FARMERS' EXTENT OF ADAPTATION STRATEGIES TOWARDS SALINITY EFFECTS IN AGRICULTURE

MD. ARIFUR RAHMAN PEAL

DEPARTMENT OF AGRICULTURAL EXTENSION AND INFORMATION SYSTEM

SHER-E-BANGLA AGRICULTURAL UNIVERSITY

DHAKA- 1207

JUNE'15

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BY

MD. ARIFUR RAHMAN PEAL

REGISTRATION NO.:14-06319

A thesis

Submitted to the Department of Agricultural Extension and Information System

Sher-E-Bangla Agricultural University, Dhaka

In partial fulfillment of the requirements for thedegree of

MASTER OF SCIENCE (MS)

IN

AGRICULTURAL EXTENSION

SEMESTER: JANUARY- JUNE'2015

APPROVED BY:

Dr. Mohummed Shofi Ullah Mazumder	**Dr. Muhammad Humayun Kabir**
Associate Professor	Associate Professor
Supervisor	Co-Supervisor
Department of Agricultural Extension and Information System	Department of Agricultural Extension and Information System
Sher-E-Bangla Agricultural University	Sher-E-Bangla Agricultural University

Dr. Mohummed Shofi Ullah Mazumder

Chairman

Examination committee

Department of Agricultural Extension and Information System

Sher-E-Bangla Agricultural University

DEPARTMENT OF AGRICULTURAL EXTENSIONAND INFORMATION SYSTEM

Sher-E-Bangla Agricultural University

CERTIFICATE

This is to certify that the thesis entitled '**FARMERS' EXTENT OFADAPTATIONSTRATEGIES TOWARDS SALINITY EFFECTS IN AGRICULTURE**' 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 bonafide research work carried out by **Md. Arifur Rahman Peal**, Registration Number: **14-06319** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

……..

Dr. Mohummed Shofi Ullah Mazumder

Associate Professor

Supervisor

Department of Agricultural Extension and Information System

Sher-E-Bangla Agricultural University

DEDICATED

TO

MY BELOVED

PARENTS

ACKNOWLEDGEMENT

At first the author expresses his gratefulness to almighty Allah who has helped him to pursue his higher education in agriculture and for giving the potency of successful completion of this research work.

With deepest emotion the author wish to express his pious gratitude, indebtedness, felicitation, sincere appreciation to his research Supervisor ***Dr. Mohummed Shofi Ullah Mazumder****, Associate Professor, Department of Agricultural Extension and Information System, Sher-E-Bangla Agricultural University, Dhaka, Bangladesh for his discursive guidance, intense supervision and continuous encouragement during the entire period of research work.*

The author also highly grateful and obliged to his research Co-Supervisor, ***Dr. Muhammad Humayun Kabir****, Associate Professor, Department of Agricultural Extension and Information System, Sher-E-Bangla Agricultural University, Dhaka, Bangladesh for his continuous encouragement, innovative suggestions, and affectionate inspiration throughout the study period.*

The author is also grateful to his all the teachers of Department of Agricultural Extension and Information System, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh for their continuous encouragement and innovative suggestions.

The author also grateful to Upazila Agriculture Officer and his stuffs for enabling author by giving suggestions and valuable information during time of collecting data.

Finally, the author expresses his heartfelt indebtedness and favor to his beloved father ***Md. Jalal Ahmaed****; mother* ***Lipi Sultana****, and spouse* ***Dr. Tarifa Hayet*** *for their sacrifice, encouragement and blessing to carry out his higher study.*

The Author

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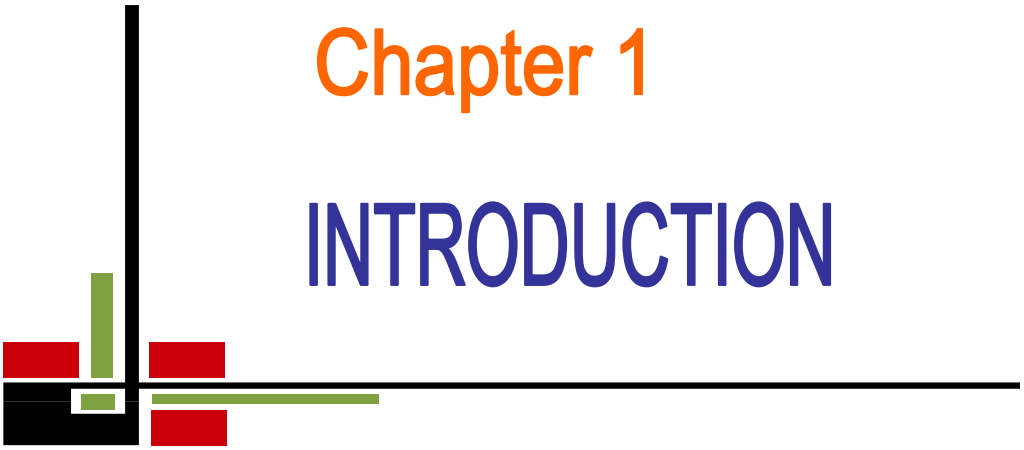
ABBREVIATIONS

BBS	Bangladesh Bureau of Statistics
CCC	Climate Change Cell
CEGIS	Center of Excellence for Geospatial Information
DAE	Department of Agricultural Extension
DCRMA	Disaster and Climate Risk Management in Agriculture
EU	European Commission
et al.	All others
GDP	Gross Domestic Product
HYV	High Yielding Variety
IPM	Integrated Pest Management
SAAO	Sub-Assistant Agriculture Officer
SLR	Sea Level Rise
NAPA	National Adaptation Program on Action

ABSTRACT

The study was to about extent of adaptation strategies of farmers' who were struggling to adapt salinity effects in agriculture day by day. The purpose of the study was to describe the socio-economic profile of the salinity affected farmers in the study area; to determine farmers' extent of adaptation strategies towards salinity effects in agriculture and to explore contributing relationship between the selected characteristics of the salinity affected farmers and their extent of adaptation strategies towards salinity effects in agriculture. The study was undertaken purposively in Kalapara upazila under Patuakhali district. Validated and well-structured interview schedule (questionnaire) was used to collect data from 131 farmers during 20th February to 30th March 2016. Data analysis was done using simple and inferential statistical tools such as frequency counts, mean, standard deviation, and multiple regressions. The findings showed that majority of the farmers (48.1 percent) had medium level adaptation, 28.2 percent of them had high level adaptation while 23 percent had low level adaptation strategies towards salinity effects in agriculture. The results also showed that farmers' age, educational background, farming experience, agricultural extension contact and farmer's category were significant factors for farmers' extent of adaptation strategies towards salinity effects in agriculture; and within this, age, agricultural extension contact and farmer's category were the most significant contributing factors. It is concluded that, the study farmers had opportunity to enhance their knowledge through proper school or mass education that made them enthusiastic and interested to take risk, and motivated them to come out from traditional behavior and practices in agriculture.



Chapter 1

INTRODUCTION

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INTRODUCTION

1.1 General background

Bangladesh is an agrarian country and agriculture is the backbone of our national economy. Most of the people depend on agriculture for their livelihood. More than 80% of total population is directly or indirectly involved with agriculture. The coastal zone of Bangladesh is worldwide recognized as an extremely susceptible area influences by climate change and sea level rise which have real consequences on the livelihoods of the coastal people as it would be affected by salinity disturbance, variations in temperature and rainfall, drought, cyclone and storm surges and erosion of the land masses (Hasan *et al.*,2013).

Salinity intrusion in soil also caused by climate-induced hazards, especially cyclones and sea level rise (SLR) is adversely affecting crop production in coastal region of Bangladesh. According to Inter governmental Panel Climate Change (IPCC, 2007) sea level in the coastal region of Bangladesh has been predicted to rise up to 80 cm by 2100. World Bank (2000), showed 0.10 m, 0.25 m and 1 m rise in sea level by 2020, 2050 and 2100; affecting 2%, 4% and 17.5% of total land mass respectively 1 cm per year sea level rise in Bangladesh. Salinity is a measure of the content of salts in soil or water. Salts are highly soluble in surface and groundwater and can be transported with water movement. The factors which contribute significantly to the development of saline soil are, tidal flooding during wet season (June-October), direct inundation by saline water, and upward or lateral movement of saline ground water during dry season (November-May) due to evaporation (Rasel *et al.,* 2013).

The coastal saline area of Bangladesh is distributed unevenly in 64 upazilas of 13 districts covering eight (08) Agro-Ecological Zones (AEZ) of the country (Seraj and Salam, 2000). The large portions of saline land fall in the districts of Satkhira, Khulna, Bagerhat, Patuakhali, Barguna, Pirojpur and Bhola in the West of Bangladesh. Again, the coastal areas of Bangladesh cover more than 30% of the cultivable lands of the country. About 53% of the coastal areas are affected by

salinity which is reducing the agricultural productivity and putting far-reaching impacts on the livelihood strategies of resource poor farmers (Hassnain *et al.,* 2005).

Salinity causes unfavorable environment and hydrological situation that restrict the normal crop production throughout the year. It also affects crops at the critical stages of growth, which reduces yield and in severe cases total yield is lost and affects in income which leads poor in socio-economic status. Rabbani *et al.,* (2013) explained that, after AILA in 2009 farmers were faced high salinity in their field which affects their socio-economic status compared to past five years. Farmers could not grow regular crops due to high salinity. Due to salinity crop production is reduced and off-firm activities are increased but it cannot contribute same as well from agricultural activities. Adaptation is an important measure to fight with this devastating factor.

Adaptation is essential measure to reduce the impacts of salinity on farmers' livelihood. Adaptation strategies are activities that reduce the negative effects of salinity and/or takes advantage of new opportunities that may be presented which includes activities that are taken before impacts are observed (anticipatory) and after impacts have been felt (reactive) (Mcdowell and Heiss, 2012). Adaptation in agriculture is how perception of climate change is translated into the agricultural decision-making process (Bryant *et al*., 2000). Farmers have experienced that climate change and variability like salinity have directly affected the agriculture sector, especially in crop production. That situation led the people to take adaptation strategies to mitigate the risk. Adaptation can be a specific action like a farmer changing crops, a systemic change like diversifying livelihoods or an institutional reform like changing resource management practices. It can also denote the whole process, including learning about risks, evaluating response strategies, mobilizing resources, implementing adaptations and revising choices with new learning (Leary *et al.* 2008).

Adaptation measures are therefore important to help these communities to better face extreme weather conditions and associated climatic variations (Adger *et al*., 2003). So, it can be said some practices that are followed by farmers in their farm level or off-firm level traditionally or by learning that reduce negative effects of this

dangerous climatic variation which hampers agricultural productivity. The main goal of adaptation towards salinity effects is reducing vulnerability and builds resilience to the impacts bought by salinity. It is very important to create awareness and motivate farmers to take adaptive measure to mitigate its effects.

Salinity effects are now a boisterous issue on agriculture sector which is limitedly discussed as a component of climatic variations. Many researcher conducted various study on climate change adaptation of farmers which including flood, drought, cyclone, rainfall variability etc. but few research had so far been conducted on farmers' adaptation measure or practices against salinity effects in agriculture. Farmers are adapted various strategies traditionally against salinity effects and adaptive practices of farmer towards salinity effects is now essential to enhance crop production in those area and also important to mitigate its effects on their socio economic status. So, it is a significant issue in our country which is essential to brought under consideration.

