ASSESSING RESILIENCE IN SEED SYSTEM OF NARSINGDI DISTRICT

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CERTIFICATE

This is to certify that thesis entitled **"Assessing Resilience in Seed System of Narsingdi District"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE IN AGRICULTURAL EXTENSION,** embodies the result of a piece of *bona fide* research work carried out by **ABDUR RAHMAN, Registration No. 15- 06877** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

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DEDICATED to
MY
BELOVED PARENTS

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ABSTRACT

Resilient seed system is essential for achieving food security in the context of climate change. The main objectives of the study were to develop a set of indicators and to assess resilience in seed system (i.e., production and processing).The study was conducted in three villages of Shibpur Upazilla of Narsingdi district. Data were collected from a sample of randomly selected 110 farmers by using a structured interview schedule. Resilience of seed system was assessed by developing a resilience index. This study was adapted a resilience assessment framework (dimension X capacity) proposed by the German Corporation for International Cooperation (GIZ). Data quality was checked through employing data screening tests, e.g., dealing with outliers. Based on literature review and expert appraisals nine indicators of resilient seed systems were determined. Results show that (i) in terms of social, economic and ecological dimensions, about 66% seed producers had medium to high resilient seed systems; (ii) they had more adaptive capacity than absorptive and transformative; and (iii) a number of indicators, access to information, non-farm income generating activities and pest and disease management had positive and highly significant relationships with the seed systems resilience index. This study concludes that (one-third of) seed growers were facing climatic challenges and a range of options such as improving access to climatic information and promoting non-farm income generation activities can build their resilient seed systems through improving absorptive and transformative capacities. Several problems were identified in achieving seed system resilient.

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LIST OF ABBREVIATIONS AND ACRONYMS

BADC	Bangladesh Agricultural Development Corporation
BBS	Bangladesh Bureau of Statistics
BRRI	Bangladesh Rice Research Institute
DAE	Department of Agricultural Extension
GO	Government Organization
MS	Master of Science
MOA	Ministry of Agriculture
NGO	Non-Government Organization
No	Number
"r"	Co-efficient of Correlation
SD	Standard Deviation
UNDP	United Nations Development Program
IGAs	Non-farm Income Generation Activities
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit

CHAPTER I

INTRODUCTION

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1.1 General Background

Climate change impacts on agriculture are being witnessed all over the world, but countries like Bangladesh are more vulnerable due to the huge population dependent on agriculture, excessive pressure on natural resources and poor coping mechanisms. The warming trend in Bangladesh over the past 100 years has indicated an increase of 0.60° that results has negative impacts on production of many crops thus impacting food security (Kotschi and Muller-Samann, 2004). There are already evidences of negative impacts on yield of wheat and paddy in parts of Bangladesh due to increased temperature, water stress and reduction in number of rainy days (Lotter et al., 2003). Responding to perceived crises and growing evidence suggests that a more cost effective strategy is required to build a system's capacity in advance to absorb stresses and adapt to changes. In this context, it is important to build its resilience to climatic and non-climatic shocks and stresses (Davies et al., 2008).

Resilience refers to the ability of communities/individuals/systems to withstand and recover from stress, such as environmental change or social, economic, or political upheaval, while for natural systems. It is a measure of how much disturbance (e.g., storms, disasters) an ecosystem can handle without shifting into a qualitatively different state. Seed systems are an important area for enhancing such resilience, as seed security has several direct links to food security (McGuire and Sperling, 2013) and to resilient livelihoods more generally (e.g., access to the right seeds can facilitate more production and income). The seed resilience is the ability of farmers to manage changes and shocks due to mainly climate change by maintaining or transforming the whole seed management (production, processing and marketing) without compromising their long term prospects.

Resilience can be described as the capacity of systems, communities, households or individuals to prevent, mitigate or cope with risks (disaster) and recover from shocks, i.e., drought. In general, resilience is the opposite of vulnerability. However, resilience adds a time dimension long and/or short-term planning. A system is resilient when it is less vulnerable to shocks across time and can recover from them. Essential to resilience is adaptive capacity. Adaptive capacity encompasses two dimensions: recovery from shocks and response to changes in order to ensure the 'plasticity' of the system (Gitz and Meybeck, 2012). To a great extent increasing resilience can be achieved by reducing vulnerabilities and increasing adaptive capacity. This can be done by reducing exposure to risk, reducing sensitivity and increasing adaptive capacity for every type of risk.

Resilience of seed system can be pursued at various scales, in agricultural systems and in food chains. Being efficient without being resilient would not be really helpful in the long term, given the fact that shocks (e.g., market failures) will happen more often. Being resilient without being efficient or without allowing for an increase in production would pose problem for food security in the long term and for support to livelihoods. In the pursuit of these two goals, there might be trade-offs, but there might be synergies (FAO, 2013). Increasing efficiency could lead to greater sensibility to certain shocks (Gitz and Meybeck, 2012). For instance, more productive see production is more sensible to flooding. On the contrary, increased efficiency can be a factor of increased resilience. For example, increasing production in food importing countries will improve their resilience to price volatility (McGuire and Sperling, 2013; FAO, 2013). In sum, a resilient seed system ensures growers sustainable farming/seed production that is capable to manage changes such as market failures, economic volatility, and environmental change.

Despite resilient agriculture/farming is an important issue of several development organisations like FAO, USAID and others. The government is also perusing to promote resilient production systems, at the local level. However, it is difficult to get research on resilient farming, in general and resilient seed systems, in particular. This study is designed to assess resilience in seed system at the local level to generate knowledge on this issue and to develop policy information.

Literatures indicate that research on resilience is scarce. In the context of climate change, it is increasingly reported by the researchers that farming systems need more resilient production systems to face the imminent shocks and stresses. Being an agricultural vibrant area the Narsingdi district will be suitable study area for generating knowledge on resilience seed systems that will contribute to formulate pertinent strategies and policies. Specifically, three outputs will be produced by conducting this study. Notably, it produces information on (i) how farmers' seed production can be promoted, (ii) determinants of resilient seed production to climatic shocks and stress (iii) how resilient seed production can be developed in the Narsingdi district. It is clear that the findings of this study will have immense socio-economic importance for strategies formulation and policy information generation.

1.2 Statements of the Problem

An increase in the variability and intensity of climate events the international community has started putting in place numerous projects and programmes to empower food producers in order to improve their capacity to survive, recover from, and even thrive in changing climatic condition. In this context, the need to measure and monitor climate resilience while at the same time empowering smallholder farmers and producers to develop climate resilience in a participatory manner has become more and more apparent. Climate resilience is often described as the ability to withstand the challenges of climate that include rainfall failure, increased temperatures, and greater variability. Climate resilience is thus highly relevant to maintaining and improving farmers' and producers' livelihoods worldwide. It is recognized that higher yielding crops alone will not necessarily protect against hunger as for example famines or child malnutrition are often not a result of a lack of the total food but that many other factors contribute. To a great extent increasing resilience can be achieved by reducing vulnerabilities and increasing adaptive capacity. This can be done by reducing exposure to risk, reducing sensitivity and increasing adaptive capacity for every type of risk. It can act in each domain, either biophysical or economic and social.

The study assessed the resilience of seed system inNarsingdi district. Thefollowing research questions are considered:

1. What are the indicators represent resilient seed system?
2. To what extent the seed system of Narsingdi district is resilient?
3. What are the indicators that are highly correlated to the resilient seed system?

1.3. Specific Objectives

To conduct the study the following objectives are taken:

- To develop a set of indicators of a resilient seed system.
- To assess resilience in seed systems of Narsingdi district.
- To identify problems in building resilient seed system.

1.4. Justification of the study

Resilience of "what" to "what" (Carpenter et al., 2001) has to be understood properly in resilience assessment. Resilience of "what" refers to the context, i.e. system or process, whose resilience is being evaluated. Systems include human populations, social groups, communities, households, countries, institutions, regions, ecosystems, and infrastructure. Processes might relate to governance or the delivery of services. Resilience to "what" is about 'disturbances', 'shocks' or 'stresses' to which a system or process is exposed or vulnerable. Disturbances can take many forms such as climatic or environmental (e.g., drought, and flooding) social (exploitation and discrimination), political (political unrest and repression), or economic (market failure and high fuel price) in nature.

Considering the research gaps (based on literature review) in mind and realising the present context of world‘s climate change and food insecurity, this study, first developed a set of indicators in resilient seed system. Secondly, assessing the resilience level in seed production. Thirdly, identifying the existing problems of seed producers. Based on generated indicators and dimensions, this study, then assessed the resiliency of seed system (production, processing and marketing). This study has academic and socioeconomic merits in the sense that it generates knowledge on resilience research and it produces policy information that will be helped to address the negative impacts of climate in agriculture- a mainstay of the country’s economy.

1.5 Scope of the study

The main focus of the study was to determine the resilience of seed system in Narsingdi district. The findings of the study would be specifically applicable to the selected three villages namely Shibpur, Masimpur and Dulalpur under ShibpurUpazilla of Narsingdi district. However, the findings would also have implication for other areas of the country where the physical, socio-economic, cultural and geographical conditions are more or less similar with the study area. The investigator believes that the findings of the study would reveal the phenomenon related to the resilience of seed system in the Narsingdi district.

The findings of the study are expected to help the researchers, academicians, trainers, development practitioners and policy maker. The result also help to conduct more research on it that would generate knowledge on resilient seed systems. The findings were also expected to be useful to the field works of different nation building departments and organization to develop appropriate extension strategies for effective working procedure for farming communities.

1.6 Assumptions of the study

The researcher had the following assumptions in the mind while undertaking this study:

1. The respondents selected for the study area were capable to provide proper response to the question in the interview schedule.
2. The responses furnished by the respondents were reliable. They expressed the truth about the conviction and awareness.
3. Views and opinion furnished by the respondents included in the sample were the representative views and opinion of the whole population of the study area.
4. The researcher who acted as interviewer was well adjusted to the social and cultural environment of the study area.

1.7 Limitations of the study

In order to make the study manageable and meaningful from the point of view of research, it was necessary to impose certain limitations as noted below:

1. The study was confined to purposively inShibpur, Masimpur and Dulalpur under ShibpurUpazilla of Narsingdi district.
2. The indicators of the farmers were many and varied, but only nine indicators were selected for investigation in this study.
3. The study results are based on the responses of the seed growers.

CHAPTER II

REVIEW OF LITERATURE

CHAPTER II
REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter deals with the review of past research related to this investigations. The reviews were conveniently presented based on the major objectives of the study. In spite of sincere effort adequate numbers of direct related literatures were not readily available for this study. However, the literatures of available studies have been briefly discussed in this chapter as effectiveness of result demonstration program in resilience of seed system.

2.2 Resilience

“Resilience” is the ability of a system and its component parts to anticipate, absorb, accommodate or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration or improvement of its essential basic structures and functions (IPCC, 2012).

Resilience is used to describe the magnitude of a disturbance that a system can withstand without crossing a threshold into a new structure or dynamic (Shonkoff et al., 2011).

Resilience refers to the ability of communities to withstand and recover from stress, such as environmental change or social, economic, or political upheaval, while for natural systems (Levin, 1999).

It is a measure of how much disturbance (e.g., storms, fire, and pollutants) an ecosystem can handle without shifting into a qualitatively different state (Nelson et al., 2007).

2.3 General resilience

General resilience is captured in the key phrases "the ability to cope with shocks and to keep functioning and the capacity to absorb disturbance and reorganize" (Walker and Salt, 2012). Resilience, in the context of environmental management and sustainability, is the capacity of a social-ecological system to absorb disturbance, reorganize, and thereby retain essential functions, structures and feedbacks (Walker and Salt, 2012). A rich and growing literature addresses specified resilience, the resilience of a particular aspect of a social-ecological system to a particular kind of disturbance (Adger, 2005). For example, management of catchments in Australia seeks to avoid a water-table threshold that salinizes the soil and thereby destroys the fertility of agricultural land. Vulnerability is a related concept that considers the stresses that lead to threshold changes in social-ecological systems. More specifically, "vulnerability is the state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt" (Adger, 2006).

2.4 General Resilience as a Strategy

Extreme events, including record-breaking extremes and new kinds of shocks, have been with us forever and may intensify in the future. General resilience—the capacity of social-ecological systems to adapt or transform in response to unfamiliar or unknown shocks is essential for sustainability in the face extreme events (Adger, 2005). However, the wide-ranging nature of general resilience makes it difficult to define specific steps for creating it. Instead it is possible to identify conditions that can enable or support the development of general resilience (Shonkoff et al., 2011). Diversity provides for different kinds of processes within a social-ecological system (functional diversity).

2.5 Characteristics of resilience

The concept of resilience provides a new and useful framework of analysis and understanding on how individuals, communities, organizations and ecosystems cope in a changing world facing many uncertainties and challenges (Levin, 1999).

Sometimes change is gradual and things move forward in continuous and predictable ways, but sometimes change is sudden, disorganizing and tubule.

2.5.1 Positive outcomes

All definitions of resilience refer to a positive outcome, be it the ability of a material to absorb and release energy and return to its original state, or the ability of an individual, group or organization to continue in existence in the face of some sort of surprise (Levin, 1999), or the ability to recover from or adjust easily to misfortune or sustained life stress, or the capacity of a system to absorb disturbance and still retain essentially the same function.

2.5.3 Being prepared

Resilience involves the ability or capacity to absorb, and then recover from an abnormal event. This capacity may be built formally and deliberately by developing plans, standards and operational procedures, or by developing physical (Walker and Salt, 2012), economic and/or human capital. It may also evolve informally through the development of social capital, or it may exist naturally through the properties of the material being used.

