IMPACT OF CLIMATE SMART AGRICULTURE ON FARMERS' LIVELIHOODS

MOHAMMAD MAHASHIN

A DISSERTATION
FOR THE DEGREE OF

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IN
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DEPARTMENT OF AGRICULTURAL EXTENSION & INFORMATION SYSTEM

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CERTIFICATE

This is to certify that the Dissertation entitled "**IMPACT OF CLIMATE SMART AGRICULTURE ON FARMERS' LIVELIHOODS**" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University (SAU), Dhaka in partial fulfillment of the requirements for the degree of DOCTOR OF PHILOSOPHY IN AGRICULTURAL EXTENSION AND INFORMATION SYSTEM, embodies the result of a piece of authentic research work carried out by **MOHAMMAD MAHASHIN**, Registration No: **16-07515. The research has been conducted** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that the cooperation and help to collect and analyze the relevant information from different sources and personnel has been availed during the course of this investigation has duly been acknowledged.

Dated: 25 JANUARY, 2021
Place : Dhaka, Bangladesh

Prof. Dr. Md. Rafiquel Islam
Chairman, Advisory Committee
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Dedicated to My late Parents, Spouse and All Other Family Members

Declaration by the author

It is hereby declared that the content of this dissertation has neither been published in any other papers nor elsewhere yet. This is absolutely prepared by the author himself. None part has been copied from any other documents.

The author

June, 2019

BIOGRAPHICAL SKETCH

The researcher was born in the district of Cumilla on 31st December, 1962. He is the son of late Md. Sarafat Ali and late Mrs. Roushan Ara begum.

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Travelling to enjoy the beautiful and charming natural beauties at home and abroad is the favorable hobby of the researcher.

The Researcher

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The Researcher

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIX

ABBREVIATIONS and ACRONYMS

ACSA	: After Climate Smart Agriculture
AEZ	: Agro-Ecological Zone
BCSA	: Before Climate Smart Agriculture
BKB	: Bangladesh Krishi Bank
BTV	: Bangladesh Television
BBS	: Bangladesh Bureau of Statistics
BCAS	: Bangladesh Center for Advanced Studies
BIDS	: Bangladesh Institute of Development Studies
BARC	: Bangladesh Agricultural Research Council
BRAC	: Bangladesh Rural Advancement Committee
BRDB	: Bangladesh Rural Development Board
BRRI	: Bangladesh Rice Research Institute
BSMRAU	: Bangabandhu Sheikh Mujibur Rahman Agricultural University
CCDB	: Christian Commission for Development Bangladesh.
CFS	: Climate Field School
CLCI	: Composite Livelihood Change Index
CSA	: Climate Smart Agriculture
DAE	: Department of Agricultural Extension
DCRMA	: Disaster and Climate Risk management in Agriculture
DD	: Deputy Director
DFID	: Department for International Development
DTW	: Deep Tube Well
FAO	: Food and Agriculture Organization
FGD	: Focus Group Discussion
GDP	: Gross Domestic Product
GNP	: Gross National Product
GO	: Government Organization
GOB	: Government of Bangladesh
HYV	: High Yielding Variety
IPM	: Integrated Pest Management
JBL	: Janata bank Limited
K. Cal	: Kilo Calories
LL	: Landless
LLP	: Low Lift Pump
LIFDC	: Low Income Food Deficit country
LSMS	: Living Standard Measurement Surveys
MF	: Marginal Farmer
MoA	: Ministry of Agriculture
NGO	: Non-Government Organization
PRA	: Participatory Rural Appraisal
PMU	: Project Management Unit
RDRS	: Rangpur Dinajpur Rural Services

SAAO	: Sub Assistant Agriculture Officer
SAU	: Sher-e-Bangla Agricultural University
SF	: Small Farmer
SL	: Sustainable Livelihood
SLM	: Sustainable Land management
SLP	: Sustainable Livelihood Policy
SPFS	: Special Programme for Food Security
SPSS	: Statistical Package of Social Science
STW	: Shallow Tube Well
T. Aman	: Transplanted Aman Rice
UAO	: Upazila Agriculture Officer
UN	: United Nations
UNDP	: United Nation Development Programme
WB	: World Bank

IMPACT OF CLIMATE SMART AGRICULTURE ON FARMER'S LIVELIHOODS

Mohammad Mahashin

ABSTRACT

The present study was undertaken to determine the impact of Climate Smart Agriculture on farmers livelihoods.Data were collected from 376 households from CSA (study group) and non CSA (control group) farmers during July to December, 2018. In order to collect relevant information from the respondents, structured interview schedule was used. Before-After study with control method was adopted for the study to assess the impacts on farmer's livelihoods. It is observed that an overwhelming majority of the respondents (86.60%) in the CSA group had medium to high change in livelihoods whereas the change in non-CSA group was 26.60%.The findings indicated that CSA approach had significant improvement in most of the livelihood parameters. Substantial positive changes were observed in food consumption (calorie intake), food stock (availability), taking balance diet intake level, housing, safe drinking water, sanitation, clothing and healthcare faculties. The analysis revealed that out of 13 variables, 6 variables namely knowledge on Climate Smart Agriculture practices, benefit obtained from CSA, empowerment status, use of CSA technologies and organizational support had significant contribution on the change of farmers' livelihoods. Whole model of 13 independent variables explained 45.9% of the total variation showed in livelihoods of the farmers. Out of 45.9% explained variance, two variables namely knowledge on CSA and benefit obtained from CSA contributed (39%). It reflects those two variables are the most dominant and signifying predictors for changing the livelihoods of CSA practicing farmers. This study can establish a message that positive changes in the livelihoods of farming community are associated with practicing Climate Smart Agriculture.

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Keywords: CFS, CSA, Intervention, Adaptation, Livelihood, Study and control group.

CHAPTER I
INTRODUCTION

1.1 General background

Climate change is a natural phenomenon but anthropogenic activity enhance greenhouse effect, resulting to global warming and pushing threat towards the growth and development of living being in the Universe. Recently the components of climate like temperature, rainfall, humidity are showing irregular pattern that is exception to the trend.

Gradual expansion of urbanization and industrialization are causing environmental pollution which is ultimately affecting the climatic phenomenon. Carbon di oxide ($CO_{2)}$ an important component of rise in atmospheric temperature is caused by injudicious deforestation. Emission of other greenhouse gasses like Nitrous oxide (NO), Carbon monoxide (CO), Chlorofluorocarbon (CFC), methane gas (CH_4) are the side effects of urbanization, industrialization and technological evolution towards civilization. Methane is a much more powerful Green House Gas (GHG) causing global warming than carbon dioxide. It has a warming potential of 25 times than that of carbon dioxide over a 100-year time horizon (Foster et al., 2007). Methane is thought to account for about 20% of the global warming.

Greenhouse gasses are causing damage to the ozone ($O_{3)}$ layer of the atmospheric zone which resulting the intrusion of ultraviolet ray to the earth. Global warming, sea level rise, are the two alarming problems carrying risk to the lives in the earth being forecasted by the researchers, experts and scientists. Frequency and magnitude of different hazards like erratic rainfall, too much cold or excessive heat, flood, flash flood, river erosion, storm, cyclone, tidal surge etc. are going to be amplified due to climatic change.

The issue of climate change first comes to the thought of the world leaders, experts and scientists while seeing some variation in yearly climatic condition. The trend of wind speed, frequency of disasters, trends of temperature and cold while showing the changing characters indicated the effects of climate change. Some other symptoms of climate change may be cited as for example that some of the bird species are going to be extinct while the existing climate does not allow them to survive. The regular trend of diseases and insect pest attack in the crop field is seemed to be irregular and found severely terrible or out of management to some extent. Disease incidence on human health is also showing a new dimension causing by rapid multiplication of some bacteria and viruses prevailing in the environment due to changed climatic situation. Cold feeling in the summer or spring, erratic rain in the autumn or winter, almost cloudy sky, corrosive heat, too much cold along with frequent cold wave may be counted as the effects of climate change. A very alarming news headline published in the daily newspaper Nayadiganta on 03.01.2016, on abolishing one country namely Tavalu Island from world Map due to sea level rise. Since 1993 the island is being losing some land due to sea level rise which is an effect of climate change. Many Asian, European and American countries are being remaining under threat of abolishing from world map like Tavalu. Bangladesh is at the high risk situation in this connection. Agricultural production and productivity is under the main threat of climate change.

Climate-smart agriculture (CSA), as defined and presented by FAO at the Hague Conference on Agriculture, Food Security and Climate Change in 2010, that contributes to the achievement of sustainable development goals. It is an integrated approach to address these interlinked challenges of food security and climate change that explicitly aims for three objectives or dimensions (1) Sustainably increasing agricultural productivity to support equitable increases in farm incomes, food security and development (2) Adapting and building resilience of agriculture and food security systems to climate change at

multiple levels and (3) Reducing and/or removing greenhouse gases emissions from agriculture (including crops, livestock and fisheries) & where possible.

CSA invites to consider these three objectives together at different scales-from farm to landscape-at different levels-from local to global-and over short and long time horizons, taking into account national and local specificities and priorities. The three dimensions of sustainable development (economic, social and environmental) for jointly addressing food security and climate challenge are being treated as three main pillars of CSA.

CSA is an approach to developing the technical, policy and investment conditions to achieve sustainable agricultural development for food security under climate change. The magnitude, immediacy and broad scope of the effects of climate change on agricultural systems create a compelling need to ensure comprehensive integration of these effects into national agricultural planning, investments and programs. The CSA approach is designed to make identifying and operational sustainable agricultural development within the explicit parameters of climate change.

1.2. Climate change; Bangladesh perspective:

Bangladesh is one of the most vulnerable countries in the world considered to be the highest victim of climate change effect. According to climate risk index, Bangladesh is one of the most disaster-prone countries in the world (Harmeling, 2009). Almost every year, the country experiences disasters of one kind or another like tropical floods, cyclones, storm surges, coastal erosion, tornadoes and droughts (Ali, 1996). Past history review revealed that events like floods, droughts and cyclone have affected 174 times during the year 1974 to 2007. Cyclones heat Bangladesh on an average every three years. During the year 1970 and 19991, cyclones killed 500000 and 140000 people respectively.

The devastating floods of 1988 and 1998 made huge economic stress in Bangladesh resultant towards a high poverty trend. The recent Cyclone (sidr), 2007. Aila, 2009, Nargis, Mohasen, (Rabbani and Mallik, 2015). Cyclone Foni (2019) and likewise disasters also made major loss and damages of financial and physical resources. The daily newspaper "Prothom Alo Bangladesh" in a report on April '2016 stated that the temperature and warm feeling of this year during April (Baishak)' 2016 has broken the records of last 30 years. During late March'2017 to late April'2017, the flash flood caused by unnatural rainfall, destroyed crops, livestock and fisheries. Especially in the seven Haor districts, it made a loss of resources equivalent to BDT 1, 30,000 million (Daily Smakal, 5th May, 2017). As per BTV weather news on 19th July'2018 temperature in Bangladesh has been recorded as 39.8^0c which does not supposed to happen during the rainy season. On the other hand during summer the average temperature was 20^0-25^0c. Heat wave during the rainy season and comparatively low temperature during summer are the clear indications of climate change situation in Bangladesh. Farmers cannot transplant Aman seedlings for the scarcity of water where there is no rain during the rainy season. A study revealed that 41% of country's total area is under risk which is gradually being heightened (Mandal, 2016).

The ongoing and foreseen challenges of climate change in Bangladesh are sea level rise, frequent cyclone, salinity intrusion, floods, flash floods, drought, riverbank erosion, landslide (especially in the hilly areas) which ultimately threaten the individual, household and national food, nutritional and livelihood security as well. Scientists forecasted that within next fifty years one third of the south and southwest coastal zone of Bangladesh might be undergone into water due to sea level rise caused by the effect of climate change. About 10-20% of people might become climate refugees. Taking into account the aforesaid threats, the Inter-governmental Panel of Climate Change (IPCC), 2007 forecasted that developing countries like Bangladesh will continue to be affected by extreme weather variability such as temperature, severe water

shortage and floods caused by erratic rainfall effect during the coming decades. We must be aware about the challenges of climate change and to identify what should be our strategic plans and programs towards combating the effects, hazards, losses and damages.

1.3. Climate change hot-spots; losses and damages scenario in Bangladesh

Cyclone risk hotspots: starts from Bay of Bengal and damage crops, vegetation and lead to floods and storm surges. South, south east-west region i.e. Cox's bazar, Chittagong, Patuakhali, Barguna, Sathkhira, Khulna districts of Bangladesh are vulnerable to cyclone and storm surges. Violent cyclone Sidr, Aila, Nargis Mohasen, Mora, heated those districts very recently.

Cyclone Aila on May 25th 2009 hit 26 districts in southern coastal area affecting a population of 9 million households. The cultivated land damaged in that area is around 96,617 ha which is worth about 6776 million BDT (about 99 million USD). A scenario of estimated damages is given below:

Table 1. Losses in ha and estimated value in BDT (FAO, 2009)

Sl. No.	Item	Total land (ha)	Total loss (BDT)
1	Aus seed bed	5493	30211
2	Transplanted Aus	53122	2390490
3	Summer vegetables	18921	2270520
4	Banana	6952	2085600
	Total	84488	6776821

Flash-flood and Flood risk hotspots: North and north east regions namely Sunamganj, Moulavi bazaar, Hobiganj, Sylhet districts are flash-flood prone areas. Erratic and uneven rainfall caused by climate change results in sudden flood in those areas make damages in standing crops, vegetation, soil erosion, livestock and poultry. Middle regions namely Manikganj, Munshiganj, Tangail,

Dhaka, Cumilla, Brahmanbaria districts are flood prone areas where serious loss of crops and vegetables are accounted frequently. Flood & flash flood due tidal surge and high tide are frequent in the coastal area like Patuakhali, Barguna, Pirujpur, Barisal and Jhalokathi districts. Once in every 4-5 years, there is a severe flood that may cover over 60% of the country and cause loss of life and substantial damage to infrastructure, housing, agriculture and livelihoods. During severe floods, it is poorest and the most vulnerable ones who suffer most because their houses are often in more exposed locations. Following Table represents a scenario of financial loss and damage during last 25 years.

Table 2. Serious floods in the last 25 years (MOEF, 2007)

Event	Impact
1984 flood	Inundated over 50,000 sq.km. estimated damage USD 378 million
1987 flood	Inundated over 50,000 sq.km. estimated damage USD 1 billion, deaths occurred 2055 nos.
1988 flood	Inundated 61% of the country estimated damage USD 1.2 billion, more than 45 million homeless, between 2500-6500 deaths.
1998 flood	Inundated nearly 100000 sq.km., rendered 30 million people homeless damaged 500000 homes heavy loss to infrastructure, estimated damage USD 2.8 billion,1100 deaths.
2004 flood	Inundation 38%, damage USD 6.6 billion, affected nearly 3.8million people.
2007 flood	Inundated 32000 sq.km. ,over 85000 houses destroyed and almost I million damaged, approximately 1.2 million acres of crops destroyed or partially damaged, estimated loss over USD 1 billion,649 deaths.

Drought risk hotspots: Mainly located in northern west region which includes, Rajshahi, Chapainawabganj (Barind tract), Kurigram, Nilphamari, Rangpur and Dinajpur districts. Rice and other crop production are seriously hampered in those areas due to scarcity of irrigation water.

Salinity risk hotspots: Coastal belt south and south west regions are identified as salinity vulnerable areas. It is reported that salinity has already been penetrated in 100 kilometer north to the South west coast. Patuakhali, Barguna, Sathkhira, Khulna, Pirojpur and Gopalganj districts are being reported as the salinity affected areas where local rice variety, rice other than saline tolerant varieties, vegetables are difficult to produce.

1.4. Importance of Climate Smart Agriculture (CSA)

Between now and onwards 2050, the world's population will increase by one-third. Most of these additional 2 billion people will live in developing countries. At the same time, more people will be living in cities. If current income and consumption growth trends continue, FAO estimates that agricultural production will have to increase by 60 percent by 2050 to satisfy the expected demands for food and feed. Agriculture must therefore transform itself if it is to feed a growing global population and provide the basis for economic growth and poverty reduction.

Climate change will make this task more difficult under a business-as-usual scenario, due to adverse impacts on agriculture, requiring spiraling adaptation and related costs. To achieve food security and agricultural development goals, adaptation to climate change and lower emission intensities per output will be necessary. This transformation must be accomplished without depletion of the natural resource base. Climate change is already having an impact on agriculture and food security as a result of increased prevalence of extreme events and increased unpredictability of weather patterns.

This can lead to reductions in production and lower incomes in vulnerable areas. These changes can also affect global food prices. Developing countries and smallholder farmers and pastoralists in particular are being especially hard hit by these changes. Many of these small-scale producers are already coping with a degraded natural resource base. They often lack knowledge about

potential options for adapting their production systems and have limited assets and risk-taking capacity to access and use technologies and financial services.

Enhancing food security while contributing to mitigate climate change and preserving the natural resource base, vital ecosystem services requires the transition to agricultural production systems that are more productive. Use of inputs more efficiently, have less variability and greater stability in their outputs, and are more resilient to risks, shocks and long-term climate variability. More productive and more resilient agriculture requires a major shift in the way land, water, soil nutrients and genetic resources are managed to ensure that these resources are used more efficiently. Making this shift requires considerable changes in national and local governance, legislation, policies and financial mechanisms. This transformation will also involve improving producers' access to markets. By reducing greenhouse gas emissions per unit of land and/or agricultural product and increasing carbon sinks, these changes will contribute significantly to the mitigation of climate change.

1.4.1 What to be addressed by CSA

CSA seeks to support countries to be putting in place the necessary policy, technical and financial means to mainstream climate change considerations into agricultural sectors and provide a basis for sustainable agricultural development under changing conditions. Innovative financing mechanisms that link and blend climate and agricultural finance from public and private sectors are a key means for implementation as are the integration and coordination of relevant policy instruments and institutional arrangements.

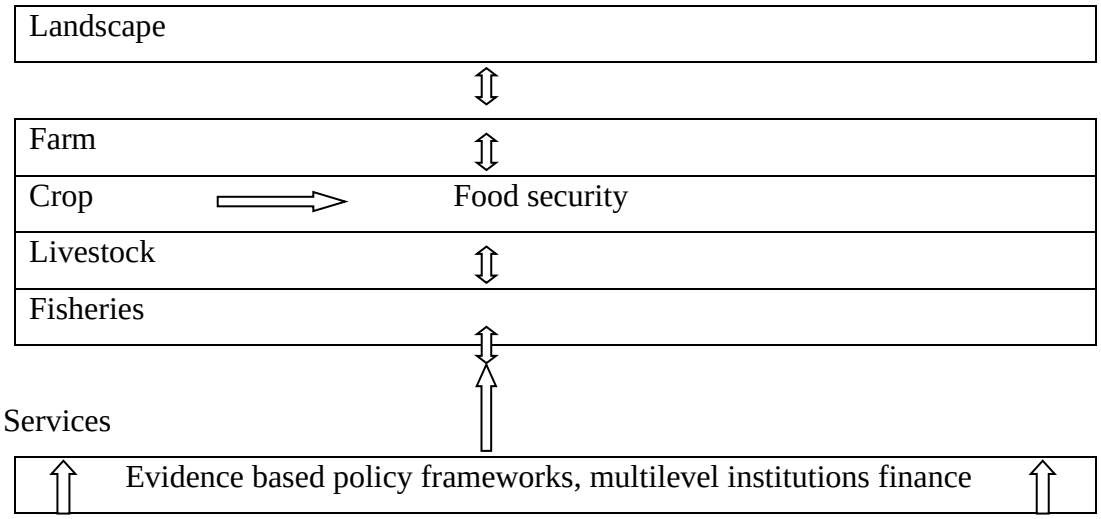
The scaling up of climate-smart practices will require appropriate institutional and governance mechanisms to disseminate information, ensure broad participation and harmonize policies. It may not be possible to achieve all the CSA objectives at once. Context-specific priorities need to be determined, and benefits and tradeoffs evaluated.

CSA is not a single specific agricultural technology or practice that can be universally applied. It is an approach that requires site-specific assessments to identify suitable agricultural production technologies and practices. The benefits to be obtained from this approach are:

- Addresses the complex interrelated challenges of food security and climate change, identifies integrated options that create synergies, benefits and reduce trade-offs;
- Recognizes that these options will be shaped by specific country contexts and capacities and by the particular social, economic, and environmental situation where it will be applied;
- Assess the interactions between sectors and the needs of different involved stakeholders;
- Identifies barriers to adoption, especially among farmers, and provides appropriate solutions in terms of policies, strategies, actions and incentives;
- Seeks to create enabling environments through a greater alignment of policies, financial investments and institutional arrangements;
- Strives to achieve multiple objectives with the understanding that priorities need to be set and collective decisions made on different benefits and trade-offs;
- Should prioritize the strengthening of livelihoods, especially those of smallholders, by improving access to services, knowledge, resources (including genetic resources), financial products and markets;
- Addresses adaptation and builds resilience to shocks, especially those related to climate change, as the magnitude of the impacts of climate change has major implications for agricultural and rural development;
- Considers climate change mitigation as a potential secondary co-benefit, especially in low-income, agricultural-based populations;
- Seeks to identify opportunities to access climate-related financing and integrate it with traditional sources of agricultural investment finance.

1.4.2. Elements of CSA

CSA relates to action both on-farm and beyond the farm, incorporates technologies, policies, institutions and investments, the elements includes (i) management of farms, crops, livestock, Aquaculture and capture fisheries to manage resources, better produce more with less while increasing resilience (ii) Ecosystem and landscape management to conserve ecosystem services that are key to increase at the same time resource efficiency and resilience (iii) Services for farmers and land managers to enable them to implement the necessary changes.



1.4.3. Technology identified as Climate Smart Agriculture (CSA) in the crop subsector of Bangladesh

As discussed with FAO and Bangladeshi experts dealing with CSA the following technologies are specifically mentioned as the best adaptation practices for Bangladesh.

i) Alternate wetting and drying, ii) Construction of mini-pond near crop field, iii) Cultivation of less water loving crops, iv) Zero or minimum tillage v) Sarjan method of cultivation, vi) Floating cultivation, vi) Relay /inter cropping, vi) use of saline or stress tolerant varieties, vii) Cultivation of creepers crop on trees. viii) Urea deep placement .Furthermore the adaptation

technologies mentioned in training manual of Climate Field School are; (I) Intercropping with legume (II) Crop rotation, (III) New crop varieties (e.g stress resistant) (VII) Drip irrigation (IX) Change in cropping pattern.

1.4.4. Climate Field Schools (CFS) for CSA in Bangladesh

DAE made a partnership with multidonor UN financed project titled "Disaster and Climate Risk Management in Agriculture (DCRMA), under Comprehensive Disaster Management Project (CDMP) Phase-II during the period from 2010-2014.Donors (UNDP, UK AID, EU, Norwegian Embassy, Sweden and Australian AID) were involved with the Government of Bangladesh for conducting several projects. The specific objective of DCRMA project was to increase DAE capacity to cope with climate change impacts. The project had been implemented 26 districts of Bangladesh covering all the climate change hotspots. During this period, Union Disaster Management Committee (UDMC) was established at local level.

One of the main achievements of the project was to conduct Climate Field Schools (CFS) at the targeted 52 Upazilas. CFS is such a Non-Formal Educational (NFE) arrangement to capacitate the farmers as to improve their socio-economic conditions by acquiring expertise on combating the effects of climate change in agriculture. In this connection, 156 IPM/ICM clubs were selected where there was participation of 25 male-female farmers in each club.

Objectives of CFS were:

- To make aware of the farmers to keep the impacts of climate change at minimum level,
- To capacitate the farmers to address the challenges of climate change
- To increase the self-confidence of farmers on the face of adverse effects of climate change
- To prepare the farmers to understand the forecast of disasters and climate change
- Learning by doing, and
- To help the farmers to be cooperative and socialistic.

Four stages of CFS implementation are baseline survey, input supply, technology demonstration and conduction of session. Sessions were conducted in the drought prone, flood, flash flood prone and salinity areas following a definite schedule and lesson plan. This study aimed to find out what impacts being exerted by the CFS in some selected areas those could be generalized as the positive improvements indicators of livelihood.

1.5. Statement of the problem

The problem that seems to be the most threatening factor for our agriculture and livelihood is climate change. It is evident that Bangladesh is a victim country of climate change effects, caused by the industrialist and mostly developed countries those releasing huge amount of carbon in the atmosphere. Government of Bangladesh with its development partners like NGOs and international agencies have been working and producing demand for compensation before different development forum. A high power administrative, technical and expert team has joined the 21st meeting titled as the Conference of Parties (COP-21) held at Paris on December '2016. Hopeful negotiation and agreement have been made by the statesman of developed countries where 200 billion dollars commitment has been made for the victim countries. By this time different initiatives and measures are being undertaken through development projects for adaptation and mitigation of the effects of climate change correlated to improve the livelihood and food security situation in Bangladesh. Government of Bangladesh has already made a climate change trust fund amounting BDT 7000.00 million being handled by the Ministry of Environment and Forest. Department of Agricultural Extension under the Ministry of Agriculture has so far implemented some development projects. Some are ongoing with the financial help of some development partners like FAO and UNDP. The projects like Livelihood Adaptation to Climate Change (LACC) phase-1 (2005-2007) and LACC-2 (2008-2009) had been implemented by DAE under the Technical Assistance of FAO. Another project has recently been completed titled, CDMP phase-2 under UNDP assistance. DAE also

implementing another project on floating agriculture under GOB trust fund administered by DOEF. After the terrible Cyclone (Sidr) a project titled Emergency' 2007 Cyclone Recovery and Restoration project (ECRRP) had been implemented by DAE under the technical assistance from FAO in southern coastal areas of Bangladesh. DAE has been demonstrating some technology like i) Alternate wetting and drying, ii) Construction of mini-pond near crop field, iii) Cultivation of less water loving crops, iv) Zero or minimum tillage v) Sarjan method of cultivation, vi) Floating cultivation, vi) Relay /inter cropping, vi) use of saline or stress tolerant varieties, vii) Cultivation of creepers crop on trees and viii) Urea deep placement.

Government and Non-government organizations project-based extension supports might have some impact on the local adaptation strategy and making aware of our farmers to minimize the loss and damages supposed to be occurred in the coming days.