1.2 Statement of the problem

In our country salinity is emerged as a devastating problem due to climatic hazards. Due to rising sea level resulting from climate change every year it gives an alarm to us the effects of climatic variations which include salinity intrusion. Salinity is increasing day by day in coastal region in our country. Like other country the people of coastal areas are suffering by its impacts. Around 37 million of people living in the coastal districts and 70 percent of them are engaged in farming activities (BBS, 2003). Every year farmers of the coastal region are facing new problems in crop production due to the boisterous effects of salinity and even they give up their regular farming activities and engaged in off firm activities. Finally they are facing low income which leads to poor economic status. From this short discussion it can be said that salinity problem in Bangladesh is certainly a crucial development challenge and we need deeper understanding of people's adaption strategies and responses to mitigate salinity effects and their adaptation extent towards the effects in agriculture. The study aimed at providing information about the following queries:

i. What is the scenario of socio-economic profile of farmers in study area?

ii. What is the extent of adaptation strategies of farmers' towards salinity effects in agriculture?

iii. Is there any contributing relationship between the selected characteristics of farmers with their extent of adaptation?

1.3 Specific Objectives

Specific objective(s) are pre-requisite for conducting any research work which gives a guideline to researcher to obtain concerned goal. From the above statement of problem the researcher had set the following specific objectives:

i. To describe socio-economic profile of the salinity affected farmers;

ii. To determine farmers' extent of adaptation strategies towards salinity effects in agriculture; and

iii. To explore the contributing relationship between the selected characteristics of salinity affected farmers and their extent of adaptation strategies towards salinity effects in agriculture.

1.4 Justifications of the study

The main aim of the study was to determine the extent farmers' adaptation strategies towards salinity effects. In our country salinity problem causes tremendous effects and it hampers our agricultural production in coastal areas. People do not cultivate crop comfortably for this problem. Salinity rise is a boisterous component of climate change which affects farmers seriously in socio-economic aspects. It is now recurrent phenomenon which is now an alarming discussion to every country in the world. People are taking indigenous adaptive measure against salinity effects which need to be enhanced scientifically to reduce its impact.

In our country Government and Non-Government organization has carried out different policy to mitigate the problem by enhancing and adopting some important

adaptive measures by the farmers. Various studies were conducted about climate change, climatic hazards and its variation, adaptation of climate change in agriculture, but lack of study has conducted specifically on adaptation strategies towards effects of salinity problem which is a boisterous problem resulting from climate change effects. In our country farmers are facing various problems in agriculture due to salinity and it is very important to challenge against the problem by adapting some measures. Considering the above circumstances, the researcher became interested to undertake a study entitled, 'Farmers' extent of adaptation strategies towards salinity effects in agriculture'.

1.5 Assumptions of the study

The following assumptions have been taken into consideration for the present study:

The researcher who acted as an interviewer was well aware of the social and cultural environment of the study area. Hence, the data collected by the researcher were free from bias and the respondents furnished their opinions without hesitations.

i. Respondent's response, views and opinions were the representative views and opinions of the whole target population.

ii. The respondents selected for the study were decent to satisfy, the exploration of research and their responses were reliable.

iii. The items, questions and scales used for measuring the variables were reasonably adequate to reflect the respondents' real answer.

iv. The findings of the study would be useful for planning and implementation of the program of extension services.

1.6 Limitations of the study

Researcher had some limitations considering budget, time and other resources are noted below:

i. The study was confined to four villages in Kalapara upazila under Patuakhali district.

ii. Characteristics of the farmers were many and varied. Only (08) eight characteristics were selected as independent variables for this study.

iii. Researcher was depended on only farming practices as adaptation strategies where farmers had also off-firm strategies towards salinity effects.

iv. In the study area around 15-20 farm practices was regularly or irregularly followed by farmers from where researcher was take only ten (10) adaptation practices for determining adaptation extent.

v. For information about the study, the researcher has to depend on the data furnished by the selected respondent's instant memory during the interview time.

vi. Time allocation and budget was also limitation in this study.

1.7 Definition of related terms

In this study, the certain terms have been frequently used. These are defined and explained below for clarity of understanding to the investigator and readers.

Age: Age of the respondent refers to the period of the time in actual years from his birth to the time of interview.

Educational background: It was defined to the development of desirable changes in knowledge, skill and attitudes in an individual through reading, writing, working, observations and others activities. It was measured on the basis of classes passed from a formal educational institution by the respondents'.

Effective farm size: The term related to the hectare of land owned by a respondent on which he carried out his farming activities, the area being estimated in terms of full benefit to the farmers. A farmer was considered to have full benefit from cultivated area either owned by her/him or got lease from others and obtain half benefit from the area which was either cultivated by him on *borga* or given to others for cultivation on *borga* basis.

Farming experience: Farming experience refers to the experience of a farmer in agricultural works and expressed in years.

Annual family income: The term annual family income referred to the total earning by the earning members from agriculture, livestock, fisheries and other accessible sources (business, service, daily labor etc.) during a year. It was expressed in Thousand Taka.

Training experience: Training experience refers to the extent of participation of the farmers to any kind of training program offered by different organizations and agencies up to the time of interview.

Agricultural extension contact: It is a communication about agriculture-related information among agricultural stakeholders and between agricultural and non-agricultural stakeholders.

Farmer's category: Farmer's category is the classification of farmers based on different views. For example, Based on innovativeness farmers are categorized into Innovator, Early adopter, Early majority, Late majority and Laggards.

Innovativeness: Rogers (1983), defined innovativeness as 'the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of the social system'.

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

Climate: It is a larger term view of the weather patterns of a particular locality is frequently called climate.

Crop diversification: It is the growing of different species of crops in a farm or in a land.

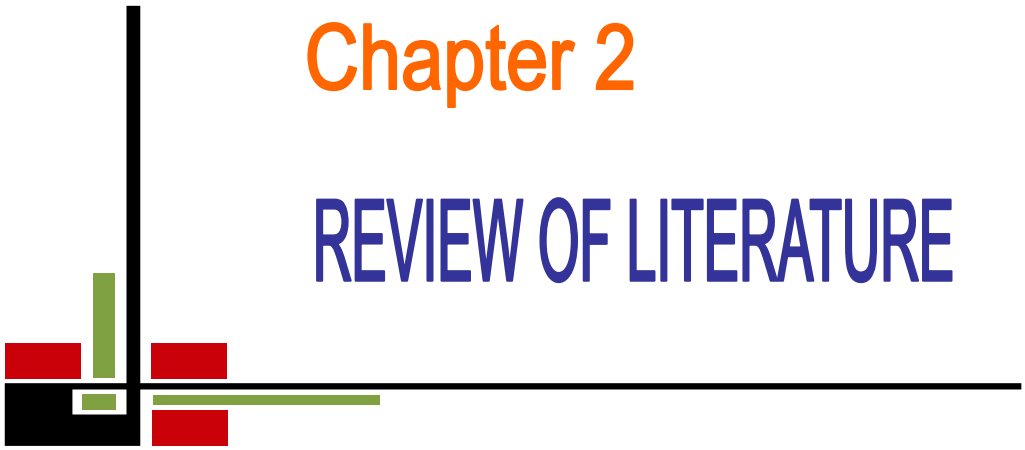
Homestead cultivation: It is growing of different crops around the house or house premises.

Short duration crop: The crop which life cycle is short.

Intercropping: Intercropping means the growing of two or more crops simultaneously on the same field.

Alternative irrigation system: It is irrigation mechanisms in which farmers are irrigate their field by making furrow locally named *khari* for conserving rain water or fresh water from other sources.

Adaptation: It refers to change in behavior, resource, Infrastructure or the functioning of a system that reduces vulnerability.



Chapter 2

REVIEW OF LITERATURE

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REVIEW OF LITERATURE

An exertion was made in this chapter to represent a brief review of related research information which gives a very clear direction to the researcher for selection research issue by identifying research gap. Review of literature forms a linkage between a past and present research works related to problem that helps an investigator to draw a satisfactory conclusion. However, no study was found systematic and directly related to the present study. Therefore, an attempt has been made to review and document closely related literatures in this chapter available from books, journals, review papers, concept note, daily news papers, magazines, etc. Relevant literatures have been reviewed and illustrated in different sections as stated below:

2.1 Salinity issues

Bangladesh is a disaster-prone country and due to these unwanted events, the country experiences disasters of one kind or another (such as tropical cyclones, storm surges, coastal erosion, salinity intrusion, floods, and droughts) almost every year causing heavy loss of life and resources and jeopardizing the development activities (NAPA, 2005). Rashid and Islam (2007) identified drought, flood, soil salinity and cyclones as the major extreme climatic events. Climate change has emerged as one of the greatest environmental challenges facing the world today (IPCC, 2007; Anik and Khan, 2012).

Bangladesh is one of the most vulnerable countries to climate change. Climate induced hazards are increasing day by day. The last era the country has faced many climatic hazards. The country has faced devastating *Sidr* in November 2007, Aila in April 2009, series of flood of 2004, 2007 and 2009, *Nargis* in 2010 and *Mahasen* in May 2013 (Ahmed, 2010; MOEF, 2009). The main reasons for its vulnerability include its tropical climate; the predominance of floodplains for the majority of the land area; the low level of elevation and proximity to sea level; the high population density; and limited technological capacities to offset climate change effects (MOEF, 2005; DOE, 2007; Shahid and Behrawan, 2008; Pouliotte *et al*., 2009).

Climate change effects are already occurring, as measured by increasing temperatures, variable rainfall and an increase in climate related extreme events such as floods, droughts, cyclone, sea level rise, salinity and soil erosion and sea level rise is most occurring factor of salinity (Yu *et al*., 2010).

Sea level rise has increased coastal flood frequency which caused salinity intrusion in coastal area (Ali, 2005). World Bank (2000), showed 0.10 m, 0.25 m and 1 m rise in sea level by 2020, 2050 and 2100; affecting 2%, 4% and 17.5% of total land mass respectively 1.0 centimeter per year sea level rise in Bangladesh which develops salinity. Salinity intrusion is a growing problem in around the globe, especially in the low-lying developing countries. The rate of salinity intrusion in coastal Bangladesh is faster than it was predicted a decade ago (Agrawala *et al*., 2003). The problem becomes exacerbated particularly in the dry season when rainfall is inadequate and incapable of lowering the concentration of salinity on surface water and leaching out salt from soil. Haque (2006) identified "the factors which contribute significantly to the development of salinity are, tidal flooding during wet season (June-October), direct inundation by saline or brackish water and upward or lateral movement of saline ground water during dry season (November-May).

It has been found that the sea level rise of 0.5 m over the last 100 years has eroded approximately 162 km of Kutubdia, 147 km of Bhola and 117 km of Sandwip (CCC, 2007). Maximum soil salinity was observed in pre-monsoon, whereas, minimum was in monsoon in all coastal districts. It was observed that soil salinity starts increasing from post-monsoon and continued to increase in pre-monsoon when it reaches the highest level. Highest (1.14 ds/cm) soil salinity was measured in pre-monsoon at Shahporir Dwip of Cox's Bazar district while lowest (0.82 ds/cm) was in monsoon at Alaipur union of Khulna district (Hossain *et al*., 2012).

Salt occurs naturally in many of the world's wetland systems, whether it is from the ocean in estuaries and tidal marshes or from the ground and atmosphere in inland potholes and playas. Coastal wetlands are dominated by NaCl salts derived from the oceans, whereas inland wetlands may contain various salt combinations leached from bedrock and surface material, deposited from atmospheric salts and agricultural

run-off. In addition to salt composition, inland wetlands may vary in salt concentration (Topping and Scudder, 1977).

2.2 Effects of salinity in agriculture

Even though salinity intrusion is a slow process, but the effects are devastating. Based on observable symptoms, it is therefore assumed that agricultural lands in the coastal area will be affected by salinity (Sarwar, 2005). Sikder (2010) studied on long-term climatic and crop productivity data, regional climatic scenarios and impact analysis of different aspects of climate change on agriculture. The study reveals that the crop yield would be negatively impacted by salinity.