2.5.4 Desire/commitment to survive

Survival is a basic human instinct, and individuals who demonstrate the strongest will to remain alive are able to accept extreme and abnormal conditions and recover from traumatic event (Nelson et al., 2007). Similarly, groups, communities and organizations with a unity of purpose and a collective commitment to survive are more likely to succeed. This is achieved through strong leadership and by shared organizational values and beliefs (Shonkoff et al., 2011).

2.5.5 Adaptability

We live in a world which is constantly evolving, in some cases through natural processes and in other cases through the intervention of mankind (Walker and Salt, 2012). There is common agreement in the literature that systems, organizations and people who are able and willing to adapt tend to be more resilient.

2.5.6 Collective and coordinated response interdependency

As society becomes more complex and interconnected, and the impact of global factors become more immediate and apparent, we find ourselves more vulnerable to disruptive events (Walker and Salt, 2012). In facing such interconnected threats, resilient communities and organizations and indeed nations tend to be those which are well coordinated and share common values and beliefs. But researchers such as Bill Dronie suggest that shared community values and beliefs in the modern world have been replaced by self-interest and personal gain, resulting in vulnerable societies which are less able and willing to plan for, and react to, disruptive events (Levin, 1999).

2.6 Resilience and vulnerability

Assessing the resilience of communities is a complex process as it involves the interaction of individuals, families, groups and the environment (Walker and Salt, 2012). Many of the theoretical models which address the concept of resilience focus on the issues which reduce the vulnerability of individuals and communities.

Vulnerability arises from the intersection of human systems, the natural environment and the built environment. The most obvious factor contributing to community vulnerability is its proximity to hazards such as coasts (Levin, 1999), floodplains, seismic zones, highly combustible forests, industrial contamination (Nelson et al., 2007), or to explosive remnants of war such as minefields.

2.7 Resilience of “what”

Resilience of “what” to “what” (Carpenter et al., 2001) has to be understood properly in resilience assessment. Resilience of “what” refers to the context, i.e. system or process, whose resilience is being evaluated. Systems include human populations, social groups, communities, households, countries, institutions, regions, ecosystems, and infrastructure. Processes might relate to governance or the delivery of services (Adger, 2005). Resilience to “what” is about ‘disturbances’, ‘shocks’ or ‘stresses’ to which a system or process is exposed or vulnerable. Disturbances can take many forms such as climatic or environmental (e.g., drought, and flooding), social (exploitation and discrimination), political (political unrest and repression), or economic (market failure and high fuel price) in nature (Nelson et al., 2007). In the seed system it is the resilience of seed production, processing and marketing.

2.8 Resilience to “what”

Disturbances, disruptions to the system, and uncertainty around the timing and magnitude of such events all present challenges to the management of social-ecological systems and the reliable supply of ecosystem services, including the provision of resources (Adger, 2005). A disturbance can generally be thought of as anything that causes a disruption to a system. Disturbances in social-ecological systems can include drought, fire, disease, or hurricanes, as well as recessions, innovations, technological change, and revolutions (Walker and Salt, 2012). Human intervention in an ecological system can also be a form of disturbance, for example the building of irrigation canals, intensive fishing, or mining operations. As populations and consumption levels grow, human-caused disturbances can intensify (Levin, 1999), with consequences for a system’s general resilience. A disturbance that occurs as a relatively discrete event in time is referred to here as a “pulse” disturbance, while more gradual or cumulative pressure on a system is referred to as a “press” disturbance (Nelson et al., 2007). Both types of disturbances can be part of the natural variability of a social-ecological system. Understanding a disturbance regime, i.e., the pattern of disturbance events over time, can inform how to work with the disturbance regime as opposed to attempting to control or prevent it, which may ultimately weaken a system's resilience (Shonkoff et al., 2011).

There are many ways to characterize disturbances, for example their frequency, duration, severity, and predictability. This information can contribute to understanding a system's disturbance regime. In addition, any given system may be vulnerable to a suite of different disturbances. Combinations of disturbances and the timing of events can cause interaction effects. An otherwise benign disturbance may have much greater consequences if it follows another disturbance from which the system has not yet had a chance to recover (Walker and Salt, 2012). In the seed system it should be resilient to different natural calamities such as drought, heavy rainfall and high temperature. Some points are discussed below:

2.9 Risk

Adger (2005) cited that “Risk” is used here to designate the potential of shocks and stresses to affect, in different ways, the state of systems, communities, households or individuals). Probability, uncertainty (when probabilities of occurrence or even nature of impacts are unknown), severity, economic scale, time scales and direct and indirect costs should be taken into account (Nelson et al., 2007).

2.9.1 Various risks

Agricultural production is submitted to risks of various types: political instability, economic and price-related risks, climatic, environmental, pests and diseases, at different scales. Risks affecting yield in main staple crops are particularly important for smallholders, who tend to consume a large part of their own production. Farmers are also exposed to economic risks including land tenure insecurity, variations in access to inputs (fertilizers, seeds, pesticides, and feed) in quantity and quality, and variations in access to markets. Often risks of various types (Levin, 1999), when superposed, exacerbate their effects, as for example in the case where livestock that are already weakened by a lack of feed owing to a drought would be more prone to becoming infected by a disease. Also, after a poor harvest, seeds could be lacking for the next growing season. Risks faced by producers not only compromise food security directly but also indirectly as they constraint agricultural development by preventing investment and access to credit (Walker and Salt, 2012).

2.9.2 Risk management

Risk management can involve various levels of systems and/or various dimensions. Solidarity at community level can help poorer households to support the effects and to recover (for instance, cattle lending practices in pastoral societies) (Levin, S.A. 1999). Some risks, such as plant pests and animal diseases, can spread from one farm or territory to another. Here risk management strategies, involving prevention, monitoring, early warning and early action can prevent the shock from spreading and having catastrophic effects. The FAO Emergency Prevention System (EMPRES) programmer on locust in West Africa successfully avoids catastrophic crises such as the one of 2003–2005 for a cost of less than 0.6 percent of the value of the crops lost in 2003–2005 (Cossée and Hassane, 2009). Finally, in a given system, production shocks are transmitted in the economic and social dimensions. This transmission can be linear, amplified or reduced, depending on the policies and institutions that are in place (Walker and Salt, 2012).

2.10 Vulnerability

Vulnerability is an essential component of the climate resilience discussion because people that are the most likely to experience the majority of negative impacts of climate change are those that are least capable of developing robust and comprehensive climate resiliency infrastructure and response systems (Walker and Salt, 2012). However what exactly constitutes a vulnerable community is still open to debate. The International Panel on Climate Change has defined vulnerability using three characteristics: the “adaptive capacity, sensitivity, and exposure” to the effects of climate change (Cossée and Hassane, 2009). The adaptive capacity refers to a community’s capacity to create resiliency infrastructure, while the sensitivity and exposure elements are both tied to economic and geographic elements that vary widely in differing communities (Adger, 2005).

2.11 Inter-connectivity between climate resilience, climate change, adaptability, and vulnerability

A conversation about climate resilience is incomplete without also incorporating the concepts of adaptations, vulnerability, and climate change (Walker and Salt, 2012). If the definition of resiliency is the ability to recover from a negative event, in this case climate change, then talking about preparations beforehand and strategies for recovery (aka adaptations), as well as populations that are more less capable of developing and implementing a resiliency strategy (aka vulnerable populations) are essential(Adger, 2005). This is framed under the assumed detrimental impacts of climate change to ecosystems and ecosystem services (Cossée and Hassane, 2009).

2.12 Relationship between selected indicators and resilience

2.12.1 Social Capital:

Trewevas (2002) conducted that social capital is a fundamental livelihoods. Grower’s human capital can be improved by ingredient for sustainable community. Its key elements are increasing access to education, training programs and mutual interest, collaborations and partnerships, services such as farmers’ field schools, IPM club and embedded shared purposes, develop and nurture extension activities. Tibbs (2011) said that it was observed that farmer’s human relationships and reciprocity through trust.

UNDP (2011) observed that it consists capital like leadership, motivational and organizational of two complementary components: structural skills were significant to make resources available, (organizational networks) and cognitive (norms, values, accessible and valuable.so the person who bears more social capital will be more knowledgable about resilient.

2.12.2 Human Capital:

MacGillivary (2004) conducted that human capital is an essential constituent of social emerging problem. By building capacity it is easier to sustainability, which means the total capability residing reach to root of the problem and every single farmer can within an individual, based on his or her stock of play a significant role as a grower, leader as well as a knowledge, skills, experience, health and nutrition practitioner.

Nelson (2013) expressed that institutional, market and society's human capital are crucial for several reasons, mainly; it capacity development can act as a catalyst for managing develops an educated and skilled generation of growers and promoting individual and social wellbeing with up-to-date knowledge, technical skill and innovation.

2.12.3 Non-farm income generation (IGA) activities

Trewevas (2002) cited that non-farm income generation can help to overcome food insecurity when economic factors are a fundamental cause of food insecurity and when food is available in local markets but lack of money is the main difficulty faced by the vulnerable population.

MacGillivary (2004) conducted that the main thrust of the women's development activities would be to assist women in the sustainable establishment of income generating activities to be undertaken in or near the home. In some pilot villages this could be also one of the main objectives of the self-help female groups formed with the support of the Project through its reinforcement of group promotion activities.

Leeuwis (2004) expressed that it is essential to guarantee that women will have the control of the funds (saving funds, loans etc.) and the free disposal of them to implement IGAs. During the feasibility study project staff should be very careful on not raised expectations.

2.12.4 Access to information on climate change and cropping pattern

Paul (1989) cited that Access to information and freedom of access to it may seem like a fundamental right but there are many people who think, rightly or wrongly, it is for your own good that it is hidden.The person who is more knowledgable on agriculture,climate change and current market price is more resilient on seed systems.

2.12.5 Use of climate smart practices

Transformations are needed in both commercial and subsistence agricultural systems, but with significant differences in priorities and capacity. In commercial systems, increasing efficiency and reducing emissions, as well as other negative environmental impacts, are key concerns. In agriculture-based countries, where agriculture is critical for economic development (World Bank, 2008), transforming smallholder systems is not only important for food security but also for poverty reduction, as well as for aggregate growth and structural change. In the latter group of countries, increasing productivity to achieve food security is clearly a priority, which is projected to entail a significant increase in emissions from the agricultural sector in developing countries (IPCC, 2012). Achieving the needed levels of growth, but on a lower emissions trajectory will require a concerted effort to maximize synergies and minimize tradeoffs between productivity and mitigation. Ensuring that institutions and incentives are in place to achieve climate-smart transitions, as well as adequate financial resources, is thus essential to meeting these challenges. In this context mitigation finance can play a key function in leveraging other investments to support activities that generate synergies.

2.12.6 Availability of extension services

Paul (1989) found that annual income of the farmers had a significant positive relationship with their opinion on effect of result demonstration on the adoption of improved practices in rice cultivation. Paul (1995) in his study found a positive significant relationship between income of the farmers and their adoption of recommended practices in sugarcane cultivation. Chowdhury (1997) found that the annual income of the respondents had a positively significant relationship with their adoption of selected BINA technologies. Similar findings were reported by Sarker (1997) and Alam (1997).

2.12.7 Pest and disease management

Paul (1989) found that pest and disease management of the farmers had a significant positive relationship with their resilience in seed cultivation processing and marketing. Paul (1995) in his study found a positive significant relationship between pest and disease management and their resilience in seed system practices.

Chowdhury (1997) found that the pest and disease management of the respondents had a positively significant relationship with their resilience in seed system practices. Similar findings were reported by Sarker (1997) and Alam (1997).Islam (2002) conducted a study on adoption of modern agricultural technologies by the farmers of Sandip. He observed that pest and disease management of the farmers had no relationships with their adoption of modern technology in seed system.

Aurangozeb (2002) conducted a study on adoption of integrated homestead farming technologies by the rural women in RDRS. He found that there was a positive significant relationship between pest and disease management of the respondent and their adoption of integrated homestead farming technologies.

2.12.8 Access to finance

Ahmed (1977) study also indicated existence of a positive and significant relationship between access to finance and use of information sources in the adoption of three improved practices. The practices wares recommended variety of Jute, recommended doses of fertilizer and seed processing. Paul (1989) found that access to finance of the farmers had a significant positive relationship with their seed processing practices.

Rahman (1995) studied farmers' knowledge of improved practices in potato seed indicated a significant relationships between access to finance of improved practices. Sarker (1997) found that access to finance of potato seed had a positive significant relationship with their resilience in seed system. Chowdhury (1997) also observed similar findings.

Alam (1997) studied use of improved farm practices of rice cultivation by the farmers of Anwara thana of Chittagong district. The study indicated no significant relationships with their use of resilience in rice cultivation. Hussen (2001) conducted a study on farmers' knowledge and adoption of modern sugarcane cultivation practices. He found that access to finance of the growers had significant relationships with their adoption of modern resilience in seed cultivation.

2.12.9 Market access

Ibrahim and Mahmoud (2004) showed that market access had the highest impact on agricultural extension engineers' knowledge and practice, followed by use of a sound filmstrip, a video film, a cassette and a pamphlet.

Muhammad et al. (2005) conducted a field study in Punjab, Pakistan, to assess the market access in the seed production by the farmers. The data show that majority (56.67%) of the respondents were aware of the existence system of seed processing in their area/village. None of the respondents acknowledged the seed system in the dissemination of rice crop recommendations including seed rate, seed treatments, time of sowing/transplanting, seed bed preparation, use of fertilizers, application of zinc sulfate, irrigation, weed control, application of plant protection measures and harvesting.

Shamsuzzoha (1967) in another study with Texas cotton seed growers, observed that 70 percent of cotton farmers received information about market access in cotton production from farm magazine followed by newspaper and country agricultural agent with 67 and 65 percent, respectively. These were again followed equally by radio, demonstration and field tours with 60 percent in each case. Other important sources of information used were television, friend and neighbors.

