguous in treatment					
7.	Unavailability of medicinal plants/ ingredients used for ITKs in the local market					

Serial	Problems of ITKs adoption	Extend of problems				
		Highly severe (4)	Severe (3)	Moderately severe (2)	Less severe (1)	Not at all (0)
8.	Low productivity					
9.	ITK is not a complete solution in all situations					
10.	Preference of farmers for sophistication with reliance on readymade inputs					
11.	Lack of expert guidance/ extension support for the adoption of ITKs					
12.	Weak coordination between Research and Development Organizations					
13.	Many new problems have no traditional cure					
14.	Lack of full confidence of applying ITKs as Govt. officials and educated people give less recognition to this knowledge					
15.	Experienced farmers do not transfer their knowledge to any person except their family member					

17. Solutions for the adoption of ITKs in agriculture:

Serial	Solutions to ITKs adoption	Suitability of the solution				
		Highly suitable (4)	Suitable (3)	Moderately suitable (2)	Less suitable (1)	Not at all (0)
1.	Proper identification and documentation of ITKs					
2.	Building upon local people's knowledge					
3.	Increase awareness among the younger generation and develop an appreciation of an indigenous system					
4.	Using ITKs in a scientific way to get desired results within a short time					
5.	Using updated tools and implements to reduce the					