Soil salinization has been worldwide recognized as being among the most important problems for crop production in arid and semi-arid regions (FAO, 2008). Soil salinization affects an estimated 1 to 3 million hectares in Europe, mainly in the Mediterranean countries. It is regarded as a major cause of desertification and therefore is a serious form of soil degradation being salinization and sodification among the major degradation processes endangering the potential use of European soils. For instance, in Spain 3% of the 3.5 million hectares of irrigated land is severely affected, reducing markedly its agricultural potential while another 15% is under serious risk (EC, 2012). It is estimated that up to 20 % of irrigated lands in the world is affected somehow by different levels of salinity. In Iran for example, about 15% of lands, that is about 25 million ha, are suffering from this problem, including 0.32 million hectare of lands in Isfahan province (Feizi, 1993). Robertson *et al*., (2007) discussing dry land salinity problem in Western Australia found that “salinity was a second order issue for many landholders, particularly those higher in the catchments and it was mentioned as a pressing threat mostly by landholders in the valley floor and is not expected to greatly worsen in the catchments, so many landholders see little merit in investing in salinity prevention when the benefits are typically small” and it was perceived to be a problem that only gradually would effect on farm profitability. They identified lack of knowledge on salinity management as a great constraint of the farmers.

Being an agrarian country, 60% people of Bangladesh are directly or indirectly dependent on agriculture for their livelihood, with the contribution of 20 percent to its GDP (BBS, 2011). The dominant land use in coastal Bangladesh is also agriculture. Even though gross and net-cropped areas in the coastal zone of Bangladesh are 144,085 and 83,416 hectare respectively (Islam, 2004), but net-cropped area of coastal zone has been showing a decreasing trend over the years due to a combination of factors. Coastal agro-lands often suffered from saline intrusion that prevented crop production in dry season (Gowing *et al*., 2006).

Increased salinity alone from a 0.3 meter level sea rise will cause a net reduction of 0.5 million metric tons of rice (World Bank, 2000). In recent cyclone *Sidr*, among the productive sectors, damage was highest (USD 0.43 Million) in agriculture. Latest estimates shows; about 800,000 to 1300,000 MTs (metric tons) of paddy have been destroyed in *Sidr* which created severe food insecurity among the affected people (GoB, 2008). In last thirty years', salinity intrusion has degraded land quality and farmers can't grow any agricultural crops in their fields. Thus farmer's become zero productive land owners, in one sense landless with their existing saline land. Size of land which is the firm of shrimp with Transplanted Amon (rice) decrease 15294 hectares to 10000 hectares cause of salinity (Hasan *et al*., 2013).

In general, soil salinity is believed to be mainly responsible for low land use as well as cropping intensity (Rahman & Ahsan, 2001). This problem is not only reducing the agricultural productivity, but is also putting far reaching effects on the livelihood strategies of small farmers (Tanwir *et al.*, 2003). Due to sea level rise related effect particularly salt water intrusion can destroy all kinds of livelihood of the coastal population where 100 million people could be affected; (Finan, 2009). Reduction of fresh water availability due to salinity caused by tidal flooding is seen as a threat to livelihood of coastal region in Bangladesh especially agriculture (Rashid and Islam 2007).

Salinity also affects farmer's socio-economic status. It is estimated that salinity of irrigated lands causes annual global income loss of about US$ 12 billion (Ghassemi *et al*., 1995). Generally, the worst salinity effects occur where farming communities

are relatively poor and face economic difficulties. In severe cases, salinity causes occupational or geographic shifting of the affected communities, with the male population seeking alternate off-farm income opportunities (Abdel-Dayem, 2005).

2.3 Concept of adaptation

Adaptation is widely used in the biological sciences to refer a successful coping strategy. In social sciences and especially in Anthropology the term has long been used to describe successful or functional interactions of human cultures in localized environment (Finan, 2009). Sometimes it is used as synonymous to adjustment, cope with and other similar words. But one thing is common to all discipline and that is adaptation is related to habitat. Adaptation can be a specific action like a farmer changing crops, a systemic change like diversifying livelihoods or an institutional reform like changing resource management practices. It can also denote the whole process, including learning about risks, evaluating response strategies, to enable adaptation, mobilizing resources, implementing adaptations and revising choices with new learning (Leary, 2008). Adaptation refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Adapt or adaptation is a synonym to make more suitable or to fit some purpose by altering or modifying (Smith *et al.,* 1999). The main goals of climate change adaptation are to reduce vulnerability and build resilience to the impacts brought by climate change (IPCC, 2007).

Adaptation can be spontaneous or planned and can be carried out in response to or in anticipation of change in conditions (Watson *et al.*, 1996). There are many different conceptualizations of adaptation, including actions to improve situations, measures by which to embrace new circumstances and conditions, or strategies to reduce vulnerability, or enhance resilience. Strategies such as coastal protection, adjustments in agriculture and forest management, early warning systems and migration corridors have all been considered adaptation and it is a response to short-term climate variability, long-term climate change and extreme events (Schipper, 2004).The concept has been criticized for being too techno-managerial, offering the

promise that problems are manageable. It excludes the possibility of non-adaptation or simply accepting losses (Orlove 2009; and Schipper, 2004).

2.4 Salinity effects adaptation practices in agriculture

Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation (Haddad, 2005). The born rice fully dependent on the irrigation water or the short duration variety of Aus rice is often cultivated by local people taking water from the kharies, canals (locally called khal) and ponds (Muller, 2009).

Mini pond for supplementary irrigation (dry seedbed) practice with minimal supplemental irrigation), homestead gardening, Jujube cultivation, cultivation of chickpea after T. Aman, the utilization of fallow land by establishing homestead garden to cultivate year round homestead vegetables, preparing the mini nursery and established nursery, linseed production as less water loving crop cultivated in rain fed area. This technology had been induced to farmers and peasant's communities have been practicing some extent (Hasan, 2011).

Saline tolerate rice varieties like BINA dhan - 8, BINA dhan - 10, BRRI dhan - 47, BRRI dhan-55 are cultivated by more than one million farmers in Bangladesh. BINA dhan-8 and BINA dhan-10 have been cultivated by farmers in Satkhira, Khulna and Bagerhat districts of south-west coastal region in Boro season. Farmers cultivate BRRI dhan-47 variety that requires less water and tolerance capacity to saline soil is quite high (Alam *et al*., 2013). BINA dhan-8 varieties have salt tolerance capacity are cultivated by farmers in those regions (DCRMA, 2011).

Floating bed is a popular practice in Gopalganj, Madaripur, Barisal, Pirojpur and Jhalokhathi districts where land remain submerged most of the time in a year. Farmers are raising seedlings and producing vegetables, spices and more than thirty crops using floating gardens in pond or other places where there is no saline water intrusion occurs (AAS, 2012). Cultivated vegetables in floating bed include okra, cucumber, bitter guard, kholrabi, pumpkin, water gourd, turmeric, ginger, karalla, arum, tomato, turturi and potato (Alauddin & Rahman, 2013).

Shallow depth sorjans are suitable for the year round cultivation of vegetables and monsoon rice, where the sorjans with higher depths also allow rice-fish or rice-duck farming along with the year-round vegetables cultivation on raised beds. This sorjan system is very popular among the farmers in this coastal region of Patuakhali and annul net return from investment in sorjan system is very high (Sattar & Abedin, 2012).

Homestead gardening is a widely accepted practice in Bangladesh and mainly managed by women in saline area. It ensures food security and additional income by enhancing livelihoods of poor people. Leafy vegetables such as kangkong, batisak, sweet tasting stem, amaranth (Ktoradanta) are grown in homestead gardens (FAO, 2008).

Two crop production cycles are also popular as nutrition requirement of crops is supplemented by each other cultivation like sunflower, chickpea and Khesari after the cultivation of T.Aman in coastal regions (Rashid *et al*., 2014). Salt tolerant sugarcane variety ISWARDI-40, BINA sarisa-5 and BINA sarisa-6, sweet potato varieties like BARI SP-6 and BARI SP-7, BARI Mung and 6, BARI Sweet Gourd-1 and 2, spinach, BARI Tomato-1, Knolkhol and beet are being cultivated as adaptive options in the coastal areas.

Salinity problem is persists not only in Bangladesh but also many parts of the world though the causes are varies country to country even within a country. Unlike causes responses are also different based on nature of salinity, available technology and resources. Most of the existing research on climate change and its variation, responses to salinity address highly technical aspects of the problem like measurement of salinity, plant tolerance capacity to salinity, salinity adapted crop production, desalinization process, etc. and only a few studies shed light on farmers' adaptation strategies towards salinity effects in agriculture. All of these studies failed to establish strong evidence against the questions what is the extent of adaptation strategies of farmers' towards salinity effects in agriculture; and what factors influences on the extent of their adaptation strategies towards salinity effects in agriculture. The studies are still inadequate in respect to all considered popular and

effective strategies. It was the gap and need to be emphasized. It is therefore sought to address these issues in the current study.

2.5 CONCEPTUAL FRAMEWORK OF THE STUDY

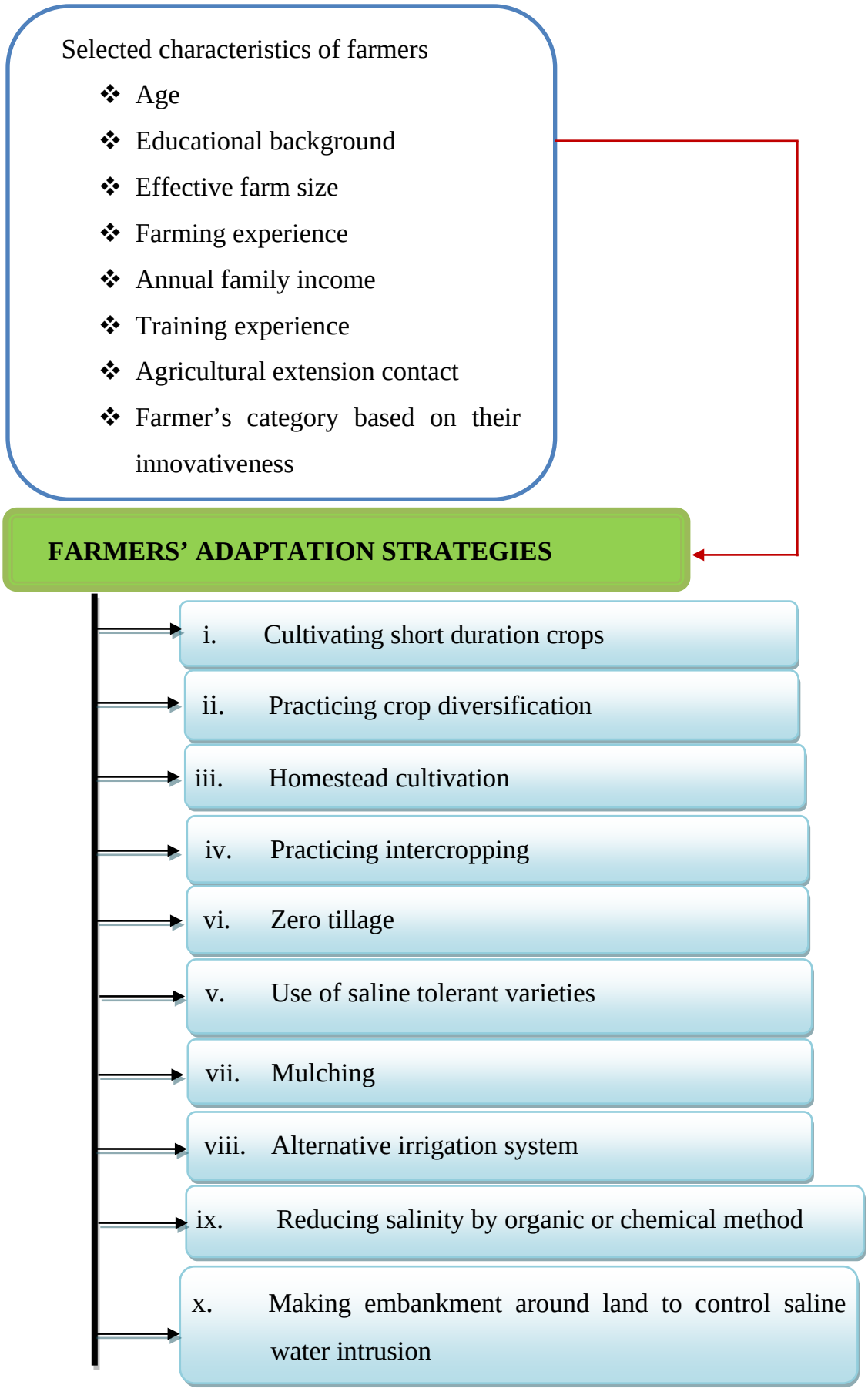
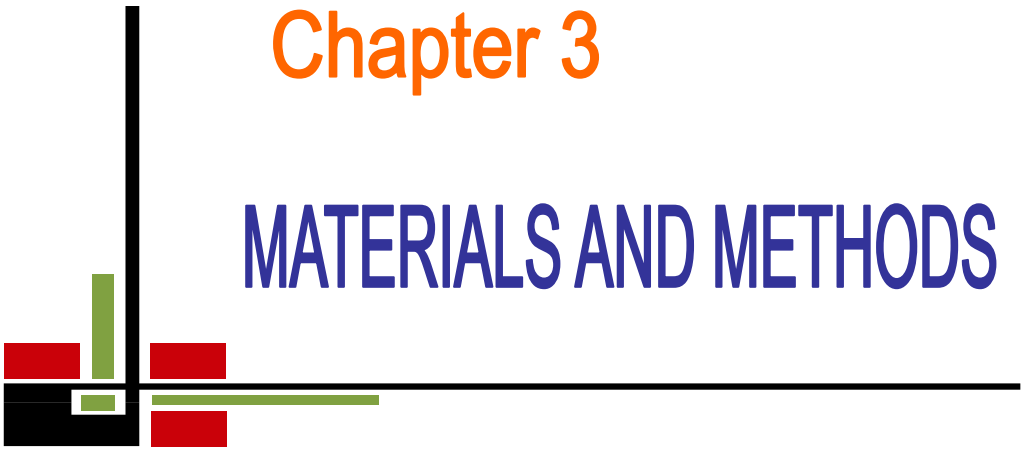