As mentioned in the para 1.4.4, CFS in three Upazilas under two southern districts of Bangladesh were Pirojpur and Patuakhali where the upazilas included were Nazirpur, Kalapara and Mirzagonj respectively. It is dire need to determine the impacts of adaptation and mitigation practices have so far been using by the farmers of those areas. What changes in livelihood has also been made by the relevant initiatives. Since Climate Smart Agriculture (CSA) is a multidimensional approach that addresses the problems of farmers relevant to the livelihood improvement and food security. The terminology being introduced since, 2010 have been accepted and implemented by different countries successfully. In Bangladesh the technologies although not identified as CSA but have been practiced by the farmers since 2005, under many extension support. As reported so far, widely used technologies are i) Zero or minimum tillage ii) Sarjan method of cultivation, iii) Floating cultivation, iv) Relay /inter cropping, v) use of saline or stress tolerant varieties, vi) Cultivation of creepers crop on trees. vii) Urea deep placement, have been

practicing by the farmers since long. An impact evaluation needs to be made for further policy support. A little study had been conducted on the impact of the adapted technologies so far (research gap). This study might find out the existing impacts and its weaknesses for further improvement which will ensure the food security and improved livelihood of the rural population supposed to be victimized under the challenges of climate change. The present study has been undertaken to answer the following research questions:

1. What are the socio- demographic predictors of farmers living in the climate change hotspots of Bangladesh?
2. What impact does practicing Climate Smart Agriculture made on farmers' livelihood?
3. What are the differences in livelihood among the farmer's practicing Climate Smart Agriculture and non-practicing Climate Smart Agriculture?
4. What contribution does made by the selected predictors of the farmers to the impact of practicing Climate Smart Agriculture on their livelihood?
5. What are the problems faced by the Climate Smart Agriculture (CSA) and non CSA practicing farmers and what remedial measures could be suggested?

1.6. Justification of the study

The alarming issue climate change has been putting an adverse impact on production and productivity thus deteriorating livelihood. The evolving traditional practices are of no use. Scientists of different organizations and institutions are trying to find out the effective way to combat with the climate change effects. Bangladesh as a whole is being forecasted as vulnerable to climate change. There are some hot spots where the people are more victimized under the threats of climate change. A little research has been found on the contribution of approaches made under CSA. Identification of interventions already provided by extension services and future need of interventions in the climate change hotspots is an important task. Assessment of CSA knowledge, levels of adoption of adaptation technologies by the farmers and reviewing

their opinion on the climate change issue is also important. Climate Smart Agriculture (CSA) first introduced by FAO-UN in 2010 is importantly a new approach to be implemented by the extension service providers. It's dimension is to address production, productivity, livelihood improvement, food security through adaptation and mitigation practices. All those issues got a little importance in the previous research works so far. In the above circumstances, conduction of this study had been well justified by the researcher for the following reasons:

1. The study will reflect the CSA interventions impacts in some hotspots who are the victims of different disasters.
2. It would make a comparison of change in livelihood between CSA and non CSA practicing farmers.
3. Through this study, livelihood improvement and food security status measurement before and after the CSA interventions would be synthesized.
4. The study would identify the strengths and weaknesses of the given interventions and may formulate new strategies and opportunities for future interventions.
5. Ongoing problems and faced by the farmers in connection to climate change adaptation and mitigation might be dug out and solution for future might be recommended through this study.

1.7. Objectives of the study

The general objective of the study was to make an overview of livelihood changes of farmers under the impact of Climate Smart Agriculture approach.

Specific objectives:

1. To describe the selected predictors of the farmers;
2. To assess the impact of Climate Smart Agriculture on farmers' livelihood;
3. To draw a comparative analytical feature among the livelihood of Climate Smart Agriculture and non Climate Smart Agriculture practicing farmers;

4. To determine the contribution of selected predictors of the farmers to the impact of practicing Climate Smart Agriculture on their livelihood;
5. To identify the problems faced by the climate change victim farmers and to suggest their remedial measures.

1.8. Assumptions of the study

"An assumption is the supposition that an apparent fact or principle is true in the light of the available evidence" (Goode, 1945). The study was conducted under the following assumptions.

1. The respondents included in the sample will be capable of furnishing responses to the question reflected in the interview schedule.
2. The responses furnished by the respondents will be reliable.
3. Views and opinions furnished by the respondents will be representative of all populations in the study area of both treatment and control group.
4. The findings of the study will be useful for planning and execution of various programs to mitigate food insecurity and livelihood problem of Bangladesh in the perspective of climate change.
5. The findings will provide some indication of problems related to utilization of CSA practices and would suggest some measures in accordance.

1.9. Scope and Limitations of the study

Out of 156 CFS in 52 Upazilas of 26 districts under DCRMA project (2010-2014), only 9 CFS from three Upazila namely, Kalapara, Mirzagonj and Nazirpur of Patuakhali and Pirojpur districts had been selected as study area. In those areas study were conducted in order to have an idea about how CSA practices and or interventions was changing the socio-economic conditions of the rural area and affecting livelihood of the rural poor. Among the several hotspots of climate change vulnerable areas in Bangladesh, three villages namely Shakharia, Krishnapur and Maddhya Rakudia from Amtali, Banaripara and Baubaganj Upazilas of Barguna and Barisal districts were selected as control areas. The study would thus provide a scope to make a comparative

study among the livelihood improvement between the CSA practicing under CFS and non CFS farmers. It also made a scope to review the emerging issues like access and empowerment of the rural poor through this approach and helped to come up with some suggestions for policy intervention for future activities. However, for completing the study in a meaningful manner within available time and resources, the following limitations were imposed on the study:

1. Due to the limitations of resource availability and time constraints the study was confined only within the selected 09 CFS and 03 non CFS villages. So the findings of the research have some degree of limitation regarding application of findings in other regions of Bangladesh.
2. Characteristics of the respondents are many and varied. However, only few characteristics of the respondents were selected for the study.
3. For information, the researcher was dependent on the data furnished by the respondents and focus group discussants during the interview as well as the data from secondary sources.
4. Due to time constraints, the study had to be accomplished only covering the Crop subsectors where fishery, livestock and forestry subsectors could not be taken into account. Out of numerous NGOs and GOs working with several projects under climate change issues, only DAE's DCRMA project had been considered to measure the impacts of CSA approach.

1.10. Hypothesis

Hypothesis is a proposition or principle which is assumed in order to draw logical or empirical consequences, and by this method to test its accord with facts which are known or may be determined (Ray et al., 1999). According to Goode and Hatt (1952), a hypothesis is a proposition which can be put to a test to determine its validity. It may seem contrary to or in accord with common sense. It is necessary to formulate null hypotheses of the research problems. A null hypothesis states that there is no significant relationship between the concerned variables. If a null hypothesis is rejected on the basis of statistical

test, it is assumed that there exists a significant relationship between the variables.

The following null hypotheses were put forwarded for the present study:

I. There is no contribution of the selected predictors of the farmers to the impact of practicing Climate Smart Agriculture on their livelihood;
II. There is no significant difference to the impact of practicing CSA and non CSA farmers' on their livelihood improvement before and after development interventions made by CSA approach

1.11. Definitions of the related terms

Terms used throughout the study are defined and interpreted below for clarity of understanding:

Adaptation: It is a process by which strategies to moderate, cope with and take advantage of consequences of climate events are enhanced, developed and implemented. Types are included participatory, reactive, private, public and autonomous adaptation.

Balance diet: A diet that contains the proper proportion of carbohydrates, fats, proteins, vitamins, minerals and water necessary to maintain good health is termed as balance diet. The perfect balance diet mentioning the percentage prepared by Neeti Jaychander in December11, 2018 Are to be dish full of (I) Fibre rich carbohydrate -25%, Protein-25%, Fats-10%,Vitamins and minerals (fruits and vegetables)-40%.

Climate Change: The most general definition of climate change is a change in the statistical properties (principally its mean and spread) of the climate system when considered over long periods of time, regardless of cause. Accordingly, fluctuations over periods shorter than a few decades such as EL-nino do not represent Climate change.

Climate Smart Agriculture (CSA): Climate-Smart-Agriculture (CSA) as defined and presented by FAO at the Hague Conference on Agriculture, Food Security and Climate Change in 2010,that contributes to the achievement of sustainable development goals. It is an integrated approach to address these interlinked challenges of food security and climate change that explicitly aims for three objectives or dimensions.(I)Sustainably increasing agricultural productivity to support equitable increases in farm incomes, food security and development.(2) Adapting and building resilience of agriculture and food security systems to climate change at multiple levels and (3) Reducing and/or removing greenhouse gases emissions from agriculture(including crops, livestock and fisheries) & where possible.

Climate Field School: A non-formal training arrangement organized by grass root level DAE offices under DCRMA project. This was arranged to educate farmer how to use the adaptation technologies to combat the climate change effects.

Constraints/problems: It refers to different socioeconomic situation and circumstances that hinder respondents of the study areas to participate in project activities.

Cropping intensity: Number of crops grown in a sequence in a given plot during one year; it can be expressed as percentage.

CSA farmers: Respondents under this study who participated in the CFS be known as CSA farmers.

Control group: The respondents who had never been participated in any Climate Field School.

Decision making authority: It means the freedom of taking decision independently by the respondents.

Food Security: Food security is generally perceived as access to safe, adequate and nutritious food to all people at all times to lead a healthy and active life. Food security exists when all people, at all times have physical and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life. Food security can be achieved when all people have attained the capability of access to sufficient food both in quality and quantity without risk of loss of access.

Food habit: Food habit refers to the daily habit of food intake on the meal basis.

Green House Effect: It is the name for the physical process whereby energy from the sun passes through the atmosphere relatively freely while heat radiating from the earth is partially blocked or absorbed by particular gasses in the atmosphere.

Global warming: It is defined as a natural or human induced increase in the average global temperature of the atmosphere near earth's surface. It occurs as a result of accumulation of greenhouse gasses in the atmosphere.

Intervention: Simply defined, intervention is the interference or interrupting some existing circumstances to generate effects or differences from the previous one.

Livelihood: A livelihood comprises people, their capabilities and their means of living, including food, income and assets (tangible and intangible). The concept of livelihood is relatively new but is now widely used in poverty and rural development literature. The word "livelihood" originated from the word "live". The simple dictionary definition of livelihood is a "means of living".

Livelihood comprises the “capabilities, assets and activities required for a means of living”. Livelihoods are the ways people combine their capabilities, skills and knowledge with the resources at their disposal to create activities to enable them to make a living. Livelihood means the way of living, the style, status, position through which people live in the society.

Meaning of impact: Rogers (1983) termed the impact of extension intervention as ‘consequences of innovations’ and defined as “the changes that occur to an individual or to a social system as a result of the adoption or rejection of an innovation”. Consequences of innovations are classified as desirable and undesirable. Desirable consequences are the functional effects of an innovation or technology to an individual or to a social system. Undesirable consequences are those effects of an innovation to an individual or to a social system that considered as undesirable.

Non-CSA farmers: Respondents who never heard about CFS nor participated any of the training class relevant to climate change adaptation be known as Non- CSA farmers.

Perception: Perception is the process by which we receive information or stimuli about our environment and transform it into psychological awareness (Van den Ban & Hawkins, 1998). In psychology and the cognitive sciences, perception is the process of acquiring, interpreting, selecting, and organizing sensory information. Methods of studying perception ranges from essentially biological or psychological approaches to the often ‘abstract thought-experiments’ of mental philosophy.

Productivity: The term '**Productivity**' is regarded as “A ratio of the output to input in relation to land, labor, capital and over all resources employed in agriculture”. Bhatia (1967) defined agricultural efficiency as, “The aggregate performance of various crops in regard to their output per acre.

Respondent: Respondent refers to the rural poor being involved in SPFS project activities and included in the sample.

Resilience: The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and way of functioning, capacity of self-organization and the capacity to adopt to stress and change.

Rural household: A group of individuals live together and take food from same kitchen are treated as one household and households situated in the rural areas are considered as rural household.

Study group: The group of respondents who participated in the Climate Field School organized under DCRMA project.

Village: Smallest geographic unit of a rural area which is known to the people as village. A village always has a known name.

Vulnerability: It is the degree by which a system is susceptible to or unable to cope with adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude and rate of climate change and variation to which a system is exposed, it's sensitivity and it's adaptive capacity. Climate change vulnerability is assessed by applying the equation; Vulnerability=Hazards x risks/capacity.

CHAPTER II
REVIEW OF LITERATURE

The term climate change is now a day's neither any imagination nor only propaganda, it is a reality. It is now a local, national and global concern. Effects of climate change have made an alarming excitement among the scientists, researchers, political and civil societies throughout the world. United Nations Framework Convention on climate change (UNFCC) has been organizing conference of parties (COP) to find out the solutions to minimize the ongoing and future hazards of climate change. COP 24 had been held at Katowice Poland, from December, 2-14' 2018. It is reported that developing countries have made progress of 100 billion USD per year for adaptation and mitigation purpose (odi, 2019). Researchers are conducting study in different forms on different issues of climate change since 90s. Firstly to assess the present and future losses and damages in financial values, secondly what adaptation and mitigation measures are to be taken, what effects being exerting on livelihood due to climate change effects and so on. Climate Smart Agriculture (CSA), comes up with a new approach during, 2010. Users countries of CSA as reported by FAO are Africa, Asia, Latin America, and the Caribbean, Mexico and central America, Eastern Asia, West Africa, Southern Africa, Eastern Asia, South eastern Asia, Southern Asia. The countries that mentioned in the success stories of FAO on CSA practices are Kenya, Tanzania, Malawi, Vietnam, Zambia and Nigeria (FAO sourcebook, 2013).

In Bangladesh climate change adaptation although started since 2005 but the CSA approach initiation could be listed during 2010-2014 after the introduction of Climate Field School (CFS) under DCRMA project. In the year,2017 a review report had been documented by Two FAO expert on the title," Bangladesh's experiences with climate resilience agriculture and sustainable land management practices: moving forward for effective implementation "(Matieu and Saifullah (2017). The review was conducted under the project

titled" Addressing the 2030 agenda on climate change and food security through climate smart agriculture. Another booklet has so far been published by multidonor initiative on the title" Climate Smart Agriculture in Bangladesh Researchers from different sectors teachers, students, NGO workers started study on climate change and its effects on different horizons. No study till documented on CSA and its impacts on livelihood. The purpose of this Chapter is to review available literatures having relevance to the present study. Exhaustive efforts were made by the researcher to review the previous research works directly or indirectly related to the present study in home and abroad. The researcher has tried his best to collect needed information through searching relevant studies, journals and periodicals. The reviews are presented as bellows.

2.1. Impact of climate change on Agriculture

Intergovernmental Panel on Climate Change (IPCC) claimed that the world may reach a threshold of global warming beyond which current agricultural practices can no longer support large human civilizations." by the middle of the 21st century. In 2019, a report published in which it says that millions already suffer from food insecurity due to climate change and predicted decline in global crop production of 2% - 6% by decade (Amanda, 2019).

The effects of climate change are heterogeneous and region specific. For example, a rise in temperature with reduced and more variable rainfall has already affected the natural and physical ecosystems of Bangladesh, predominantly the northwest with its recurrent droughts and the southwest with rising soil salinity (Ahsan et al., 2011).

The temperature is rising all over the world due to global warming as a result of gas emission and anthropogenic activities. The ice-sheets of the Antarctica and glaciers of the Himalayas are melting quickly due to increased temperature. Being situated at the base of the Himalayas, Bangladesh suffers from various

natural calamities which impacted negatively on fish and fisheries of the country (Rahman, 2008).

Global average temperature has warmed and cooled many times in the twentieth century and is likely to rise constantly in the future mainly due to an increased concentration of Green House Gas (GHG) in the atmosphere. Without GHGs, the earth surface temperature was raised by 0.740 and 0.180 (1.33± 6.0F) during 20th century and scientists estimated that it could increase as much as 6.4^0c average in the 21th century (UNFCC, 2007).

Edward H. Allison (2004) predicted that during the next 50 years, temperatures in Bangladesh are predicted to increase by 1.1° C during the flood season and by 1.8° C during the dry season.

The effect of temperature on agriculture is complex due to a number of interplaying factors: However, while higher Carbon-dioxide levels and solar radiation theoretically can increase food production, heat stress, shorter growing seasons and higher evapotranspiration resulting in soil moisture levels being lowered counteract the former influences leading to overall lower production of most foodstuffs such as most varieties of rice, wheat and potato. Reductions in yield could potentially be as high as a 17-28% decline for rice and 31-68% decline in wheat production (Karim et al., 1999). So, 8% smaller rice harvests and a 32% smaller wheat harvests by 2050 now look likely (IPCC in Reid et al., 2007). Alam et al. (2009) found that the highest monthly rainfall (362.4mm) was occurred in July 2007 and no rain in December 2006 in the Basantapur beel under Natore district. The highest rainy day was recorded in 26th July, 2007.

IPCC predicts that precipitation will increase in high latitudes, and decrease in most subtropical land regions some by as much as about 20 percent. (IPCC, 2007). A holistic perspective on changing rainfall-driven flood risk is provided

for the late 20th and early 21st centuries Kundzewicz et al. (2014). Sea levels continue to rise due to climate change. It has already been observed that the mean annual water level in the southwest region is increasing by 5.5 millimetres per year (Rahman et al., 2011). The effects of sea level rise go beyond the gradual inundation of coastal land areas to include the intrusion of saline water into freshwater rivers and aquifers. About 10 to 25 millimeters of sea-level rise was observed over the 20th century and models predict continued rise in a range of anywhere from 20 to 90 centimeters within the 21st century (IPCC, 2013).

In a report published by CEGIS (2005) stated that in Khulna, Bagerhat and Satkhira districts of southwest region of Bangladesh, areas for transplanted Aman rice cultivation will reduce from 88% to 60% with 32 cm rise in sea level and 12% with an 88 cm rise in sea level

Rabi droughts in winter months affect boro rice, wheat and other crops grown in the dry season, most severely in the Barind Tract and west of Khulna division, severely in areas of the Chittagong Hilltracts, Northeast Sylhet Division and other parts of Rajshahi Division and slightly in remaining areas of western, northern and central Bangladesh (Selvaraju et al., 2006; Agricultural Research Council, 2005).

In fact, 60% of the cyclone related deaths that occurred worldwide between 1980 and 2000 were in Bangladesh (Nicholls et al., 2007). In 1991, a devastating cyclone hit the coastal region, accompanied by a tidal bore, which was between five and eight meters high with winds of up to 240 kilometres per hour that damaged rice and agricultural crops (Paul, 2009).

It is evident from the above discussion that climate change effects the production, productivity and resources. No research findings are being found relevant to address those affects. So there is a gap.

2.2. Impact of Climate Smart Agriculture on Agricultural activities

In different literature, a wide range of climate resilient interventions for crop production are suggested. The agriculture extension experts proposed eleven CSA interventions for all major crops of Bangladesh. Based on their judgment and field experience all interventions are identified, Matieu and Saifullah (2016). The CSA interventions in Bangladesh as identified by FAO are, Alternate wetting and drying (AWD) in rice cultivation, Saline tolerant and high yielding variety, Solar powered irrigation, Urea deep placement, Conservation agriculture, Short duration and high yielding variety, Agro forestry practices, Direct seeding of rice, Biogas production, Improved compost production and Ribbon retting of jute.

CFS conducted by DCRMA project introduced some validated technologies as CSA, LACC II, (2011). The technologies are zone based on disaster vulnerabilities. Study revealed that CSA is the solution towards food security through adaptation and mitigation practices.

Bhandari (2001) investigated the economics of irrigation, examined its impact, and analyzed the nature of technological change in rice production with different modes of access to irrigation. Data were gathered from 162 STW owner and 162 non-owner households in the Terai region of Nepal. Costs and returns analysis and Cobb-Douglas type of production function were employed to analyses the data. STW irrigation had a significant positive effect on cropping intensity, rice productivity, farm income and employment.

Dimithe et al. (2000) reported that for improving national food security, Mali government had always focused on expanding and intensifying production in the government managed irrigation schemes, which accounted for about 50% of domestic rice production. This paper used data from a survey of 334 selected farmers and secondary data for examining the potential contribution that these

undeveloped selected farmers could make to improve their food security and rice exports in Mali.

Mustafizur et al. (1995) analyzed the effects of irrigation on household income and food security based on a study of 200 households in five villages in a deeply flooded area of Bangladesh. The study findings indicated that irrigation increased net annual income and access to rice, and increased substantially the food grain production and calorie uptake of the households.

Study should be conducted for identifying the most popular technologies as to suggest the policy makers to continue support the CSA approach to make the country be secured in food production.

2.3. Impact of Climate change on farmers' livelihood

Nasreen et al. (2013) conducted a study on Climate change and livelihood in Bangladesh, revealed that 75% of the male respondents remain unemployed year-round indicating a poor livelihood condition. Poddar (2015) Showed Climate change effects farmer's livelihoods significantly.

No more relevant review on livelihood and it's association with climate change has been found. The above review represents the main components of livelihood security. Since they are interrelated to climate change effects the study has been under taken to review the situation in Bangladesh.

2.4. Adaptation to climate change

Climate Change Adaptation encompasses a broad range of human policies and activities primarily intended to reduce the risks posed by climate change. It includes both realized and expected risks, Nature.com (2019). Adaptation to climate change for agricultural sectors includes the resilient variety, cropping pattern, irrigation techniques, sustainable land management (SLM), early warning, research, subsidies, supply of inputs etc (Report ACPS, 2013).

Reviews indicate that farmers of different regions in Bangladesh are using adaptation technologies to continue the production and productivity as usual for their survival. An evaluation is necessary to identify which technologies are widely used by the farmers as an adaptation technology to combat climate change.

2.5. Impact of different interventions on farmers' livelihood

Ahmed and Roy (1988) conducted a study on development of communication and grassroots participation in the context of Bangladesh. They analyzed communication methods in order to assess their participation and development. The beneficiary households were from the programs of BRDB and BRAC. The analysis revealed that BRAC programs had performed better than BRDB programs in terms of effectiveness of development communication and grassroots participation.

Begum and Rahman (1998) also found that labor absorption for housewives in tailoring, teaching and other non-agricultural activities has been increased by 22% after their involvement with RDRS.

CIRDAP (1998) found that in nominal terms, the average household's income for the poor increased by 2% over the December 1995 to April 1997 period, whereas the increase was about 16% for the non-poor. They also found that most of the households reported their access to pure drinking water. The findings indicated that with the increase in income, consumption of the most households is also likely to be increased.

Ghosh (1997) carried out a study to examine the household and agricultural activities performed by participating members in PROSHIKA programs and found on an average per family total income of the beneficiaries under PROSHIKA programs increased by 164 percent and the total employment situation was better after participation of the respondents in Proshika activities.

Huq (2000) represented "The effect of BRAC membership on calorie consumption of the program participants". The analysis was based on the food intake data of 2061 households of the first round survey of the BRAC-ICDDRB joint research project. They found that only 25 percent of the total households had adequate calorie intake (>2310 Kcal/day). Calorie consumption was significantly higher among BRAC member households compared to non-members (<0.05).

Halder (1995) observed that credit encouragement shifted wage employment to self-employment among the rural poor, especially among the women. Ninety two percent of the loan money was found to use for productive purposes. Women's participation in income generating activities affected their behavior pattern and raised their status and self-confidence.

Hossain (1995) observed that higher educational level allowed the members for better utilization of the rural development program (RDP) inputs. Greenly et al. (1992) observed in their study that increased knowledge of rural women about BRAC had significant positive relationship with their improved living condition like cleanliness, use of tube well, sanitary latrines and better housing.

Islam (2016) in a study on "Impact of flower cultivation on farmers' livelihood" found that most of the farmers gained medium livelihood improvement through flower cultivation, while 13.9% had high impact.

Khatun et al. (1998) studied to determine the effect of BRAC membership on calorie consumption of the program participants. The analysis was based on the food intake data of 2061 households of the first round survey of the BRAC-ICDDRB joint research project. They found that only 25 percent of the total households had adequate calorie intake (>2310 K.cal/day). Calorie consumption was significantly higher among BRAC member households

compared to non-members (<0.05). Similar findings were also observed by Huq (2000).

Mazumder (2014) in a study on “Impact of microfinance program towards rural livelihood and empowerment status in Bangladesh found that microfinance appears to increase the basic rights of rural people and help improve quality of life; the positive changes are consistently higher in non-governmental microfinance recipients.

Morris and Banegas (1999) studied the impact of a rural development project on household food security and nutrition. A quasi-experimental study design was used to compare the experience of members of 13 Honduran smallholder farmers groups which had already received a year of credit and technical assistance, with another 13 groups which had just joined the project, and 13 control communities. All these communities were followed up for one year (April, 1997-March, 1998). Farmers participating in the project showed a greater increase in maize stores than farmers in the control communities. The impact of the project on the nutritional status of under 5's was a small improvement in their dietary diversity.

Mutert et al. (1999) studied that the present trend of land intensification in Southeast Asia's rice-based food production required a constant increase in production in order to maintain food security for the region's fast growing population. The impact of fertilizers applied with and without addition of farmyard manure (FYM) was studied during 3 years (1996-98) at two representative sites of alluvial and degraded soils of the Red River in northern Vietnam. The results indicated that fertilizer nutrients were necessary to support large scale productions of spring and summer rice at both locations.

Nguyen (2001) reported that Food Security Project had a positive impact on irrigation sector for rice production since 1996 in Senegal.

Nguyen et al. (2002) stated that the Red River Delta (RRD) in Vietnam has sufficient water resources and a high agricultural potential. Economic reform called "Doi Moi", in 1986 greatly contributed to the agricultural development of RRD. Water management system was improved, and land use was intensified and diversified. Rice production increased to meet food security. Agricultural development in RRD after "Doi Moi" was reviewed from the viewpoint of water management, land use and rice production that improved farmer's livelihood.

Parvin (1998) found that annual income of Grameen Bank (GB) member households increased by 126 percent against the non-GB members and mean income of GB household was found highly significant at 0.01 level between the previous GB household's income and the current non-GB household's income. She also observed that monthly savings per family rose from 34.25 taka to 293.75 taka. She further noticed that family asset increased by 41 percent after their involvement in GB.

Paul (1996) conducted a study on the impact of livestock program of BRAC in Sadar thana of Mymensingh district. The results of the study revealed that a substantial positive change have occurred in terms of increase in family income of the participants after their joining in the milk cow rearing and beef fattening program of BRAC.