Dinpanah (2005) conducted a questionnaire survey among wheat farmers in Isfahan, Iran, to determine the influence of market value of seed and other factors on the farmer's technical knowledge in seed cultivation. Multiple regression analysis of the data revealed that mechanization level, size of wheat-cultivated landholding, market access and wheat farming experience explain 36.4% of the variation in wheat farmers' technical knowledge in seed system. It also revealed that wheat farmer social status, extent of familiarity with media, and extent of availability of market access 55.7% of the variation in wheat.

2.13 Building resilience

To a great extent, increasing resilience can be achieved by reducing vulnerabilities and increasing adaptive capacity (Levin, 1999). This can be achieved by reducing exposure, reducing sensitivity and increasing adaptive capacity, for every type of risk. It can act in each domain, either biophysical, economic and social (Adger, 2005). One way to achieve better resilience is to reduce transmission of shocks between types of risks, between scales and between domains and to organize compensation between scales (for instance transport of feed) or between domains (for instance safety nets) to avoid cumulative and long-term effects. In this section we make an attempt to describe the bricks that can be used to build strategies for resilience (Walker and Salt, 2012).

2.13.1 Three ways to build resilience

In a first approximation we can identify the following three ways to build resilience:

1. Reduce exposure. There is a fundamental difference between climatic and non-climatic shocks in this regard because most of the shocks on-farm can be reduced at the source, or limited in their extension, contrary to climatic shocks. Here the best example is probably the eradication of rinderpest, which has totally suppressed a major risk for livestock and those depending on it (Walker and Salt, 2012).
2. Reduce the sensitivity of systems to shocks. Sensitivity to drought can, for instance, be reduced by using drought-resistant varieties or keeping stocks of hay (Levin, 1999).
3. Increase adaptive capacity. This includes considering the modifications of a system taking into account all the potential shocks and changes altogether (to take into account compensating, cumulative or exacerbating effects (Adger, 2005).

2. 14 Seed system

A sustainable seed system is the continuous procedure that will ensure that high quality seeds of a wide range of varieties and crops are produced and fully available in time and affordable to farmers and other stakeholders(Walker and Salt, 2012).

2.14.1 Characterization of systems

Importantly, these notions of vulnerability and resilience are applied to 3 systems, which means that first the system(s) to be considered (its components, their boundaries and delineation) has to be clarified in order to assess its vulnerability and/or resilience.

- Systems can be embedded into one another, meaning that one system can be a component of a major system (Levin, 1999).
- Systems can be delineated according to various perspectives (including expected functions), environmental, economic or social (including political and institutional), even though they are linked.

- Food systems are by nature ecological, economic and social (Füssel and Klein, 2006). Each dimension has its own organization and interacts with the others (Adger, 2005).

2.15 Summary: Identifying gaps in the existing literature

The amount of literature on assessing resilience in seed systems is difficult to quantify. Moreover, this review of the existing literature has identified a number of gaps or weakness. The specific gaps related to the given research areas are outlined below:

 There is a lacking of operational definition of resilience according to the different measurement scales (e.g., national and local level), particularly a workable definition of resilience farming needs to be developed.

 An inclusive resilience indicator generation framework for agricultural sector is yet to be developed.

 It is clear that there are gaps in assessing resilience in seed systems such production processing and marketing and this perspective is more evident in evaluating resilience.

 An array of tools is developed for assessing resilience in seed systems. However, more integrated assessment tools, namely, transition management are still evolving.

2.16 Conceptual framework of assessing resilience of seed system in Narsingdi district

The present study would be tried to focus two concepts: first the dimension and the second, the indicators. In scientific research selection and measurement of indicators constitute an important task. An indicator is that factor which appears, disappears or varies as the researcher introduces (Townsend, 1953). Sometimes it's said that indicator is that factor which is manipulated by the researcher in his attempt to ascertain its relationships to an observed phenomenon. Indicators together are the causes and the phenomenon is effect and thus, there is cause effect relationship in the universe. Resilience in seed system was considered nine selected indicators. It is not possible to deal with all indicators in a single study. It was therefore necessary nine indicators which include (a) human capital, ii) social capital, iii) availability of extension services, iv) use of climate smart agricultural practices, v) pest and disease management, vi) access to information on climate change, cropping practices and meteorological aspects, vii) market access, viii) non-farm income generation activities and ix) access to finance for this study. Considering the above mentioned discussion, a conceptual framework has been developed for this study, which is diagrammatically presented in the following Figure 1.1.

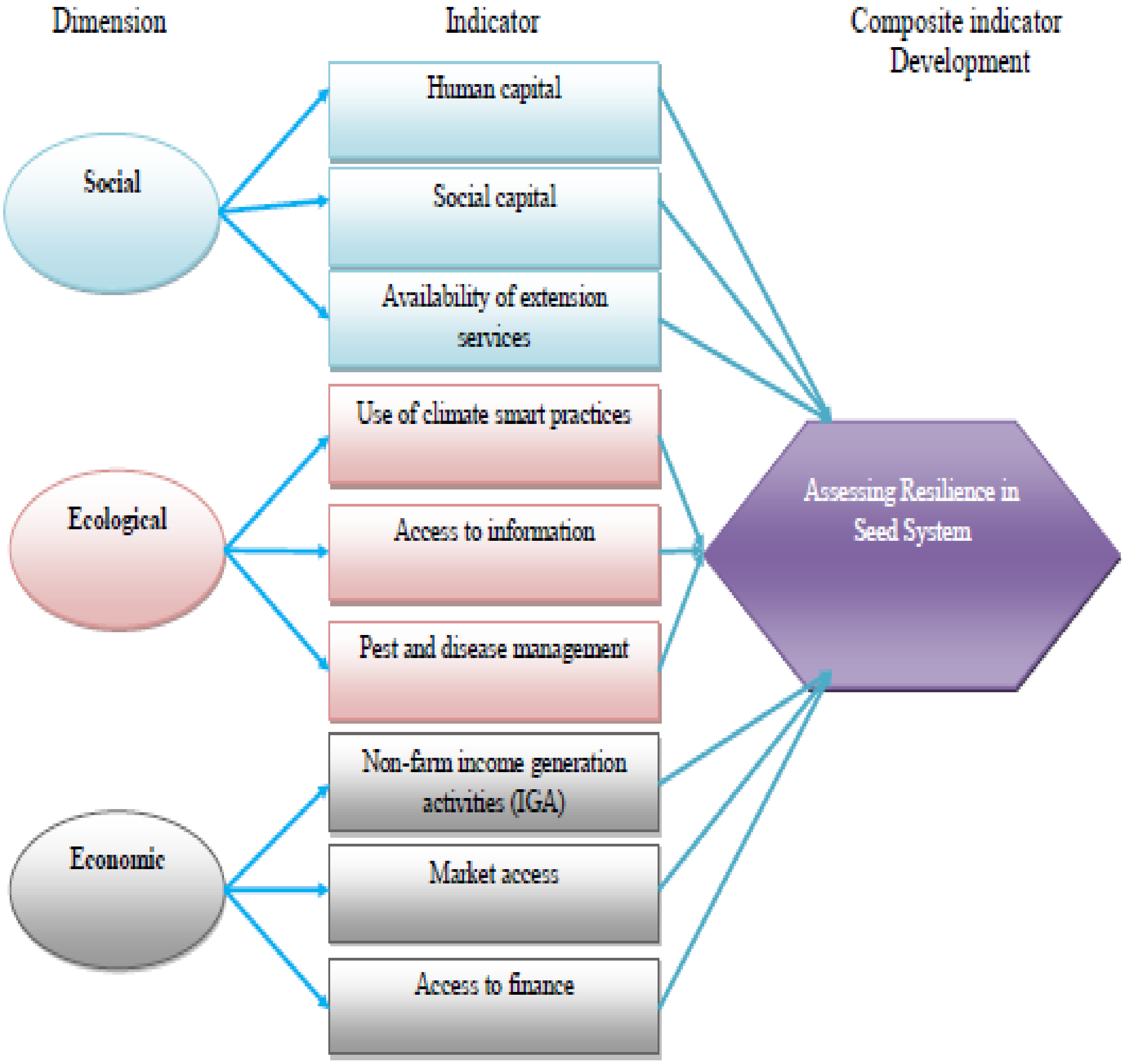

Figure 1.1: Conceptual framework of assessing resilience in seed system.

Figure 1.1 Conceptual framework of assessing resilience of seed system.

CHAPTER III

METHODOLOGY

CHAPTER III
METHODOLOGY

To measure the resilience of seed systems a suitable methodology was used. Keeping this in mind, the researcher had taken a good care for the use of proper methods in all respects of the present investigation. Methods followed in this investigation were described below:

3.1 Study Location

Three villages of Shibpur Upazila of Narsingdi district was the study location. The total 110 households were selected from the population for informal interview, employing a simple random sampling technique. Narsingdi district is selected due to its huge vegetables (e.g., eggplant, cabbage, spinach, and cucumber) production capacity as well as growers increasing interest in seed production. Meetings were organised among the farmers of Narsingdi district to explore their capacity, problems, and production profitability as well as to observe their social, economic and environmental changes that influence seed production.

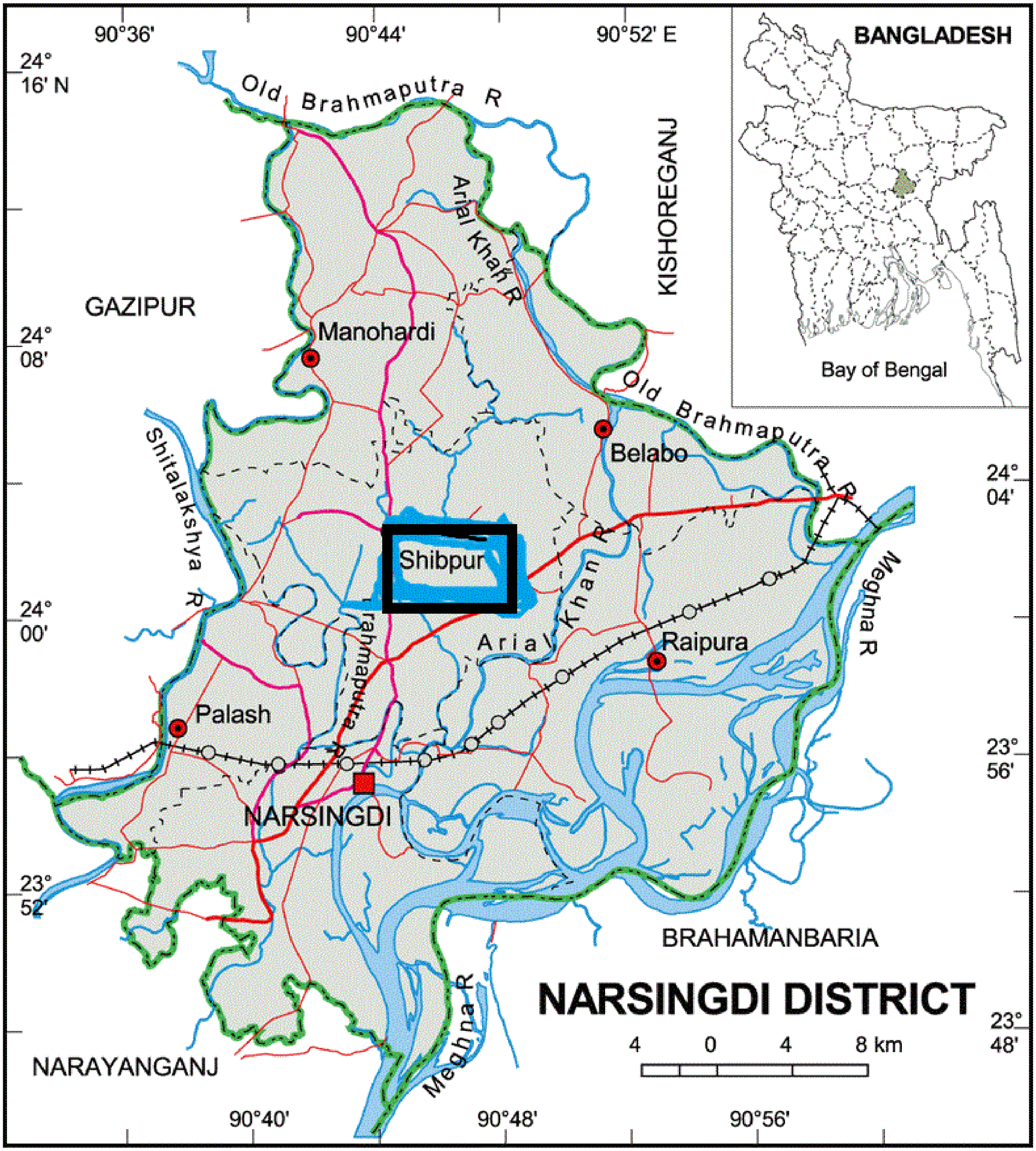

Figure 3.1 A map of Narsingdi district showing Shibpurupazila.