Figure 2.1 Conceptual framework of the study

Chapter 3

MATERIALS AND METHODS



CHAPTER 3
MATERIALS AND METHODS

The reliability of a scientific research depends to a greater extent on the appropriate materials and methods which made the research authentic. The researcher has great responsibility to describe clearly as to what sorts of research design, methods and procedures he would follow in collecting reliable data and to analyze and interpret those to draw reliable conclusions. A sequential description of the materials, methods, and procedures used for this research was stated below:

3.1 Locale of the study

The study was conducted purposively in selected areas of Kalapara upazila under Patuakali District. There are 12 unions namely Chakamayia, Tiakhali, Lalua, Nilgong, Mithagong, Dhankhali, Mohipur, Dhulasor, Latachapli, Dalbuganj, Baliatoli, Champapur in this upazila. Two unions namely Latachapli and Dhulasor were also purposively selected which is severely affected by salinity; again two villages namely Khajura and Noyapara from Latachapli union, and Anantopara and West Dhulasor from Dhulasor union were selected randomly as the locale of the study. A Map of study area was given in Figure 3.1.

3.2 Population and Sampling

The Researcher himself with the help of Upazila Agriculture Officer, Local leaders and concerned Sub-Assistant Agriculture Officer (SAAO) was collected an updated list of farmers of the selected villages. The farmers of the selected four villages constituted the population of the study. The total numbers of farm families head in four villages were 1022. According to Yamane's (1967) formula, sample size was 131 at 8% precision level, 50% degree of variability and the value of the standard normal variable (Z)=1.96 at 95% confidence level. The given formula is stated as:

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

Where, n = sample size

N = population size

e = the level of precision

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

P = the proportion or degree of variability

The sample was then selected from the four villages by considering proportionate random sampling procedure. A reserve list of 20 farm families head (about 15% of the sample) was kept purposively if any respondent was unavailable at the time of data collection. The distribution of population and sample was shown in Table 3.1.

Table 3.1 Distribution of study area's population and sample

District	Upazila	Union	Village	No. of farm family head (N)	Sample size (n)	Reserve farm family head
Patuakhali	Kalapara	Latachapli	Khajura	400	51	8
			Noyapara	252	32	5
		Dhulasor	Anontopara	210	27	4
			West Dhulasor	160	21	3
			Total:	1022	131	20

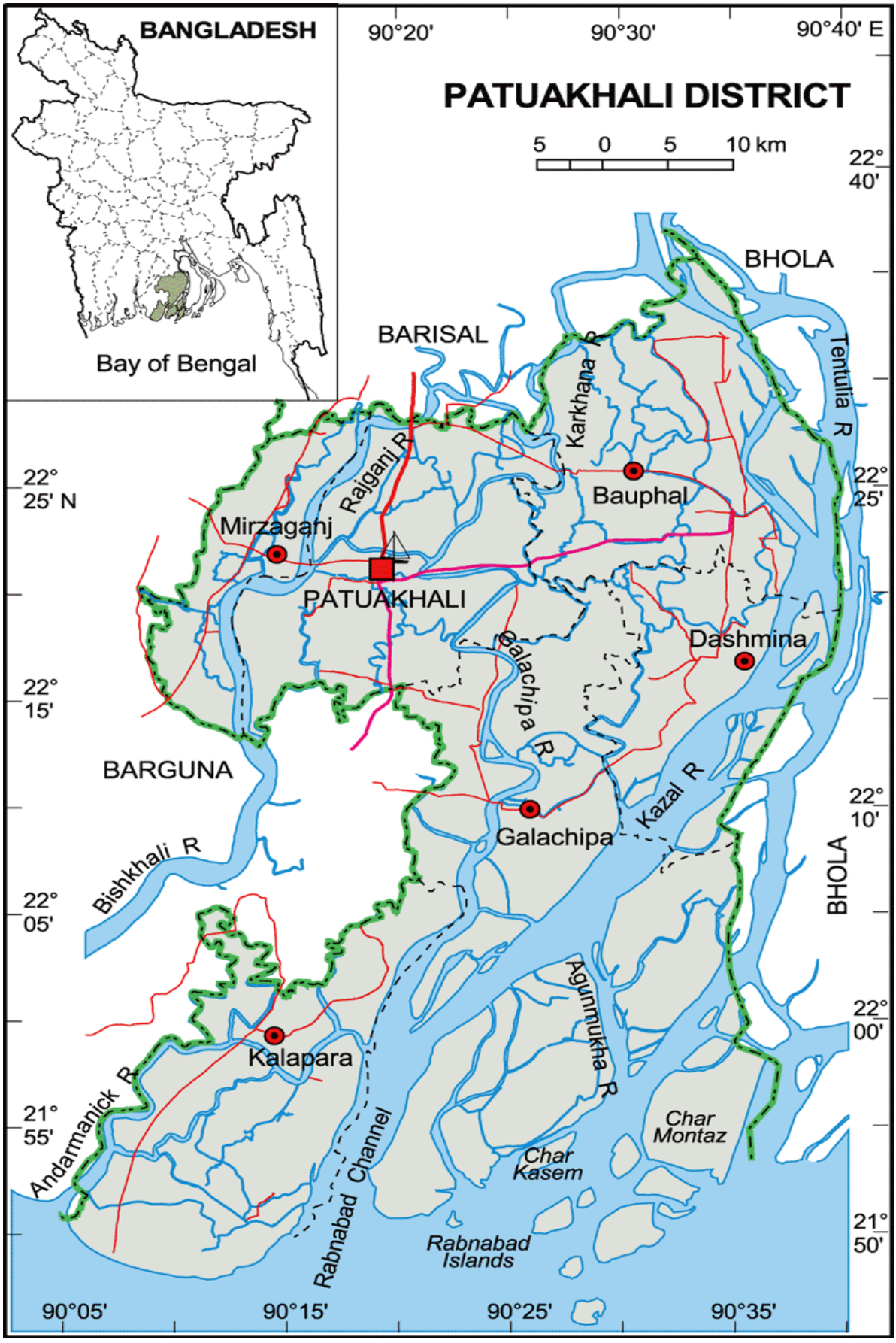


Figure 3.1 Map of Patuakhali District showing Kalapara Upazila

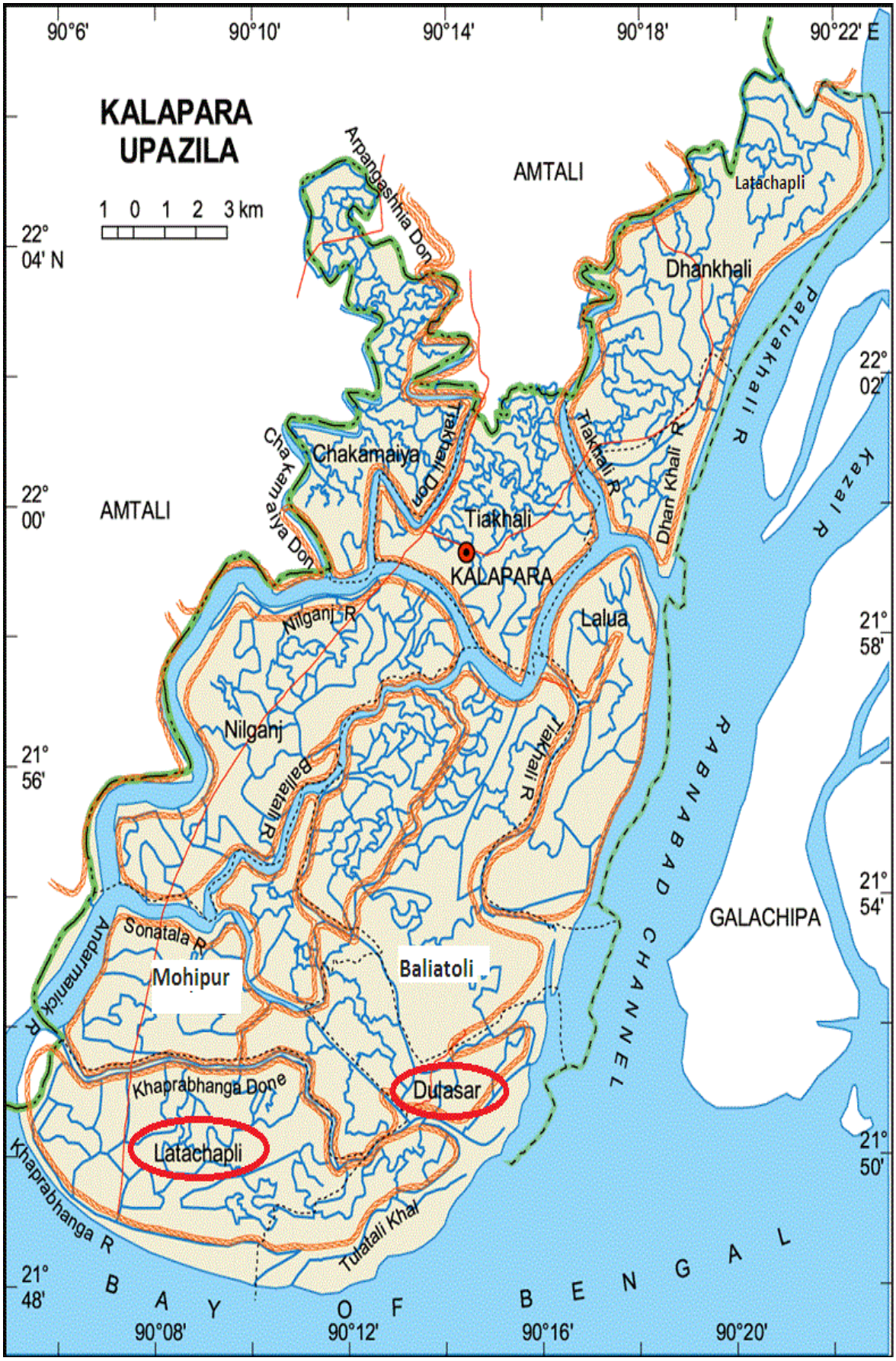


Figure 3.2 Map showing study area in Kalapara Upazila

3.3 Variables of the study

In a descriptive social research, selection and measurement of the variable is a momentous task. An organized research usually contains at least two identical elements viz. independent and dependent variable. Variables are important for social research on which the statistical analysis was done by obtained score on these variables. The following 8 (Eight) characteristics of farmers were considered as independent variables in this study and these are:

i. Age;
ii. Educational background;
iii. Effective farm size;
iv. Farming experience;
v. Annual family income;
vi. Training experience;
vii. Agricultural extension contact; and
viii. Farmer's category based on their innovativeness

In the study the dependent variable was **Farmers' extent of adaptation strategies towards salinity effects in agriculture.**

3.3.1 Measurement of independent variables

3.3.1.1 Age

Age of the respondent farmers was measured by the period of time from her/his birth to the time of conducting interview. It was measured in terms of actual year(s) on the basis of their response. A score of one (01) was assigned for each year. For example, if a farmer age was 40 years then her/his age score was assigned as 40.