Proshika (1999) reported that households participated in their programs earned on an average 22.2% higher than non-Proshika households, where Proshika female household heads earned on an average 68.1% higher and male household heads earned 28.6% higher than non-Proshika counterparts. The average household's asset was about 57% higher, their savings 239% higher and overall rate of return on investment was also 25% higher than non-Proshika households. They also reported that Proshika programs had contributed

positively in case of immunization and had more access to tube wells and better latrines than non-Proshika households.

Rahman (1993) studied the resource use efficiency, income and employment generation of homestead agro-forestry. The findings suggested that income, employment and social status, particularly of women in the study area increased substantially due to their involvement in the agro-forestry project.

Roy (1989) stated that most of the members were below poverty level before joining to the Grameen Bank. But soon after joining the Grameen Bank they recovered themselves from that type of reality and rapidly reached above poverty level.

Roy (1989) stated that most of the members were below poverty level before joining to the Grameen Bank. But soon after joining the Grameen Bank they recovered themselves from that type of reality and rapidly reached above poverty level.

Rahman and Khandaker (1994) observed that all the three credits programs (BRAC. BRDB and Grameen Bank) were successful in expanding the opportunities of self-employment.

Robinson (1991) while assessing impact of NGOs in rural poverty alleviation in India found that NGOs had some success in improving the income and consumption levels of the poor, but encountered difficulties in reaching the extreme poor. Moreover, success was heavily contingent on the existence of a favorable local environment, especially economic and climatic factors.

From the above reviews we can have an idea that interventions from government and non-government organizations to improve farmers' livelihood put an impact. Specifically. we can't draw inference upon those impacts are

due to practicing Climate Smart Agriculture. So, there is a gap of study in that issue.

2.6. Farmers socio economic characteristics and its relationship with impacts on livelihood improvement

Aktar (2000) reported a positive and significant relationship between the farm size of the rural poor and their decision making role in the family with regard to development activities.

Alam (1997) observed that the level of education of the farmer revealed significant positive relationship with the use of improved farm practices. Studying the use of improved farm practices regarding rice cultivation by the farmers he observed that the farm size had a significant relationship with their use of improved farm practices in rice cultivation.

Ali (2008) in his study "Adoption of selected ecological agricultural practices by the farmers "showed that among the benefit parameters obtained by the farmers from ecological practices; Social benefit ranked first followed by technical, economical and psychological benefits.

Basak (1997) in his study entitled "Impact of BRAC Rural Development Activities as Perceived by the Participating Women" showed that the age of rural women under BRAC had no significant relationship with their impact of involvement in BRAC Rural Development activities.

Begum (1998) noted that family size had no significant relationship with their poverty alleviation as a result of involvement in ASA activities.

Biswas (2003) reported that extension contact of rural women had positive and significant relationship with their accessibility to family decision making.

Hasan (2015) in his study on "Role of FFS in diffusion of IPM practices in rice cultivation as perceived by the farmers" find that; Knowledge on IPM practices had significant contribution on role of FFS. Stepwise multiple regressions exposed that result. Islam (2016) in a study found that knowledge on sunflower contributed 2.3% impact on farmers' livelihood improvement.

Hossain (1990) also found that age did not have any significant relationship with crop yield.

Hossain (2009) in his study found that education has significant and positive relationship on farmers' livelihood made by food security project interventions. This study found that family size has significant and positive relationship on farmers' livelihood made by food security project interventions. His study found a significant and positive relationship of annual family income on farmers' livelihood made by the food security project interventions. He found no significant and positive relationship of innovativeness on the farmers' livelihood due to SPFS project interventions. Study also found that knowledge had a positive and significant relationship on farmers' livelihood changing through project interventions.

Islam (2016) found that annual family income contributed 2.8% on farmer's livelihood of the sunflower cultivators. His study on the "Impact of sunflower cultivation on farmer's livelihood" found 3.5% contribution of the level of education on livelihood improvement. The study found that there is neither any significant relationship between the age of the farmers and the impact of livelihood of the sunflower cultivators nor any contribution of age on the livelihood improvement of sunflower cultivators.

Mazumder (2014) in his study on "Impact of microfinance program towards rural livelihood and empowerment in Bangladesh": a comparative study between the selected GO and NGO indicated that the changes in economic

indicators were comparatively greater in NGO respondents, while GO respondents made greater changes in family, social and political sector. Similarly microfinance respondents showed a greater effect than non-recipients in majority of the empowerment indicators.

Muttalab (1995) in his study observed that farm size of the farmers had a positive relationship with the adoption of improved potato cultivation practices.

Poddar (2015) in his study on "Effects of Climate Change on Rural Livelihood" showed positive and significant ($p<0.01$) relationship between farmers' knowledge and climate change adaptation.

Rahman (1995) while studying impact of farmers' knowledge on improved potato cultivation practices on their adoption by the farmers of Kajipur thana of Sirajgang district observed a significant relationship between the variables.

Roy (1997) while studying the factors associated with the extent of adoption of integrated pest management practices by the Boro rice growers in Sadar thana of Magura district found that age and farm size of the respondents did not show significant impact on the adoption of IMP practices.

Rahman (1986) in his study found that education had significant and positive relationship with the adoption of improved farm practices.

Saha (2001) found that family size had no significant relationship with their knowledge of pineapple cultivation.

Sarkar (1996) observed that there was no significant relationship between age of the respondents and their adoption of improved potato cultivation practices. Similarly, Karim and Mahboob (1986), Rahman (1995), Singh (1990), Sarker (2002) found that the relationship between the farm size and knowledge of the

farmers about BRRI dhan-29 was found significant. Chowdhury (1997) and many others also observed similar results. Sarker (1997) found that the level of education of the farmers had a positive and significant relationship with the adoption of improved potato cultivation practices.

Sultana (2018) in her study on "Effectiveness of Krishoker Janala for disseminating agricultural Information" showed that 11.3% respondents find high effectiveness of the ICT program Krishoker Janala for disseminating agricultural information.

Above review indicates that farmers' socio economic characteristics put impacts on livelihood where some have significant and positive correlation. Those also have contributions on livelihood improvement. No specific studies have been found on the change on livelihood indicators due to practicing Climate Smart Agriculture.

2.7. Concept of livelihood

A livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living: a livelihood is sustainable which can cope with and recover from stress and shocks, maintain of enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and in the long and short terms (Chamber and Conway, 1992).

Sustainable Livelihood Approaches (SLA) place people pack in the center of development rather than focusing on the resources that people use. So the principles of SL approach are people centered, holistic, dynamic, built on strength, promote micro-macro links, encourage broad partnering and aim at long term sustainability. The sustainable livelihood development is process oriented and interlocked with some complicated issues.

2.7.1. Livelihood outcome and food security

Livelihood outcomes are the achievements or outputs of livelihood strategies. The basic requirement for the improvement of livelihood of the household is to enhance people's strength (capabilities, assets etc.) followed by activities. The livelihood approach is founded on a belief that people require a range of assets to achieve a positive livelihood outcome. The major livelihood assets are the human, natural, financial, physical and social capitals. It is noted that a single category of asset which a person own is not sufficient to yield different types of livelihoods outcome. The main factors that affect livelihood status are the vulnerability due to shocks (e. g. drought, cyclone), trends (e. g. population), seasonality (e. g. change on weather), and transformation of structure (e. g. government organization/ non- government organization), and process (e. g. Laws and policies). Transforming structures and process within the livelihood framework are the institution, organization, policies and legislation that shape the livelihoods. They operate at all levels, from the most private to the most public (DFID, 2002). Depending on the vulnerability context and the transforming structures and process, the people undertake a range of activities and choice (including productive activities, investment strategies, reproductive choice etc.) in order to achieve their livelihood outcome (Samsuzzaman and Haque, 2002).

Amir and Ahmed (2013) made a study on climate change and its impact on food security in Bangladesh. The study conducted at Kalapara upazila under Patuakhali district, revealed that climate change events like high temperature, erratic rainfall, salinity intrusion etc has adverse impact on food security and livelihood as stated by 30% respondents.

Wichelns (2001) in his study indicated that the 'virtual water' was the key factor of production. The paper also discussed 'virtual water' by describing a nation's goals regarding food security within a broader framework that included other objectives such as providing national security, promoting economic growth,

and improving the quality of lives for the citizens. The analysis suggested that land, labor and capital must also be considered when evaluating a nation's production and trade opportunities to improve rural incomes and enhance food security.

Yadav et al. (1999) found that the major portion of a balanced diet is confined to cereals, and the production of cereals in India is greatly influenced by fertilizers, as most of the soils have a low fertility status. Balanced fertilizer application based on IPNS (Integrated Plant Nutrition Systems) on different agro-ecological zones proved useful. Adoption of a farming system approach throughout the country would help to increase cereal production for food security and balanced diet.

Zeller et al. (1998) observed that In Malawi, maize was the major crop and staple food, cultivation of which increased household income leading to improving food security. An analysis of determinants of adoption of maize crop significantly influenced its cropping shares and farm income.

2.7.2. Livelihood security

An issue that is linked to the issue of food security is livelihood security. It puts food security in a broader perspective. In general, security means stability and continuity, and livelihood security means security in the provision of basic human needs such as food, clothing, shelter, education and health. Thus, household food security can be seen as an integral part of livelihood security. According to Frankenberger and Mccastin (2001), the concept of livelihood security developed through the evolution of concepts and issues related to food and nutrition security. When a household's livelihood is secure, it should be food-secure as well. But a food- secure household might not be secure in terms of livelihood. The word "livelihood" originates from the word "live". The simple dictionary definition livelihood is a "means of living". Longman's contemporary English Dictionary puts this a bit more elaborately as "the way

by which one earns enough to pay for what is necessary" .The concept of livelihood is relatively new but is now widely used in poverty and rural development literature." It meaning can often appear elusive, either due to vagueness or to different definitions being encountered in different sources" (Ellis, 2000:7). Huq (2000:177) argues that "livelihoods encompass income, both cash and kind, as well as social institutions relating to kinship, family, neighborhood and village, women's groups and property rights required to support and to sustain a given standard of living. Livelihoods involve social and kinship networks for facilitating and sustaining diverse income possibilities".

The availability of resources and skills to utilize these properly is crucial in determining the dynamics of household level livelihood security.

The concept of livelihood has gained wide acceptance as a valuable means of understanding the factor that influence people's lives and well-being, particularly those of the poor in the developing world (Carney, 1999; Davies, 1996; Rennie and Singh, 1996; Bernstein et al., 1992). It has been embraced by a number of development agencies, with UNDP the first to do so fully and the Department for International Development (DFID) adopting it as central to its strategy for meeting the goals set out in its 1997 White Paper 'Eliminating World Property'.

'Livelihoods' has a number of meanings, and there are a number of definitions for the term. Clarity and rigor are therefore needed if the approach is to achieve its full potentials, a basis for robust developments initiatives that are in tune with the realities of what is and is not possible on the ground. One of the challenges involved is the presentation of a generic livelihood process model which is inclusive enough of a wide variety of empirical material – diversity of local circumstances being an acknowledged reality- but clear enough to provide a heuristic device for public discussion. There is a trade-off between

exclusivity and comprehensiveness on the one hand and usefulness and comprehension on the other. The model therefore must have analytical rigor as well as intuitive and discursive appeal.

Livelihood is a more tangible concept than 'development', easier to discuss, observe, describe and even quantify' (Rennie and Singh, 1996). 'Predominantly the poor of the world depend directly on the natural resources, through cultivation, eroding, collecting or hunting for their livelihoods. Therefore, for the livelihoods to be sustainable, the natural resources must be sustained' (Rennie and Singh, 1996). Ashley (1999) defined "Livelihoods as a multidimensional whole embracing all forces and constraints material and non-material in nature, which determines a families' existence." Ashley also stated that," Livelihoods are ways of keeping oneself meaningfully occupied by using one's endowments (human and material) to generate adequate resources to meet the requirements of the household in a sustainable manner."

As one of UNDP's five corporate mandates, sustainable livelihoods offer both a conceptual and programming framework for poverty reduction in sustainable manner. Conceptually, livelihoods denote the means, activities, entitlements and assets by which people make a living. Assets are defined as: natural/biological (i.e. land, water, common property resources, flora, fauna); social (i.e. community, family, social networks); political (i.e. (participation, empowerment); human (education, labor, health, nutrition); physical (i.e. roads, clinics, markets, schools, bridges); and economic (i.e. jobs, savings, credit).The sustainability of livelihoods becomes a function of how men and women utilize asset portfolios on both a short and long-term basis. Sustainable livelihoods are those that are:

- able to cope with and recover from shocks and stresses (such as drought, civil war, policy failure) through adaptive and coping strategies;
- economically effective;

- ecologically sound, ensuring that livelihood activities do not irreversibly degrade natural resources within a given ecosystem; and
- Socially equitable, which suggests that promotion of livelihood opportunities for one group should not foreclose options for other groups, either now or in the future.

Barrett and Reardon (2000) described livelihoods as being similar to a production function in that they are processes that map assets (akin to factors of production) to outputs. As such livelihoods cannot be compared because they are by nature processes. They also noted that the livelihood concept has tended to ignore the importance of prices and price risk, which are important determinants of income derived from livelihood strategies.

Chambers and Conway (1992) defined that a 'livelihood comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living: a livelihood is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels and in the long and short term'.

Carney et al. *(*1999) highlighted that CARE's livelihood approach is its primary programming framework, in use across its relief and development work. CARE sees this framework as an effective way to improve inter-sectorial coordination and thus increase the impact of its work. The approach is deemed to be sufficiently comprehensive to address the challenge of large-scale poverty, yet sufficiently flexible to address context-specific constraint. Three fundamental attributes of CARE's 5 livelihoods approaches are: the possession of human capabilities (such as education, skills, health, psychological orientation); access to tangible and intangible assets; and the existence of economic activities.

Drinkwater and Rusinow (1999) described that livelihoods can be made up of a range of on-farm and off-farm activities that together provide a variety of procurement strategies for food and cash. Thus, each household can have several possible sources of entitle men which constitute its livelihood. These entitlements are based on the endowments that a household has and its position in the legal, political and social fabric of society. The Centre for Environment and Society (2005) described that "livelihood comprises the capabilities, assets (including material and social resources) and activities required for a means of living, a livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its assets and capabilities whilst not undermining the natural resource base."

Carswell et al. *(*2000) mentioned that Sustainable Livelihoods Policy (SLP) research in Ethiopia has demonstrated that shortage of labour is often a critical constraint for poorer households in rural areas. While such shortages may result from a number of factors (including the position of the household in the demographic cycle and government policies such as forced recruitment of young men into the military), several SL case studies demonstrated how the prolonged illness or death of a person of working age is one of the factors most likely to push the whole household into poverty. People in all the study areas emphasized the threat to livelihood sustainability which ill-health represents, and access to health care was accordingly given a very high priority when they came to identify areas for action to protect livelihoods.

Ellis (2000) defined livelihood as the "assets, the activities, and the access to these that together determine the living gained by an individual or household". Household activities map into outcomes. Activities may lead to single or multiple outcomes. In certain circumstances, outcomes are directly linked to a household asset rather than obtained from a particular activity. The concept of livelihoods is, however, a dynamic concept that recognizes long-term planning by households.

The UNDP (2005) described livelihoods as the means, activities and entitlements by which people make a living. A livelihood system is a dynamic realm that integrates both the opportunities and assets available to a group of people for achieving their goals and aspirations as well as interactions with and exposure to a range of beneficial or harmful ecological, social, economic and political perturbations that may help or hinder groups' capacities to make a living. A livelihood is sustainable if it can cope with, recover from and adapt to stresses and shocks, maintain and enhance its capabilities and assets, and enhance opportunities for the next generation.

The UNDP (2005) highlighted that the sustainable livelihoods (SL) is a systemic and adaptive approach that links issues of poverty reduction, sustainability and empowerment processes (e.g. participation, gender empowerment, and good governance). The attractiveness of SL lies in its applicability to different contexts, situations of uncertainty and in its capacity as a consultative and participatory process for the cross-fertilization of ideas and strategies between various stakeholders. Those living in extreme poverty and outside the formal labor market, for example, constantly improvise their livelihood strategies due to high uncertainty and limited options. A subsistence farmer in the off-season or during drought becomes a wage laborer and could later revert back to farming when it is time to plough the field. The SL approach has the flexibility to tap into such kinds of adaptive responses and utilize them as entry points for policy making.

Singh and Perpetua (1995) described that sustainability and vulnerability are "processes" and not events. Livelihood systems and groups (i.e. individuals, households, communities) on the above-mentioned continuum are dynamic in nature. Based on the specific configuration of this space, livelihood systems can be located at a certain point on this continuum. Additionally, accounting for vulnerable and sustainable livelihoods as processes that allows us to view the relationship between, for example, economic growth and social equity, or even sustainability and vulnerability not in either/or

terms, but as more complex relationships where the existence of such contradictions is a part of the process.

Saleh and Swaminathan (1993) described that sustainable livelihoods are derived from people's capacity to make a living by surviving shocks and stress and improve their material condition without jeopardizing the livelihood options of other people's, either now or in the future. This requires reliance on both capabilities and assets (i.e. stores, resources, claims and accesses) for a means of living. One of the ways to understand SL systems is to analyze the coping and adaptive strategies pursued by individuals and communities as a response to external shocks and stresses such as drought, civil strife and policy failures.

The DFID (1999) described that the livelihoods approach is a way of thinking about the objectives, scope and priorities for development. The livelihoods approach puts people at the center of development. This focus on people is equally important at higher levels (when thinking about the achievement of objectives such as poverty reduction, economic reform or sustainable development) as it is at the micro or community level (where in many cases it is already well entrenched). The sustainable livelihoods approach is broad and encompassing. It can, however, be distilled to six core objectives. DFID aims to increase the sustainability of poor people's livelihoods through promoting: (i) improved access to high-quality education, information, technologies and training and better nutrition and health; (ii) a more supportive and cohesive social environment; (iii) more secure access to, and better management of, natural resources; (iv) better access to basic and facilitating infrastructure; (v) more secure access to financial resources; and (vi) a policy and institutional environment that supports multiple livelihood strategies and promotes equitable access to competitive markets for all.

The DFID (1999) further described that the sustainable livelihoods framework presents the main factors that affect people's livelihoods, and typical relationships between these. It can be used in both planning new development activities and

assessing the contribution to livelihood sustainability made by existing activities. In particular, the framework provides a checklist of important issues and sketches out the way these link to each other; draws attention to core influences and processes; and emphasizes the multiple interactions between the various factors which affect livelihoods. The framework is centered on people. It does not work in a linear manner and does not try to present a model of reality. Its aim is to help stakeholders with different perspectives to engage in structured and coherent debate about the many factors that affect livelihoods, their relative importance and the way in which they interact. This, in turn, should help in the identification of appropriate entry points for support of livelihoods. The asset pentagon (human capital, social capital, natural capital, physical capital and financial capital) lies at the core of the livelihoods framework within the vulnerability context.

The Oxfam (1999) highlighted its livelihood approach through accommodating issues of environmental change together with concerns about globalizing markets, deteriorating economic rights, gender and wider social inequality and the need to strengthen deprived peoples participation in the development process. It stresses that sustainability needs to be looked at from several perspectives like: economic (e.g. the functioning of markets, credit supply); social (networks, gender equity); institutional (capacity building, access to services and technology, political freedom) and ecological (quality and availability of environmental resources).

Roy (1998) highlighted that UNDP's sustainable approach includes poverty eradication, employment and sustainable livelihoods, gender, protection and regeneration of the environment, and governance. Sustainable livelihoods are those that are: able to cope with and recover from shocks and stresses (such as drought, civil war, policy failure)through adaptive and coping strategies, economically effective, ecologically sound (ensuring that livelihood activities do not irreversibly degrade natural resources within a given ecosystem) and socially equitable (which suggests that promotion of livelihood opportunities for one group should not foreclose options for other groups, either now or in the future).

Turton (2000) mentioned that the SL approach added value to the project design process. It encouraged a more holistic understanding of the needs and priorities of the poor and also drew attention to the importance of policy and institutional structures. This presented the DFID with a new set of challenges. How do projects prioritize their activities? Conceptually the projects illustrated the importance of drawing on past experience, existing skills, established partnerships and opportunities to *support positive directions* of change. Much of the success of such project was expected to depend on policy-led changes in the institutions and processes that provide the current framework of social and economic activity.

Shankland (2000) highlighted that sustainable livelihoods (SL) framework has now been adopted, tested and adapted. There remains a wide gap between bottom-up livelihoods analysis and top-down policy analysis. He argued that it is possible to use the SL approach as a starting-point for bridging this gap, but that doing so requires three elements which have so far been lacking: a model of the interactions between policy and livelihoods, which is consistent with the SL framework; a clearer understanding of the role of social and political capital within the framework; and an approach to policy analysis, structured to ensure that it can both draw on and feed into SL analysis.

Toufique (1999) highlighted in his study report that 'contests over state and non-state resources in the context of unequal power relationships amongst the claimants' were such a significant influence on livelihood strategies and outcomes that the SL framework should be modified to include 'political capital'. He also treats 'political capital' as effectively synonymous with power and therefore, as a factor at the intra-household and intra- community levels as well as in vertical relations with state structures. In a study he found that sustainability of natural resource base is perceived by farmers to be under serious threat. This is however, not encouraging for the sustainability of livelihoods. Livelihoods in rural Bangladesh depend greatly on land, either for production or for security. Both factors are affected by environmental degradation. In terms of livelihood creation, casual agricultural laborers have been

found to be employed, for a period of long enough to attain a gainful livelihood. Livelihood diversification into low productivity activities did not contribute much in terms of asset accumulation, but it did help the people to cope with uncertainties, shocks, and poverty.

Brock and Coulibaly (1999) as quoted by Shankland (2000) found that power inequalities based on ethnicity can be a major factor in social exclusion, which in turn accentuates the vulnerability of the excluded. The case of the village of Dalonguebougou in Mali's Southern Sahel illustrates that social difference within ethnic groups was found to play a more significant role in determining vulnerability. Dalonguebougou has been dominated by Bambara people since it was first settled over a century ago. They control access to land and water and had consistently refused to allow households belonging to the minority Maure ethnic group to dig wells from which to water their herds. The village also had a large number of Bambara farmers who came in recent years to cultivate fields within its territory, but who returned after the harvest to their villages of origin. These households belonged to the same ethnic group as the dominant households in the village.

However, they did not have the status of permanent residents, and relied on kinship obligations alone for the continued right to farm in Dalonguebougou. With increasing pressure on land in the village, these obligations came under strain. As a result, the livelihoods of the visiting Bambara were less secure than those of the Maure households, who despite their apparent second-class status in the village have developed long-term relationships with the resident Bambara which have proved robust enough for past attempts to expel them from the village to have come to nothing.

Keeley and Scoones (1998) described that the findings of the SL studies have highlighted the importance of migration, whether seasonal or longer-term, rural-urban or rural-rural, internal or international and in-households' efforts to construct sustainable livelihoods. However, while international migration may be a

high-profile policy issue in destination countries, it is rarely so in migrants' countries of origin. As a result, opportunities to enhance the livelihood impact of migration tend to be missed. Seasonal or temporary migration from one rural area to another is also a neglected policy area: the only form of rural-rural migration generally promoted by governments is that of permanent resettlement. Rural-urban migration, on the other hand, is more frequently acknowledged by policymakers, though the emphasis is on discouraging rather than facilitating it. Policy statements on the need to 'keep people in the countryside' ignore the fact that rural-urban migration is often temporary and involves not whole families but individual members of households, which remain rooted in rural areas. SL research has shown that far from encouraging the wholesale movement of households from rural to urban areas, migration by individuals contributes to the sustainability of the rural households from which they come. Above studies were not conducted to assess the impact of CSA

2.7.3 Different Livelihood Frameworks

Although the sustainable livelihood approach has been widely deployed as a guiding principle for rural development practice in the last few years, there is no unanimity regarding the origins of this approach. Singh (1995), for example, located the emergence of the “sustainable livelihood concept” in the United Nations World Commission on Environment and Development (WECD) popularly known as the Brunt land Commission after the Norwegian Prime Minister who chaired it even though the notion of sustainability precedes WECD.

Ellis (2000) suggested that the SL approach originated from strands of livelihoods ideas developed through the 1980s and 1990s (Chambers and Conway, 1992; Bernstein et al., 1992 and from famine analysis, Sen, 1981). This notwithstanding, it is clear that the sustainable livelihoods approach is firmly rooted in multidisciplinary research, which explained why it has been applicable in multiple geographical regions and sectors.

2.7.3.1. Livelihood framework as used by DFID (2000)

According to the Department for International Development (DFID) of the British government, the SL framework (Fig.1) has been developed to help understand and analyze the livelihoods of the poor. In addition to improving understanding of livelihoods, the framework can be used in planning new development activities and assessing the contribution of livelihood sustainability made by existing activities (DFID, 2000).