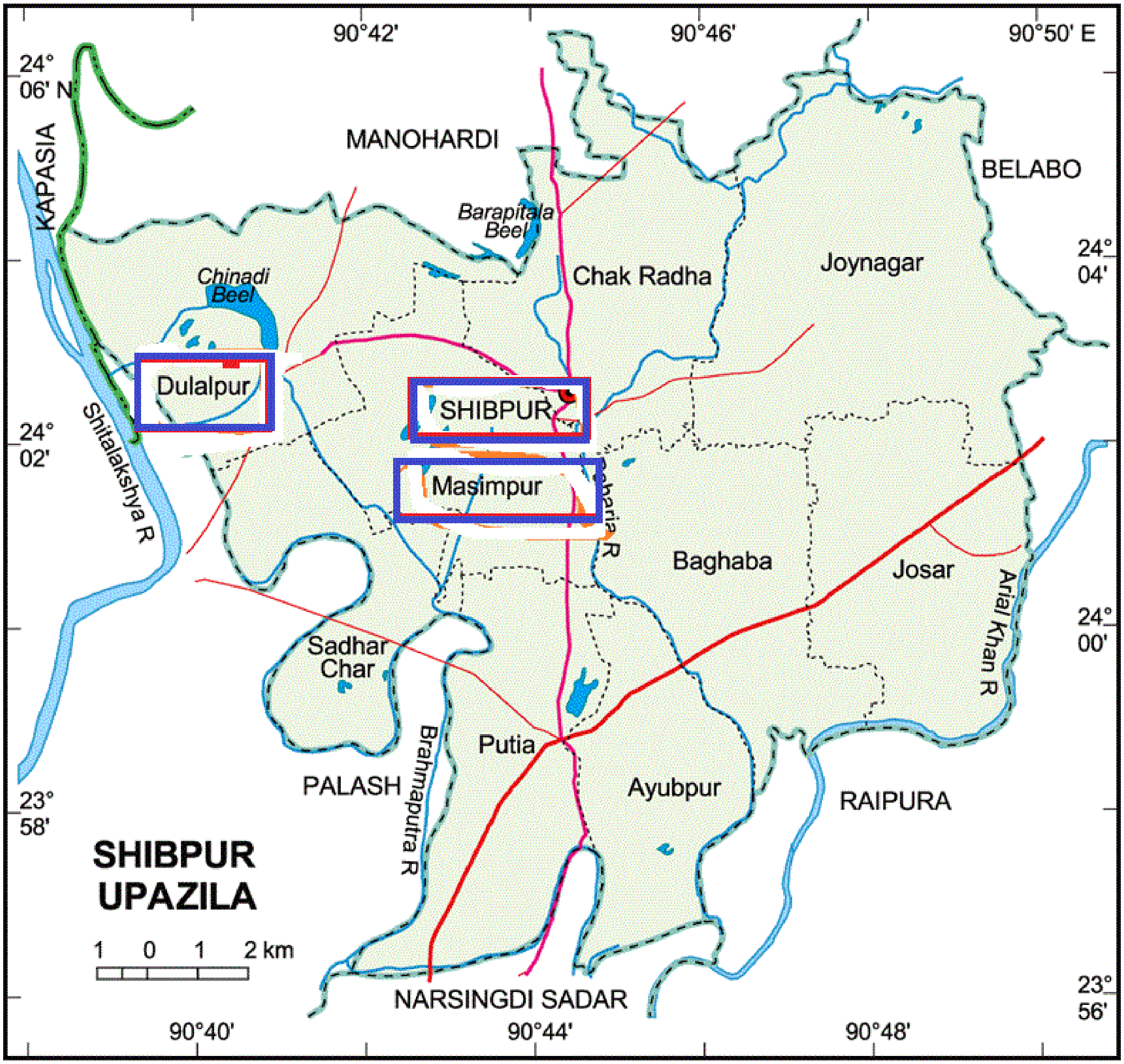

Figure 3.2 A map of Shibpursadarupazila showing the study Area (villages).

3.2 Population and Sampling

Firstly, the list of seed producers/vegetable growers were collected from the local upazila agricultural office with the help of Sub Assistant Agricultural Officers (SAAO). Three villages Shibpur, Dulalpurand Masimpur under Shibpur upazila were purposively selected. Aup to date list of the farmers of these three villages was collected from the local upazila agricultural office with the help of Sub Assistant Agricultural Officers

(SAAO).Then the farmer's list was chronologically numbered from 1 to 1165 in which the number of farmers of Shibpur, Dulalpur and Masimpur were 356, 302 and 507 respectively. 110 farmers constitute the sample of the study. Sample size was determined as 110 farm by taking help from the following Yamane's (1967) given formula ,where, 9% level of precision, 50% degree of variability and 95% Confidence level were chosen. Then 110 farmers were selected by using simple random sampling method.

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

Where

n = sample size

N = population size (Here, N =1165)

e = level of precision (Here, e = 10%)

z = confidence level (Here, z = 95%)

P = degree of variability (Here, P = 50%)

The distributions of the farmers included in the population, sample and those in the reserve list from the selected villages in shown in the table 3.1

Table 3.1 Population and sample distribution

Name of the villages	Population	Sample size	Types of farmers*		
			Small	Medium	Large
Shibpur	356	50	15	30	5
Dulalpur	302	40	10	24	5
Masimpur	507	20	12	8	1
Total	1165	110			

* Small: Land holding [0.25–2.5 acre], Medium: Land holding [2.5–7.5 acre], and Large: Land holding above 7.5 acre (Roy et al., 2014).

3.3 The Research Instrument

An interview schedule was used as the data collecting instrument for this study. Both open and close form questions were included in the schedule. Simple and direct questions were also included to assess resilience in the seed system of Narsingdi district. The interview schedule was prepared in accordance with the objectives of the study. The interview schedule was pre tested with 10 farmers from the study area other than listed in the sample. Necessary correlation, addition, alternation and modification were made in the interview schedule based on the pre-test results. The modified and corrected interview schedule was then printed as final form in English. A copy of the Interview schedule is presented in Appendix I.

3.4 Data Collection Procedure

The researcher himself collected the data from the sample respondents through conducting interview with the help of interview schedule. Whenever any respondent faced difficulty in understanding questions, more attention was taken to explain the same with a view to enabling the farmers to answer properly. No serious problem was faced by the investigator during the data collection period. Data collection was started in 24 June, 2016and completed in 20 August, 2016.

3.5 Indicators of the study

Based on literature review (FAO, 2015; GIZ, 2015; Roy, 2015; Roy et al., 2014; Bene et al., 2012; Roy et al., 2015; Mitchel, 2013; and Roy and Chan, 2014) and expert appraisal initially 20 indicators were selected such astrust and cooperation, education, social status, annual family income, seed sources, access to communal resources, seed availability,energy sources, social capital, human capital, availability of extension services, use of climate smart practices, pest and disease management, access to information, non-farm income generation activities, access to finance. Later on with the discussion of extension officers and other experts only 9 indicators were selected. The selected indicators include: i) human capital, ii) social capital, iii) availability of extension services, iv) use of climate smart agricultural practices, v) pest and disease management, vi) access to information on climate change, cropping practices and meteorological aspects, vii) market access, viii) non-farm income generation activities and ix) access to finance.

3.5.1 Measurement of indicators

To keep the research within the manageable limit, 09 indicators were selected for the study. The measurement procedures of the selected indicators were as follows:

3.5.1.1 Social capital

Social capital of a respondent was measured on the basis the nature of his/her involvement in different organisations and contact with that during the time of interview as well as how much confidence they have in selected organizations (Roy et al., 2014). Scores were 1= members of organization and 0= otherwise. Yes (1) / No (0), Number of contacts: 3 = ‘weekly contact’; 2 = ‘monthly contact’; 1 = ‘yearly contact’; Confidence level: 5 = ‘a great deal’; 4 = ‘quite a lot’; 3 = ‘no opinion’; 2 = ‘not very much’; and 1 = ‘none at all’.

3.5.1.2 Human capital

Human capital measures farmers’ knowledge, skills capacities that are important for obtaining resilience in seed system (Pretty, 2008). For each category: 5= ‘definitely’; 4= ‘probably’; 3= ‘probably not’; 2= ‘not sure’; 1= ‘definitely not’.

3.5.1.3 Availability of extension services

This indicator is quantified by asking the extent of extension contact made by the farmers to extension personnel, and vice versa in the last year (Roy, 2015). 4 = ‘4 times and above’; 3 = ‘2–3 times’; 2 = ‘once’; and 1 = ‘no visit’.

3.5.1.4 Access to information on climate change, cropping practices and meteorological aspect

Access to information indicator defines and measures farmers' awareness and knowledge (FAO, 2015). For available: 1 = 'yes'; and 0 = 'no'. If yes, then one right answer was given 1 point.

3.5.1.5 Pest and disease management

Pest and disease management means whether or not farmers apply chemical and non-chemical measures for pest, disease management on seed (Roy, 2015). For 1=chemical and 0= non-chemical. Based on significance, knowledge, and use, this indicator measures whether or not they applied chemical and non-chemical measures in pest and disease management. For each sub indicator: 1 = 'yes' and 0 = 'no'. If yes, then we used a 3-points likert scale in which scores from 1 (minimum) to 3 (maximum).

3.5.1.6 Use of climate smart practices

This indicator defines availability of different practices for hazard free environment (FAO, 2015). For examples; do you use integrated pest management instead of using pesticides? Used categories: 1 = 'yes'; 0= 'no'.

3.5.1.7 Market access

Market access refers to the capability of an individual to sell goods and services in the market (FAO, 2015). There are two categories of market access: buying and selling. For each category: 1= 'yes'; 0= 'no'. If yes, then right answer receives 1 point.

3.5.1.8 Non-farm income generation activities

Non-farm income generation activities means family income sources other than farming (Roy et al., 2014). For examples; do you have any income source other than agriculture? 1= 'yes'; 0 = 'no'. If yes, then right answer receives 1 point.

3.5.1.9 Access to finance

Access to finance indicator defines and measures farmers' source of finance (FAO, 2015). For 3= 'sustained access' 1 = 'intermittent access'; 0 = 'no access'.

3.5.2.1 Resilient Assessment

Resilience was assessed by constructing a resilience index (GIZ, 2015). Resilience index was developed on the basis of three dimension such as social ecological and economic and three capacities such as absorptive, adaptive and transformative capacities (fig 3.5).Building on the general considerations stated above, climate resilience is defined as the ability of social-ecological systems to absorb and recover from climatic shocks and stresses, whilst positively adapting and transforming their structures and means for living in the face of long-term change and uncertainty (GIZ, 2015; Mitchell, 2013). Climate resilience thus is a combination of absorptive, adaptive and transformative capacities, which can be delineated according to the responses to climatic shocks and stresses they facilitate.

3.5.2.1.1 Absorptive capacities

Ability of a system to prepare for, mitigate or recover from the impacts of negative events using predetermined coping responses in order to preserve and restore essential basic structures and functions (e.g., human life, housing, productive assets) (Béné et al., 2012).

3.5.2.1.2 Adaptive capacities

Ability of a system to adjust, modify or change its characteristics and actions in order to better respond to existing and anticipated future climatic shocks and stresses and to take advantage of opportunities (Béné et al., 2012).

3.5.2.1.3Transformative capacities

Ability of a system to fundamentally change its characteristics and actions when the existing conditions become untenable in the face of climatic shocks and stresses (Béné et al., 2012).

		Capacities		
Dimension		Absorptive	Adaptive	Transformative
	Social	Social capital	Human capital	Availability of extension services
	Ecological	Use of climate smart practices	Access to information on climate change cropping practices and meteorological aspects	Pest and disease management
	Economic	Non-farm income generation activities	Market access	Access to finance

(GIZ, 2015)

Fig.3.5 Climate resilience matrix and/or index

3.5.2 Developing composite indicators

3.5.2.1 Maintaining data quality

Following careful consideration, indicator values were quantified (Table 3.2) to get a data set. A good quality data is essential for constructing a meaningful and communicative composite indicator. Adequate cares were taken for maintaining data quality, which was accomplished in two ways, namely applying data-screening tests and bivariate analysis to examine the overall structure and suitability of thedata set for subsequent methodological choices. Data screening was employed to ensure the data are useful, reliable, and valid for testing and drawing conclusion. The validity, interpretability, and explanatory power of the index largely depend on the quality of underlying data. Data screening tests such as detecting missing data, removing outliers, and identifying multicollinearity among the variables were conducted to ensure the data quality. Missing data were imputed by mean value substitution. Outlier has a strong impact on correlation structure (Roy and Chan, 2015). It needs particular care.

Table 3.2 Descriptive statistics of data set

Indicators	Minimum	Maximum	Mean	Std. deviation
Social capital	14	56	42.1	3.7
Human capital	11	40	30.2	3.9
Availability of extension services	22	39	30.3	2.9
Pest and disease management	5	18	14.5	1.7
Non-farm income generation activities	0	6	4.6	2.4
Use of climate smart practices	0	12	7.6	3.4
Access to information on climate change cropping practices and meteorological	0	18	11.6	4.4
Access to finance	0	27	20.6	4.4
Market access	0	16	10.5	3.5

3.5.2.2 Pros and Cons of composite indicators

Composite indicators (CIs) have attributes to follow the precautionary principles (consider the existence of uncertainties) of assessment and consider subject to certain methodological choices during normalization, weighing, and aggregation which largely depend on the choice of indicators (Lee, 2006). CI has the ability to summarize multidimensional issues and provide a precise picture (Saisana et al., 2005). It evaluates sustainability performance in an innovative way (Singh et al., 2007), helps in setting policy priorities and monitoring performance (OECD, 2008), and accelerates easy communication and interpretation to the public (Kondyli, 2010). They are flexible to quantify a wide range of issues such as economics, environment, and conduct integrated assessment. However, CI may send misleading policy messages if poorly constructed (e.g., lack of a representative set of indicators). In addition, CI may be misused to support a desired policy, if the construction process lacks a sound theoretical foundation. Some others advantages and disadvantages of CIs are discussed in the table 3.5.