3.3.1.2 Educational background

The educational background of a respondent was measured on the basis of her/his year(s) of schooling completed in any educational institute, which was measured by her/his response. A score of one (01) was given for each complete year of schooling.

For example, if a respondent passed class Five (V) his education score was given as 05. If a respondent passed the final examination of class IX, his score was taken as 09. If a respondent took non-formal education then her/his education score was compared with equivalent to formal education score. A score of 0.5 was given to that respondent who could sign her/his name only. A score of zero (0) was assigned to the illiterate respondents who cannot read and write. The educational background was categorized into following level:

Category	Score
Illiterate	0
Can sign only	.5
Primary level	1-5
Secondary level	6-10
Higher Secondary level	11-12
Above Higher secondary	Above 12

3.3.1.3 Effective farm size

The term related to the hectare of land owned by a respondent on which she/he carried out her/his farming activities, the area being estimated in terms of full benefit to the farmers. A farmer was considered to have full benefit from cultivated area either owned by her/him or got lease from others and obtain half benefit from the area which was either cultivated by him on *borga* (share cropping basis) or given to others for cultivation on *borga*. The Effective farm size was measured for each respondent in terms of hectare by using the following formula:

$$\mathbf{EFS = A_1+A_2+A_3+1/2(A_4+A_5)}$$

Where,

EFS =Effective farm size

$\mathbf{A_1}$=Homestead area (including pond area)

$\mathbf{A_2}$=Own land under own cultivation

$\mathbf{A_3}$=Land taken on lease from others

$\mathbf{A_4}$=Land given to others as *borga*

$\mathbf{A_5}$=Land taken from others as *borga*

3.3.1.4 Farming experience

Farming experience refers to the experience of a farmer in agricultural works in her/his field or others. It was expressed in terms of year(s). If a farmer has five years experience on farming activities then it was assigned score of 05.

3.3.1.5 Annual family income

Annual family income of a respondent referred to the total earning by her/him and other members of her/his family from agriculture, livestock, poultry, fisheries, and other sources (service, business, daily wages by working, etc.) during a year. It was expressed in Taka. In measuring this variable, total earning of an individual respondent was converted into score. A score of one (01) was given for every one (01) thousand ('000') taka.

3.3.1.6 Training experience

Training experience refers to the extent of participation of the farmers' to any kind of agricultural training program related to salinity effects and its adaptation offered by different organizations and agencies up to the time of interview. Score (01) was given for each day of training. If a respondent took training for 3 days, she/he got a score of 03.

3.3.1.7 Agricultural extension contact

Agricultural extension contact of a respondent was measured by respondent's extent of contact with communication channels used by extension services. The degrees of contact was 'regularly', 'frequently', 'occasionally', 'rarely', 'not at all' against suitable scores are assigned as 4, 3, 2, 1 and 0 respectively.

Degree of contact	Score
Regularly	4
Frequently	3
Occasionally	2
Rarely	1
Not at all	0

If the number of communication channels are ten (10), then an individual respondent can obtain highest score 40 and minimum score 0 (zero).

3.3.1.8 Farmer's category based on their innovativeness

Rogers (1983), defined innovativeness as 'the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of the social system'. It was measured on the basis of some criteria of a farmer and categorized as follows:

Innovator (Have interest to take risk, have the highest social status, have financial liquidity, adopt an innovation within 1year of hearing);

Early adopter (Highest degree of opinion leadership, higher social status, financial liquidity, advanced education, adopt an innovation within >1 to 2 years of hearing);

Early majority (Adopt an innovation after innovator and early adopter, have above average social status, seldom hold position of opinion leadership, adopt an innovation within >2 to 3 years of hearing);

Late majority (Have below average social status, little financial liquidity, little opinion leadership, adopt an innovation within >3 to 4 years of hearing);

Laggards (Show little to no opinion leadership, tend to be concentrated on tradition, lowest social status, and lowest financial liquidity, adopt an innovation > 4 years of hearing).

Scores assigned for a respondent farmer in respect of innovativeness are given below:

Category	Scores
Innovator	5
Early adopter	4
Early majority	3
Late majority	2
Laggards	1

3.3.2 Measurement of dependent variable

The dependent variable of the study was farmers' extent of adaptation strategies towards salinity effects in agriculture. The variable was measured on the basis of 10 (ten) adaptation strategies followed against salinity effects in agriculture by the farmers. The strategies are stated below:

i. Cultivating short duration crops
ii. Practicing crop diversification
iii. Homestead cultivation
iv. Practicing intercropping
v. Use of saline tolerant varieties
vi. Zero tillage
vii. Mulching
viii. Alternative irrigation system
ix. Reducing salinity by organic or chemical method
x. Making embankment around land to control saline water intrusion

Every farmer was asked about mentioned each strategy whether she/he followed or not as adaptation strategies in her/his farm level activities while she/he faced salinity problem to overcome from its bad effects. Adaptation score was made in percentage based on her/his response (yes/no) against each strategy. Score one (01) was given to

‘yes’ and zero (0) was given to ‘no’ response.

In this study Ten (10) strategies were selected by pre survey technique and if one respondent follow or adapt 1 (one) strategies in her/his farm level activities then her/his adaptation score would be

$$\frac{1}{10} \times 100 = 10\%$$

3.4 Validity and Reliability of the data collection instruments

3.4.1 Validity measures

Validity refers to whether the means of measurement are accurate and whether they are actually measuring what they are intended to measure (Caramines and Zeller, 1979). The procedures for maintaining internal and external validity of the study were presented in Table 3.2 following Towhid, 2014.

Table 3.2 Validity measures of the data collection instruments

Types of validity	Measures undertaken
A. Internal validity	
1. Face validity	In order to ensure the face validity of the research instruments, the researcher consulted with experts, fellow colleagues and local extension agents who were involved in similar kind of work. The researcher read sufficient literature in order to select and conceptualize variables and used appropriate scaling techniques.

2. Content validity	The instruments developed for this research, especially the interview schedule prepared for survey, were judged by the concerned supervisors and local extension agents in the study area who provided valuable feedback on the instrument for necessary modification as well as conceptualization of selected variables and items.
B. External validity	
Ecological validity	The findings, conclusions and recommendations of this research were applicable to similar area in Bangladesh at large which fulfill the ecological validity criteria.

3.4.2 Reliability measures

The extent to which results are consistent over time and an accurate representation of the total population under study is referred to as reliability and if the results of a study can be reproduced under a similar methodology, then the research instrument is considered to be reliable (Joppe, 2000).

A pre-test was done with 20 respondents before going to final data collection. After that, the data were analyzed to test the reliability of the instrument and the schedule was finally prepared with necessary correction by considering basis of reliability.

3.5 Data collection

Data were collected by the researcher himself through face to face interview. With the help of Upazila Agricultural Officer and his field staffs, input dealers (Seed, fertilizer and pesticide) a reliable farmers list were collected. The researcher made a rapport to respondent for collecting authentic data keeping the objectives of survey in his mind.

A well-structured interview schedule (Questionnaire) was developed based on the objectives of the study for collecting information. The schedule contained direct and

simple with open form and closed form questions. The interview schedule was pre-tested with 20 farmers by the researcher. The pre-test facilitated the researcher to identify faulty and unnecessary questions in the draft schedule and hence, necessary additions, corrections and modifications were made in the schedule on the basis of the pre-test results. A copy of the interview schedule was presented as Appendix- A.

3.6 Data processing

After completion of data collection data were coded, compiled and tabulated, categorized according to the objectives of the study. The entire individual respondent's data were transferred into a master sheet for facilitating the required analysis. Local units were converted into standard units. In case of qualitative data, appropriate scoring technique was followed to convert the data into quantitative form.

3.7 Statistical analysis

The statistical measures such as range, means, standard deviation, number and percentage distribution were used to describe the variables. Multiple linear regression analysis was done for explore contributing relationship between variables. Statistical package for social sciences (SPSS) version 24 was used for analysis of data. Five percent (0.05) level of probability was considered as the basis for rejecting any null hypothesis.

3.8 Statement of hypothesis

According to Kerlinger, (1973) a hypothesis is an inferential statement of the relation between 2 or more variables. In statistical hypothesis testing, two hypotheses are compared and these are research hypothesis and the null hypothesis.

To find out relationship between variables, a researcher first formulates research hypothesis which states anticipated relationships between variables.

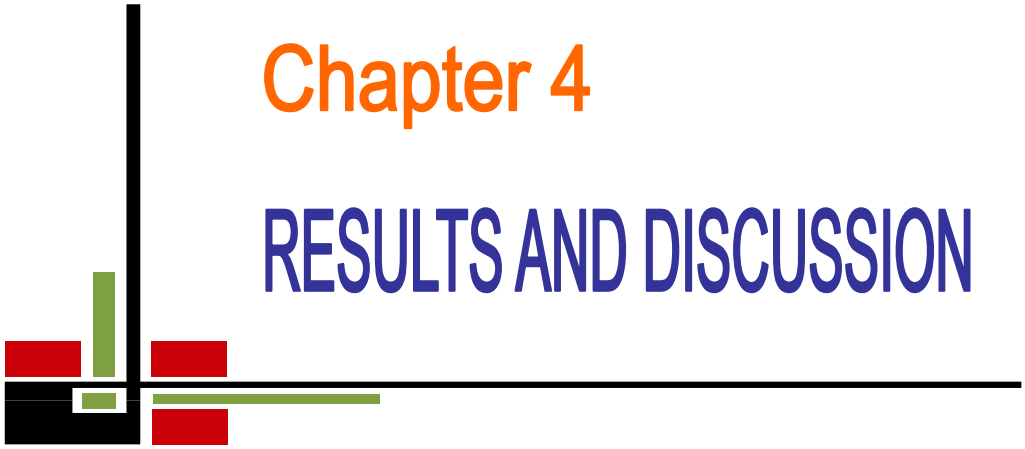
3.8.1 Research hypothesis

Each of the 8 (Eight) selected characteristics (age, educational background, effective farm size, farming experience, annual family income, training experience, agricultural extension contact, farmer's category based on their innovativeness) of the farmers have contributing relationship with their extent of adaptation strategies towards salinity effects in agriculture.

3.8.2 Null hypothesis

A null hypothesis states that there is no relationship between the concerned variables. The following null hypotheses were formulated to explore the relationship.

Each of the 8 (Eight) selected characteristics (age, educational background, effective farm size, farming experience, annual family income, training experience, agricultural extension contact, farmer's category based on their innovativeness) of the farmers have no contributing relationship with their extent of adaptation strategies towards salinity effects in agriculture.