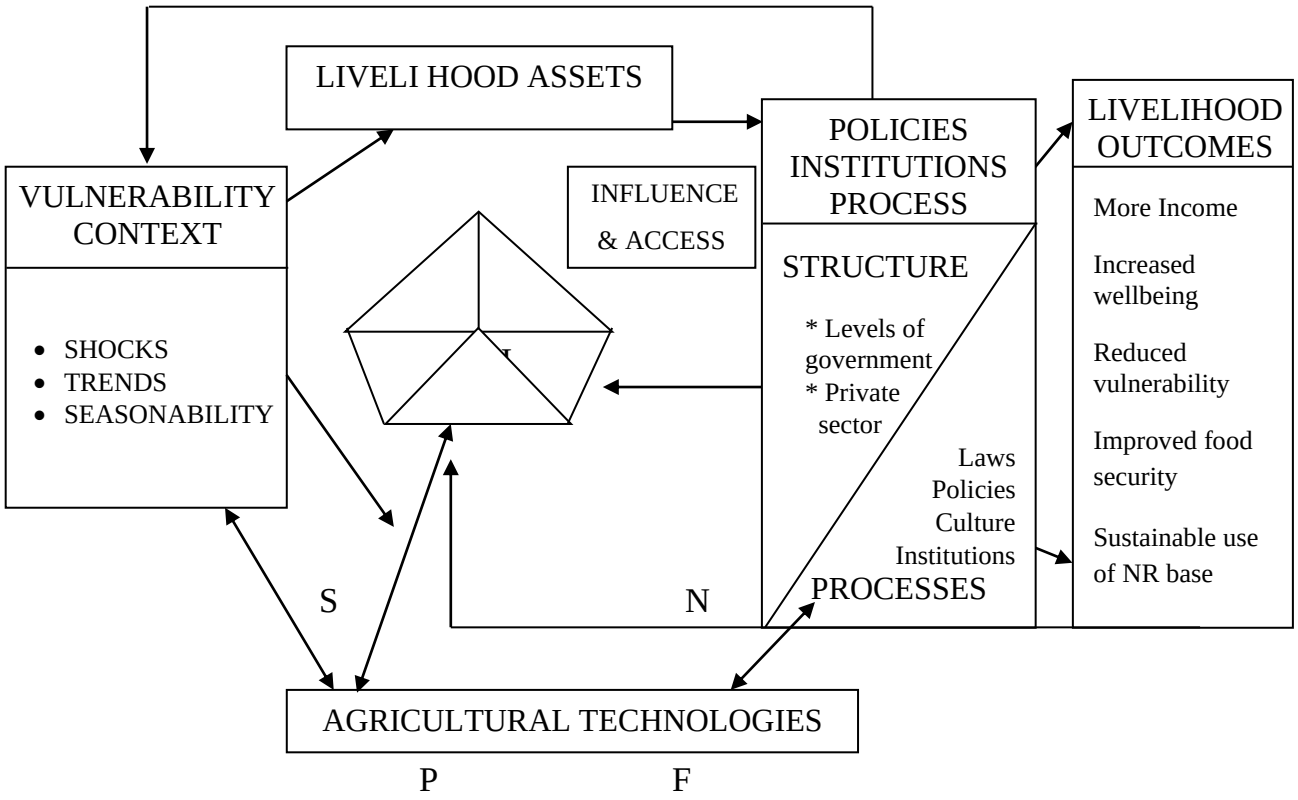


Figure 1. Livelihood framework as used by DFID (2000)

H – Human capital, S – Social capital, N – Natural capital
P- Physical capital, F – Financial capital

In the flow chart (Figure 1) livelihood assets which composed of human, natural, physical, social and financial capitals interact with policy, institutions and processes to shape the choice of livelihood strategies. These in turn shape the livelihood outcomes encompassing increased income, wellbeing, vulnerability reduction, enhanced food security, sustainable use of natural

resources base which are often the types of impact we are interested in. However, those outcomes are not necessarily the end point as the feedback into the future asset base. The policy reflects the vulnerability context that refers to things that are outside people control. The vulnerability context encompasses trends in population, resources and economic indicators such as prices, governance or even technology, shocks such as changes in human or animal health, natural disasters, sudden economic changes or conflict and seasonality in prices, agricultural production, employment opportunities, resource availability or health.

This model possesses the basic elements of livelihood components and being the basis for development of other models. The later models however, include some other external factors which are likely to influence and interact with the whole process.

2.7.3.2. Livelihood framework as used by Ashley (1999)

The framework starts with livelihood assets or capital endowments which include physical capital, financial capital, natural capital, social capital and human capital being as illustrated in Figure 2. Poverty analysis has shown that people's ability to escape from poverty is critically dependent on their access to assets (Booth et al., 1998).

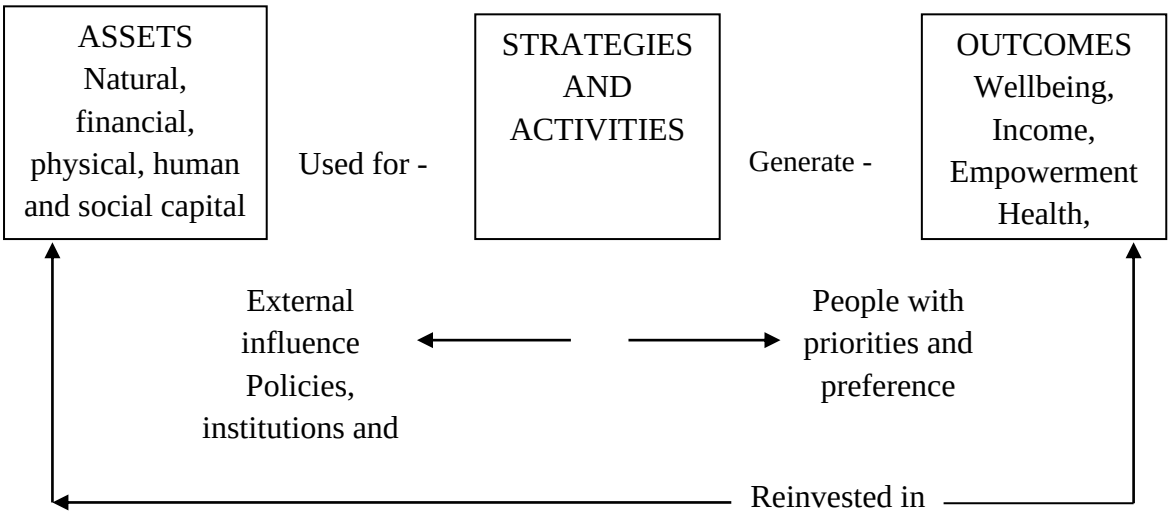


Figure 2. Livelihood framework as used by Ashley (1999)

Both the quality and quantity of assets matter along with the options to convert assets into productive activities. These capital assets and belongings need to interact towards achieving their ultimate goal. Those are the activities- what people do. Poor people usually pursue a diverse portfolio of activities including on farm activities e.g. crop production, livestock and poultry rearing, fish culture and off farm activities like various types of income generating activities. These matters helps people earn and increase their income level and eventually bring wellbeing, empowerment, health improvement and reduce vulnerability.

Sometimes institutions, organizations and policies that affect the assets and opportunities available and their productivity e.g. government policy, formal organizations (farmers group, local authority) and internal institutions which include social norms, market network, credit system, discrimination etc. Nevertheless, vulnerability context is the external environment in which people operate. The natural, demographic, and economic context shapes people access to assets and shock and trend to increase their vulnerability.

People's own priorities help shape their livelihood strategies may never be articulated but they nevertheless influence people's choice of which activities to combine which outcomes to pursue and which assets to invest in. for example, reducing vulnerability and coping with flood may be priority for some, others may choice for investing in family education. The various components of livelihood are closely interrelated; change in one often leads to change in others.

2.7.3.3. Livelihood model of Blaikie and Soussan (2000)

Like other models described earlier, the following model (Figure 3) as given by Blaikie and Soussan (2000) starts with vulnerability context which has been identified by market price of some commodities that is likely to disrupt the normal lifestyle of the people. Social norms and political agenda like hartals,

bandh etc. greatly influence the vulnerability. Population growth, ill health and natural disasters - all these elements are available with vulnerable context. The vulnerability context being influenced by some external agents.

The external institutions encompasses policy framework, legal institutional and economic context of a country, even a person can disrupt or affect the livelihood of a person. The commodity- local institutions context has been another external element to consider for vulnerability context. The natural resource destruction hampers greatly on environment which eventually changes weather and climate cycle and may cause on vulnerability context.

People need to face all the vulnerability threats and stand up with strengths to cope with the circumstances called coping strategy (short term responses to immediate shock and stresses). These conditions start with entitlement and access they possess to the resource base in their locality. These in turn called natural capital available to their household. The natural capital is one form of livelihood assets represented by the pentagon (financial capital, socio-political capital, physical capital and human capital). These capital assets represent the capabilities and assets i.e. ‘the factors of production’ that the household can deploy to make living. The entitlement box is consequently a part of the access of the household.

Taken together with those assets people deploy various livelihood strategies e.g. farming, labor, various household activities and different off-farm income generating activities which become a part of household budget. This income is in turn allocated a second key set of decision called the income strategy. Income can be allocated to saving or investments that enhance the value of assets to pay for inputs (fertilizer, raw materials, labor) that go into production and finally to consumption that is a part of outcome. A part of production is spent for social payment, e.g. taxes, loans etc.

The interaction among various elements take place in livelihood framework may vary from people circumstances and way of undertaking the livelihood strategy in various situations. Figure 3 illustrates livelihood framework as used by Blaikie and Soussan (2000).

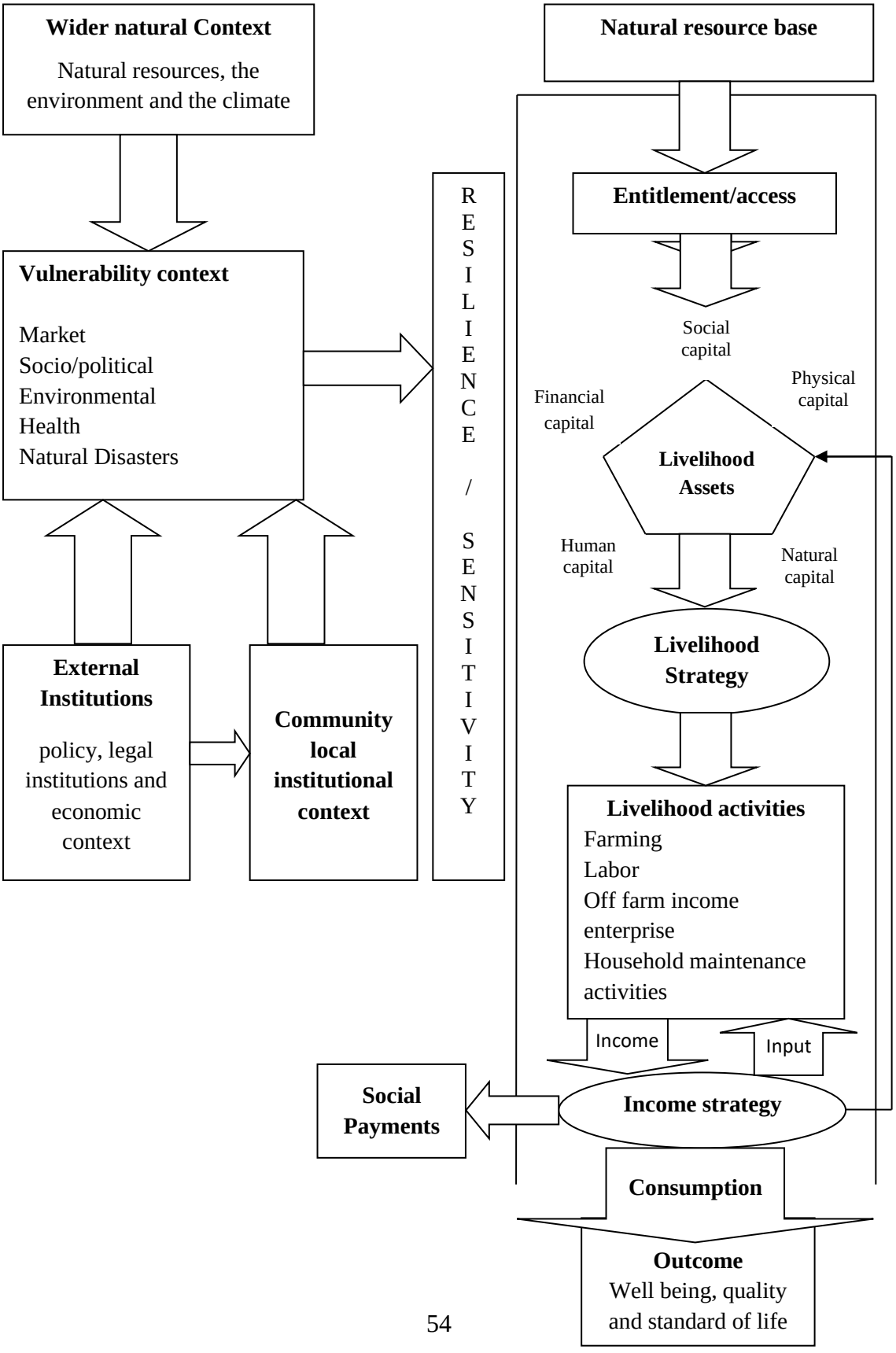


Figure 3. Livelihood framework as used by Blaikie and Soussan (2000)

2.8. Research gap prevailed so far in livelihood and its relevant models

Different researchers, Institutions find livelihood differently that reflects in the above mentioned review. The frameworks of livelihood are also based on dissimilar components. Concepts and studies are reflecting the periods during late 90's and early 20th. Recent studies are yet absent to find out the relevancy among climate change, climate Smart Agriculture and livelihood. This study might be able to find out the new components of livelihood their contributions and relevancy towards suggesting a new model.

2.8.1 Overall research gap

Above reviews represents that some of study have been conducted on the effects of climate change, farmers' livelihood, food security, and relevant field of agriculture. Most of the mentioned study reflects the vulnerability of climate change effects, forecasting natural hazards, identifying some adaptation technology etc.

Impact studies on some particular interventions are fewest. As discussed in the introductory chapter that CSA is a new approach especially for Bangladesh. Farmers of Bangladesh are practicing CSA upon receiving knowledge from CFS. No study on the impact of CSA on farmers' livelihood being found yet. In depth studies on CSA approach and recommendations based on that study could help the policy makers to support the approach to be broadly accepted in the field of agriculture production and productivity. This study is conducted to fill up the gap.

2.9 Conceptual framework of the present study

Based on the foregoing review of literature, a conceptual framework of the present study has been developed taking into consideration of major findings and applicability in the context of Bangladesh, with special reference to the

DCRMA Project of DAE. The framework envisaged that the Project interventions are expected to bring significant changes in the selected livelihood indicators that will ultimately improve their livelihood status. Project beneficiaries' personal, social, psychological and technological - knowledge related characteristics also expected to influence the level of change in livelihood status as a result of project interventions. This study has been conducted among two groups of farmers receiving and non-receiving supports. Predictors of both the group have been differentiated by selecting 13 and 10 relevant behavior. Both the selected groups are under climate change effects as situated in nearer agro ecological zone and practicing same agricultural activities as well. Same livelihood indicators have been considered to study the changes due to CSA and non CSA interventions. There might have difference in livelihood outcome among both the group. This difference might be treated as impact of CSA on farmers' livelihood (as presented in Figure 4).

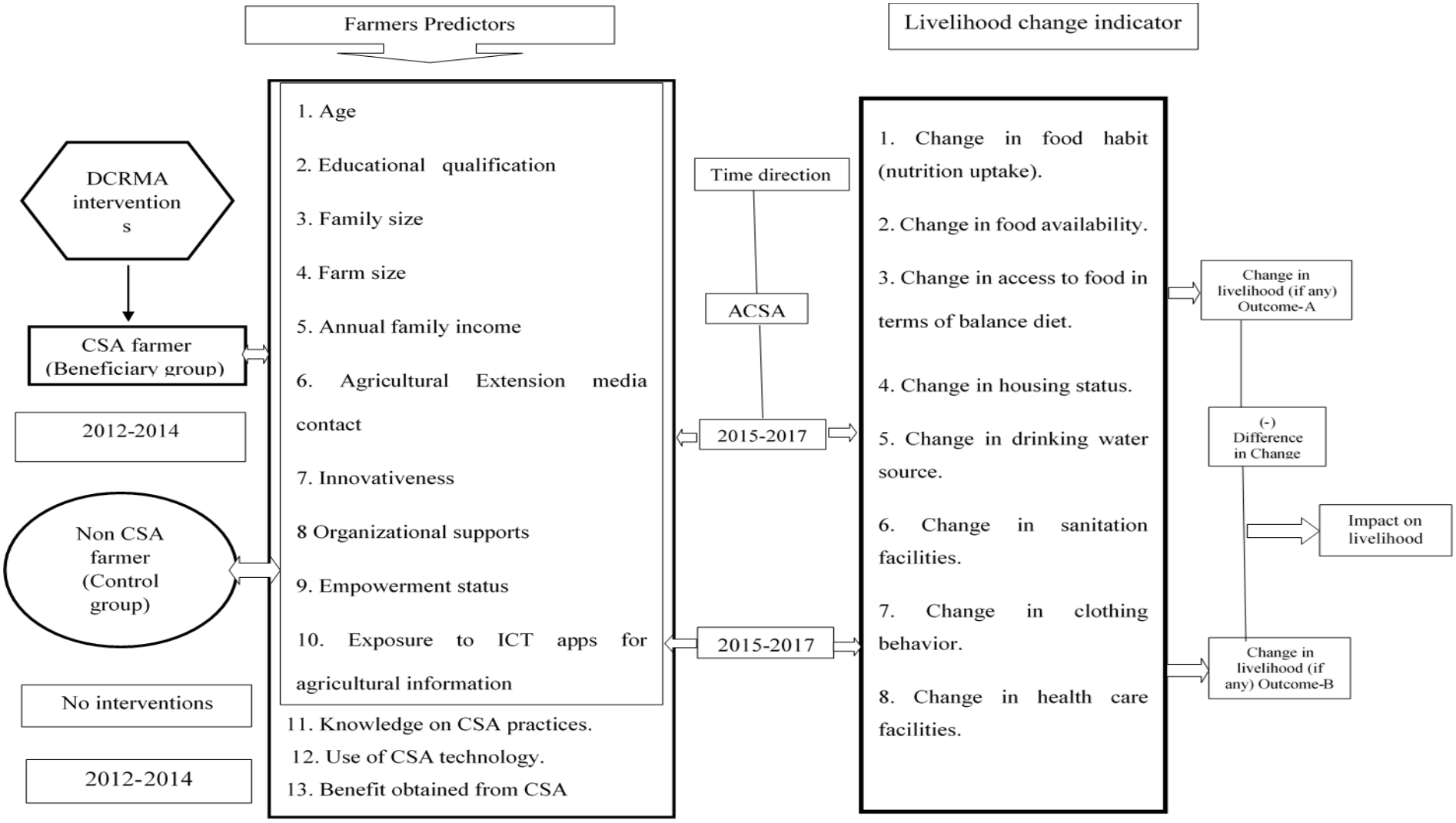


Figure 4: Schematic diagram of the conceptual framework of the study

2.10. Conclusion

In agricultural extension, the term evaluation being defined as an important tool to take any corrective measure on any agricultural intervention already implemented to achieve some benefit. In the same way impact study also helps any researchers to know the extent of benefit obtained by the target beneficiaries by using any intervention. This study titled “Impact of CSA on farmers’ livelihoods” will try to dig out the extent of change in livelihood already achieved by the CFS interventions those implemented under DCRMA project of DAE. It will also identify the knowledge and practices of adaptation and mitigation of climate change effects already popularized in the selected areas. Policy support could be made by this study for further improvements of existing practices and to be utilized in a wider range.

CHAPTER III
MATERIALS AND METHODS

3.1 Locale of the study

Four districts from southern part of Bangladesh namely Patuakhali, Barguna, Pirojpur and Barisal were selected for the study considering the vulnerabilities to climate change effects on agriculture and food security. Out of those Patuakhali and Pirojpur districts were under the CSA practicing areas and Barguna and Barisal districts were under the control areas. In the year 2010-2015 a multidonor project titled Disaster and Climate Risk Management in Agriculture (DCRMA) had been implemented in two Upazilas of patuakhali district namely Kalapara and Mirjagonj. Same project had been implemented in Nazirpur upazila of Pirojpur district. Under that above mentioned project three Climate Field School (CFS) were been organized participating 25 farmers in each. The study aimed to know what changes being observed in the livelihood of the CFS participating farmers after the interventions made by the project.

On the other hand, such type of interventions had not been recorded yet among the climate change victim farmers of Barguna and Barisal districts. Although, all of the four districts have been located in more or less same ecological zones but climate change effects for example, salinity, tidal surge, drought and high temperature are common hazardous events of all the selected districts. Amtali Upazila of Barguna district were selected as control area considering same climate change events and socioeconomic conditions of Kalapara upazila. In the same way, Banaripara and Babuganj upazila of Barisal district were selected as the control area considering the same socio economic condition of Nazirpur Upazila under Pirojpur District. Listed below are the villages from where data had been collected from the respondents to accomplish the research work.

Table 3. List of villages under study and control areas

Study areas			Control areas		
District	Upazila	Village	District	Upazila	Village
Patuakhali	Kalapara	Pachdunia	Barguna	Amtali	Shakharia
		Majidpur			
		Islampur			
	Mirzagonj	Rampur			
		Kismatpur			
		Sunapura			
Pirojpur	Nazirpur	Vimkathi	Barisal	Banaripara	Krishnapur
		Purba kathalia		Babugonj	Madhya Rakudia
		Pashchim Baychakathi			

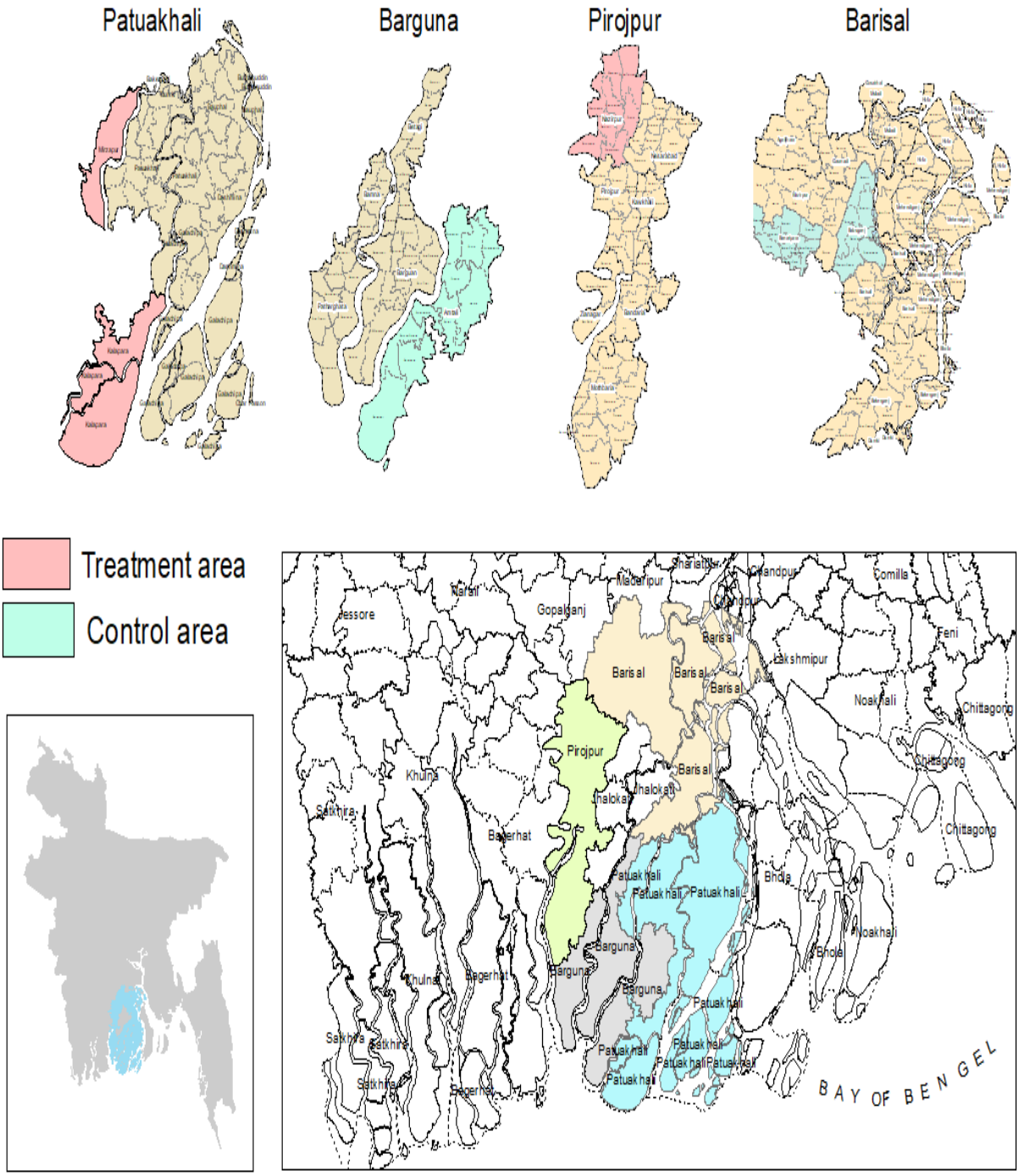


Figure 5. Map showing the study and control areas of different districts in Bangladesh

3.2 Unit of analysis

Male and female CFS participants whose are still engaged purely in agricultural practices were considered as the study group. Similarly both male and female farmers who never heard either CSA or CFS were considered as the control group.

3.3 Population and sample size

3.3.1 Population

Participants of the Climate Field School (CFS) conducted in the three upazila were the study group population of this study. DAE records revealed that there were three CFS in each of the Upazila participating 25 farmers' those constitute a total number of 75 farmers in each of the treatment Upazila. Therefore total number of population under these Upazila in this study for treatment group stands as 75x3=225 numbers of farmers.

On the other hand, one village from each of Amtali, Banaripara and Babugonj Upazila were randomly selected for control group study. Those villages were selected with the help of Upazila Agriculture officers of the respective Upazila. The villages were Shakharia, Krishnapur and Maddhyarakudia respectively. Total numbers of farming households of the three villages were 393, 320 and 370 which constituted the total population of 1083 farming households. Among the 1083 farming households, firstly a screening was conducted by using a simple question yes or no based on the source of income agriculture (crop) or non-crop, to identify the farmers having the profession of absolutely agricultural farming. Within the same questionnaire the farmers either received any climate related training or ever heard about CSA were excluded. It was found that among the 1083 farm families 83, 78 and 90 farmers from Shakharia, Krishnapur and Maddhya Rakudia villages were not absolutely engaged in crop agriculture and heard about CSA or CFS. Excluding those farmers from the population list, a total population of 832 (310+242+280) farmers were selected for the study under control group. Within the 832

farmers a pretest were conducted taking 5 % (15+12+13) farmers from each of the upazila to justify the validity of the instrument. Thus the total number of population of non CSA farmers in the control group under study stands as 792. The population from Shakharia, Krishnapur and Maddhya Rakudia were 295, 230 and 267 respectively. A reserve list of 5% farmers from each Upazila had also been maintained keeping 15, 12 and 13 farmers to fill the gap of any missing farmer those had not been included in the sample. Thus the population for the control group study stands as 752 farmers.

3.3.2 Sample size

(a) Study group: Farmers participating CFS were treated as CSA farmers. Since the number of CSA farmers were a small quantity in each upazila, so the whole 225 numbers of populations from the three upazila under the study were considered as sample. A pretest of the questionnaire were administered among the 5% of the sample respondent to test the validity of the instrument. A number of 15 farmers, 05 from each upazila had been kept in the reserve list to fill the gap of absence of any respondents during the interview period. As a result 27 farmers were excluded among the sample. Moreover a screening were conducted among the sample respondent with a question whether their earning source had been shifted other than agricultural farming? Under a yes no question it was evident that 10 (4+3+3) farmers shifted their profession from Agriculture, so they were dropped from the list. Thus the absolute CSA farmers stands as 188 that were treated as sample respondents.