Table 3.5 Pros and cons of composite indicators (CIs)

Pros	Cons
Can summarise complex, multidimensional realities (e.g. farming sustainability) with a view to supporting policy makers.	May send misleading policy messages if poorly constructed or misinterpreted.
Can assess progress of farms, agricultural systems, regions and countries over time.	May be misused, e.g. to support a desired policy, if the construction process is not transparent and/or lacks sound statistical or conceptual principles.
Are easier to interpret than a battery of many separate indicators	May invite simplistic policy conclusions.
Reduce the visible size of a set of indicators without dropping the underlying information base.	The selection of indicators and weights could be the subject of political dispute
Facilitate communication with general public (e.g. citizens, media, etc.) and promote accountability	May disguise serious failings in some dimensions and increase the difficulty of identifying proper remedial action, if the construction process is not transparent
Help to construct/underpin narratives for lay and expert audiences.	
Enable users to compare complex dimensions effectively	

3.5.2.4 Steps of composite indicators development

Composite Indicators (CIs) are an aggregated index, comprising the individual indicator based on an underlying model (Valdivia et al., 2013). CIs are becoming increasingly popular tools for sustainability assessments at various scales. This is because CIs can adopt participatory approach by involving stakeholder's indifferent steps of CIs construction (e.g., indicator generation and weighting measurement). In this study three methods such as normalization, weighting and aggregation were used to develop composite indicators.

3.5.2.4.1 Normalisation

In the literature (e.g., OECD 2008), the term 'normalisation' refers to the transformation of indicator values measured on different scales and in different units into unit-less values on a common scale. A second important aspect of normalisation is to get from numbers to a meaning by evaluating the criticalness of an indicator value. Indicators measured using a metric scale are normalised by applying the minimum and maximum method. This method transforms all values to scores ranging from 0 to 1 by subtracting the minimum score and dividing it by the range of the indicator values. The following formula is used to apply min-max:

$$X_{i,\,0\ to\ 1} = \frac{X_i - X_{Min}}{X_{Max} - X_{Min}}$$

WhereXi represents the individual data point to be transformed, X_{Min} the lowest value for that indicator, X_{Max} the highest value for that indicator, and X_i 0 to1 the new value you wish to calculate, i.e., the normalised data point within the range of 0 to 1.

3.5.2.4.2Weighting

There is no consensus for the appropriate weighting method. Researchers are continuing to debate the suitable methods for weighting that reward greater weight of variables.

There is a dichotomy between the participatory (subjective) and statistical (objective) method of weighting. A number of weighting methods exist. However, each method has been reported to have limitations. Equal weighting (EW) is the most widely used method, and has the risk of double counting (by combining variables with high degree of correlation) and ignores the statistical and empirical basis, implying a judgment on the weights being equal (Nardo et al., 2005). Babbie (1995) reported equal weighting should be the standard and the application of other weighting method desires a proper justification. Researchers such as Hueting and Reijnders (2004), Munda (2005), Böhringer et al. (2007) criticized the participatory approaches of weighting for their arbitrary nature, as well as inherent lacking of statistical and empirical point of view. From the policy perspective, public opinion-based weighting has been established. Although it is a legitimate choice, it is not unique and its arbitrary characteristic raises criticism. These methods are justifiable only when there is a well-defined basis for national policy (Munda, 2007). Despite CI being a subject of subjectivity, the use of objective method for calculating indicator weight is increasing progressively. The main reasons for using the objective or statistical methods are methodological soundness, transparency, impartiality, and thorough data-driven. When conceptualizing policy perspective, these methods are inconsistent with the goal of CI (Munda, 2008), and the priorities of policy makers, who ultimately play the key role by investing on sustainable development. Realising the suitability of the method, this study employed factor analysis for weighting measurement, following the instructions of Nicoletti et al. (2000).In this study equal weighting method was used.

3.5.2.4.3Aggregation

Aggregation influences compensation among variables (Munda, 2008). Therefore, it is a very delicate part of the construction of an index that needs particular care. A number of aggregation methods exist, and the choice of a suitable method depends on the purpose of CI and the nature of the subject being measured. Aggregation technique is strongly related to the method used to normalise the raw data (Nardo et al., 2005; OECD, 2008).

The linear method is useful when indicators have the same measurement unit. Geometric aggregation is suitable when sub indicatorsare non-comparable and have strictly positive value in ratio-scale of measurement. Based on the data properties, this study used ‘weighted arithmetic aggregation’to combine indicators within the dimensions with a view to minimize measurement error and capture inconsistencies.

$$CI = \frac{(I_1 * w_1 + I_2 * w_2 + \ldots I_n * w_n)}{\sum_1^n w}$$

Where *CI* is the composite indicator, e.g., sensitivity, *I* is an individual indicator of a dimension and *w* is the weight assigned to the indicator. If equal weighting applies, indicators are simply summed and divided by the number of indicators. Assigning a weight of 2 (or 3) to one or more indicators implies that these indicators are twice (or three times) more important than indicators which retain a weighting of 1.To enable meaningful aggregation of individual indicators, remember that all indicators of the three vulnerability components must be aligned in the same way. This means that a low or high score represents a ‘low’ or ‘high’ value in terms of resiliency.

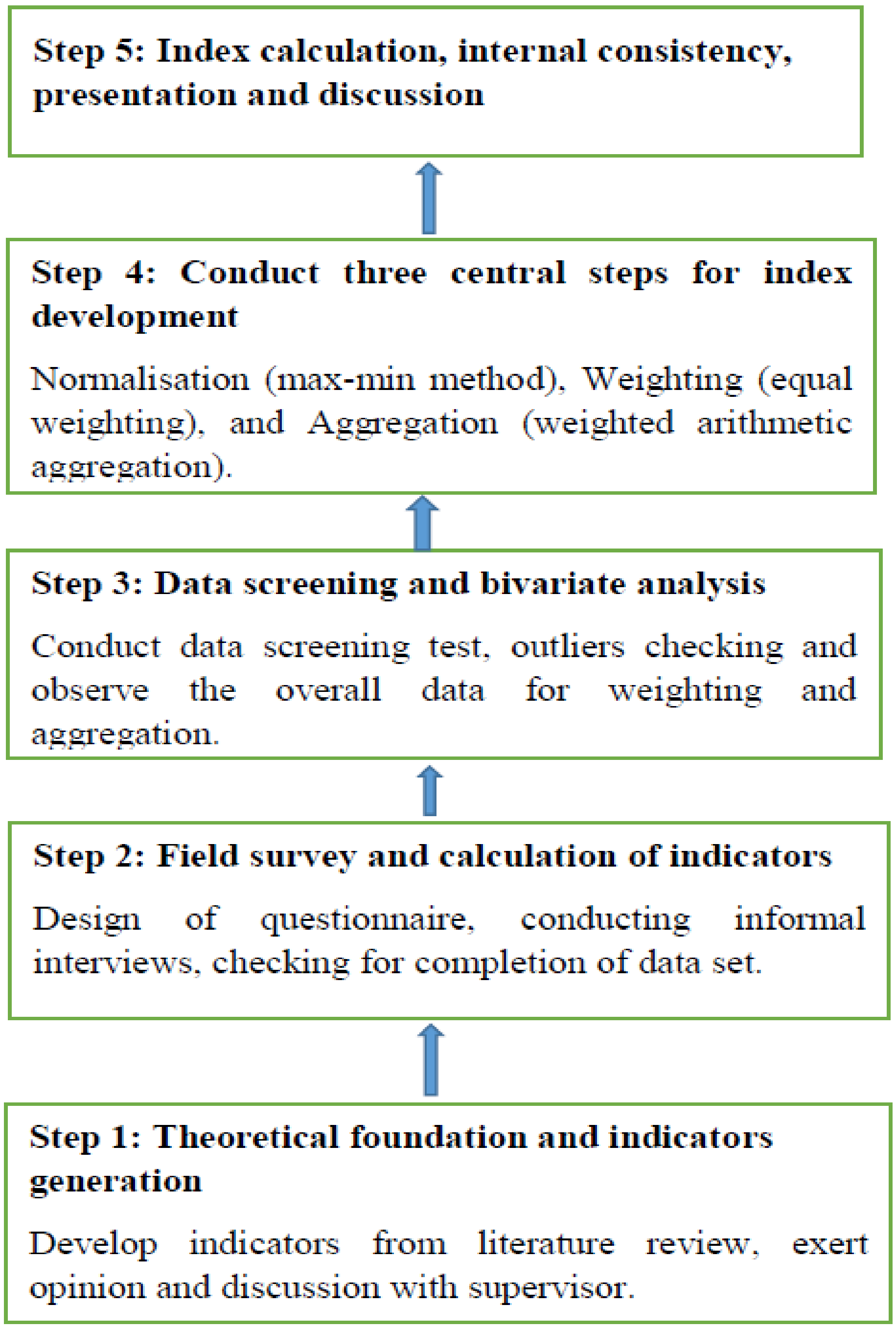

Fig. 3.5.2 Methodology employed for the construction of the composite indicator (CI) of resilience in the study.

3.6 Data Processing

The following steps were followed for data processing:

3.6.1 Data checking

There was no outlier and multicollinearity among the indicators rather there was strong correlation among the indicators. Outliers were checked manually and multicollinearity was observed through correlation table. A number of options are available for dealing with outliers, we applied remove the case and change the score (i.e., the next highest score plus one) approaches.

3.6.2 Data Compilation

After completion of field survey all the interview schedules were complied, tabulated and analyzed according to the objectives of the study. In this process, all the responses in the interview schedule were given numerical coded values. The responses to the question in interview schedule were transferred to a master sheet to facilitate tabulation. Tabulation was done on the basis of categories developed by the investigator himself.

3.7 Respondents' Categorization

Respondents were classified into various categories for describing the indicators. In developing categories, the researcher was guided by the nature of data and general consideration prevailing in the social system. The procedures have been discussed while describing the variable in the subsequent sections of the next chapter.

3.8 Data analysis

Data collected from the respondents were complied, coded, tabulated and analyzed in accordance with the objectives of the study. Various statistical measures such as frequency counts, percentage distribution, average and standard deviation were used in describing data. SPSS (Version 15) computer program were used for analyzing the data. The categories and tables were used in describing and processing data for better understanding.

3.9 Summary

Data collection is comparatively complicated if the subject matter has some extent ambiguities. Adequate initiatives were taken to select growers from the three categories such as large, medium and small for interview with a view to obtain a representative statement on resilience in seed system. In this case, the assistance received from the local extension agents was beneficial. Taking into account the importance of a quality data set for the construction of composite indicator (CI), necessary cares were taken in data collection as well as in data management. As a part of this process, several discussions were conducted for the purpose of cross checking the data. Equally, after quantifying the variables, a range of data screening tests as well as bivariate and multivariate analyses were employed. Data quality is a vital issue of CI. This was because the construction process of CI itself dubious, as using a certain amount of data and employing several methods, finally it produces a small index score. Therefore, the index construction process largely depends on the craftsmanship of the modeler than the employment of established scientific rules (OECD, 2008).

CHAPTER IV

RESULTS AND DISCUSSION

CHAPTER IV
RESULTS AND DISCUSSION

Results and discussion are the focal point of the research work. The quality of research depends upon the how well findings of the research are discussed and interpreted. So to make the results and discussion meaningful and acceptable. The results and discussion are presented according to the objectives of this study.

4.1 Developing a set of indicators of a resilient seed system

Considering research limitations and discussion with supervisor finally 9 indicators were selected. The selected indicators include: i) human capital, ii) social capital, iii) availability of extension services, iv) use of climate smart agricultural practices, v) pest and disease management, vi) access to information on climate change, cropping practices and meteorological aspects, vii) market access, viii) non-farm income generation activities and ix) access to finance.

4.2 Characteristics of the selected indicators of the respondents

4.2.1 Social capital

Social capital of the respondents ranged from 14 to 56 with the mean and standard deviation of 34.16 and 3.71, respectively. According to social capital the respondents were classified into three categories (mean ± standard deviation) namely ‘low’, ‘medium’ and ‘high’ category. The distribution of the resilience in seed system according to their social capital is presented in the table 4.1

Table 4.1 Distribution of the respondents according to their social capital

Category	Score		Farmers		Mean	SD
	Basis	Observed(possible)	Number	Percent		
Low	≤ 39	14-56(14-61)	20	17.3	34.16	3.71
Medium	39-46		80	77.2		
High	>46		11	6.7		
Total			110	100.0		

Data in table 4.1 indicates that most of the respondents (77.2%) have medium social capital followed by the low category (17.3 percent). This results show a good sign that can help farmers to develop their seed system resilient in production, processing and marketing. Only 6.7 percent respondents had high access of social capital.

4.2.2 Human capital

Human capital of the respondents ranged from 11 to 40 with the mean and standard deviation of 22.2 and 3.98, respectively. According to human capital the respondents were classified into three categories (mean ± standard deviation) namely 'low', 'medium' and 'high' category. The distribution of the resilience in seed system according to their human capital is presented in the table 4.2

Table 4.2 Distribution of the respondents according to human capital

Category	Score		Farmers		Mean	SD
	Basis	Observed(possible)	Number	Percent		
Low	≤ 27	11-40(9-45)	25	20.3	22.2	3.98
Medium	27-34		70	70.2		
High	>34		15	10.5		
Total			110	100.0		

Data in table 4.2 indicates that most of the respondents (70.2%) have medium human capital followed by the low category (20.3%). This results show a good sign that can help farmers to develop their seed system resilient in production, processing and marketing. Only 10.5% respondents had high access of human capital.

4.2.3 Availability of extension services

Availability of extension services of the respondents ranged from 2 to 11 with the mean and standard deviation of 5.3 and 1.97, respectively. According to Availability of extension services the respondents were classified into three categories (mean ± standard deviation) namely 'low', 'medium' and 'high' category.

Table 4.3 Distribution of the respondents according to availability of extension services

Category	**Score**		**Farmers**		**Mean**	**SD**
	Basis	**Observed(possible)**	**Number**	**Percent**		
Low	≤ 5	2-11(3-12)	35	30.4	5.3	1.97
Medium	6-10		70	60.4		
High	>10		5	10.2		
Total			110	100.0		

Data in table 4.3 indicates that most of the respondents (60.4%) have medium availability of extension services followed by the low category (30.4%). This results show a good sign that can help farmers to develop their seed system resilient in production, processing and marketing. Only 10.2% respondents had high access of availability of extension services.