Chapter 4

RESULTS AND DISCUSSION

CHAPTER 4
RESULTS AND DISCUSSION

The findings of the study and their interpretation have been presented in this chapter. Procedures of using these data for the measurement needed some discussion for clear understanding. Necessary explanation has also been made showing possible and logical basis of the findings whenever necessary. This chapter is presented in three sections according to the objectives of the study. This chapter is arranged in the following section:

- ❖ The first section deals with the selected characteristics for describe the socio-economic profile of the salinity affected farmers;
- ❖ The second section deals with the extent of adaptation strategies towards salinity effects in agriculture; and
- ❖ The third section describes the contributing relationship between the selected characteristics of the salinity affected farmers and their extent of adaptation strategies towards salinity effects in agriculture.

4.1 Socio-economic profile of farmers

Eight (08) characteristics of the farmers were selected for the study which are:

- Age
- Educational background
- Effective farm size,
- Farming experience
- Annual family income
- Training experience
- Agricultural extension contact
- Farmer's category based on their innovativeness

These characteristics of the farmers are described in this section which focused study as farmers' socio-economic profile. The salient features of the characteristics of farmers were shown in Table 4.1.

Table 4.1 Salient features of the selected characteristics of farmers

SL. No.	Characteristics	Unit of measurement	Possible range	Observed range	Mean	Standard Deviation
1	Age	Year	unknown	25-56	42.09	6.57
2	Educational background	Level of schooling	unknown	0.5-10	3.55	2.63
3	Effective farm size	Hectare	unknown	0.06-4.65	1.07	1.05
4	Farming experience	No. of years	unknown	8-40	24.54	6.84
5	Annual family income	‘000’Taka	unknown	40-420	130.28	90.53
6	Training experience	No. of days experience	unknown	0-12	3.65	2.46
7	Agricultural extension contact	Score	0-40	7-30	16.21	5.88
8	Farmer’s category based on their innovativeness	Score	1-5	1-5	2.28	1.17

4.1.1 Age

On the basis of their age, farmers were classified into three categories considering National Youth Policy: “young” (18 to 35 years), “middle aged” (36 - 50 years) and “old” (above 50 years). The observed age of the farmers ranged from 25 to 56 years, the average being 42.09 and the standard deviation was 6.57. The distribution of the farmers according to their age was shown in Table 4.2.

Table 4.2 Distribution of farmers according to their age

Categories (Years)	Number	Percent	Mean	Standard deviation
Young aged (18 to 35)	23	17.6	42.09	6.57
Middle aged (36-50)	97	74		
Old aged (above 50)	11	8.4		
Total	131	100		

It was found that 17.6 percent of the farmers were young aged, 74 percent were middle aged and the rest 8.4 percent were old aged. Here data revealed that most of the farmers in the study area were middle aged. It might be due to the middle aged farmers comparatively give more preference to agricultural activities than the young old aged farmers as they had more good health.

4.1.2 Educational background

Educational background of the farmers were classified into four categories namely can sign only (0.5), primary level (1-5), secondary level (6-10) considering their level of schooling. The educational background of the farmers ranged from 0.5 to

10 with mean 3.55 and the standard deviation was 2.63.

The distribution of the farmers according to their educational background is shown in Table 4.3.

Table 4.3 Distribution of farmers according to their educational background

Categories	Number	Percent	Mean	Standard deviation
Can sign only (0.5)	19	14.5	3.55	2.63
Primary level (1-5)	88	67.2		
Secondary level (6-10)	24	18.3		
Total	131	100		

It was found that 14.5 percent of the farmers were under can sign only category, 67.2 percent farmers were in primary level category and the rest 18.3 percent were in secondary level category. Data showed that most of the farmers in the study area had primary education. Highest portion (81.7 percent) farmers in this study area had low level education. It seemed to be the majority of the farmers of the study area could not reach the above level from primary level due to various socio-economic problems. It should be enhance education at higher level among the farmers which helps the farmer to broaden their outlook and expand mental horizon by helping them to develop favorable attitude.

4.1.3 Effective farm size

On the basis of the respondent's effective farm size they were classified into four categories as suggested by DAE (1999): Marginal (land ownership up to 0.20

hectare), Small (land ownership 0.201-1 hectare)", Medium (land ownership 1.01-3 hectares) and Large (land ownership above 3 hectares). The effective farm size of the farmers ranged from 0.06 to 4.65 hectares with an average 1.07 and the standard deviation was 1.05. The distribution of the farmers according to their effective farm size was shown in Table 4.4.

Table 4.4 Distribution of farmers according to their effective farm size

Categories (hectare)	Number	Percent	Mean	Standard deviation
Marginal (up to 0.20)	26	19.8	1.08	1.07
Small (0.201-1)	54	41.2		
Medium (1.01-3)	43	32.8		
Large (above 3)	8	6.1		
Total	131	100		

It was found that majority of the farmers had small farm size (41.2 percent) where 19.8 percent marginal and 32.8 percent of them had medium farm size where 6.1 percent had large farm size. Data revealed that the highest portion (74 percent) of the farmers had small to medium farm size. It might be the farmers in the study area were facing land erosion due to tidal surges which resulting from cyclone, flood that was appeared comparatively every year in coastal area.

4.1.4 Farming experience

On the basis of farming experience farmers were classified into three categories: 'Low farming experience' (experience up to 18 years), 'Medium farming

experience' (experience 19 -30 years), and 'High farming experience' (experience above 30 years) considering Mean ±1sd. The farming experience of the farmers ranged from 8 to 40 years with an average 24.54 and the standard deviation was 6.84. The distribution of the farmers according to their farming experience was shown in Table 4.5.

Table 4.5 Distribution of farmers according to their farming experience

Categories (Years)	Number	Percent	Mean	Standard deviation
Low farming experience (experience up to 18)	26	19.8	24.54	6.84
Medium farming experience (experience 19-30)	85	64.9		
High farming experience (experience above 30)	20	15.3		
Total	131	100		

Data present in Table 4.5 shows that majority of the farmers (64.9 percent) had medium farming experience compared to low farming experience 19.8 percent of farmers. The rest 15.3 percent farmers had high farming experience. This means highest portion (84.7 percent) of farmers had low to medium farming experience. It was assumed that, farmers in the study area were engaged in farming activities for a long time. It might be that, farmers in the study area depended mostly on agriculture and they were engaged long time in farming activities.

4.1.5 Annual family income

On the basis of their observed annual family income scores farmers were classified into three categories; 'low income' (up to Taka 140 thousands), 'medium income'

(Taka 141-280 thousands) and 'high income' (above Taka 280 thousands). Annual family income of the farmers ranged from Taka 40 thousands to 420 thousands, the mean being 130.28 and standard deviation 90.53. Distribution of farmers according to their annual family income was shown in Table 4.6.

Table 4.6 Distribution of farmers according to their annual family income

Categories ('000' Taka)	Number	Percent	Mean	Standard deviation
Low income (up to 140)	82	62.6	130.28	90.53
Medium income (141-280)	41	31.3		
High income (above 280)	8	6.1		
Total	131	100		

Table 4.6 shows that majority (62.6 percent) of the farmers were in low income category while 6.1 percent were in high income category and 31.3 percent were in medium income category. Highest portion of farmers (93.9 percent) were in low to medium income category. It might be the farmers were low to medium income because of they could not cultivate crops without difficulty due to salinity effects which causes low production in agriculture. A farmer with low income could not invest large amount of money in farming activities also another hindering factors to their income development.

4.1.6 Training experience

On the basis of their training experience scores farmers were classified into four categories: 'No training experience (0 day experience)', Low training experience (1-

3 days experience)', 'Medium training experience (4-8 days experience)', and 'High training experience (above 8 days experience). Training experience of the farmers was ranged from 0 days to 12 days, the mean being 3.65 and standard deviation was 2.46. Distribution of farmers on the basis of their obtained training score was shown in Table 4.7.

Table 4.7 Distribution of the farmers according to their training experience

Categories	Number	Percent	Mean	Standard deviation
No training experience (0 day experience)	6	4.6	3.65	2.46
Low training experience (1-3 days experience)	71	54.2		
Medium training experience (4-8 days experience)	48	36.6		
High training experience (above 8 days experience)	6	4.6		
Total	131	100		

Data furnished that a vast portion of the respondents (54.2 percent) had low training experience while 4.6 percent had high training experience. Data also showed that 36.6 percent had medium training experience and 4.6 percent had no training experience. It seemed to be the training experience of farmers was low because of institutional co-operation, farmer's lack of consciousness or proper motivation towards training. Training enhances farmer's knowledge, attitude, and perception and enables to show skill which is important to make positive decision to adapt against effects of climatic variation. So, it should be increased training experience among farmers by offering them training on current issue such as salinity effects and its adaptation.

4.1.7 Agricultural extension contact

On the basis of respondent's agricultural extension contact scores they were classified into four categories: 'low agricultural extension contact (score up to 11), 'medium agricultural extension contact (score 12-21)', 'high agricultural extension contact (score above 21)' considering Mean ±1sd. Agricultural extension contact score of the farmers ranged from 7 to 30 against the possible ranged from 0 to 40 while mean being 16.21 and standard deviation was 5.88 respectively. Distribution of farmers according to their agricultural extension contact was shown in Table 4.8.

Table 4.8 Distribution of the farmers according to their agricultural extension contact

Categories (score)	Number	Percent	Mean	Standard deviation
Low agricultural extension contact (up to 11)	41	31.3	16.21	5.88
Medium agricultural extension contact (12-21)	63	48.1		
High agricultural extension contact (above 21)	27	20.6		
Total	131	100		

Data revealed that about 48.1 percent famers had medium extension contact while 31.3 percent farmers had low extension contact and 20.5 percent farmers had high extension contact. Highest portion of farmers (79.4 percent) possess low to medium agricultural extension contact with various communication sources. It might be the farmers in the study area had low contact due to inappropriate communication. Though agricultural extension contact was gradually increased to medium category. So, it should be increased to high category by proper policy implications by both GO and NGO in the area.

4.1.8 Farmer's category based on their innovativeness

On the basis of their categorical score based on innovativeness the farmers were classified into five categories were: Innovator, b) Early adopter, c) Early majority, d) Late majority, and e) Laggards.

The observed range of farmers' category was 1 to 5 with mean and standard deviation 2.28 and 1.17 respectively. Distribution of the farmer's category based on innovativeness was shown on Table 4.9

Table 4.9 Distribution of the farmer's category based on their innovativeness

Categories (score)	Number	Percent	Mean	Standard deviation
Innovator (5)	8	6.1	2.28	1.17
Early Adopter (4)	9	6.9		
Early Majority (3)	37	28.2		
Late Majority (2)	35	26.7		
Laggards (1)	42	32.1		
Total	131	100		

Data shown on Table 4.8 indicate that the majority of the respondent (32.1 percent) were 'Laggards' while 6.1 percent farmers were 'Innovator' , 6.9 percent were 'Early adopter', 28.2 percent were 'Early majority' and 21.4 percent were 'Late majority' category. It seemed to be that the highest portion farmers were laggards for their average below social status, little financial liquidity and they were adopted an innovation more than above 4 years of hearing. So, it should be increased by proper financial and technical support and motivation to them.

4.2 Farmers' extent of adaptation strategies towards salinity effects in agriculture

Farmers' adaptation strategies was categorized into three categories: low adaptation strategies (score up to 41), medium adaptation strategies (score 42-79) and high adaptation strategies (score above 79) considering Mean ±1sd. Data revealed that the observed range of adaptation of farmers was 40 to 90 percent against the possible range of 0 to 100 percent with mean 60.46 and standard deviation was 19.45.