(b) Control group: Farmers never been participated in any climate related group activities or never heard about CFS, even never received any training on climate change issue, were treated as non CSA farmers. Among the 752 population of the three villages 25% farmers were selected as sample. Proportionate random sampling technique was followed based on the number of population of the three villages to calculate the number of sample as equal to the sample size of study group. Thus the sample stands as 70, 54 and 64

farmers respectively from the selected three villages those made a total sample size of 188 farmers. Following table represents the population and sample size of both the study and control group.

Table 4. Population and sample size of the study group

Sl no.	Name of the districts	Name of the Upazila	Total CFS	CFS participants	Population (CFS member)	Pretest involving & other income farmers	Reserve list	Sample size
1	Patuakhali	Kalapara	3	25	75	8	5	62
		Mirzagonj	3	25	75	7	5	63
2	Pirojpur	Najirpur	3	25	75	7	5	63
	Total		9	75	225	22	15	188

Table 5. Population and sample size of the control group

Sl no.	Name of the districts	name of the Upazila	Name of the villages	population	Pretest involving & other income farmers	Reserve list	Actual population	Sample size
1	Barguna	Amtali	Shakharia	393	295	15	280	70
2	Barisal	Banaripara	Krishnapur	320	230	12	218	54
		Babuganj	Maddhya Rakudia	370	267	13	254	64
	Total			1083	792	40	752	188

3.3.3 Removal of endogeneity, attrition and attenuation bias

An earlier study by Pitt and Khandker (1998) showed that endogeneity program placement and program participation) is a serious issue; results could be misleading if endogeneity is not taken into account during estimation. In this study, program placement and program participation had been conducted in climate change vulnerable areas. To reduce spill-over effect i.e. to avoid the problem of information flow from CSA farmers to Non CSA farmers, study and control group were selected from separate Places. The Shakharia, krishnapur and maddhya rakudia villages are 70KM, 100KM and 120KM far away from the CSA practicing farmers' area. Two ways stratified random sampling had been used to keep the equity of the socioeconomic status among the treatment and control group farmers. Education and annual family income was the strata (Mazumder, 2015 and Haque, 2002). Education was categorized into three groups: group 1 (denoted E_1), respondents are illiterate or can sign only; and group 2 (denoted E_2), respondents have primary education; and group 3 (denoted E_3), respondents have secondary or higher education. Similarly, Family annual income was also categorized into three groups: group 1 (denoted H_1), low -income group (income up to BDT 60000 per year); group 2 (denoted H_2), medium- income group (income BDT 60001 to BDT 100000 per year); and group 3 (denoted H_3), high–income group (income BDT 100001 and above per year) (Mazumder, 2015).

Following table shows the two way stratified random data of the study and control group respondents based on their level of education as household income as strata.

Table 6. Showing the two ways stratified random data of the study and control group respondents.

Category	% respondents	No. of respondents from study group	No. of respondents from control group
E_1xH_1	10.11	19	19
E_1xH_2	8.51	16	16
E_1xH_3	8.51	16	16
E_2xH_1	13.83	26	26
E_2xH_2	11.70	22	22
E_2xH_3	11.70	22	22
E_3xH_1	11.70	22	22
E_3xH_2	13.30	25	25
E_3xH_3	10.64	20	20
Total	100.00	188	188

The attrition bias was excluded by conducting interview from the reserve list respondents whenever necessary. There would have been every possibility of this effect if some farmers of the control group were received any training relevant to climate change. It was minimized by selecting the farmers who never received any training on climate change issues until conducted their interview period.

Attenuation bias was excluded by interviewing farmers of young aged selected purposively.

3.4 Research design

A research design is the detailed plan of an investigation. It is the road map followed by a researcher to reach the end points of the study objectives through using appropriate methods, instruments and tools. The present study is an *ex-post-facto* survey type investigation. In *ex-post-facto* survey-type research, the researcher has no control over the variables; rather he/she only reports what has already happened or what is happening. This type of research is concerned with hypothesis formulation and testing, the analysis of relationship between the focus and predictor variables and arriving of generalisation. Unlike experimental method, where variables are deliberately arranged and

manipulated through the intervention of the researcher, in *ex-post-facto* survey research, variables that exist or have already occurred are selected, observed, and analysed.

The present study was conducted to compare the livelihood improvement status of the CFS participating farmers (study group) over the farmers who never participated (control group). Those farmers were selected as CFS participating farmers who received training and support under the DCRMA project. The livelihood standards were assessed both before and after intervention of the CFS. To collect relevant information from different sources (e.g. respondents, published and unpublished secondary sources), several methods such as interview, focus group discussions and review of information from different secondary sources (DAE reports on LACC-II project and DCRMA project reports) were used. To achieve the objectives, the study comprised of different steps/stages. First, the change in important livelihood dimensions of the sample beneficiary households was identified.

To compare the actual change in livelihood of the CFS participating farmers' data had been collected from a group of non CFS participating or non CSA farmers. The difference in standard of livelihood had been treated as the outcome of the CSA approach.

3.5 Preparation of data collection instruments

In order to collect relevant information from the respondents, interview schedule was used. The schedule was carefully designed keeping the objectives of the study in mind. The interview schedule contained both open and close-ended questions. The questions were arranged systematically so that the sample respondents can easily understand during its usage.

3.6 Validity of the Instrument

A panel of experts from SAU, BCAS, Action Aid, CCDB, FAO, UNDP, BAU and DAE verified the interview schedule to establish the content validity of the instruments (**Appendix-2**). Through email, the objectives along with the interview schedule was sent to some experts working under Consultative Group for Agricultural Research (CGIAR [1]), now termed as Consortium of the Agricultural Research centers (CGIAR[2]). Based on the experts' opinion from home and abroad the preprimary interview schedule was drafted. Before finalization, the interview schedule was pre-tested. After pre-testing and assessing, the schedule was modified through incorporating necessary correction with the aim of enhancing understandability by the respondents as well as improving reliability of the instruments. Then the researcher discussed with Advisory Committee and statistician about the nature of the data and problem encountered by the researcher during pre-testing. Based on the discussions, researcher's observation and experiences from the pre-testing period, the interview schedule was corrected, modified, edited and finalized.

3.7 Reliability of instrument

It refers to the precision or accuracy of the measurement of score. It had been done by applying Test –Retest method. Scale developed to test on knowledge, use of CSA technology, and benefit obtained from CSA were conducted by the reliability test. A single form of test was administered through a primary pretest of the interview schedule. After pretesting, same interview were conducted after 15 days interval. These two tests yielded two independent sets of scores. Correlation test of the two results showed a positive and significant correlation that ensured the reliability of the interview schedule.

3.7.1 Reliability of climate change knowledge scale

The reliability of knowledge on climate change scale was measured by split-half method. The scale was administered to 24 farmers by taking 8 from each of 3 CSA upazilas of the study area (based on a portion of final data). All the

items of the climate change knowledge scale were divided into 2 equal halves. These two sets of items, one with odd numbers and the other with even numbers were the major two components of the scale. The coefficient of correlation between the two sets of score was computed and the value was found to be strongly significant (0.748) at 0.000 levels with 22 degrees of freedom. The reliability co-efficient, thus obtained indicated that the 'internal consistency' of the CSA knowledge scale developed for the present study was quite okay. Thus the reliability of use of CSA technology, and benefit obtained from CSA were conducted.

3.8 Measuring impact indicators and impact assessment

Generally three methods are used in impact assessment (Kothari, 1990). These are:

i. Before-after study without control;
ii. Post (after) study with control; and
iii. Before - after study with control.

In using the first approach, benchmark information. i.e. pre-intervention assessment of the situation is necessary. After pre-intervention baseline assessment study, the interventions are made and post–intervention data are collected at the end of the intervention. Here, benchmark data are considered as 'control'. Impact is measured subtracting pre-intervention values from the post intervention values. Main disadvantage of this method is: there exist no scopes to measure and assess the impact of non-intervention external impact indicators (variables) that may affect the beneficiaries over the period. In the second method, i.e. Post (after) study with control, in addition to the intervention area 'control' location is selected. At the end of the intervention indicators' data are obtained from the 'control' location are subtracted from the data of intervention area for assessing the intervention impact. In the third method, i.e. Before-after study with control, benchmark data are available for comparison between pre- and post-intervention. Impact of external variables (if any) is calculated by subtracting the changes that occurred in the 'control' location from the end-of intervention period.

Considering all pros and cons, the second method i.e. after study with control was the best choice of the researcher since no strong and authentic record had been available before or during the CFS intervention period. Recalling the respondents experience before the CFS participation was been used as the livelihood standard before CFS (Bhuiyan, 2019 and Moin, 2020)

3.9 Variable measurements

Summary of the variables measurement that could made them operational are given as follows.

Table 7. Measuring units and Operational technique of independent and dependent variables

Variables	Measuring unit	Operational technique
A) Independent variables		
Age	Actual years	Direct question
Educational qualification	Schooling years	Direct question
Family size	Number of family members	Direct question
Farm size.	Hectares	Direct question
Annual family income	Amount (TK.)	Direct question
Extension media contact	Score	Scale developed by Poddar, 2015
Innovativeness	Score	Scale developed by Poddar, 2015
Organizational support	Score	Scale developed for this study
Empowerment status	Score	Scale developed by Mazumder, 2014
Exposure to ICT Apps for agricultural information	Score	Scale developed for this study
Knowledge on CSA practices	Score	Scale developed by Ali, 2008
Use (Adoption level) of CSA technology	Score	Scale developed by Ali, 2008
Benefit obtained from CSA	Score	Scale developed by Ali, 2008
B) Dependent variable		
Impact of CSA on farmers' livelihood	Change in score (After-before interventions)	Scale developed by Mazumder, 2014. All score obtained from changes of score under each head like, food security, housing, drinking water, sanitation, clothing status, and

		healthcare facilities were measured under a scale in ascending order of livelihood changes. A livelihood index was developed through Normalization, weighting and aggregation of observed data under the eight dimensions of livelihood.

3.9.1 Measurement of the Independent Variables

I. Age: Age of the respondents refers to the period of time from birth to the time of interview. It was measured in terms of actual years on the basis of the statement of the respondents. A score of one (1) was assigned for each year of age.

II. Educational qualification: The education of a respondent was measured by giving one score for one of the successful schooling. Score (o.5) had been assigned for those who can sign only. A score of (0) were assigned for never schooling or illiterate. Non Formal Education equivalent score were calculated as stated by the respondent.

III. Family size: It was measured by total number of family members of the respondents.

IV. Farm size: It was measured by using the formula-FS= {A+B+1/2(C+D)+E-F},Where, FS means farm size, A=Homestead area (including pond & vegetable garden),B=Own land under cultivation=Land given to others as borga, D=land taken from other as borga, E=Leased in and F= leased out.

V. Annual family income: Annual family income of a respondent were measured by taking sum of income amount in taka earned by a respondent and other member of the family in a year from sources such as: crop sector, livestock and fisheries sector and non-agricultural sector.

VI. Agricultural extension media contact: Respondents were asked to indicate how frequently they have contact with 13 selected information sources to be replied as not at all, rarely, occasionally and regularly. Weights were assigned as 0 for not at all, 1 for rarely, 2 for occasionally and 3 for frequently contact. Thus the possible range of agricultural extension media contact score were 0-39, while 0 indicating no contact and 39 indicating highest extension media contact.

VII. Innovativeness: An innovation is an idea, practice or object that is perceived as new by an individual or other unit of adoption (Ray, 1996). According to Rogers (1962) the farmers are generally categorized into five categories on the basis of innovation adoption behavior. Those are termed as; innovators, early adopters, early majority, late majority and laggards. Innovativeness refers to the degree to which an individual relatively earlier in adopting new ideas than other members of a social system (Rogers, 1995). In this research, Farmers` categories were identified on the basis of innovativeness of the respondents. Innovator (Willing to take risk, have the highest social status, have financial liquidity), Early adopter (Highest degree of opinion leadership, higher social status, financial liquidity, advanced education), Early majority (Adopt an innovation after innovator and early adopter, have above average social status, seldom hold position of opinion leadership), Late majority (Adopt an innovation after the average participant, have below average social status, little financial liquidity, little opinion leadership), Laggard (show little to no opinion leadership, tend to be focused on tradition, lowest social status, lowest financial liquidity). Scores assigned for respondent's farmer in respect of innovativeness were as 5, 4, 3, 2, and 1 for innovators, early adopters, early majority, late majority and laggards respectively.

VIII. Organizational support: Question was framed to know from the respondents as to how many organizations were involved to provide all the

selected supporting facilities required by them. Score 1 was assigned for each of the organizations against each of the facilities. For example if the respondents received credit support from 3 organizations then score were 3. Collected information's were represented as number. It reflected how much organizations supported the respondents, in receiving some selected items of information to perform agricultural activities.

IX. **Empowerment status:** It was measured based on the respondent's access to the empowerment issues as mentioned in the interview schedule. Score, 3was assigned for the respondent's own decision, 2 for decision influenced by spouse or other members of the family, 1 for the decision influenced by the outsiders. Thus the score for empowerment status ranges from 13-39.

X. Exposure to ICT Apps for agricultural information: It was measured on total number of methods the respondent uses by adding the weights against his/her responses to some selected modern communication system. The respondent was asked to mention among the available ICT apps how many times per month he or she uses those in order to receive agricultural information. A score of 1was assigned for one time use of each apps. Sum of the total score indicated the total value of use of ICT apps by the respondent farmers.

XI. Knowledge level on CSA practices: Knowledge is those behavior and test situations which emphasized the remembering either by recognition or recall of idea, material or phenomenon (Bloom et al., 1956). In this study Climate Smart Agricultural knowledge would be indicated by the extent of understanding how they perceived the knowledge of implementing CSA technology and to what extent they are using those? It was measured based on the responses to a set of 30 questions by taking 6 from remembering 6 from understanding 6 from applying 5 from analyzing 4 from evaluating and 3 from creating related to adaptation and mitigation technology of climate change. Score of 2 was given

for each of the correct answer. Partial score was assigned for partial correct answer. Thus the range of score could be 0-60, while 0 indicating very low knowledge and 60 indicating very high knowledge on CSA practices.

XII. Use of CSA technology: Thirty five (35) items of CSA technologies were selected for this study. Those were finalized after thorough consultation with the relevant experts and searching available literatures. Among the items, 11 were selected from flood/tidal surge, 7 from salinity, 13 from drought and 4 from high temperature dimensions. Score of the items were assigned as 0, 1, 2 and 3 for never, rarely, occasionally and frequently use respectively. Total score of a respondent of use of CSA technology was determined by adding all the scores of the respondent against all the 35 items of CSA technologies. Thus the range use of CSA technology could be 0-105, while 0 indicating no use and 105 indicating highest use of CSA technology.

XIII. Benefit obtained from practicing CSA: For measuring this variable, items containing social, economic, environmental, technical and psychological benefits were selected after thorough consultation with the extension experts, researchers and from other available sources. A total of 13 items of benefits containing 4 social, 2 economic, 5 technical and 2 psychological items were arranged in the scale in order to have real feelings on benefits obtained from practicing CSA. The nature of responses from the respondents to the items was; 'highly benefitted', 'medium benefitted', 'little benefitted' 'not at all benefitted and scores were assigned as 3, 2, 1, and 0 respectively. Score of benefits obtained from CSA of a respondent as perceived by he or she were determined by adding up all the scores for all the responses of the items of that respondent. The possible range of score of benefits obtained from CSA of a respondent was 0 - 39, where 0 indicated not at all benefit and 39 indicated highest benefit obtained from CSA.

3.9.2 Measurement of impact of Climate Smart Agriculture on farmers' livelihood

Five security aspects such as economic, food, health, education, and empowerment are the basic indicators of livelihood security. Economic security is the dominating component followed by food (Rahman and Shaheen, 2010). Changes in the livelihood status of the respondents would be resulted from the intervention of CSA technologies. Hossain (2009), measured the impact on livelihood considering socioeconomic parameters mainly basic rights and food security aspects.

Mazumder (2014) measured impacts on livelihood considering three parameters, (a) Changes in basic rights, (b) Changes in poverty level and (c) Changes in empowerment. Since the researcher is going to measure the changes in livelihood under the impact of CSA, so this research considered mainly the food security aspects as included by FAO (2007). The livelihood dimensions under this study were: (I) per capita food consumption, (II) food availability, (III) access to food, (IV) housing status, (V) drinking water source, (VI) sanitation, (VII) clothing behavior and (VIII) healthcare facilities. A livelihood change index was computed to make the scores unit free. Analytical results helped to categorize the impact of Climate Smart Agriculture on Farmer's livelihood as low, medium and high impact.

3.9.2.1 Changes in per capita food consumption (nutrition uptake)

It was measured based on calculated nutritive value of the daily food habit of the respondent' family members. What type of food and how many times they are up taking? It was measured under the mentioned amount kg for each time breakfast, lunch, and dinner and other. The total daily average intake per person per day was converted into to nutritive value Kilo calorie following a standard chart (appendix -9). Score (1) were assigned for each 100 Kcal nutrition consumption ability per head per day. The change was obtained by

subtracting the value of before involving CSA from and after involvement with the CSA.

3.9.2.2 Food availability

It was measured as the mentioned total amount kg against each meal stocking ability. The category were 3meals, 21meals, 90 meals and >90 meals those were estimated as kg. Score 1 was assigned for each kg of food stock ability of the respondents. If he or she had the stock of 10kg for his or her survival, the score stands as 10. The change was obtained by subtracting the value of before Involvement with CSA from after involvement with the CSA.

3.9.2.3 Access to food

It was measured to examine the amount of balance diet taken against the essential food elements as carbohydrate, protein, fats and oils, vitamins and minerals. As referred by Neeti Joy chander (2018) the perfect balance diet for a person per day mentioned as those diet having fiber rich carbohydrate (25%), Protein (25%), Fat (10%), vitamin and minerals (40%). Farmers were asked to what extent they maintain their diet to make it balance. The total number of calories a person needs each day varies depending on a number of factors, including the person's age, sex, height, weight, and level of physical activity. In addition, a need to lose, maintains, or gain weight and other factors affect how many calories should be consumed. Estimated amounts of calories needed to maintain calorie balance for various age and sex groups are provided in (appendix-). These estimates are based on the Estimated Energy Requirements (EER) equations, using reference heights (average) and reference weights (healthy) for each age-sex group. For children and adolescents, reference height and weight vary. For adults, the reference man is 5 feet 10 inches tall and weighs 154 pounds. The reference woman is 5 feet 4 inches tall and weighs 126 pounds.

Estimates range from 1,600 to 2,400 calories per day for adult women and 2,000 to 3,000 calories per day for adult men. Within each age and sex category, the low end of the range is for sedentary individuals; the high end of the range is for active individuals. Due to reductions in basal metabolic rate that occur with aging, calorie needs generally decrease for adults as they age. Estimated needs for young children range from 1,000 to 2,000 calories per day, and the range for older children and adolescents varies substantially from 1,400 to 3,200 calories per day, with boys generally having higher calorie needs than girls. These are only estimates, and approximations of individual calorie needs can be aided with online tools such as those available at www.supertracker.usda.gov.

Score (1), were given each percentage of elements they mentioned. For example if they mentioned their diet were as rich as having carbohydrates 25% then they obtained score against carbohydrates were 25. If he or she mentioned all the elements the score stands 100, If it is 80% the score was 80 and less than 80% score stands as 50.The change was obtained by subtracting the value of before involvement with the CSA from after involvement with the CSA.

3.9.2.4 Changes in housing status

Score were assigned to know the housing status of a respondent as follows:

Types of houses	Scores
Katcha/mud wall with gulpata roof	1
Tin shed with tin/mud/bamboo wall	2
Tin shed with tin wall	3
Tin shed with brick wall (semi-pucca)	4
Tin shed high-rise hose	5
High rise Pucca (brick wall & roof)	6

The change was obtained by subtracting the value of before involvement with the CSA from after involvement with the CSA.

3.9.2.5 Change in drinking water source

Score was assigned to know the drinking water sources of a respondent as follows:

Drinking water source	Scores
Pond/river without treatment	1
Pond/river with simple treatment	2
Tube well not examined arsenic	3
Tube well with arsenic	4
Arsenic free tube well	5
Common/Others' tube well	6
Own tube well normal base	7
Own tube well high-rise base	8

The change was obtained by subtracting the value of before involvement with the CSA with after involvement with the CSA.

3.9.2.6 Changes in sanitation

Score was assigned to know the sanitation status a respondent as follows:

Types of latrine	Scores
No latrine/bush/field	0
Open pit/ kacha latrine	1
Sanitary ringslab latrine	2
Pucca latrine upon normal base	3
Pucca latrin upon high risebase latrin	4

The change was obtained by subtracting the value of before involvement with the CSA from after involvement with the CSA.

3.9.2.7 Changes in clothing behavior

Respondents were asked to mention how many sets of cloths on an average they used under the categories of ordinary, medium, high value and warm. They were also asked to mention their average value in BDT. Values of clothing were furnished as follows:

Cloth type	During (12-14)		
	No.	**Value (TK.)**	**Score**
Ordinary set			
Medi. value coarse set			
High value fine set			
Warm set			
Total			

Score 1 was assigned for equivalent 1000/= TK. value of cloths.

The change was obtained by subtracting the value of before involvement with the CSA from after involvement with the CSA.

3.9.2.8 Health care facilities

The respondents were directly asked to mention the healthcare facilities that their family members availed in both before and after intervention periods. The healthcare facilities of the respondents were determined based on the access to different types of medicare services. The selected types of services are: **pir/fakir** (who prescribes and provide water/oil/oral incantation, use of sacred amulet etc.), **homeopaths**, **trained village doctor** and **MBBS/specialist doctors**. Scores were assigned for using different types of medicare services were as follows:

Medicare	Score
Pir/Fakir	1
Homeopath	2
Trained village doctor	3
MBBS/specialist	4
Total	

Based on availing type of Medicare services healthcare scores of an individual respondent were estimated both for the pre- and post-CSA intervention period. The change was obtained by subtracting the value of before involvement with the CSA from after involvement with the CSA.

3.9.2.9 Key steps of composite livelihood Change Index (CLCI) development

In general, indicators in a dataset are incommensurate with each other, and have different measurement units. Therefore, normalization is the best way to make them comparable. The method of normalization should be determined based on data properties and the aim of the index. The handbook on constructing Composite Indicator (CI), discussed several normalization methods (OECD, 2008). Considering the pros (e.g. simplicity) and cons (e.g. presence of outliers which were observations point that were distant from other observations) of various methods, this study used max-min normalization method.

There is no consensus on how to determine the appropriate weight for an indicator. Researchers continue to debate suitable methods for weighting variables. There is a dichotomy between the participatory (subjective) and statistical (objective) methods of weighting. In the literature, equal weighting is the method most commonly used. Researchers (Munda, 2007; Bohringer et al., 2007) have also criticized the participatory approaches of weighting for their ‘‘arbitrary’’ nature, as well as their inherent lack of statistical and empirical foundation. On the contrary, recommended that equal weighting should be the standard and that the application of other weighting method should be properly justified. Although composite indices are subject to subjectivity, the application of objective methods to calculate indicator weight is increasing. The main reasons for using subjective methods are their methodologically soundness, their transparent nature, their impartiality and are thoroughly data-driven. From the policy perspective, these methods are inconsistent with the goal of CI (Munda 2007). Moreover, participatory methods do not fulfill the priorities of policy makers, who ultimately play the key role by investing on learning assessment. Keep in all consideration, this study used Equal weighting approach method of weighting.

Aggregation deserves particular attention, since it influences ‘‘compensation’’ or ‘‘marginal rate of substitution’’ among indicators (Munda, 2007). The determination of the right method depends on the purpose of CI and the nature of the subject being measured. Nardo et al. (2005) stressed that the aggregation employed should be strongly related to the method used to normalize the raw data. The condition for application of linear aggregation is that the sub-indicators should have the same measurement unit and further ambiguities due to the scale effects should have been neutralized. Geometric aggregation is suitable when sub-indicators are non-comparable and have strictly positive values in ratio-scale of measurement. Based on the data properties, this study used arithmetic summation to combine indicators within the dimensions with a view to minimize measurement errors and capture inconsistencies.

3.9.2.9.1 Normalization

Indicators were normalized to render them comparable. Attention needs to be paid to extreme values as they may influence subsequent steps in the process of building composite indicator. Skewed data were also identified and accounted. Normalization is required prior to any data aggregation as the indicators in a data set often have different measurement units. A number of normalization methods exist (Munda, 2007).

Min-Max normalizes indicators to have an identical range [0, 1] by subtracting the minimum value and dividing by the range of the indicator values. However, extreme values/or outliers could distort the transformed indicator. On the other hand, Min-Max normalization could widen the range of indicators lying within a small interval, increasing the effect on the composite indicator more than the z-score transformation.

Indicators measured using a scale is normalized by applying the min-max method. This method transforms all values to scores ranging from 0 to 1 by

subtracting the minimum score and dividing it by the range of the indicator values. The following formula was used to apply min-max:

$$X_{(0\ to\ 1)} = \frac{X_1 - X_{Min}}{X_{Max} - X_{Min}}$$

Where

X= 0 to1, the new value we wish to calculate, i.e. the normalized data Point within the range of 0 to 1.

Xi = Represents the individual observed data point to be transformed (raw data);

X_{Min}= the lowest observed value for that indicator;

X_{Max}= the highest observed value for that indicator.

3.9.2.9.2 Weighting and aggregation

Indicators were aggregated and weighted according to the underlying theoretical framework. Correlation and compensability issues among indicators need to considered and either be corrected for or treated as features of the phenomenon that need to retained in the analysis. The literature covers various aggregation methods, each with their strengths and weaknesses. For aggregating individual indicators into composite indicators, the Vulnerability Sourcebook recommends a method called 'weighted arithmetic aggregation'. This is a common, simple and transparent aggregation procedure. Individual indicators were multiplied by their weights, summed and subsequently divided by the sum of their weights to calculate the composite indicator (CI) of a vulnerability component, as indicated in the following,

$$CI = \frac{(I_1 * w_1 + I_2 * w_2 + \ldots In * w_n)}{\sum_{1}^{n} w}$$

Where, *CI* is the composite Index, *I* is an individual indicator (normalized data) of a livelihood dimension and *w* is the weight assigned to that indicator

dimension. Assigning a weight of (1/8=0.125) were given to each of the dimension. Indicators were simply summed and divided by the number of indicators.