4.2.4 Pest and disease management

Pest and disease management of the respondents ranged from 5 to 16 with the mean and standard deviation of 7.5 and 1.6, respectively. According to pest and disease management the respondents were classified into three categories (mean ± standard deviation) namely 'low', 'medium' and 'high' category.

Table 4.4 Distribution of the respondents according to their pest and disease management

Category	Score		Farmers		Mean	SD
	Basis	**Observed(possible)**	**Number**	**Percent**		
Low	≤ 6	5-16(6-18)	15	20.7	7.5	1.6
Medium	7-14		85	76.2		
High	>14		10	4.1		
Total			110	100.0		

Data in table 4.4 indicates that most of the respondents (76.2%) have medium pest and disease management followed by the low category (20.7%). This results show a good sign that can help farmers to develop their seed system resilient in production, processing and marketing. Only 4.1% respondents had high access of pest and disease management.

4.2.5 Non-farm income generation activities

Non-farm income generation activities of the respondents ranged from 1 to 5 with the mean and standard deviation of 2.6 and 1.4, respectively. According to non-farm income generation activities the respondents were classified into three categories (mean ± standard deviation) namely 'low', 'medium' and 'high' category.

Table 4.5 Distribution of the respondents according to their non-farm income generation activities

Category	Score		Farmers		Mean	SD
	Basis	Observed(possible)	Number	Percent		
Low	≤ 1	1-5(0-6)	17	12.3	2.6	1.4
Medium	2-4		84	78.2		
High	>4		9	9.7		
Total			110	100.0		

Data in table 4.5 indicates that most of the respondents (78.2%) have medium non-farm income generation activities followed by the low category (12.3%). This results show a good sign that can help farmers to develop their seed system resilient in production, processing and marketing. Only 9.7% respondents had high access of non-farm income generation activities.

4.2.6 Use of climate smart practices

Use of climate smart practices of the respondents ranged from 2 to 10 with the mean and standard deviation of 5.6 and 2.4, respectively. According to use of climate smart practices the respondents were classified into three categories (mean ± standard deviation) namely 'low', 'medium' and 'high' category.

Category	Score		Farmers		Mean	SD
	Basis	Observed(possible)	Number	Percent		
Low	≤ 4	2-10(0-11)	23	15.3	5.6	2.4
Medium	5-9		77	85.2		
High	>9		10	10.7		
Total			110	100.0		

Table 4.6 Distribution of the respondents according to their use of climate smart practice

Data in table 4.6 indicates that most of the respondents (85.2%) have medium use of climate smart practices that meant 85.2% respondents are highly used climate smart practices followed by the low category (15.3%). This results show a good sign that can help farmers to develop their seed system resilient in production, processing and marketing. Only 10.7% respondents had high access of use of climate smart practices.

4.2.7 Access to information on climate change, cropping practices and meteorological aspects

Access to information on climate change, cropping practices and meteorological aspects of the respondents ranged from 4 to 15 with the mean and standard deviation of 7.6 and 2.4, respectively. According to access to information on climate change, cropping practices and meteorological aspects the respondents were classified into three categories (mean ± standard deviation) namely 'low', 'medium' and 'high' category.

Table 4.7 Distribution of the respondents according to their access to information on climate change, cropping practices and meteorological aspects

Category	Score		Farmers		Mean	SD
	Basis	Observed(possible)	Number	Percent		
Low	≤ 7	4-15(0-17)	44	37.3	7.6	2.4
Medium	8-13		60	60.2		
High	>13		6	2.7		
Total			110	100.0		

Data in Table 4.7 indicates that the medium category farmers are highly (60.2%) access to information on climate change, cropping practices and meteorological aspects followed by the low category (37.3%). Only 2.7 percent respondents had high access to information on climate change, cropping practices and meteorological aspects.

4.2.8 Access to finance

Access to finance of the respondents ranged from 4 to 27 with the mean and standard deviation of 12.6 and 2.4, respectively. According to access to finance the respondents were classified into three categories (mean ± standard deviation) namely ‘low’, ‘medium’ and ‘high’ category.

Table 4.8 Distribution of the respondents according to their access to finance

Category	Score		Farmers		Mean	SD
	Basis	Observed(possible)	Number	Percent		
Low	≤ 6	4-27(0-30)	15	10.4	12.6	2.4
Medium	7-25		86	88.2		
High	>25		9	1.7		
Total			110	100.0		

Data in Table 4.8 indicates that the medium category farmers are highly (88.2%) access to access to finance followed by the low category (10.4%). This results show a good sign that can help farmers to develop their seed system resilient in production, processing and marketing. Only 1.7 percent respondents had high access to finance.

4.2.9 Market access

Market access of the respondents ranged from 2 to 6 with the mean and standard deviation of 2.7 and 1.5, respectively. According to market access the respondents were classified into three categories (mean ± standard deviation) namely ‘low’, ‘medium’ and ‘high’ category.

Table 4.9 Distribution of the respondents according to their market access

Category	Score		Farmers		Mean	SD
	Basis	Observed(possible)	Number	Percent		
Low	≤ 3	2-6(0-8)	24	30.2	2.7	1.5
Medium	4-5		71	57.3		
High	>5		15	12.7		
Total			110	100.0		

Data in the table 4.9 indicates that 57.3% farmers had medium access to market followed by the low category (30.2 percent). Only 12.7 percent respondents had high access to market.

4.3 Catagorisation of resilient seed system

Resilience in the seed system of the respondents ranged from 40 to 91 with the mean and standard deviation of 65.5 and 15.5, respectively. According to Resilience in the seed system of the respondents were classified into three categories (mean ± standard deviation) namely 'low', 'medium' and 'high' category. The distribution of the resilience in seed system according to their resilience level is presented in the table 4.10.

Table 4.10 Distribution of the respondents according to their resilience

Category	Score		Farmers		Mean	SD
	Basis	Observed	Number	Percent		
Low resilient	≤ 49	40-91	40	40.2	65.5	15.5
Medium resilient	50-81		60	50.3		
High resilient	>81		10	9.7		
Total			110	100.0		

Data in the table 4.10 indicates only 9.7% respondents are high resilient and half of the respondents (50.3%) are medium resilient followed by the low category (40.2 %).

4.4 Results of resilient assessment

The resilient index result indicates that average 65.5% farmers' seed systems (production, processing and marketing) were resilient to natural calamities such as drought, heavy rainfall, flood and high temperature. Therefore, the rest 34.5% of the farmers are vulnerable to different natural hazards in their seed system.

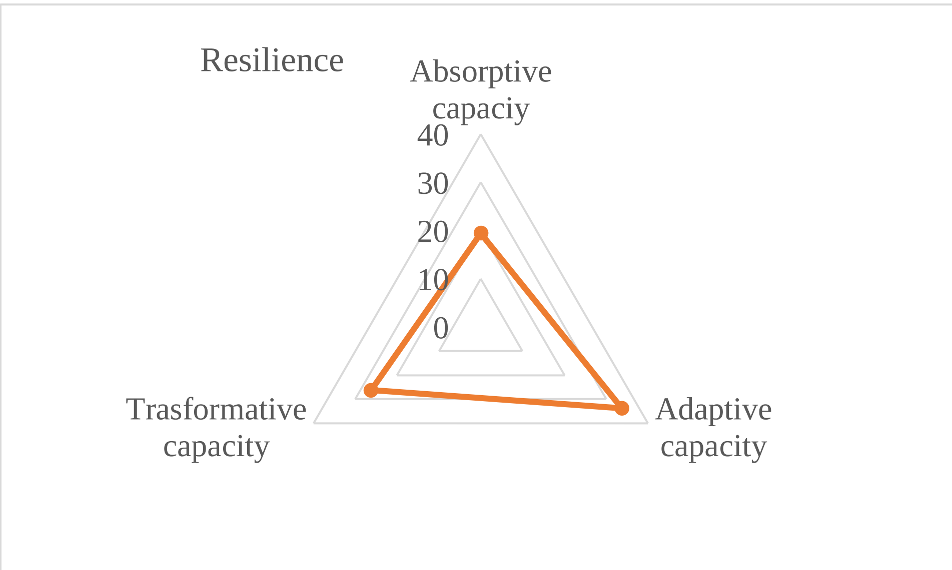

Fig 4.4.1 Different capacities of resilience in seed system

Different capacities of the resilience are measured in this research. Among these capacities farmer's had higher adaptive capacity (35%) than transformative and absorptive capacities (fig 4.4.1). Adaptive capacity here means to adjust, modify or change its characteristics and actions in order to better respond to existing and anticipated future climatic shocks and stresses and to take advantage of opportunities (Béné et al., 2012).

The results has several meaning, first, farmers have inherent knowledge about how to adopt with adverse condition, like flooding. They usually make change of their farming system in response to climatic factors, e.g. high temperature. Second, absorptive capacity is part of adaptive phenomena. It is better to say that it is difficult to differentiate absorptive and adaptive capacity, particularly at the farmer's level. Farmers had less transformative capacity which is acceptable and consistent with the findings of other research, like GIZ (2015).

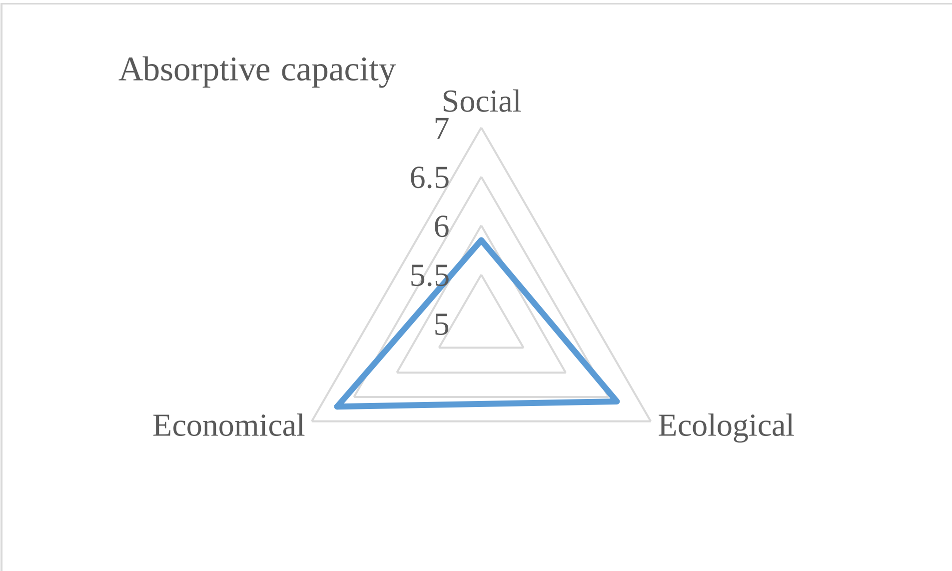

Fig 4.4.2 Different dimensions of absorptive capacity in resilience of seed system

Fig 4.4.2 show a breakdown of absorptive capacity, which indicates they had economic and ecological capacity than social dimension. This indicates their profitable seed production system as well as they are aware about environmental issues such as use of IPM. Fig 4.4.3 shows farmers adaptive capacity had influenced by more social and ecological dimension. In building this capacity farmers were economically less strong.

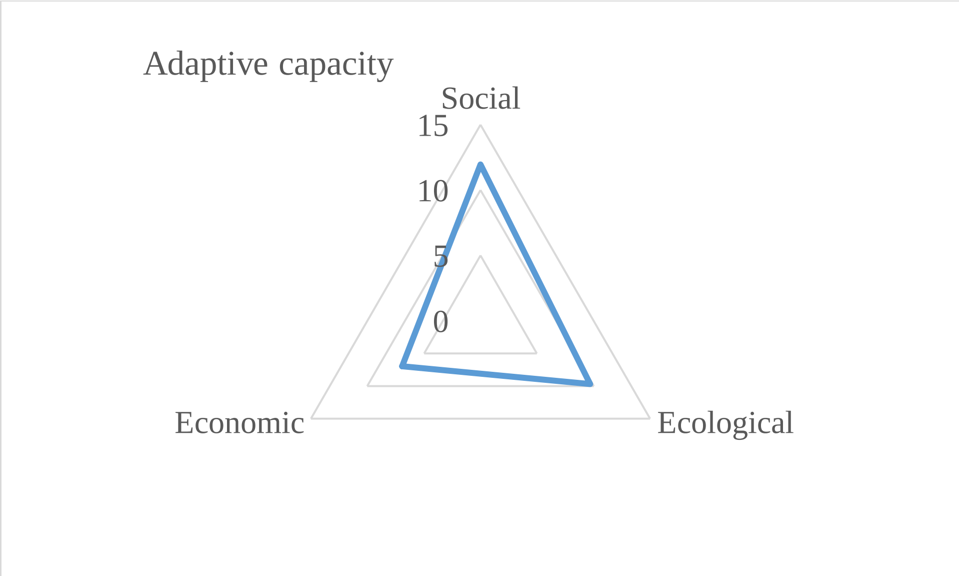

Fig 4.4.3 Different dimensions of adaptive capacity in resilience of seed system

There are few research on how to improve transformative capacity (Roy et al., 2014). This finding indicates seed producers transformative capacity was influenced by ecological dimension. The condition of social and economic dimension was the almost same in improving transformative capacity.