Table 4.10 Distribution of farmers according to their adaptation score

Adaptation (Score)	Number	Percent	Mean	Standard deviation
Low level adaptation (Up to 41)	31	23.7	60.46	19.4
Medium level adaptation (42-79)	63	48.1		
High level adaptation (above 79)	37	28.2		

It was showed that majority of the farmers (48.1 percent) had medium level adaptation while 23.7 percent of farmers had low level adaptation and 28.2 percent had high level adaptation. Data also showed that the highest portion of farmers (76.3 percent) had medium to high level adaptation. It was assumed that maximum farmers were taken adaptive strategies against salinity effects for maximize their production. Majority portion of them had medium level adaptation which indicates that they had been facing obstacles to make decision to adapt strategies. For clear understanding, the extent of adaptation was showed through a pie chart Figure 4.1.

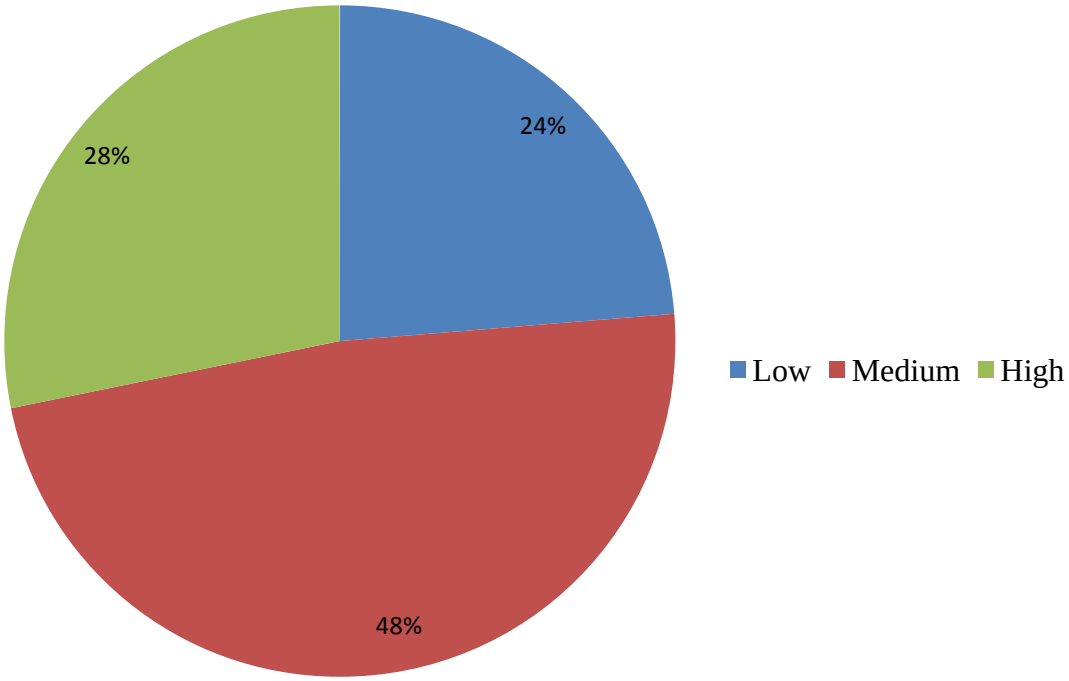


Figure 4.1 Pie chart showing farmers' extent of adaptation strategies towards salinity effects in agriculture

In the pie chart it showed that the majority portion of the respondent had medium level adaptation towards salinity effects in agriculture.

4.3 Contributing relationship between selected characteristics of farmers and their extent of adaptation strategies towards salinity effects in agriculture

This section deals with the findings exploring the contributing relationship between the selected characteristics of farmers and their extent of adaptation towards salinity effects in agriculture. The contributing factors were age, educational background, effective farm size, farming experience, annual family income, training experience, agricultural extension contact, and farmer's category based on their innovativeness. The main focus of the study was, "Farmers' extent of adaptation strategies towards salinity effects in agriculture.

Assessing contributing relationship between selected characteristics of farmers and their extent of adaptation strategies towards salinity effects in agriculture, a multiple linear regression analysis was done. The multiple linear regressions results have been shown in the Table 4.11.

Table 4.11 Multiple linear regression coefficients of contributing variables of farmers' extent of adaptation strategies towards salinity effects in agriculture

Dependent variable	Independent variables	B	*p*	R^2	Adj. R^2	F	*p*
Farmers' extent of adaptation strategies towards salinity effects in agriculture	Age	.342	.001**	.763	.747	49.09	.000**
	Educational background	.153	.039*				
	Effective farm size	-.153	.478				
	Farming experience	-.214	.033*				
	Annual family income	.060	.788				
	Training experience	.046	.580				
	Agricultural extension contact	.297	.007**				
	Farmer's category based on their innovativeness	.480	.000**				

** Significant at $p<0.01$

* Significant at $p<0.05$

The null hypothesis was there is no contributing relationship between selected characteristics of farmers (age, educational background, effective farm size, farming experience, annual family income, training experience, agricultural extension contact and farmer's category based on their innovativeness) and farmers' extent of adaptation strategies towards salinity effects in agriculture.

The findings of the study revealed that, the eight (08) characteristics of the farmers were taken as independent variables together were effective in predicting farmers' extent of adaptation strategies towards salinity effects in agriculture. The observed F ratio was significant at 0.01 level of significance which was an indication that the combination of the independent variables in farmer's adaptation was effective. 76.3 percent (%). (R^2 =.763) of the variation in the respondents' adaptation can be attributed to their age, educational background, effective farm size, farming experience, annual family income, training experience, agricultural extension contact and farmers' category based on their innovativeness making contribution on farmers' extent of adaptation strategies towards salinity effects.

However, each predictor may expound some of the variance in respondents' adaptation conditions simply by chance. The adjusted R-square value penalizes the addition of external predictors in the model, but values of .747 still show that the variance in farmers' extent of adaptation strategies towards salinity effects in agriculture can be attributed to the predictor variables rather than by chance and the F value indicate that the model was significant (p<0.01) .

From Table 4.11 it was observed that age, educational background, farming experience, agricultural extension contact and farmer's category based on innovativeness of farmers had significant contribution on Farmers' extent of adaptation strategies towards salinity effects in agriculture. Data also showed that here age, agricultural extension contact and farmers' category based on their innovativeness (innovator, early adopter, early majority, late majority and laggards) had most significant contribution at 1% (p<0.01) level of significance on adaptation of farmers. It was also showed that farmer's farming experience, educational background had also significant contribution at (p<0.05) 5% level of significance on

their extent of adaptation strategies towards salinity effects in agriculture.

In summary, the model suggest that the respective authority should consider farmer's age, educational background, farming experience, their agricultural extension contact and farmer's category based on their innovativeness when made policy for their extent of adaptation strategies towards salinity effects in agriculture to be improved.

Data furnished from Table 4.11 that, farmer's age was positively influenced on farmer's extent of adaptation strategies and it could be said that young and middle aged farmers were given more preference to agricultural activities than the old aged. Data also showed that, the respondent farmers had most significant influence ($p<0.01$) on farmers' extent of adaptation strategies towards salinity effects in agriculture. The study was found that most of the farmers in study area were middle aged. It might be that the middle aged farmers were more conscious about farming than young and old aged farmers for their comparative good health condition.

Farmer's category had positive influence on farmers' extent of adaptation strategies towards salinity effects in agriculture. It had most significant (significant at $p<0.01$) contribution on their adaptation. It might be the innovators had more adaptive capacity due to their highest financial liquidity, had interest to take risk and they possess fast (adopted an innovation within 1 year of hearing) and high level adaptation. In the study majority of famers was early adopter who had also greater impact on adaptation. It seemed to be the laggards showed lengthy in decision of adaptation but they took decision when the practice became older ones however they receive innovational information from peer ones but later she/he showed few adaptation which had also contribution to adaptation extent.

Data revealed from Table 4.11 showed that, farmer's agricultural extension contact positively influenced on farmers' extent of adaptation strategies towards salinity effects in agriculture. It had most significant (significant at $p<0.01$) contribution on their adaptation. It might be that, communication with extension media enhances farmers' knowledge, attitudes, perception to innovation which was suitable for her/his problem to be solved. Farmer's agricultural extension contact was made

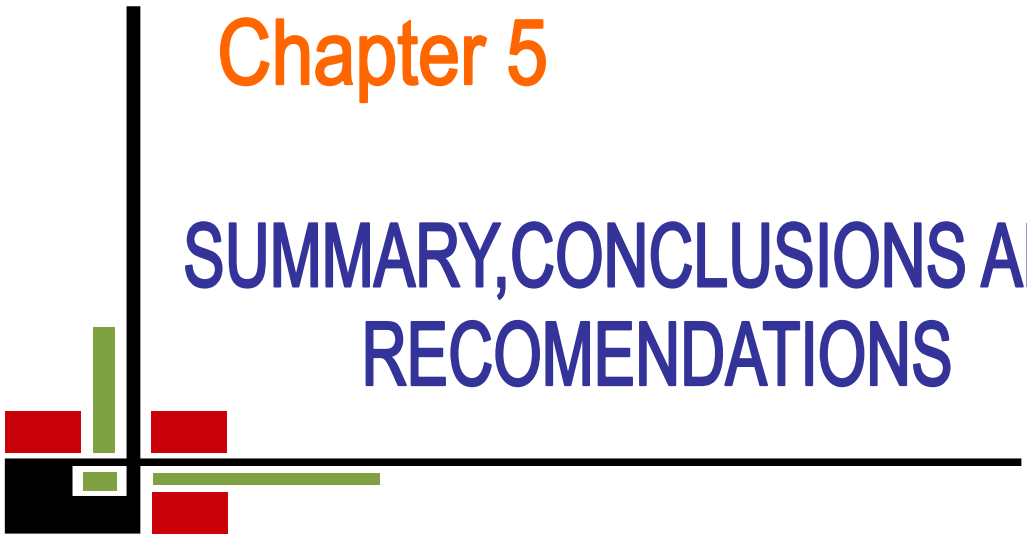
her/him motivated towards adaptation. So, it could be said that, more agricultural extension contact of farmers were enhanced their adaptation.

Farming experience showed negative influence on adaptation. It also found that the farming experience of farmers had significant (significant at $p<0.05$) contribution on their extent of adaptation strategies towards salinity effects in agriculture. It could be said that sometimes new technologies were not accepted by high experienced farmer compared to traditional ones and they might faced obstacles sometimes to take new decision for going outside from traditional practices considering benefit.

Data revealed from Table 4.11 showed that, farmer's educational background was positively influenced on their adaptation. Farmer's educational background had significant (significant at $p<0.05$) contribution on their extent of adaptation strategies towards salinity effects in agriculture. It seemed to be the educated farmers had more knowledge, a greater ability to understand and respond to anticipated changes, were better able to forecast future scenarios and, overall, have greater access to information and opportunities than others, which might encourage adaptation.

Chapter 5

SUMMARY,CONCLUSIONS AND RECOMENDATIONS



CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The study was undertaken with the objectives: i) to describe socio economic profile of the salinity affected farmers; ii) to determine farmer's extent of adaptation strategies towards salinity effects in agriculture; and iii) to explore contributing relationship between the selected characteristics of the salinity affected farmers and their extent of adaptation strategies towards salinity effects in agriculture. In this chapter, the first section deals with summary of the findings; the section deals with conclusions and the third section deals with recommendations.

5.1 Summary of findings

5.1.1 Farmers' extent of adaptation strategies towards salinity effects in agriculture

Farmers' extent of adaptation strategies were categorized into three categories: low level adaptation (score up to 41), medium level adaptation (score 42-79) and high level adaptation (score above 79) considering Mean ±1sd. Data also showed that the highest portion of farmers (76.3 percent) had medium to high adaptation strategies towards salinity effects. The extent of adaptation strategies of farmers was 20 to 90 percent with mean being 60.46 and standard deviation was 19.45 while possible range was 0 to 100 percent.

5.1.2 Socio- economic profile of the salinity affected farmers

Age of the farmers' ranged from 25 to 56 years, the average being 42.09 and the standard deviation was 6.57. It was found that 17.6 percent of the farmers were young aged, 74 percent were middle aged and the rest 8.4 percent were old aged. Here data revealed that most of the farmers in the study area were middle aged.