3.9.2.9.3 Indicator Generation

The literature states that indicators provide a tangible contribution to learning development by measuring progress of economical, ecological, and social issues. Moreover, these indicators help to diagnose problems and to understand their underlying causes, which assist in monitoring progress to determine whether goals and targets are met. In addition, several national and international bodies observe policy maker's indicator-based development activities and evaluate their transparency and accountability. In this context, developing an indicator raises many challenges. Therefore, indicator generation needs a holistic approach since indicators reflect multiple motivations, for instance, advocacy, management, assessment, and decision making.

Freebairn and King (2003) have proposed an approach for the generation of indicators, illustrating the significance of key-players in the indicator development process. Many studies (Monroy-Ortiz et al., 2009) reported developing an indicator by adopting a participatory approach that was fit-for-purpose, integrative, and comprehensive in terms of the efficiency and effectiveness in formulating learning-compatible development strategies.

Moreover, expert-led indicator development with active participation of local stakeholders is recognized for consolidative assessment (Roy and Chan, 2012). The work of provided not only good guidance for indicator development but also gave a fair direction for overall assessment. To start with, previous literature (e.g. Roy and Chan, 2012; Sheheli, 2011 and Parveen, 2005) were reviewed and synthesized so as to obtain a potential set of indicators.

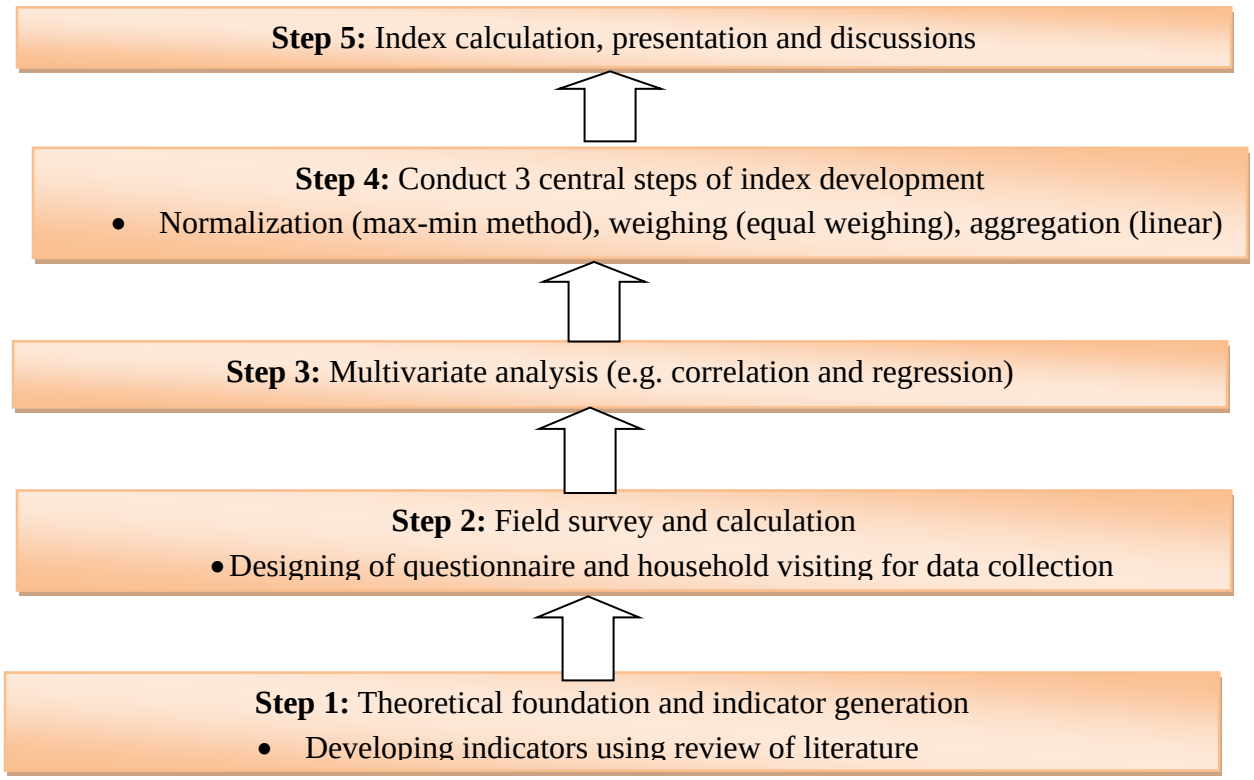


Figure 6. Methodology employed for the construction of the composite livelihood change index (CLCI) in the study

3.9.2.9.4 Determination of final impact score

After applying all the procedures and computing data, the results obtained as score. The scores were categorized to reflect the impacts of CSA on farmers' livelihood as low, medium and high impacts.

3.9.2.9.5 Indicators Selection

Measurements of indicators constitute an important task of social research. This section contains procedures for measurement of indicators and development of composite livelihood change index (CLCI) of the study. The composite livelihood change index (CLCI) is made up of 8 indicators and their specific measures, which are organized under the three dimension of learning: Social and Economic. The indicators were developed based on literature review and discussion with research supervisor (Appendix-5).

3.10 Problem faced in agricultural practices due to climate change

The respondents were asked to put their opinion about the extent of problem they have been facing during the periods (2012-2014) and (2015-2017). It was observed that the respondents faced various problems having different magnitudes. An attempt was made in this section to identify the major problems faced by the respondents with their magnitude.

Each problem faced by the respondents was rated against a 5-point rating scale as very high, high, medium, low and not at all. Score were assigned against scale were 5,4,3,2,1 and 0 respectively.

A Problem Faced Index (PFI) was computed for each problem by summing up the weights as under.

$$PFI = P_{vh} \times 4 + P_h \times 3 + P_m \times 2 + Pl \times 1 + P_n \times 0$$

Problem Faced Index (PFI) for each constraint strategies could range from 0 to 752 (188x4), where 0 indicating no problem and 752 indicating highest extent of Problem.

3.11 Data collection procedure

After preparing the final interview schedule data were collected through face to face interview during July, 2018 to December, 2018 by the researcher himself. To get valid and relevant information, the researcher made all possible efforts in explaining the purpose of the study to the respondents. Appointments with the interviewee were made in advance. In case of failure to collect information from the respondents due to their other business, re-visits were made with prior appointments.

While interviewing any respondent, the researcher took all possible care for establishing rapport with him/her so that the respondent did not feel any hesitation to furnish proper response to the questions and statements as included in the schedule. Questions were asked in multiple ways so that the

respondents could easily understand the content of the questions. If the respondents were not clear about what was wanted to know, supplementary questions were then asked for further clarification. Data were also collected through focus group discussion, from available published and unpublished secondary sources on related aspects for comparison of the conditions prevailed before and after intervention of CFS.

3.12 Data processing and analyses

After collection of data, all the information contained in the interview schedule was edited. All the collected data were then checked and cross checked, compiled, coded and entered into the XL sheets of computer for analysis and interpretation using SPSS program. Qualitative data were converted into quantitative by means of suitable scoring. Data were presented mostly in tabular forms, Statistical measures like number, range; mean and standard deviation were calculated in describing the selected characteristics of the respondents and changes in livelihood dimensions after involvement in CFS program. Parametric statistics such as t-test, analysis of variance, Step-wise multiple regression were conducted to determine the contributions of the farmers predictors and path analyses were used for exploring direct and indirect effects of those predictors.

CHAPTER IV
SELECTED PREDICTORS OF THE FARMERS

Behavior of an individual is largely influenced by his/her predictors. The major hypotheses of the study were formulated on the basis of expected changes in livelihood dimensions and possible influences of the respondents' predictors (independent variables) on the changes in livelihood status (dependent variable). These predictors are age, educational qualification, family size, Existing farm size, Annual family income, Agricultural Extension media contact, Innovativeness, Organizational support, empowerment status, Exposure to ICT apps for agricultural information, knowledge on Climate Smart Agriculture (CSA), Use of CSA technologies, Benefit obtained from CSA. Data were collected through face to face interview of the respondents from an enlisted sample. Two groups of farmers were interviewed treating CFS participating farmers as study group and never participating farmers as control group. In case of control group, among the 13 variables, last three independent variables as mentioned above were excluded. Collected data corresponding to relevant questions being statistically analyzed and obtained results are represented bellow.

4.1 Age

A report published in Dec 7, 2019 (Index mundi .com) - Information were included by sex and age group as follows: 0-14 years (children), 15-24 years (early working age), 25-54 years (prime working age), 55-64 years (mature working age), 65 years and over (elderly). Another article (Pubmed.gov) published by gerontologist 2002, Age categories documented as 18-35 yrs. as young, 36-55yrs as middle aged and >55 as older aged. However, in this study Respondents of both study and control group were classified into three categories (Table 8) on the basis of their age as done by Husain (2009).

Table 8. Distribution of the respondents according to their age

Categories (years)	Study Group				Control Group			
	Number	Percent	Mean	SD	Number	Percent	Mean	SD
Young aged (23-35)	37	19.68	46.54	10.19	34	18.09	46.57	10.99
Middle aged (36-50)	97	51.60			85	45.21		
Old aged (>50)	54	28.72			69	36.70		
Total	188	100.00			188	100.00		

Data represented in Table 8 revealed that highest proportion of the respondents of study groups were middle aged (51.60%). It indicates that middle aged farmers were very much responsive to be organized under CFS program. Middle aged respondent's (45.21%) are higher than the old age (36.70%) in control group. Young aged (19.68%) is very close to old aged (28.72%) in the study group. Comparatively A big difference exists among the young (18.09%) and old aged farmers' (36.70%) in the control group respondents. Different results were observed by Nasreen et al. (2013) in different study area where young aged respondents group was higher than the middle and old aged respondents groups. Poddar (2015) also found different variation in the age category of respondents. Mean value of farmers age in the treatment group are (46.54) with standard deviation (10.19). Both the values revealed that selection of respondents in both groups are mostly similar aged. Their agricultural experience may be same but livelihood standard may be different

4.2 Educational qualification

AS stated in Wikipedia, the 1997 International Standard Classification of Education (ISCED) describes seven levels that can be used to compare education internationally. Within a country these can be implemented in different ways, with different age levels and local denominations. The seven levels are:

- Level 0 – Pre-primary education
- Level 1 – Primary education or first stage of basic education
- Level 2 – Lower secondary or second stage of basic education
- Level 3 – (Upper) secondary education
- Level 4 – Post-secondary non-tertiary education
- Level 5 – First stage of tertiary education
- Level 6 – Second stage of tertiary education

In this study Educational qualification of the respondents' were categorized that is traditionally followed by different researchers and as categorized by Poddar (2015). It reveals that in both the study and control group observed ranges of educational categories were from (0-16) to (0-14) respectively. In the study group, highest percentage (39.89%) of the respondents belongs to secondary education categories followed by primary education (38.83%), where illiterate percentage were in a very minimum percentage (7.45%). In comparison the highest percentage (54.26%) of respondents belongs to the primary education level, followed by secondary education (31.92%) in the control group. In control group illiterate percentage of educational level were very minimum (10.63%). Results reflects a big difference among the Higher secondary and above level (13.83%) and (3.19%) respectively among the two group. Higher percentage of higher secondary and above level in the study group might be due to the farmers in the study group were selected from the members of IPM club where some highly educated farmers were interested to be the members of CFS. Following Table reflects the data.

Table 9. Distribution of the respondents according to their educational qualification

Categories (schooling years)	Study Group				Control Group			
	Number	Percent	Mean	SD	Number	Percent	Mean	SD
Illiterate (0)	14	7.45	6.89	4.26	20	10.63	5.02	3.40
Primary education (1-5)	73	38.83			102	54.26		
Secondary education (6-10)	75	39.89			60	31.92		
Higher secondary & above (11 &>11)	26	13.83			6	3.19		
Total	188	100.0			188	100.00		

Nasreen et al. (2013) found the same category of educational qualification as found in the control group whereas; Poddar (2015) found the same category as study group. National standard of education as published by BBS for the rural areas were 19.6% illiterate, 22.8% can sign only, 13% primary, 37% secondary and 7.6% belong to the higher secondary and above level, Poddar (2015).

4.3 Family size

The families in Bangladesh generally divided into three categories, namely, (a) joint, (b) extended, and (c) nuclear (www.JSTOR.ORG). In social research work different researcher categorized family size in different way. In this study, to describe the family size of the respondents, the category were followed as represented by Poddar (2015). Observed range of family size of both the study and control group are (2-9). Average size of family are also near about same as found (5.12) and (5.13) with a standard deviation (1.49) and (1.59) for both the group. Result indicates that the family size in all the study area is centered within 4-6 members. Nationally, the average family size is 4.5 people per household as studied by BAER research represented in December 6,

2018. Means that the average family sizes of both the areas are near about national standard.

Table 10. Distribution of the respondents' according to family size

Categories (No. of members)	Study Group				Control Group			
	Number	Percent	Mean	SD	Number	Percent	Mean	SD
Small family (1-4)	71	37.77	5.12	1.49	74	39.36	5.13	1.59
Medium family (5-8)	111	59.04			110	58.51		
Large family (>8)	6	3.19			4	2.13		
Total	188	100.00			188	100.00		

Table 10, reveals that both the group of respondents belongs to the medium family category (59.04%) and (58.51%) respectively followed by small family (37.77%) and (39.36%). Large family category are in minimum percentage (3.19%) and (2.13%) in both the cases.

4.4 Existing farm size

Existing farm sizes of the respondents were categorized as followed by DAE. Poddar (2016), also categorized farm holdings in the same way. In this study respondents farm size has been represented as follows (Table 11). Results revealed that most of the farmers of both the group belong to the small farm holders' category which is 66.99% and 61.17% respectively. It is followed by medium farm holders 31.91% and 34.04%. Large farm holders in both the group are in minimum percentage 1.60% and 4.79%.

Table 11. Distribution of the respondents' according to existing farm size

Categories (ha.)	Study Group				Control Group			
	Number	Percent	Mean	SD	Number	Percent	Mean	SD
Small farm (0.2-1)	125	66.49	0.997	0.658	115	61.17	1.19	0.719
Medium farm (1.1-3.0)	60	31.91			64	34.04		
Large farm (>3.0)	3	1.60			9	4.79		
Total	188	100.00			188	100.00		

Table 11 represents that the average farm size in both the groups are 0.999 ha and 1.19 ha respectively with standard deviation of 0.658 and 0.719. FAO in connection with BBS made a report on February'2016 that reveals 99% farmers of Bangladesh belongs less than 3 hectares of land. Data represented in Table 8 support the same figure.

4.5 Annual family income

Bangladesh's Annual Household Income per Capita reached 602.549 USD in Dec 2016, compared with the previous value of **439.888 USD** in Dec 2010 (Google). Annual family income categorization were followed as followed by Poddar (2015). Data reveals that majority of the farmers (48.94%) and (53.73%) from both the group belongs to the medium income category followed by low income (14.36%) and (22.87%)). In the control group low income respondents percentage is higher than that of the study group. On the other hand high income farmers percentage (36.70%) is higher that of control group (23.40%). Data indicates that Climate field School (CFS) participating farmers belongs to the study group could increase their income where there is a minimum percentage of low income category.

Table 12. Distribution of the respondents based on annual family income

Categories ('000'BDT.)	Study Group				Control Group			
	Number	Percent	Mean	SD	Number	Percent	Mean	SD
Low income (80)	27	14.36	157.46	75.86	43	22.87	136.61	65.12
Medium income (81-160)	92	48.94			101	53.73		
High income (>160)	69	36.70			44	23.40		
Total	188	100.00			188	100.00		

Table 12 reveals that the average family income of the respondents in both the group is 157.46 and 136.61 respectively with standard deviation showing 75.86 and 65.12. A web link in December 2016 represents that the average annual income of Bangladesh's households are near about 30000.00 (thirty thousand) BDT (www.ceicdata.com). The average figure in Table represents a higher amount. It indicates that the income of Bangladesh's households are increasing that might be due to Government's different development initiatives.

4.6 Agricultural extension media contact

Media contact is an important extension teaching method which plays a vital role in innovation decision process. It also helps farmers to solve their day to day problems to increase agricultural production and productivity. It is also the best way of learning, seeing, and getting feedback of an innovation. There are different types of media contact being subdivided in this study. Those are categorized and discussed in the following way.

Table 13. Distribution of the respondents based on extension media contacts

Categories (score)	Study Group				Control Group			
	Number	Percent	Mean	SD	Number	Percent	Mean	SD
No contact (0)	0	0	21.51	4.69	0	0	26.09	4.71
Rarely (1-13)	0	0			0	0		
Occasionally (14-26)	112	59.57			94	50		
Regularly (27-39)	76	40.43			94	50		
Total	188	100.00			188	100.00		

Table 13 represents that major portion of the respondents (59.57%) in the study group occasionally keep contact with extension media while in control group, it is slightly lower (50%). As mentioned in the table 9 (a) CFS participating group having fortnightly meeting with the extension agent were reluctant to make a regular contact with extension media.

4.7 Innovativeness

Innovativeness is important predictors of farmer. It is a variable mostly dependent on the degree of adoption of an innovation. Classifications of individuals are based on their willingness to try out a new innovation or new product. It is related to the Diffusion of Innovations Theory and has been applied to a number of studies, including marketing, organizational studies; knowledge management, communications and complexity studies, among others. Categories were first named and described in the landmark book "*Diffusion of Innovations*" by sociologist Everett Rogers in 1962. According to Rogers' research, there are five adopter categories — innovators, early adopters, early majority, late majority and laggards. Rogers identified key characteristics of each adopter category, such as the fact that early adopters have the highest degree of opinion leadership among the adopter categories, while the laggards are likely to be the oldest and most traditional individuals. In this study to identify the farmer's innovativeness category's score weight were followed, as followed by Poddar (2015).

Figure 7 represents that early majority of the farmers are belonging to the highest percentage (37.2%) and (36.17) % respectively in both the case of study and control group. On the other hand, innovator, early adopter categories are higher in the study group in comparison to control group. Besides, laggards' category is lower in the study group in comparison to the control group. It indicates that CSA farmers are more willing to adopt any innovation than those of non CSA farmers.

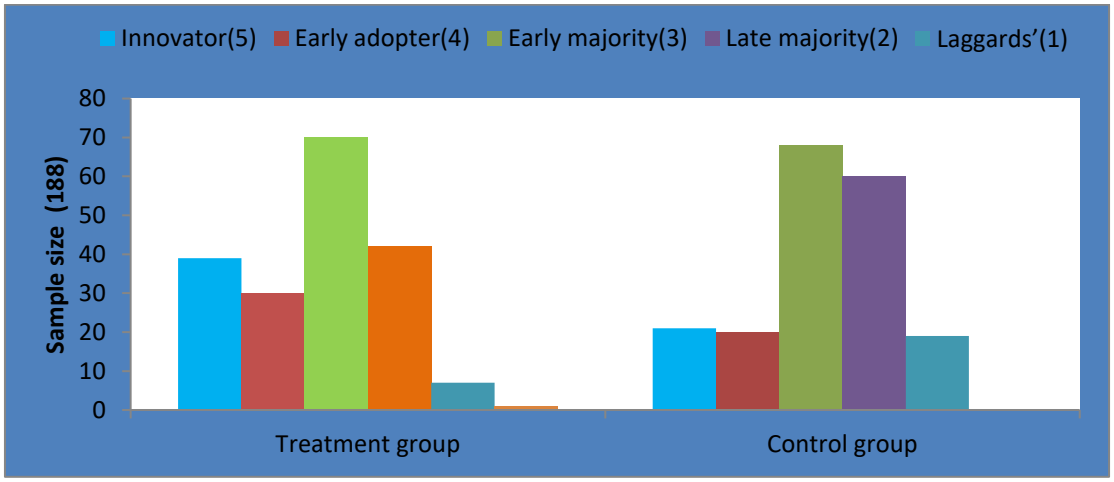


Figure 7. Graph showing the comparative distribution of the respondent's number based on innovativeness categories in both study and control group

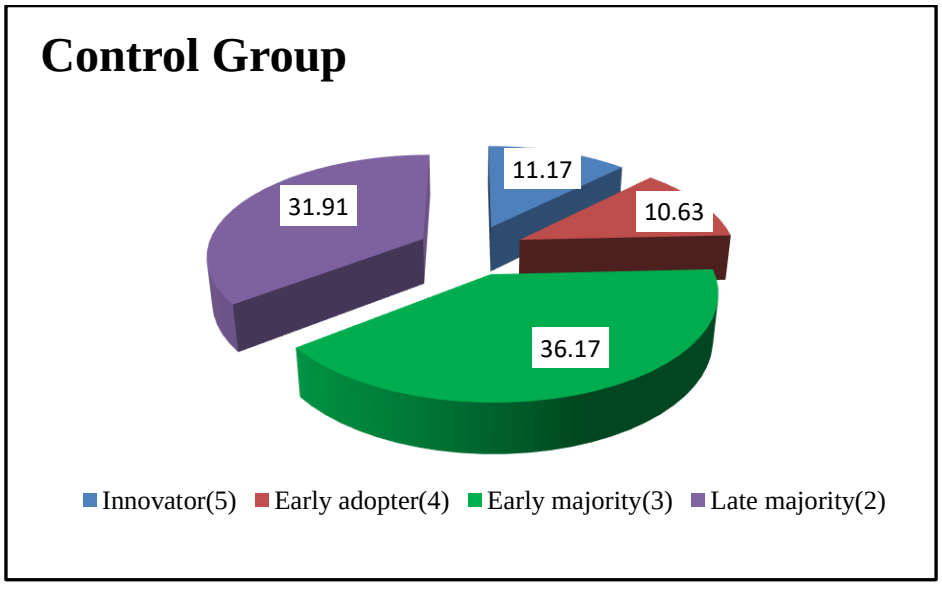


Figure 8. Percentage of the control group respondents based on innovativeness categories

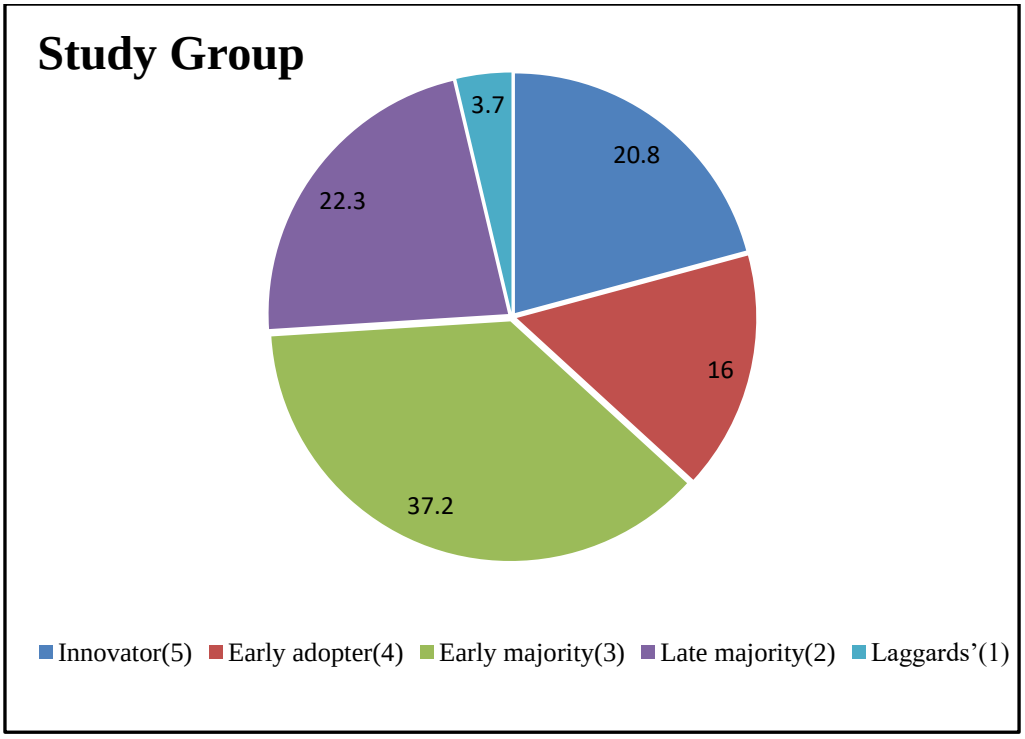


Figure 9. Percentage of the study group respondents based on innovativeness categories

4.8 Organizational support

To receive any support to perform agricultural activities is a natural character of farmers. It varies on the availability of the supporting organization and needs of the farmers. In this study, attempt were made to identify the degree of supports the farmers are receiving from the concerned organizations available in the study are against some specific needs. Categorization were made based on the observed range of score.

Table 14. Distribution of the respondents based on their extent of support received from the concerned organization available in the locality

Categories(score)	Study Group				Control Group			
	Number	Percent	Mean	SD	Number	Percent	Mean	SD
High support (16-21)	27	14.36	9.66	5.12	20	10.64	6.99	3.02
Medium support (11-15)	52	27.66			60	31.91		
Low support (3-10)	109	57.98			108	57.45		
Total	188	100.00			188	100.00		

Table 14 represents that majority of the respondents (57.98%) and (57.45%) in both the study and control area are receiving low support. It might be due to the resource constraints of those organizations available. On the other hand, high support receiving percentage (14.36%) is greater in the study area in comparison to the control area (10.64%)

4.9 Empowerment status

Empowerment as action refers both to the process of self-empowerment and to professional support of people, which enables them to overcome their sense of powerlessness and lack of influence, and to recognize and use their resources. It is a mental state which enables a person either male or female to do work with power. To describe empowerment status of the respondents in this study, the character had been subdivided into three dimensions. Mazumder (2014) made many subdivision of the empowerment dimension but in this study the categories were partially followed as relevant to the title of the research.

Figure 10, represents that considering all economic, social and political dimensions, extent of empowerment status is so high in the study group where, 71.28% respondents belongs to high status category. On the other hand only

21.28% in the control group respondents could achieve high status in all dimensions. It might be due to their less opportunity to increasing income, involving social or political activities.