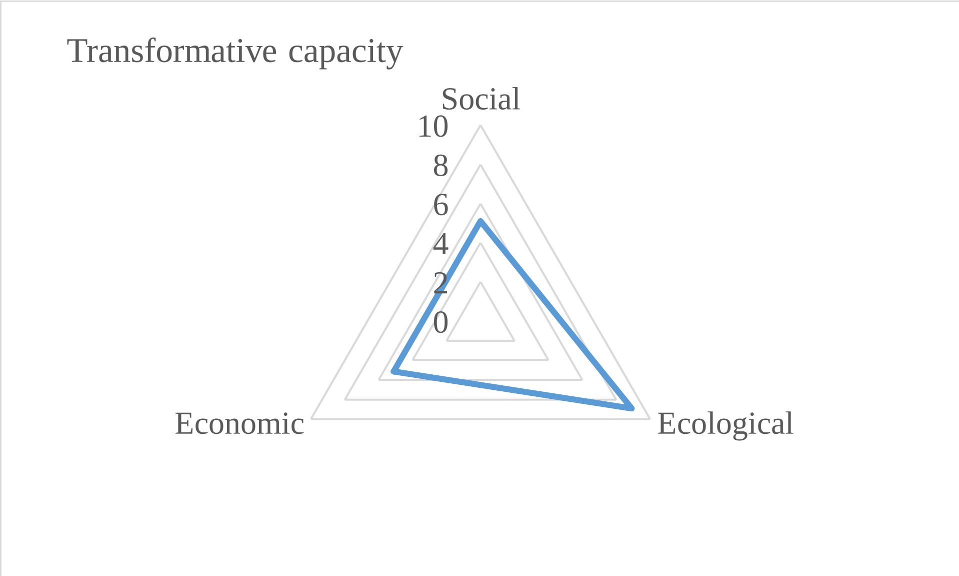

Fig 4.4.4 Different dimensions of transformative capacity in resilience of seed system.

4.5 Coefficient of correlation of different indicators and dimension of resilience in seed system

A coefficient of +1 indicates that the two variables are perfectly positively correlated. So as one variable increases by a proportionate amount. Conversely a coefficient of -1 indicates a perfect negative relationship. If one variable decreases then other variable decreases by proportionate amount.

Table 4.4.1 shows that social capital is positively related to the availability of extension services with a coefficient of r =.567, which is significant at p<.01. This coefficient value indicates as the social capital increases the availability of extension services increases, by a proportionate amount.

On the other hand, it was observed in the table 4.4.1 that access to finance is negatively correlated to use of climate smart practices, r = .514, p<.01. This means as access to finance increases, the use of climate smart practices decreases.

A coefficient of r =.566, p<.01 indicates that the two indicators market access and access to information on climate change have positive significant relationship. So as market access increases, the access to information on climate change increases by a proportionate amount. This result is consistent with the findings of GIZ (2015).

Table 4.4.1 shows that social capital is positively related to non-farm income generation activities with a coefficient of r =.628, which is significant at p<.01. This coefficient value indicates as the social capital increases, non-farm income generation activities increases by a proportionate amount.

Table 4.4.1 depicts that non-farm income generation activities is positively related to availability of extension services with a coefficient of r = .618, which is significant at p<.01.This coefficient value indicates as non-farm income generation activities increases, the availability of extension services increases.

A coefficient of $r = .663$, $p < .01$ indicates that the two indicators use of climate smart practices and access to information on climate change have positive and highly significant relationship. So as access to information on climate change increases, the use of climate smart practices increases by a proportionate amount.

In the table 4.4.1 it was found a coefficient of $r = .721$, $p < .01$ that means access to information on climate change, cropping practices and meteorological aspect have positive and highly significant relationship with the seed resilience index. So access to information on climate change, cropping practices and meteorological aspect increases, seed resilience of the respondents increases by a proportionate amount. This result is consistent with the findings of FAO (2015).

A coefficient of $r = .710$, $p < .01$ indicates that non-farm income generation activities and resilience index have positive and highly significant relationship. So as non-farm income generation activities increases, the resilience of the respondents' seed production increases by a proportionate amount. Similar findings were reported by FAO (2015) and Roy (2015).

In sum, correlation coefficient results indicate that access to information ($r = .721$) and non-farm income generation activities ($r = .710$) indicators have highest correlation with the seed system resilience; despite these results do not give indication of the direction of causality.

Although correlation cannot make direct conclusions about causality, but the correlation coefficient can take a step further by squaring it. The correlation coefficient squared (known as the coefficient of determination, R^2) is a measure of the amount of variability in one variable that is shared by the other. For example, have a look on the relationship between access to information and seed system resilience index. Then the value of R^2 can tell us how much of this variability is shared by access to information. These two variables had a correlation of .721 and so the value of R^2 will be $(.721)^2 = .519$.

This value tells us how much of the variability in resilience seed systems index is shared by access to information.

If convert this value into a percentage (multiply by 100), it can be said that access to information shares about 52 % of the variability in resilience seed systems index. So, although that access to information was highly correlated with resilience seed systems index, it can account for only 52% of variation in resilient seed systems. To put this value into perspective, this leaves 50% of the variability still to be accounted for by other variables. It can be noted that although R^2 is an extremely useful measure of the substantive importance of an effect, it cannot be used to infer causal relationships. Although researchers usually talk in terms of 'the variance in y accounted for by x', or even the variation in one variable explained by the other, this still says nothing about which way causality runs. So, although access to information can account for 52% of the variation in resilience seed systems, it does not necessarily cause this variation.

Table 4.4.1 Coefficient of correlation of different indicators of resilience in seed system

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10
X1	1									
X2	.135	1								
X3	.567**	.135	1							
X4	.590**	.173	.590**	1						
X5	.189	.170	.159	.572**	1					
X6	.587**	.014	.557**	.663**	-.035	1				
X7	.154*	.135	.014	-.084	.570**	-.010	1			
X8	.628**	.363	.618**	.544**	.554**	.514**	.053	1		
X9	-.087	.053	-.087	-.149	.562*	-.514*	.566**	.074	1	
X10	.627**	.386**	.558**	**.721****	**.663****	.554**	.514**	**.710****	.270**	1

**Correlation is significant at the 0.01 level (2- tailed)

* Correlation is significant at the 0.05 level (2 -tailed)

Where X1= Social capital, X2= Human capital, X3= Availability of extension services, X4= Access to information on climate change, cropping practices and meteorological aspect, X5= Pest and disease management, X6= Use of climate smart practices, X7= Market access, X8= Non-farm income generation activities, X9= Access to finance and X10= Seed resilience index.

Table 4.4.2 Coefficient of correlation between dimension and index of seed resilience

	Resilience index	Social dimension	Ecological dimension	Economic dimension
Resilience index	1			
Social dimension	.589**	1		
Ecological dimension	.672**	.02	1	
Economic dimension	.034	.612**	.112	1

**Correlation is significant at the 0.01 level (2- tailed)
* Correlation is significant at the 0.05 level (2 -tailed)

Table 4.4.2 indicates that the internal consistency of developed seed resilience index, as dimensions have good correlation with the index. This table shows that social dimension is positively related to the index with a coefficient of r =.589, which is significant at p<.01.This correlation indicates as the social dimension increases, the level of seed resilience increases.

A coefficient of r =.672, p<.01 indicates that resilience index and ecological dimension have positive and highly significant relationship. So as ecological dimension increases the seed resilience increases by a proportionate amount.

Table 4.4.2 shows that social dimension is positively related to the economic dimension with a coefficient of r =.612, which is significant at p<.01.This coefficient value indicates as the social dimension increases, the economic dimension increases by a proportionate amount.

4.6 Identification the problems of farmers in building resilient seed system

In the study area, various types of problems are identified in building resilient seed system such as inadequate training of farmers on developing resilience, lack of extension services, lack of quality seed and good pesticides, lack of climate change information, lack of agricultural credit/loans, lack of advice on IPM/IPM traps (biological), lack of stable market, lack of government support in giving different services like electricity and irrigation.

CHAPTER V

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

CHAPTER V

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

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

5.1 Summary of the findings

An interview was conducted in the three villages of Shibpur Upazilas of Narsingdi district. A total 110 households were selected from the population for informal interview, employing a simple random sampling technique. Meetings was organized with the farmers of Narsingdi district to explore their capacity, problems, and production profitability as well as social, economic and environmental changes problems in seed production. Initiatives were taken to select growers from the three categories such as large, medium and small for interview with a view to obtain a representative statement on resilience in seed system.

A set of indicators were developed in this study which helps to assess the resilience in seed system of the farmers. The indicators include: i) human capital, ii) social capital, iii) availability of extension services, iv) use of climate smart agricultural practices, v) pest and disease management, vi) access to information on climate change, cropping practices and meteorological aspects, vii) market access, viii) non-farm income generation activities and ix) access to finance.

In this study, it was identified that average 65.5% farmers were resilient in terms of three dimensions (social, ecological and economic) and capacities (absorptive, adaptive and transformative). Therefore, 39.9% farmers are vulnerable to different natural hazards.

According to the category, 50% growers had medium resilient in seed system followed by the low category (40.2%). Only 9.7% respondents had high resilient in seed system. The farmers had higher adaptive capacity than absorptive and transformative capacity in resilience of seed system. The farmer's economic dimension is higher in absorptive capacity in resilient seed system. In adaptive capacity, farmer's social status had better than other dimension. Farmer's ecological condition had enhanced their transformative capacity in building resilient seed system.

The social capital is positively related to the availability of extension services with a coefficient of $r = .567$, which is significant at $p < .01$.This coefficient value indicates as the social capital increases availability of extension services increases.

It was found a coefficient of $r = .721$, $p < .01$ that means access to information on climate change, cropping practices and meteorological aspect have positive and highly significant relationship with seed resilience index. So access to information on climate change, cropping practices and meteorological aspect increases the resilience of seed system increases by a proportionate amount.

A coefficient of $r = .710$, $p < .01$ indicates that non-farm income generation activities and resilience of the respondents have positive and highly significant relationship. So as non-farm income generation activities increases the resilience of the respondents increases by proportionate amount.

In the study area, a number of problems were identified in building resilient seed system such as inadequate training of farmers on resilience, lack of extension services, lack of quality seed / and good pesticides, lack of climate change information, lack of agricultural credit/loans, lack of advice on IPM/IPM traps (biological), lack of stable market, lack of government support in giving different services like electricity and irrigation.

5.2 Conclusions

On the basis of the findings and logical interpretations of the study the following Conclusions could be drawn:

1. In this study it was identified that average 65.5% farmers' seed systems (production, processing and marketing) were resilient to natural calamities such as drought, heavy rainfall, flood and high temperature. So the rest 34.5% of the farmers are vulnerable to different natural hazards in their seed system. In the study area it's observed that medium category farmers are more resilient in the seed system.
2. Around 60% seed producers had medium to high resilient seed system.
3. The farmers had higher adaptive capacity (40%) than transformative and absorptive capacity.
4. The social capital is positively related to the availability of extension services that means the social capital increases, the available of extension services increases by a proportionate amount.
5. A number of problems were identified in building resilient seed system such as inadequate training of farmers on resilience, lack of extension services, lack of quality seed and good pesticides, lack of climate change information, lack of agricultural credit/loans, lack of advice on IPM/IPM traps (biological), lack of stable market, lack of government support in giving different services like electricity and irrigation.

5.3 Recommendations

Based on the results of the present study, the following recommendation may be drawn-

1. The government should provide adequate information on climate change, cropping pattern and meteorological aspects (i.e., rainfall, temperature, preventive information on potential climatic threats) in building resilient seed system.
2. The government should invest on building social capital (i.e., improving social networks, local organization, accountability and transparency of these organization) to foster resilient seed system
3. It is also recommended that government should make the farmers efficient on pest and disease management of seed (i.e., extent of significance, knowledge and usefulness of non-chemical in managing pest and diseases) in resilient seed system.
4. The government should increase the facility of farmers' non-farm income generation activities (i.e., increasing seasonal business, availability of private and government job) to enhance resilient seed system.
5. The present study was conducted in seed system. It is recommended that similar studies should be conducted in other sectors of agriculture in Bangladesh.

CHAPTER VI

REFERENCES

REFERENCES

Adger, W.N. Vulnerability. Global Environ. Change 2006, 16, 268–281. [Google Scholar] [CrossRef]Page, S.E. The Difference; Princeton University Press: Princeton, NJ, USA, 2007; p. 424.

Adger, W.N.; Hughes, T.P.; Folke, C.; Carpenter, S.R.; Rockström, J. Social-ecological resilience to coastal disasters.Science 2005, 309, 1036–1039.

Ahmed, H. 1977. Use of in Reply to Information Sources by the Farmers in the Adoption of Improved Farm Practices in Jute Cultivation, MS. (Ag. Ext. Ed) Thesis, Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh.

Alam, M.S. 1997. Use of Improved Farm Practices in Rice Practices in Rice Cultivation by the Farmers. MS. (Ag. Ext. Ed.) Thesis, Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh.

Anonnymous, 2011. New Rice Variety Perks Up Farmers‟ Hope", retrieved from http:// www.bangladesheconomy.wordpress.com (access: 12 Nov, 2014)

Aurangozeb, M.K. 2002. Adoption of Integrated Homestead Farming Technologies by the Rural Women in RDRS. MS. (Ag. Ext. Ed) Thesis, Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh.

Béné, C., Wood, R.G., Newsham, A. & Davies, M., 2012. Resilience: New Utopia or New Tyranny? Reflection about the Potentials and Limits of the Concept of Resilience in Relation to Vulnerability Reduction Programmes, IDS Working Papers, No. 405.

Berkes, F., J. Colding and C. Folke (eds.) 2003. Navigating Social-Ecological Systems: Building Resilience for Complexity and Change. Cambridge UK, Cambridge University Press.

Bhuiyan et al. 2014. Agricultural Extension Education, g-Science Implementation & Publication, Karwanbazar, Dhaka Bangladesh.