Educational background of farmers' was ranged from 0.5 to 10 with an average 3.55 and the standard deviation was 2.63. It was found that 14.5 percent of the farmers were under can sign only category, 67.2 percent farmers were in primary level category and the rest 18.3 percent were in secondary level category. Data showed

that most of the farmers in the study area had primary education. Highest portion (81.7 percent) farmers in this study area had low level education.

Effective farm size of the farmers' was ranged from 0.06 to 4.65 hectares with an average 1.07 and the standard deviation was 1.05. It was found that majority of the farmers had small farm size (41.2 percent) where 19.8 percent marginal and 32.8 percent of them had medium farm size where 6.1 percent had large farm size. Data revealed that the highest portion (74 percent) of the farmers had small to medium farm size.

Farming experience of the farmers' ranged from 8 to 40 years with an average 24.54 and the standard deviation was 6.84 and it was found that majority of the farmers (64.9 percent) had medium farming experience compared to low farming experience 19.8 percent of farmers and the rest 15.3 percent farmers had high farming experience. This means highest portion (84.7 percent) of farmers had low to medium farming experience.

Annual family income of the farmers' ranged from Taka 40 thousands to 420 thousands, the mean being 130.28 and standard deviation 90.53 and it was found that that majority (62.6 percent) of the farmers were in low income category while 6.1 percent were in high income category and 31.3 percent were in medium income category. Highest portion of farmers (93.9 percent) were in low to medium income category.

Training experience of farmers' was ranged from 0 days to 12 days, the mean being 3.65 and standard deviation was 2.46. It was found that a vast portion of the respondents (54.2 percent) had low training experience while 4.6 percent had high training experience. Data also showed that 36.6 percent had medium training experience and 4.6 percent had no training experience.

Agricultural extension contact of the farmer's ranged from 7 to 30 against possible range was 0 to 40 with mean 16.21 and standard deviation was 5.88. It was found that about 48.1 percent famers had medium extension contact while 31.3 percent farmers had low extension contact and 20.5 percent farmers had high extension

contact. Highest portion of the farmers (79.4 percent) possess low to medium agricultural extension contact.

Farmer's category based on their innovativeness was ranged from 1 to 5 with mean and standard deviation 2.28 and 1.17 respectively. It was that majority of the farmers (32.1 percent) were laggards while 6.1 percent farmers were innovator, 6.9 percent famers were early adopter, 28.2 percent farmers were early majority, and 21.4 percent farmers were late majority category.

5.1.3 Significant factors on the extent of adaptation strategies of farmers

Farmers' age was positively influenced on their extent of adaptation strategies towards salinity effects in agriculture and it had most significant influence ($p<0.01$) on their adaptation strategies towards salinity effects in agriculture.

Farmer's category had positive influence on farmers' extent of adaptation strategies towards salinity effects in agriculture. It had most significant (significant at $p<0.01$) contribution on their adaptation.

Agricultural extension contact of farmers positively influenced on farmer's extent of adaptation strategies towards salinity effects in agriculture. It had most significant (significant at $p<0.01$) contribution on their adaptation.

Farming experience showed negative influence on adaptation. It also found that the farming experience of farmers had significant (significant at $p<0.05$) contribution on their extent of adaptation strategies towards salinity effects in agriculture.

Farmers' educational background was positively influenced on their adaptation and had significant (significant at $p<0.05$) contribution on their extent of adaptation strategies towards salinity effects in agriculture.

5.2 Conclusions

Age of the farmers had most significant contribution on their extent of adaptation strategies towards salinity effects in agriculture. So it could be concluded that age played important role to farmers' extent of adaptation strategies towards salinity effects in agriculture.

Farmer's category based on their innovativeness had most significant contribution to their extent of adaption strategies towards salinity effects in agriculture. So, it could be concluded that farmer's category (innovator, early adopter, early majority, late majority, and laggards) could play significant role in their extent of adaptation strategies towards salinity effects in agriculture.

Agricultural extension contact of the farmers had also most significant contribution on their extent of adaptation strategies. Extension contact increase more outlook and inspiration. So, it could be concluded that high extension contact of a farmer was increased tendency to adapt strategies towards salinity effects in agriculture.

Farming experience of the farmers had significant influence on their extent of adaptation strategies. So, it could be concluded that farming experience of the farmers were important factor on their adaptation but sometimes more experienced farmers remain in traditional believes and did not take new practice as adaptation strategies towards salinity effects in agriculture.

Educational background of farmers was also influencing factor on their extent of adaptation strategies towards salinity effects in agriculture. It could be concluded that education was enhanced knowledge and positive attitude of a farmer and it could make her/him more enthusiastic to justify the quality and utility of the new farm practice and fully aware of prevailing situation.

5.3 Recommendations

5.3.1 Recommendations for policy implications

i. Majority of the farmers of the study area were found to have medium level adaptation strategies towards salinity effects in agriculture. Salinity is an alarming problem in coastal agriculture and for sustainable production farmers need to be high adapted against it. For adaptation towards salinity effects in agriculture, farmers need to be motivated towards adaptation in an appropriate way. Experts GO and NGO representatives in collaboration with the farmers can play a key role in this regard and their knowledge and communication exposure should be improved through individual and group discussions.

ii. Agricultural extension contact increases farmers' diversified knowledge and make them able to cope with adverse situations. So, policies should be taken to engage farmer's with diversified extension media to broaden their outlook and to develop positive attitude on their adaptation. GOs and NGOs can also play a vital role in this regard.

iii. Innovativeness of farmers should be increased by proper guidance and inspiration by continuing training program, result and method demonstration, group discussions etc. and can be increased farmer innovativeness status as high innovative category.

iv. Education is the spine of all development activities. Low education status of farmer might make them unable to take necessary steps in adapting different farming practices. So, educational opportunity for all aged farmers should be increased in different ways among the farmers for make them enthusiastic.

v. Farmers' farming experience may play vital role on adaptation and their experience can be good suggestion for policy implications.

5.3.2 Recommendations for further research

i. In the present study only eight (08) independent variables were studied. There were some other important characteristics of the farmers' that could not be included in this study. So, opportunity will remain to study with other important variables.

ii. In this research the author conducted his survey in all category farmers who were affected by salinity. So, further study can be taken with specific farmer group or/and compare among these group.

iii. This study has been conducted to measure the farmers' adaptation strategies towards salinity effects in agriculture, some farming strategies was selected as adaptation strategies that was very confined at farm level. So, further study can be conducted on their off firm activities and other farm practices as adaptation strategies.

iv. Researcher will have opportunity or scope to identify the factors causing hindrance towards adaptation of farming practices by farmers in agriculture.

v. This study was conducted at 8% level of precision of the population. So, further research would be conducted at below 5% level of precision for more authentic findings.

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APPENDICES

APPENDIX- A

Department of Agricultural Extension and Information System

SHER-E-BANGLA AGRICULTURAL UNIVERSITY

DHAKA- 1207

An interview schedule for a research study entitle:

FARMERS' EXTENT OF ADAPTATION STRATEGIES TOWARDS SALINITY EFFECTS IN AGRICULTURE

Serial No…….

Respondent Name:

Village:

Union:

Upazila:

District:

Cell Phone No.:

Please answer the following questions:

1. Age: What is your present age?.....Years

2. Educational background: What is the background of your education?

i. Cannot read or write (Illiterate)…….

ii. Can sign only……..

iii. Have passed class…….

iv. I took …….class equivalent non-formal education

3. Effective farm size:

Please state the following information:

Type of land	Land area	
	Local unit (in decimal, acre, bigha)	Hectare(s)
$\mathbf{A_1}$=Homestead areas (including pond areas)		
$\mathbf{A_2}$=Own land under own cultivation		
$\mathbf{A_3}$=Land taken on lease from others		
$\mathbf{A_4}$ = Land given to others as *borga*		
$\mathbf{A_5}$=Land taken from others as *borga*		
Total Effective farm size: EFS=$A_1+A_2 + A_3 + 1/2\ (A_4 + A_5)$		

4. Farming experience:

How many year(s) you are engaged with farming activities?.....Year(s)

5. Annual family income:

Please state the income of your family income during the last year

i) Agriculture income……Taka

ii) Income from livestock and fisheries……..Taka

iii) Income from Non-agricultural source(s) (service/ labor/ business/ others……..Taka

Total income (i+ii+iii)……Taka

6. Training experience:

Have you participated in any agricultural training program related to salinity effects in agriculture and its adaptation?

Yes……./No……(If Yes, mention the following information)

Sl. No.	Name of training course	Sponsoring Organization	Day (s)
1			
2			
3			
4			

7. Agricultural extension contact:

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

SL. No.	Sources of contact	Extent of participation				
		Regularly	Frequently	Occasionally	Rarely	Not at all
Individual contact						
1	Upazila Agriculture Officer (UAO)/ Upazila Agricultural Extension Officer (UAEO)	>5times/ year	4-5times/ year	2-3times/ year	1time/ year	0 time/ year
2	Sub-Assistant Agricultural Officer (SAAO)	>5times/ month	4-5 times/ month	2-3times/ month	1time/ month	0 time/ month
3	Agricultural input dealer	>5times/ month	4-5 times/month	2-3times/ month	1time/ month	0 time/ month
4	Contact growers	>5times/ month	4-5 times/ month	2-3times/ month	1time /month	0 time/ month
5	NGO worker	>5times/ month	4-5 times/ month	2-3 times/ month	1time/ month	0 time/ month

SL. No.	Sources of contact	Extent of Participation				
		Regularly	Frequently	Occasionally	Rarely	Not at all
Group contact						
6	Focus Group Discussion (FGD)	>5times/ Year	4-5 times/ year	2-3 times/ year	1time/ year	0time/ year
7	Result/Method Demonstration	>5times/ year	4-5 times/ year	2-3times/ year	1time/ year	0 time/ year
Mass contact						
8	Radio	>3 times/ week	3times/ month	2 times/ month	1time/ month	0 time/ year
9	Television	>3 times/ week	3times/ month	2 times/ month	1time/ month	0 time/ month
10	Printed materials (Newspaper, Poster, Farm publications, etc.)	>3 times/ week	3times/ month	2 times/ month	1time/ month	0 time/ month

9. Farmer's Category based on their innovativeness:

(Please indicate your position under following category)

i. **Innovator** (Have interest to take risk, have the highest social status, have financial liquidity, adopt an innovation within 1year of hearing)……...

ii. **Early adopter** (Highest degree of opinion leadership, higher social status, financial liquidity, advanced education, adopt an innovation within >1 to 2 years of hearing)……..

iii. **Early majority** (Adopt an innovation after innovator and early adopter, have above average social status, seldom hold position of opinion leadership, adopt an innovation within >2 to 3 years of hearing)…….

iv. **Late majority** (Have below average social status, little financial liquidity, little opinion leadership, adopt an innovation within >3 to 4 years of hearing)……

v. **Laggards** (Show little to no opinion leadership, tend to be concentrated on tradition, lowest social status, and lowest financial liquidity, adopt an innovation > 4 years of hearing).

9. Farmers' extent of adaptation strategies towards salinity effects in agriculture:

Please mention what adaptation strategies you are use to follow against salinity effects in agriculture:

Name of the Practice	Response
i. Cultivating short duration crops	Yes / No
ii. Practicing crop diversification	Yes / No
iii. Homestead cultivation	Yes / No
iv. Practicing intercropping	Yes / No
v. Use of saline tolerant varieties	Yes / No
vi. Zero tillage	Yes / No
vii. Mulching	Yes / No
viii. Alternative irrigation system	Yes / No
ix. Reducing Salinity by organic or chemical method	Yes / No
x. Making embankment around land to control saline water intrusion	Yes / No

Thank you for your cooperation

Signature of the interviewer with date