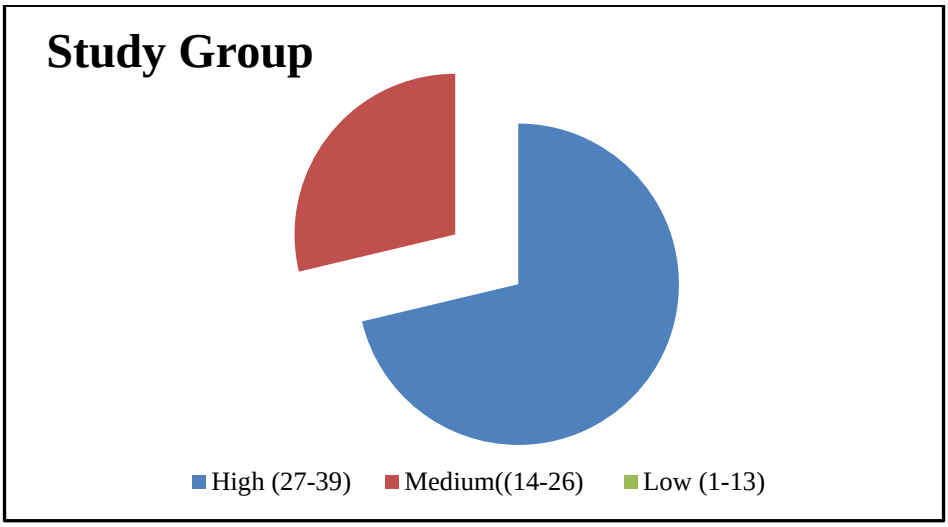


Figure 10. Percentage of the study group respondents based on empowerment status categories

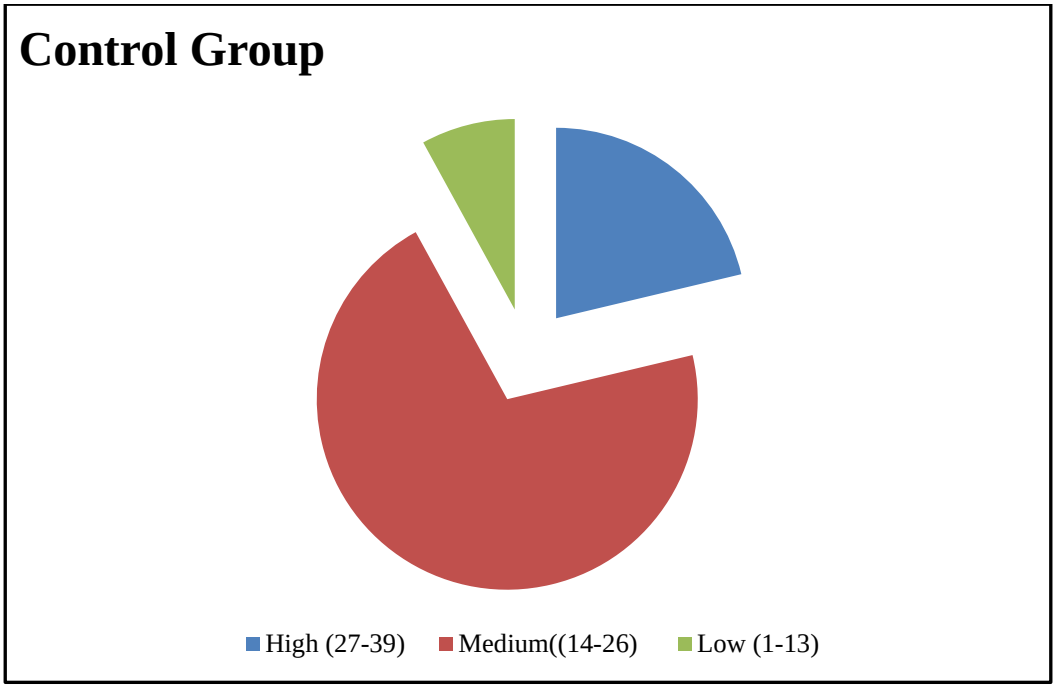


Figure 11. Percentage of the control group respondents based on empowerment status categories

4.10 Exposure to ICT apps for agricultural information

Information Communication Technology (ICT) could available at household level due to Government and nongovernment initiatives. It has also become an important media of communication for the farmers to solve their day to day problems and adoption of innovations as well. Farmers are now habituated with the use of apps like face book, U tube and call system, etc. This study tried to find out to what extent the available ICT apps are being used by the farmers in the study area to make some impact in their livelihood. The categories were made based on the observed score as against a question as how many times they used the ICT apps per month.

Figure 12, represents that the observed score of using ICT apps were (0-45). It is found that majority of the respondents 68.08% and 83.51% respectively in both the area have low exposed to ICT apps. Medium exposure percentage (30.32%) in study group is higher than that of control group (15.95%). Highly exposure percentage is also higher in the study group Results shows an increasing trend of using ICT apps by the CSA farmers. It indicates that they had some opportunity to learn about ICT apps better than those of control group.

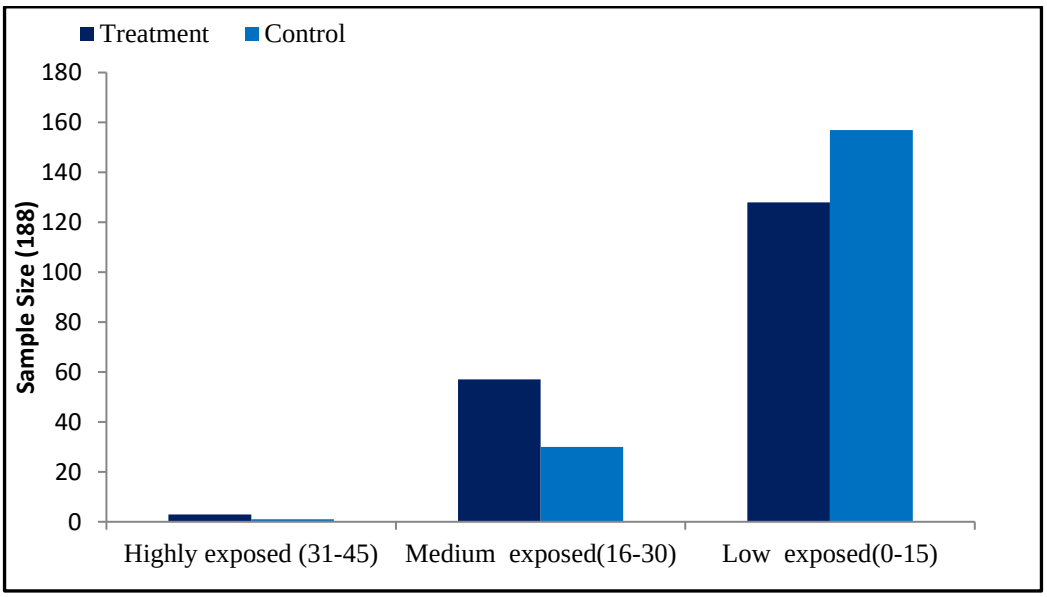


Figure 12. Graph showing the comparative distribution of the respondent's number based on Exposure to ICT apps

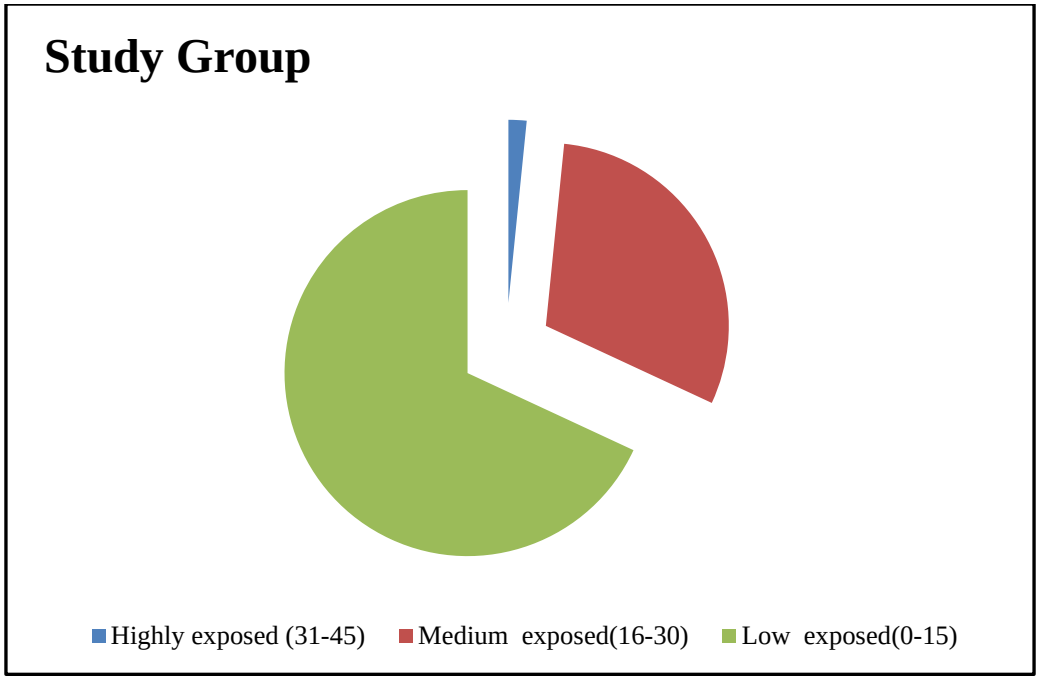


Figure 13. Percentage of the study group respondents based on exposure to ICT apps

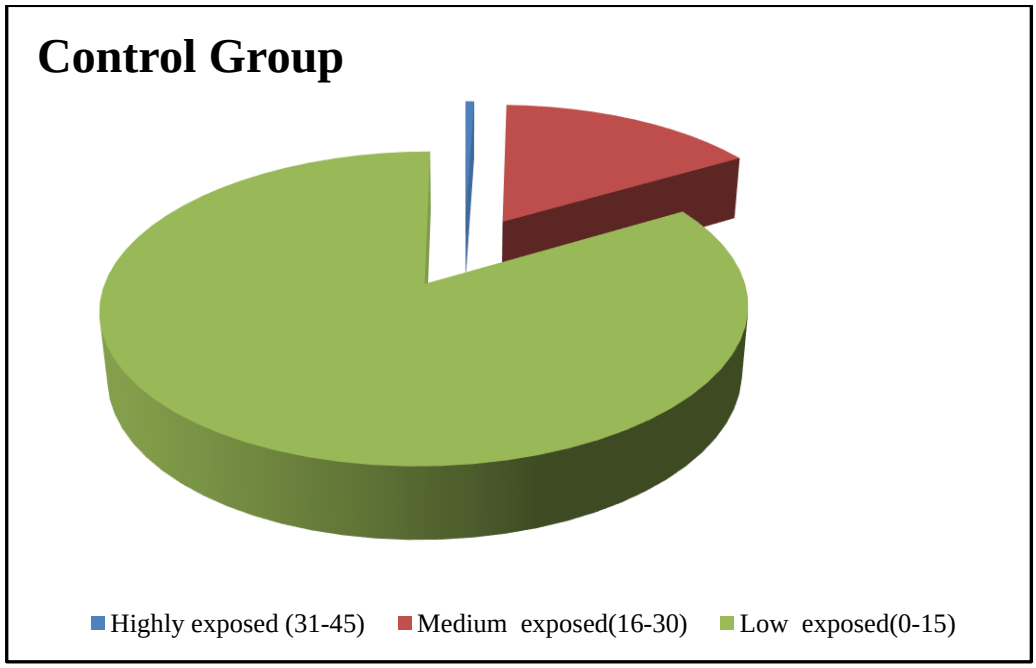


Figure 14. Percentage of the control group respondents based on exposure to ICT apps

4.11 Knowledge on Climate Smart Agriculture (study area only)

This part of interview was administered among the farmers of study area only who participated in Climate Field School (CFS). Under DCRMA project;

farmers of the study area had been given different technical support to improve the knowledge of the farmers to implement Climate smart Agriculture technologies. Questions were prepared upon considering different sections of knowledge as remembering, understanding, capturing, utilizing etc. Obtained results were categorized as represented in Table 15.

Table 15. Distribution of the respondents based on Knowledge on Climate Smart Agriculture

Categories(score)	Respondents		Mean	SD
	Number	Percent		
High knowledge (41-60)	105	55.85	43.03	9.96
Medium knowledge (21-40)	83	44.15		
Low knowledge (1-20)	0	0		
No knowledge (0)	0	0		
Total	188	100.00		

No respondents had been found having no knowledge or low knowledge on climate smart agriculture. Observed range was 21-58 against the possible range of 0-60. It means that CFS participating farmers paid attention to the lessons on adaptation technologies. Poddar (2015) in his study found that (82.6%) farmers had moderate knowledge on climate change. Islam et al in his study found that an overwhelming majority (78.8%) had medium to high knowledge on climate change effects.

4.12 Use of CSA technologies (study area only)

Farmers of the study area who only participated in CFS were interviewed to know the extent of use of CSA technologies. Questions were asked under different sections of climate change adaptation measures. The effects of climate change as observed in different dimension were taken into consideration as, flood, drought and salinity etc. Obtained results are represented in the Table 16 given some sub division of a, b, c, d and e under different dimensions.

Table 16. Distribution of the respondents according to their use of CSA technologies

Table 16 (a). Using technologies adaptation to flood/tidal surge

Categories (score)	Number	Percent	Mean	SD
No user (0)	0	0	16.15	4.77
Rarely user (1-11)	28	14.89		
Occasionally user (12-22)	141	75.00		
Frequently user (23-33)	19	10.11		
Total	188	100.00		

Most of the respondents (75%) were occasional user of the technologies adaptation to flood/tidal surge. This might be due to occasional occurrence of these events in the study area.

Table 16 (b). Using technologies adaptation to salinity

Categories (score)	Number	Percent	Mean	SD
No user (0)	0	0	8.51	3.48
Rarely user (1-7)	90	47.87		
Occasionally user (8-14)	83	44.15		
Frequently user (15-21)	15	7.98		
Total	188	100.00		

Technology adaptable to salinity was rarely and occasionally used by 47.87% and 44.15% respondents. This might be due to non-availability of suitable technology at suitable time.

Table 16 (c). Using technologies adaptation to drought

Categories (score)	Number	Percent	Mean	SD
No user (0)	0	0	16.09	4.79
Rarely user (1-13)	67	35.64		
Occasionally user (14-26)	116	61.70		
Frequently user (27-39)	5	2.66		
Total	188	100.00		

Most of the respondents (61.70%) were occasional user of the technologies adaptation to drought. This might indicate that drought is not a very regular event there.

Table 16 (d). Using technologies adaptation to high temperature

Categories (score)	Number	Percent	Mean	SD
No user (0)	0	0	7.51	1.62
Rarely user (1-4)	6	3.19		
Occasionally user (5-8)	135	71.81		
Frequently user (9-12)	47	25.00		
Total	188	100.00		

Most of the respondents (71.81%) were occasional user of the technologies adaptation to high temperature. This might indicate that either harmful effects do not cross the economic threshold level or suitable technologies are not available at suitable time.

Table 16 (e). Extent of using all adaptation technologies

Categories (score)	Number	Percent	Mean	SD
No user (0)	0	0	48.55	12.62
Rarely user (1-35)	20	10.64		
Occasionally user (36-70)	162	86.17		
Frequently user (71-105)	6	3.19		
Total	188	100.00		

It is observed that considering all the Climate change adaptation technology taught in the CFS, maximum respondents 86.17% uses those occasionally. It might either be due to resource constraints or occasional occurrence of the relevant events. Hossain in a study on "Analysis Gap between Farmers' Risk Perception and Use of Adaptation Strategies to Climate Change" found that about one third of the farmers use lower rate of adaptation strategies. Majority of the farmers (91.6%) were under low to medium user regarding use of

adaptation strategies. Only 8.4% farmers were under high user of adaptation practices.

4.13 Benefit obtained from Climate Smart Agriculture (study group only)

Obtaining benefit from any technology is one of the important aspirations of farmers. It is a natural character of the farmers having many dimensions as social, economic, technical and psychological etc. In this study attempt had been made to analyze to what extent in different dimensions and as a whole the CSA farmers obtained benefit from using the CSA approach. The following Table represents the results.

Table 17. Distribution of the respondents based on benefit obtained from Climate Smart Agriculture (study area only)

Table 17 (a). Social benefits

Categories (score)	Number	Percent	Mean	SD
Not benefitted (0)	0	0	9.67	1.80
Low benefitted (1-4)	2	1.07		
Moderately benefitted (5-8)	163	86.70		
Largely benefitted (9-12)	23	12.23		
Total	188	100.00		

It reveals that by adopting CSA technology, moderate to high social benefit were achieved by majority (98.93%) of the respondents.

Table 17 (b). Economic benefits

Categories(score)	Number	Percent	Mean	SD
Not benefitted (0)	0	0	4.38	1.12
Low benefitted (1-2)	5	2.66		
Moderately benefitted (3-4)	121	64.36		
Largely benefitted (5-6)	62	32.98		
Total	188	100.00		

Moderate to high economic benefit were achieved by most of the respondents (97.34%).

Table 17 (c). Technical benefits

Categories(score)	Number	Percent	Mean	SD
Not benefitted (0)	0	0	10.99	2.15
Low benefitted (1-5)	2	1.07		
Moderately benefitted (6-10)	91	48.40		
Largely benefitted (11-15)	95	50.53		
Total	188	100.00		

Technical benefit was achieved by 98.93% respondents similar to the social benefits.

Table 17 (d). Psychological benefits

Categories(score)	Number	Percent	Mean	SD
Not benefitted (0)	0	0	4.71	1.02
Low benefitted (1-2)	2	1.07		
Moderately benefitted (3-4)	102	54.26		
Largely benefitted (5-6)	84	44.67		
Total	188	100.00		

Psychological benefit was achieved by 98.93% respondents similar to the social and technical benefits.

Table 17 (e). Extent of Benefit obtained from CSA by the respondents

Categories(score)	Number	Percent	Mean	SD
Not benefitted (0)	0	0	30.14	4.43
Low benefitted (1-13)	0	0		
Moderately benefitted (14-26)	43	22.87		
Largely benefitted (27-39)	145	77.13		
Total	188	100.00		

It reveals that all the respondents (100%) were moderately to highly benefit by adopting CSA approach. Ali (2008) in his study on benefit obtained from ecological agriculture made a rank order of different dimension of benefit

obtained by the respondents. He found that social benefit ranked first, followed by technical and psychological benefits.

4.14 Brief representation of the farmers' predictors (study and control group)

In order to represent the farmers' predictor in a bird's eye view, statistically analytical results of all the selected predictors are shown in Table 18 and 19.

Table 18. Overall Predictors profile of the respondents farmers (Study group)

Sl. No.	Predictors	Measuring Unit	Range		Mean	SD
			Possible	Observed		
1	Age	Years	Unknown	29-80	46.54	10.19
2	Educational qualification	Years of Schooling	Unknown	0-16	6.89	4.26
3	Family size	No of family members	Unknown	2-9	5.12	1.49
4	Existing farm size	Ha	Unknown	0.2-4	0.99	0.66
5	Annual family income	'000"BDT	Unknown	48-427	157.46	75.86
6	Agril. Extension media contact	No. of contacting days	0-39	11-38	21.51	4.69
7	Innovativeness	Score	Unknown	2-5	3.42	0.96
8	Organizational support	Score	Unknown	1-21	9.66	5.12
9	Empowerment status	Score	0-39	11-38	28.70	5.05
10	Exposure to ICT Apps.	Score	Unknown	0-45	12.06	9.11
11	Knowledge on CSA	Score	0-60	20-58	43.03	9.96
12	Use of CSA technologies	Score	0-105	23-88	48.55	12.62
13	Benefit obtained from CSA	Score	0-39	15-38	30.14	4.43

Among the thirteen independent variables mentioned in the above Table 18, some remarkable observed predictors are (i) highest ranges of educational qualifications (0-16), (ii) high contact with agricultural extension media (20-38), Higher empowerment status (17-38), High knowledge on CSA (21-58),

obtaining higher benefit from CSA (15-37). Those might be due to their participation in CFS.

Table 19. Overall Predictors scenario of the Control group farmers.

Sl. No.	Characteristics	Measuring Unit	Range		Mean	SD
			Possible	Observed		
1	Age	Years	Unknown	21-80	46.57	10.99
2	Educational qualification	Years of Schooling	Unknown	0-14	5.02	3.40
3	Family size	No of family members	Unknown	2-10	5.13	1.59
4	Existing farm size	Ha	Unknown	0.23-4.75	1.19	0.72
5	Annual family income	'000"BDT	Unknown	45-425	136.61	65.12
6	Agril. Extension media contact	No. of contacting days	0-39	12-37	26.09	4.71
7	Innovativeness	Score	Unknown	1-5	3.17	1.24
8	Organizational support	Score	Unknown	1-21	6.99	3.02
9	Empowerment status	Score	0-39	13-39	23.31	6.36
10	Exposure to ICT Apps.	Score	Unknown	0-33	8.52	6.42

Among the ten selected independent variables of the control group respondents the observed highest ranges in some characteristics especially the agricultural extension media contact might be due to their keen interest to gather knowledge on agricultural production technology. Since they had no other informal institutional training arrangement like CFS, logically they had to be dependent on different media.

Table 18 and 19 represents the same socio-economic background of the treatment and control groups of respondents as mentioned in the methodology part of this study in case of educational qualifications and household income.

Variability in the observed ranges of other predictors might be due to their difference in CFS membership and non-membership. Descriptive statistical analysis revealed that CFS participating farmers had a positive change in their predictors profile over the non CFS participating farmers.

CHAPTER V
IMPACT OF CLIMATE SMART AGRICULTURE ON FARMERS' LIVELIHOODS

5.1 Impact of Climate Smart Agriculture on farmers' livelihoods

Eight dimensions were considered to measure the impact of CSA on farmers' livelihoods. The selected indicators were: (I) per capita food consumption, (II) food availability, (III) access to food, (IV) housing status, (V) drinking water source, (VI) sanitation, (VII) clothing behavior and (VIII) healthcare facilities. Each of these 8 indicators represented different facts. It was measured by computing scores according to extent of livelihood (composite index) with each of 8 selected indicators. Composite index score varied from 10.0 to 64.8 with the mean and standard deviation of 35.67 and 8.92 respectively in the study group. On the other hand index score varied from 5.2 to 61.7 with the mean and standard deviation of 27.81 and 11.13 respectively in the control group. On the basis of composite index scores, the impact found under eight indicators were classified into three categories namely high impact, medium impact and low impacts as shown in Table 20.

Table 20. Distribution of the respondents based on their extent of impact of Composite livelihood Change Index (CLCI)

Categories (score)	Study Group				Control Group			
	Number	Percent	Mean	SD	Number	Percent	Mean	SD
High impact (above 43)	34	17.5	35.67	8.92	10	5.32	27.81	11.13
Medium impact (28-43)	131	69.1			40	21.28		
Low impact (10-27)	23	11.9			138	73.40		
Total	188	100.0			188	100.0		

Table 20 represents that majority of the respondents in the study group remains under medium impact (69.1 percent) followed by high (17.5 percent) and low (11.9 percent). A great portion of control group farmers remain under low impact (73.40 percent). This might be due to their lack of knowledge on CSA.

5.2 Impact of CSA on different livelihood dimensions status as measured on the basis of mean difference value

It was studied by using paired T-test to see the comparative impact on farmers' livelihood by analyzing mean difference in livelihood changes under respective livelihood parameter. Following Tables represents the comparative difference on livelihood as an impact of CSA.

Table 21. Impact of CSA on different livelihood dimensions on the basis of pre- and post- CFS assessment (CSA farmers, outcome- A)

Sl. No.	Livelihood dimensions	Mean difference		t-value	Probability
		Pre-CSA	Post-CSA		
1.	Food consumption (calorie intake)	2714	3227	22.895***	.000
2.	Food availability (Stock/kg)	203	419	22.659***	.000
3.	Balance diet (% balance)	69	84	53.195***	.000
4.	Housing status (score)	2.46	3.69	27.310***	.000
5.	Drinking water source (score)	4.71	5.93	22.868***	.000
6.	Sanitation status (score)	1.90	2.79	31.613***	.000
7.	Clothing status (score)	3.82	6.16	21.527***	.000
8.	Healthcare facilities (score)	2.74	3.85	25.865***	.000

*** = Significant at the .001 level

Table reflects that Post CSA mean value is higher than those of pre CSA mean value. All those were significant at 0.001 levels. These results established the fact that farmers livelihood were significantly changed at higher level due to practicing CSA.

5.3 Impact on different livelihood dimensions status as measured on the basis of mean difference value (control group, outcome-B)

It was studied by using paired T-test to see the comparative impact on farmers' livelihood by analyzing mean difference in livelihood changes under respective livelihood parameter. Following Tables represents the comparative difference on livelihood difference.

Table 22. Impact on different livelihood dimensions on the basis of pre and post period of non CSA farmers (outcome- B)

Sl. No.	Livelihood dimensions	Mean difference		t-value	Probability
		(2012-14)	(2015-17)		
1.	Food consumption (calorie intake)	2357	2615	18.073***	.000
2.	Food availability (Stock/kg)	169	311	17.368***	.000
3.	Balance diet (% balance)	77	86	16.174***	.000
4.	Housing status (score)	2.24	3.42	20.901***	.000
5.	Drinking water source (score)	3.34	4.50	17.189***	.000
6.	Sanitation status (score)	1.62	2.41	20.430***	.000
7.	Clothing status (score)	2.77	3.16	15.068***	.000
8.	Healthcare facilities (score)	1.13	2.08	26.327***	.000

*** = Significant at the .001 level

Table reflects that Post CSA mean value (2015-2017) is slightly higher than those of pre CSA period (2012-2014). All those were significant at 0.001 levels. These results established the fact that farmers livelihood associated with the CSA practice led an improved livelihood in comparison to the Non CSA farmers.

5.4 Comparative representation on impact of CSA on CFS participating farmers over the non CSA farmers

Impacts of CSA were determined by examining the mean differences of T value and their level of significance considering 8 livelihood dimensions of

CSA and non CSA farmers. Following Table represents the livelihood changing level of significance of study group over control group.