Bhuiyan, M.H.1999. Extension Organization and Management (In Bengali). Gulshan Publications, Bangla Bazar, Dhaka, Bangladesh.

Brooks, N., 2003. Vulnerability, Risk and Adaptation: A Conceptual Framework, Tyndall Centre Working Papers, No. 38.

Carpenter, S.R., Walker, B.H., Anderies, J.M. & Abel, N.2001. From metaphor to measurement: resilience of what to what? Ecosystems, 4: 765–781.

Chowdhury, M.S.A. 1997. Adoption of selected BINA Technologies by the Farmers of Boira Union in Mymensing District. M.S. (Ag. Ext. Ed) Thesis, Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh.

Chowdhury, M.S.A. 1997. Adoption of selected BINA Technologies by the Farmers of Boira Union in Mymensing District. M.S. (Ag. Ext. Ed) Thesis, Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh.

Cossée, O., Lazar, M. &Hassane, S.2009. Rapport de l'évaluation à mi-parcours du Programme EMPRES composantecriquetpèlerinenrégionoccidentale. Rome.

Cutter, S.L., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E. & Webb, J., 2008. 'A Place-Based Model for Understanding Community Resilience to Natural Dis-asters', Global Environmental Change, 18(4), pp. 598- 606

Davies, M., Guenther, B., Leavy, J., Mitchell, T., Tanner, T., 2008. 'Adaptive social protection': synergies for poverty reduction. IDS Bulletin 39, 105–112.

Dinpanah, G.R.M. Chizari and Mohammadi, H.M. 2005. Effect of on fram demonstration on technical knowledge of wheat farmers. Iranian-Journal of Agricultural Sciences. Faculty of Agriculture, University Of TarbiatModarres, Tehran, Iran, 36(2): 319-329.

FAO (2015). Self-evaluation and holistic assessment of climate resilience of farmers and pastoralist. FAO, Italy. pp.166.

FAO, 2013.Climate-smart agriculture Sourcebook.FAO.pp. 570.

Folke, C., S. Carpenter, B. Walker, M. Scheffer, T. Elmqvist, L. Gunderson, and C.S. Holling. 2005.Regime shifts, resilience and biodiversity in ecosystem management. Annual Review of EcologyEvolution and Systematics 35: 557-581.

Food Security Information Network (FSIN), 2014. Resilience Measurement Principles. Toward an Agenda for Measurement Design, FSIN Technical Series, No. 1,

Gitz, V. &Meybeck, A. 2012. Risks, vulnerabilities and resilience in a context of climate change. In FAO & OECD Building Resilience for Adaptation to Climate Change in the Agriculture Sector. Rome.

Gunderson, L. and C. S. Holling. (eds.)2002. Panarchy: Understanding transformations in humanand natural systems. Washington, D.C., Island Press.

Holling, C.S. 2001. Understanding the complexity of economic, social and ecological systems.Ecosystems 4: 390-405.

IPCC.2012. Managing the risks of extreme events and disasters to advance climate change adaptation (SREX). Special Report of the Intergovernmental Panel on Climate Change (IPCC). Geneva, IPCC Secretariat.

Kotschi, J. & K. Muller-Samann. 2004. The role of organic agriculture in mitigating climate change: a scoping study. Bonn, Germany, IFOAM.64 pp.

Kondyli, J. (2010). Measurement and evaluation of sustainable development a composite indicator for the islands of the North Aegean region, Greece. Environmental Impact Assessment Review, 30, 347–356.

Leeuwis, C., 2004. Communication for Rural Innovation. Oxford, UK: Blackwell Publishing.

Lee, N. (2006). Bridging the gap between theory and practice in integrated assessment. Environmental Impact Assessment Review, 26, 57–78.

Levin, S.A. Fragile Dominion; Perseus: New York, USA, 1999. [Google Scholar] http://www.flinders.edu.au/torrens-resilience-institute/faqs/faqs_home.cfm

Lotter, D.W., Seidel, R. & W. Liebhardt. 2003. The performance of organic and conventional cropping systems in an extreme climate year. American Journal of Alternative Agriculture, 18(3): 146-154.

MacGillivary, A., 2004. The Triple Bottom Richardson. London: Earthscan, pp: 121-130.

McGuire S. and Sperling, L. 2013.Making seed systems more resilient to stress. Global Environmental Change 23: 644–653.

Ministry of Agriculture, Government of the People‟s Republic of Bangladesh.

Mitchell, A., 2013. Risk and Resilience: From Good Idea to Good Practice, OECD Development Co-operation Working Papers, No. 13.

Nelson, Donald R.; Adger, W. Neil; Brown, Katrina (2007). "Adaptation to Environmental Change: Contributions of a Resilience Framework"

OECD (2008) Handbook on constructing composite indicators: methodology and user guide. OECD, Paris.

OECD (2008) Handbook on constructing composite indicators: methodology and user guide. OECD, Paris.

Olsson, P., Folke, C., Hughes, T.P., 2008, Navigating the Transition to Ecosystem-Based Managementof the Great Barrier Reef, Australia. Proceedings National Academy of Sciences, USA 105:9489-9494.

Pal, S.K. 1995. Adoption of Recommended Sugarcane Cultivation Practices by the Farmers of two Selected Centres of North Bengal Sugar Mills. M.S. (Ag. Ext. Ed) Thesis, Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh.

Paul, P.K. 1989. Effectiveness of Result Demonstration as an Extension Teaching Method.M.S. (Ag. Ext. Ed) Thesis, Department of Agricultural Extension Education, BangladeshAgricultural University, Mymensingh.

Paul, P.K. 1989. Effectiveness of Result Demonstration as an Extension Teaching Method.M.S. (Ag. Ext. Ed) Thesis, Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh.

Roy, R., Chan, N. W., Uemmura, T. and lancer, H. (2013). The vision of agri-environmental sustainability in Bangladesh: how the policies strategies and institutions delivered? J. Env. Protection, 4: 40-51.

Roy R, Chan NW, Rainis, R. Rice farming sustainability assessment in Bangladesh. Sustainability Science, 9:31–44

Roy, R. and Chan, N, W. (2014). A multilevel evaluation of policy interpretation of human resource development in agricultural sector. Natural Resources 5: 199-129.

Roy, R., Chan, N. W. (2015). Determinant of sustainable irrigate and rainfed rice farming in Bangladesh, J. Agr. Sci Teela.17: 1421-1435.

Roy, R, (2015). Modelling and policy integration of sustainable rice farming system in Bangladesh. PhD Thesis. University Sains Malaysia. pp. 269.

Roy R, Chan NW, Xenarios. (2015) Sustainability of rice production systems: an empirical evaluation to improve policy. Environ, Dev. Sustain. 18 (1):257-278.

Sarker, D.C. 1997. Correlates of Selected Characteristics of Potato Growers with their Adoption of Improved Potato Cultivation Practices in Five Villages of Comilla District. M.S. (Ag. Ext. Ed) Thesis, Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh.

Shonkoff et al., (2011). "The climate gap: environmental health and equity implications of climate change and mitigation policies in California—a review of the literature" (PDF). Climatic change. 109 (1): 485–503.

Smit, Barry, and Johanna Wandel. "Adaptation, adaptive capacity and vulnerability." Global environmental change 16.3 (2006): 282-292.

Saisana, M. (2008). 2007 Composite learning index: Robustness issues and critical assessment. Italy: IPSC, Joint Research Centre.

Saisana, M. (2010). Tips and tricks. Constructing compositeindicators: From theory to practice. IPSC, Joint Research Centre, Italy.

Tibbs, H., 2011. Changing cultural values and theagriculture and natural resources. Operations 15(3): 13 – 32

Trewevas, A., 2002. Malthus foiled again and again.Initiatives and Public Goals. Paris, France. Nature, 418: 668-670.

UNDP, 2011. Human Development Report 2011- 4Sustainability and Equity: A Better Future for AllPlaza, New York.

Walker, B., Holling, C.S., Carpenter, S.R. &Kinzig, A., 2004. 'Resilience, Adaptability and Transformability in Social-Ecological Systems', Ecology and Society, 9(2)

Walker,B.H. and D. Salt.v2012. Resilience Practice: Building capacity to absorb disturbance and maintain function. Island Press, Washington, DC.

World Bank. 2008. World Development Report 2008, Agriculture for Development, the World Bank, Washington, D.C.

APPENDIX

APPENDIX-I

(English Version of the Interview Schedule)

Department of Agricultural Extension and Information System

Sher-e-Bangla Agricultural University

An Interview Schedule on

"ASSESSING RESILIENCE IN SEED SYSTEM OF NARSINGDI DISTRICT"

Serial no.: ....

Date: ....

Address of the Respondent:

Name of the respondent:

Village:

Union:

Upazila:

(Please answer the following questions. Your information will be used Onlyfor academic research purpose)

1. Social capital

A.How many organizations are you a member of and its frequency of contact?

Name of organization	Member		Number of contact		
	Yes (1)	No (0)	Week (3)	Month (2)	Year (1)
Farmers group (e.g., Deep tube-well committee)					
NGOs					
Mosque committee					
School development committee					
Cooperative (Credit/financial)					
Club (e.g., IPM, FFS, CFS)					
Religious group (e.g., Tablig)					
Neighborhood / Village association					
Political group					

B. How much confidence do you have in the following institution?

Institution	A great deal (5)	Quite a lot (4)	No opinion (3)	Not very much (2)	None at all (1)
Upazilla agricultural extension organization					
Local administration (Union parishod)					
Other Govt. organization (e.g., BRDB, Social Welfare)					
Input business community / members of community					

2. Human capital

Statement	DF (5)	PB (4)	PBN (3)	NS (2)	DFN (1)
knowledge					
Quality seed is free from pest and disease					
BADC is the main source of quality seed					
Quality is physically soundness and weight					
Skill					
Red/yellow discoloration of leaves is the symptoms of seed disease					
Quality seed is base for good production					
Safe pesticide application is inevitable					
Capacity					
Education is unique for sustainable seed systems					
Stone separator is good seed processing equipment					
Established market requires for profitable seed production					

DF= Definitely, PB= Probably, PBN= Probably Not, NS= Not Sure, DFN= Definitely Not Sure

3. Availability of Extension Services

Please mention the extent of extension contact in the last year

Query	Extent of extension contact in the past year			
	4 times and above (4)	2 to 3 times (3)	Once (2)	No visit (1)
Extension officers visit to farmers				
Farmers visits to extension officers				
Others (specify)				

4. Pest and disease management

Whether or not farmers apply chemical and non-chemical measures for pest, disease management on seed

	Pest		Disease	
	Chemical(1)	non chemical(0)	Chemical(1)	Non chemical(0)
Yes				
No				

If yes, then mention the extent of significance, knowledge and usefulness of nonchemical Measures in managing pests, diseases.

	Significant (S)			Knowledgeable (K)			Useful (U)		
	Very Significant (3)	Significant (2)	Not (1)	Very Knowledgeable (3)	Knowledgeable (2)	Not (1)	Very Useful (3)	Useful (3)	Not (1)
Pest									
Disease									

5. Non-farm income generation activities (IGA)

Do you have any income source other than agriculture? Yes….. [ ] (1) No….. [ ] (0)

If Yes, then answer the following …….

a. Government job [ ] b. Private Job [ ] c. Business [ ] d. Seasonal business [ ]

e. Labour to mill/factory/other house [ ] e. Other (specify) ………………

6. Use of climate smart practices

Practices	Yes (1)	No (0)
Alternate wetting and drying		
Integrated pest management		
Guti urea		
Legume crop cultivation		
Mulch cropping;		
Crop diversification		
Alterations in cropping patterns and rotations		
Cover cropping		
Restoration of cultivated peaty soils and degraded lands;		
Conservation agriculture		
Organic agriculture		

7. Access to information on climate change, cropping practices and meteorological aspects

Climate change		
Are you aware of climate change?	Yes	No

Over the last ten years, have you observed any changes relating to the weather	If yes, what changes have you noticed?								
	Increased rainfall	Decreased rainfall	Drought	Increased rainfall variability	Increased temperature	Flooding	Late onset of rainy season	Shorter rainy season	Other specify

Yes	No	If yes, how did these impact your farm system?							
		Crop failure	Unreliable stream flow	less farm income	Migration/ off farm work	Higher expenses on agricultura l inputs	Reduced fodder yields	Water salinity	other (Please)

Climatic information				
Do you have means to predict Climatic variations?	Yes	No	If yes how? If no why? (max.2)	

Do you have access to weather forecast services (including preventive information on potential climatic threats e.g. floods droughts, late rains)?	Yes	No

8. Access to finance

Medium	Sustained (3)	Intermittent (1)	No access (0)
Family			
Friends / neighbours			
Bank			
Cooperative			
Microfinance			
Loan company			
Government programme			
NGO programme			
Remittances			
Other(specify):			

9. Market access

Market access - buying				
Do you buy directly from producers?	Yes (1)	No (0)	If yes, for which products? (max.1)	
Do you have any vegetal product, which you can only access from one available seller?	Yes (1)	No (0)	If yes, which crops? (max.1)	
Are there seeds, which you can only access from one available seller?	Yes (1)	No (0)	If yes, which product?	
Do you have sustained access to market to buy farming inputs and outputs?	Yes (1)	No (0)	If yes, which product?	
Market access - selling				
Last year did you sell any of your crops/ livestock/ seeds?	Yes (1)	No (0)	If yes, which ones? (max.1)	
Do you sell/trade some of those products directly to consumers?	Yes (1)	No (0)	If yes, for which products? (max.1)	
Do you have any product with only one available buyer?	Yes (1)	No (0)	If yes, which products?	
Do you have sustained access to market to sell farming inputs and outputs?	Yes (1)	No (0)	If yes, which product?	

Date:

Signature of the Interviewer