Table 23. Comparative study representation of the CSA (study group) and non CSA (control group) respondent's livelihood changes on different dimensions

Sl. No.	Livelihood dimensions	Study group (outcome-A)	Control group (outcome-B)	Value indicating impact on study gr. livelihoods over control gr. (A-B)	T-value (Study gr.)	T-value (Control gr.)
1.	Food consumption (calorie intake)	513	258	255	22.895***	18.073***
2.	Food availability (Stock/kg)	216	142	74	22.659***	17.368***
3.	Balance diet (% balance)	15	09	06	53.195***	16.174***
4.	Housing status (score)	1.23	1.18	0.05	27.310***	20.901***
5.	Drinking water source (score)	1.22	1.16	0.06	22.868***	17.189***
6.	Sanitation status (score)	0.89	0.79	0.10	31.613***	20.430***
7.	Clothing status (score)	2.31	0.39	1.92	21.527***	15.068***
8.	Healthcare facilities (score)	1.11	0.95	0.16	25.865***	26.327***

Above Table indicates that study groups mean value difference is higher than those of control group. It is obvious that study group farmers are enjoying a better livelihood over the control group. Poddar (2015), Mazumder (2014), Hossain (2009), Zaman (2015) also found a significant livelihood change of study group over the control group as an impact of interventions as required by the farmers.

5.5 Farmers' livelihood changes according to the selected livelihood dimensions

Among the different dimensions of livelihood, eight dimensions relevant to food, housing, cloth, sanitation, drinking water & healthcare facilities were chosen to examine the pre and post CSA livelihood difference of the study and control group farmers. Following Table represents the pre and post CSA livelihood situation as an impact of CSA intervention made under DCRMA project.

5.5.1 Respondents livelihood changes according to their perceived changes in food consumption

There are various dimension of livelihood status change as well as poverty alleviation. Food consumption is one of them. The food consumption was measured by the K.cal uptake. Effort had been made to measure K.cal intake by the respondents' family members both 'before' and 'after' involvement with CSA. Based on the calorie intake the respondents were classified into four categories as: No change' (up to1800 Kcal), 'Low intake (1800-2122), medium intake (>2122-2424 Kcal), 'High intake' (>2444 Kcal). Following table represents the scenario.

Table 24. Distribution of the respondents according to their perceived changes in food consumption

Categories (K. Cal)	Study Group				Control Group			
	Number	Percent	**Mean differ-ence**	**T value (187 df)**	Number	Percent	**Mean differ-ence**	**T value (187 df)**
High intake (>2444)	141	75.0	**-513**	**22.895*** **	80	42.55	**-258**	**18.073*** **
Medium intake (>2122-2444)	47	25.00			38	20.21		
Low intake (1800-2122)	0	0			39	20.75		
No change (up to 1800)	0	0			31	16.49		
Total	188	100.00			188	100.00		

Above mentioned Table indicates that both the study and control group respondents have the significant calorie intake value but treatment group is in a better position over the control group respondents. Reasons behind for study group as remaining in better position may be their higher income level due to practicing CSA. Data represented in the above table indicates that majority of the respondents in the study group (75%) had high intakes of calorie in comparison to the control group (42.55%). It is implied that higher calorie intake by the study group respondents' family members is an indication of improved livelihood parameter. DCRMA project through CFS trained the CSA farmers how to earn more income for an improved livelihood. They might have utilized their knowledge in various income generating activities thus they could maintain better food consumption. Hossain (2009) in an impact study to analyze the food security of the respondents, found similar high intake of food above optimum level increased to 15.25% by the respondents under the food security project interventions. Reasons behind that may be noted as sometimes they could make big profit and spend substantial amount for collecting and consuming food items having high nutrient value.

5.5.2 Respondents livelihood changes according to their perceived changes in food stock availability

Food stock ability is one of the important components of farmers' food security which is very much relevant to livelihood status. It reflects how many meals they can maintain as stock to satisfy their demand of food which is also one of the five essentials of life. To know the stock status the respondents were categorized into four. Following table indicates the comparative food stock ability of study and control group farmers that will make us understand the impact of practicing CSA.

Table 25. Distribution of the respondents according to their perceived changes in food stock availability

Categories (no. of meals stock)	Study Group				Control Group			
	Number	Percent	**Mean differ-ence**	**T value (187 df)**	Number	Percent	**Mean differ-ence**	**T value (187 df)**
03 meals	0	0			12	6.38		
21 ’’	0	0			24	12.77		
90 “	19	10.11	**-216**	**22.659*****	92	48.94	**-142**	**17.368*****
>90 “	169	89.89			60	31.91		
Total	188	100.00			188	100.00		

Above Table indicates that both the study and control group respondents have the significant food stock value but treatment group is in a better position over the control group respondents. Generally it is observed that farmers who are capable of maintaining their daily expenditure through income other than selling agricultural commodities like rice they can have a sufficient food stock from their own crop. Since study group respondents were trained to be enriched with diversified sources of income thus near about 90% of the respondents were able to had a food stock of > 90 meals. Hossain (2009), Poddar (2015) find an increased food stock ability in the study group over the control group.

5.5.3 Respondents livelihood changes according to their perceived changes in having balance diet

Having knowledge on balance diet and it’s in taking status may be one indication of the respondent’s livelihood improvement indicator as food is the essential livelihood indicator defined by Neeti Joy chander (2018). The perfect balance diet for a person per day mentioned as those diet having fiber rich carbohydrate (25%), Protein (25%), Fat (10%), vitamin and minerals (40%).

Table 26. Distribution of the respondents according to their perceived changes in having balance diet

Categories (% nutrients)	Study Group				Control Group			
	Number	Percent	**Mean differ-ence**	**T value (187 df)**	Number	Percent	**Mean differ-ence**	**T value (187 df)**
Completely balanced (all elements 100%=100)	70	37.23			38	20.21		
Partially balanced (all elements 80%=80)	88	46.81	**-15**	**53.195*** **	65	34.58	**-09**	**16.174*** **
Imbalanced (<80)	30	15.96			85	45.21		
Total	188	100.00			188	100.00		

Above mentioned Table indicates that 37.23% respondents of the study group had access to complete balance diet whereas 20.21% of the respondents of the control group had access to complete balance diet. It is evident from the aforesaid discussions that study group respondents' participated different sessions of CFS, where they might learn a lot about the food value of nutritious food. It might be the reason behind the improve livelihood status of the study group over control group.

The Guardian (2019) Using data from other studies on the diets and health outcomes of millions of people, mostly in developed western nations. They calculated the health impact of eating one extra portion of each food on heart disease, stroke, type 2 diabetes and colorectal cancer. The environmental harm for each food, from greenhouse gases to water use to pollution, was calculated relative to a portion of vegetables. Producing unprocessed red meat had the highest impact for all environmental indicators and was many times worse than pulses. However, 37.23% respondents of the study group having balance diet reflects their improvement of livelihood.

5.5.4 Changes in housing condition

Condition of housing is an important indicator of livelihood status. It is also related to economic empowerment and also a potential parameter for assessing success of CSA practice. Better housing condition of a household might be the outcome of better economic condition which might be the results of better utilization of CFS knowledge. An assessment of housing condition of the beneficiaries both at 'before' and 'after' involvement with CSA (study group) in comparison to non CSA being represented in the following Table 27.

Table 27. Distribution of the respondents according to their perceived changes based on housing status

Categories (house type)	Study Group				Control Group			
	Number	Percent	**Mean differ-ence**	**T value (187df)**	Number	Percent	**Mean differ-ence**	**T value (187df)**
Gulpata shed (1)	0	0			0	0		
Tin shed bamboo wall (2)	4	2.13			9	4.79		
Whole tin (3)	71	37.77			115	61.17		
Tin shed brick wall (4)	87	46.28	**-1.23**	**27.310*** **	47	25.00	**-1.18**	**20.901*** **
Tin shed high rise (5)	11	5.85			10	5.32		
High rise double storied (6)	15	7.97			7	3.72		
Total	188	100.00			188	100.00		

Above Table indicates that about 8% farmers of the study group respondents live in high rise double storied house where the percentage in the control group is 4%. Number indicates the high awareness of the CSA farmers to save their life in the eve of any disaster like tidal surge. It might be due to the awareness

build up during their participation in CFS. Hossain (2009) in an impact study found a positive change in farmer's livelihood due to a project intervention

5.5.5 Respondents livelihood changes according to their perceived changes in drinking water sources

There is a proverb as "water is the alternative name of life". In Bangladesh, there was a time when many people died due to the scarcity of pure drinking water. Now the scenario is changing. People who are more aware about the good source of drinking water may be treated as very much aware about an improved livelihood. Following Table 28 indicates the change in farmers' livelihood as an impact of CSA.

Table 28. Distribution of the respondents according to their perceived changes in drinking water sources

Categories (source type)	Study Group				Control Group			
	Number	Percent	Mean differ-ence	T value (187df)	Number	Percent	Mean differ-ence	T value (187df)
Pond/river, non-treat (1)	0	0			0	0		
Pond/river, treated (2)	0	0			4	2.14		
Tube well not exam arsenic (3)	1	0.53			34	18.09		
Tube well with arsenic (4)	4	2.13			38	20.14		
Arsenic free tube well (5)	59	31.38	**-1.22**	**22.868*****	77	40.98	**-1.16**	**17.189*****
Common /others tube well (6)	85	45.21			26	13.86		
Own tube well normal base (7)	21	11.17			9	4.79		
Own tube well high-rise base (8)	18	9.58			0	0		
Total	188	100.00			188	100.00		

It is observed that about 11.17% respondent of the study group belongs tube well of their own where about 9.58% belongs high rise base. On the other hand, in the control group only 4.79% had tube well of their own where no one had high-rise base. This change might be due to the DCRMA project intervention through CFS which made the farmers' to learn about the importance of tube well water. High rise base of tube well are to save the source of pure drinking water from sinking down during disaster like flood due to tidal surge. Hossain (2009) found an Increase in percentage of respondents using safe water for drinking as a sign of awareness building on health and sanitation among the beneficiaries. Moreover, it indicates better livelihoods due to involvement with CFS.

5.5.6 Respondents livelihood changes according to their perceived changes in sanitation status

Sanitation is an important part of livelihood. It is very much relevant to maintain good health. We know health is wealth. Good sanitation of a household indicates a healthy living. Following Table 29 represents the impact of CSA on the sanitation status of farmers.

Table 29. Distribution of the respondents according to their perceived changes in sanitation status

Categories (sanitation type)	Study Group				Control Group			
	Number	Percent	Mean differ-ence	T value (187df)	Number	Percent	Mean differ-ence	T value (187df)
No latrin (0)	0	0	**-0.89**	**31.613*****	0	0	**-0.79**	**20.430*****
Open pit/ katcha (1)	2	1.06			0	0		
Sanitary ring slab (2)	52	27.66			116	61.70		
Pucca upon normal base (3)	118	62.77			65	34.57		
Pucca Upon high base (4)	16	8.51			7	3.73		
Total	188	100.00			188	100.00		

Above Table indicates that Majority (71%) respondents of the study group are using pucca latrin whereas 38% of the control groups are using pucca latrin. Both the study and control group respondents have the significant results in sanitation status but study group is in a better position over the control group respondents. Reasons behind the better position of the study group might be the outcome of CFS learning.

5.5.7 Respondents' livelihood changes according to their perceived changes in clothing status

Clothing stands in the second position among the five basic needs of human being. Value of clothing which put on by the people based on their income as well as financial ability. Generally it is observed that more the people are solvent the value of clothing they wear is high. Following Table represents the impact of CSA upon their clothing value.

Table 30. Distribution of the respondents according to their perceived changes in clothing status

Categories (Score of clothing value)	Study Group				Control Group			
	Number	Percent	Mean differ-ence	T value (187df)	Number	Percent	Mean differ-ence	T value (187df)
Low value (up to 1)	44	23.40	**-2.31**	**21.527*** **	118	62.77	**-0.39**	**15.068*** **
Medium value (1-2)	49	26.06			57	30.32		
High value (3-4)	68	36.17			9	4.79		
Very high value (>4)	27	14.37			4	2.12		
Total	188	100.00			188	100.00		

Above Table indicates that majority of the study group farmers (50.54%) uses high value to very high value cloths in comparison to the control group respondents (6.91%). Both the study and control group respondents have the significant results in clothing status but treatment group is in a better position over the control group respondents. Hossain (2009) found an increasing trend

of higher socio economic status of the respondents under study group who received project support to improve their livelihood.

5.5.8 Respondents livelihood changes according to their perceived changes in health care facilities

Health is one of the five important basic needs of human being. Good health of the people in a society indicates their better livelihood status. It is also an indicator of people awareness to healthy living for their best survival. Healthy living may depends on various factors like knowledge & financial ability. Available facilities and their willingness to use the facility is also a big factor. Following Table represents the impact of CSA on their change in livelihood based on utilization of healthcare facilities.

Table 31. Distribution of the respondents according to their perceived changes in health care facilities

Categories (Score of healthcare)	Study Group				Control Group			
	Number	Percent	Mean differ-ence	T value (187df)	Number	Percent	Mean differ-ence	T value (187df)
Pir/fakir (1)	0	0	**-1.11**	**25.865*** **	0	0	**-0.95**	**26.327*** **
Homeopath (2)	0	0			3	1.60		
Trained village doctor (3)	28	14.89			77	40.96		
MBBS/ Specialist (4)	160	85.11			108	57.44		
Total	188	100.00			188	100.00		

Above Table indicates an overwhelming majority of respondents (85.11%) in the study group consult with either MBBS or Specialist doctors to maintain a good health. On the other hand only 57.44% goes to MBBS or specialist doctors. Although, it is found that both the group don't visit pir /fakir but some percentage of the control group visit homeopath doctors. It reveals that the farmers who has participated CFS were very much aware to their healthcare

facilities. Hossain (2009) found the same trend in healthcare facilities of the farmers who received project interventions.

5.6 Comparative analysis among the livelihood of climate smart agriculture and non-climate smart agriculture practicing farmers

This comparative analysis was operated under descriptive statistics through SPSS software. Category, number and percentage were used to represent the comparison. Farmers' livelihood statuses were measured under eight relevant livelihood indicators. Following tables represents the results.

5.6.1 Changes in Food consumption (calorie intake)

Food is the fundamental demand of a human being. Daily Food consumption of a person can be measured by converting the consumed different food items it into calorie (chart appendix-1). Relevant questions were asked and obtained results into calories under different categories are shown in tin Table 32.

Table 32. Distribution of the respondents livelihood change in food consumption (calorie intake)

Categories (K. Cal)	Study Group				Control Group			
	Number		Percent		Number		Percent	
	BCSA	ACSA	BCSA	ACSA	2012-14	15-17	2012-14	15-17
High intake (>2444)	109	141	57.98	75.00	78	80	41.49	42.55
Medium intake (>2122-2444)	29	47	15.43	25.00	25	38	13.30	20.21
Low intake (1800-2122)	48	0	25.53	0	41	39	21.81	20.75
No change (up to 1800)	2	0	1.06	0	44	31	23.40	16.49
Total	188	188	100.00	100.00	188	188	100.00	100.00

BCSA-Before CSA ACSA-After CSA

In the study group, difference of high intake of calorie was 17% higher than before CSA approach whereas in the control group the change in high intake is only 1.06%. No respondents had been found in low intake category after adopting CSA but 20.75% respondents found in the low intake category in the control group. High intake found in study group might be due to the awareness that among the CFS participants. Non CFS respondents might have poor knowledge on the calorie value of food. It might be also be their difference in income level.

5.6.2 Respondents livelihood changes in food stock availability

Among the different dimensions of livelihood, food stock ability of a person can represents the status of improvement. Following table indicates the respondents comparative livelihood status based on food stock.

Table 33. Respondents livelihood change in food stock availability

Categories (no. of meals stock)	Study Group				Control Group			
	Number		Percent		Number		Percent	
	*BCSA	*ACSA	BCSA	ACSA	2012-14	15-17	2012-14	15-17
03 meals	0	0	0	0	20	12	10.64	6.38
21 ’’	17	0	9.04	0	35	24	18.62	12.77
90 “	108	19	57.45	10.11	80	92	42.55	48.94
>90 “	63	169	33.51	89.89	53	60	28.19	31.91
Total	188	188	100.00	100.00	188	188	100.00	100.00

In the study group, no respondents had been found in the category of having 03 to 21 meals stock after CSA. In the control group 19.15% were found to have 03-21 meals stock during the year 2015-2017. All the respondents (100%) were in the category of having 90 to > 90 meals stock after CSA whereas in the control group 80.85% having the stock of 90- >90 meals during the post CSA period (2015-17). The food stock change in the study group over the control

group was 19.15% higher. This might be due to the increase in crop yield of the study group farmers.

5.6.3 Respondents livelihood changes in having balance diet

Status of having balance diet by a household indicates the extent of livelihood improvement or deterioration. Balance diet keeps a person to maintain good health which is an indication of better livelihood status. Following Table represents the comparative change in livelihood of the respondents.

Table 34. Respondents livelihood change in having balance diet

Categories (% nutrients)	Study Group				Control Group			
	Number		Percent		Number		Percent	
	*BCSA	*ACSA	BCSA	ACSA	2012-14	15-17	2012-14	15-17
Completely balanced (all elements 100%=100)	36	70	19.15	37.23	32	38	17.02	20.21
Partially balanced (all elements 80%=80)	60	88	31.91	46.81	58	65	30.85	34.58
Imbalanced (<80)	92	30	48.94	15.96	98	85	52.13	45.21
Total	188	188	100.00	100.00	188	188	100.00	100.00

It is observed from the above table, that respondents having complete balance diet has been increased (19.15%-37.23%) = 18.08% over pre-CSA period, in the study group. On the other hand increasing percentage of the respondents in the same dimension being found as (17.02%-20.21%) = 3.19%. Obviously study group respondents could have gathered better knowledge on balance dieting.

5.6.4 Respondents livelihood changes in housing status

Among the five important fundamental demands of life, housing remains in the third important position. Hosing status is also an important indication of livelihood status. Following Table represents the scenario of comparative housing status of the respondents.

Table 35. Respondents housing status

Categories (house type)	Study Group				Control Group			
	Number		Percent		Number		Percent	
	*BCSA	*ACSA	BCSA	ACSA	2012-14	15-17	2012-14	15-17
Gulpata shed (1)	3	0	1.60	0	43	0	22.87	0
Tin shed bamboo wall (2)	115	4	61.17	2.13	63	9	33.51	4.79
Whole tin (3)	54	71	28.72	37.77	75	115	39.89	61.17
Tin shed brick wall (4)	12	87	6.38	46.28	7	47	3.73	25.00
Tin shed high rise (5)	4	11	2.13	5.85	0	10	0	5.32
High rise double storied (6)	0	15	0	7.97	0	7	0	3.72
Total	188	188	100.00	100.00	188	188	100.00	100.00

In the treatment group respondent's percentage having tin shed brick wall housing status were found to increase 40%. In the same category in control group the increasing rate is 21%. High rise base house adaptable to disaster especially flood 7.97% of respondents were found to hold in the study group whereas 3.72% respondents have the same category house in the control group. The change over control group is being found as 4.25%. Increase in income among the CFS participating members might be the cause of improvement in their housing status.

5.6.5 Respondents livelihood change in sources of drinking water

Pure drinking water is an important live saving element of human being. Purity of water depends upon the source from where it is collected. Keeping this in

mind relevant question was asked and obtained results are shown in the following Table.

Table 36. Respondents sources of drinking water

Categories (source type)	Study Group				Control Group			
	Number		Percent		Number		Percent	
	*BCSA	*ACSA	BCSA	ACSA	2012-14	15-17	2012-14	15-17
Pond/river, non-treat (1)	0	0	0	0	6	0	3.19	0
Pond/river, treated (2)	2	0	1.06	0	73	4	38.83	2.14
Tube well not exam arsenic (3)	2	1	1.06	0.53	16	34	8.51	18.09
Tube well with arsenic (4)	105	4	55.85	2.13	39	38	20.74	20.14
Arsenic free tube well (5)	37	59	19.68	31.38	52	77	27.65	40.98
Common /others tube well (6)	24	85	12.77	45.21	1	26	0.54	13.86
Own tube well normal base (7)	18	21	9.58	11.17	1	9	0.54	4.79
Own tube well high-rise base (8)	0	18	0	9.58	0	0	0	0
Total	188	188	100.00	100.00	188	188	100.00	100.00

Own tube well with high-rise base had been found in 9.58 % respondents after adopting CSA among the study group whereas no respondents has been found in the same category during the year 2015-2017. Control group respondents could not have the self-ownership of tube well might be due to either of their low income or low awareness about safe drinking water sources.

5.6.6 Respondents livelihood changes in sanitation status

Good sanitation arrangement of a household keeps the health of its family members in good health. It also indicates better livelihood status of a family. Following Table represents the comparative situation of the respondents.

Table 37. Respondent's sanitation status

Categories (sanitation type)	Study Group				Control Group			
	Number		Percent		Number		Percent	
	*BCSA	*ACSA	BCSA	ACSA	2012-14	15-17	2012-14	15-17
No latrin (0)	2	0	1.06	0	1	0	0.54	0
Open pit/ katcha (1)	36	2	19.15	1.06	70	0	37.23	0
Sanitary ring slab (2)	128	52	68.09	27.66	115	116	61.17	61.70
Pucca upon normal base (3)	22	118	11.70	62.77	2	65	1.06	34.57
Pucca Upon high base (4)	0	16	0.00	8.51	0	7	0.00	3.73
Total	188	188	100.00	100.00	188	188	100.00	100.00

High-rise base pucca sanitary latrine has been found in 8.51% respondents in the study group households. Whereas, 3.73% respondents had the high rise base pucca sanitary latrin. The big difference between the study and control group might be due to that control group respondents had a lack of knowledge about high-rise sanitary pucca latrin which could save them from contamination or sinking down of the latrins during flood.

5.6.7 Respondents livelihood changes in clothing status

Among the five important fundamental demands of life, clothing remains in the second important position. Value of clothing used by the family members of a household indicates the livelihood status of that family. Following Table represents the comparative status.

Table 38. Respondents clothing status

Categories (sanitation type)	Study Group		Control Group	
	Number	Percent	Number	Percent
Low value (up to 1)	44	23.40	118	62.77
Medium value (1-2)	49	26.06	57	30.32
High value (2.1-4)	68	36.17	9	4.79
Very high value (>4)	27	14.37	4	2.12
Total	188	100.00	188	100.00

Among the study group respondents 14.37% could achieve the ability to very high value clothing whereas this percentage is only 2.12% in the control group. The visible change in study group respondents' were 12.25% over the control group. Higher ability of the study group respondents in case of clothing might be due to their increase in income through adopting CSA approach.

5.6.8 Respondents livelihood changes in healthcare facilities

Health care facilities to be afforded by a household might be influenced by different catalyst. Generally it is observed that people enjoying better livelihood remains under better healthcare facilities. So, it is treated as an important dimension of livelihood status. Considering the available traditional and updated healthcare facilities in Bangladesh, relevant questions were asked obtained results are represented in the following Table 39.

Table 39. Respondents heath care facilities

Categories (Health care type)	Study Group				Control Group			
	Number		Percent		Number		Percent	
	*BCSA	*ACSA	BCSA	ACSA	2012-14	15-17	2012-14	15-17
Pir/fakir (1)	0	0	0	0	7	0	3.72	0
Homeopath (2)	54	0	28.72	0	60	3	31.92	1.60
Trained village doctor (3)	129	28	68.62	14.89	119	77	63.30	40.96
MBBS/Specialist (4)	5	160	2.66	85.11	2	108	1.06	57.44
Total	188	188	100.00	100.00	188	188	100.00	100.00

BCSA-Before CSA ACSA-After CSA

After adopting CSA approach 85.11% respondents in the study group could either achieve the ability or understood the importance to visit MBBS/ specialist doctors in case of health care. On the other hand this percentage is 57.44% in the control group where the visible rate of change is 27.67%. It is observed that control group respondents had lower health care facilities than those of study group. This might either be due to their lack of knowledge or lower income.

Descriptive statistical analysis on respondent's livelihood status in terms of food security, housing, drinking water sources, and sanitation, clothing and healthcare facilities reveals that study group respondents have been enjoying an improved livelihood in comparison to the

CHAPTER VI

CONTRIBUTION OF THE SELECTED PREDICTORS OF FARMERS ON THEIR CHANGES IN LIVELIHOOD AS AN IMPACT OF CLIMATE SMART AGRICULTURE (CSA)

6.1 Relationship of the variables

To determine the contribution of selected predictors of the farmers to their changes in livelihood as an impact of climate smart agriculture (CSA) were the purpose of this section. Impact is a multivariate phenomenon involving interaction of many factors. For this study 13 characteristics of the farmers were selected as the independent variables.

In order to find out the contribution, 13 predictors of the farmers were selected to find their changes in livelihood as an impact of Climate Smart Agriculture (dependent variable). The relationships among the variables were determined first by conducting Pearson Product Moment Correlation test. The results of correlation matrix containing inter-correlation among the variables are shown in Appendix-7 & 8. Correlation co-efficient of each of the selected characteristics of the respondent farmers with their livelihood changes as an impact of climate smart agriculture (CSA) are shown in Table 40.

Table 40. Results of correlation co-efficient of each of the selected characteristics of the respondent farmer with their impact of climate smart agriculture (CSA)

Dependent Variables	Farmers characteristics (Independent Variables)	Co-efficient of Correlation (r)
Livelihood Index	Age	0.182^{*}
	Education	0.444^{**}
	Family size	0.057^{NS}
	Farm size	0.196^{**}
	Annual family income	0.166^{*}
	Agricultural extension media contact	0.312^{**}
	Innovativeness	0.423^{**}
	Organizational support	0.408^{**}

	Empowerment status	0.517**
	Exposure to ICT Apps for agricultural information	0.373**
	Knowledge on Climate Smart Agriculture practices	0.487**
	Use of CSA technologies	0.425**
	Benefit obtained from CSA	0.474**

NSNot significant, *Significant at 0.05 Level, **Significant at 0.01 Level

Results of correlation co-efficient contained in Table 40 revealed that out of 13 selected characteristics of the respondent farmers, 12 characteristics had significant relationship with their changes in livelihood as an impact of climate smart agriculture (CSA). These characteristics were: age, education, farm size, annual family income, agricultural extension media contact, innovativeness, organizational support, empowerment status, exposure to ICT Apps for agricultural information, knowledge on Climate Smart Agriculture practices, use of CSA technologies and benefit obtained from CSA.

6.2 Representation of stepwise multiple regression results of CSA farmers

The independent variables in isolation would not give a comprehensive picture of the contribution of independent variables on the dependent variable (Livelihood index (Y). The different characteristics of respondent farmers may interact together to make a combined contribution to the impact of climate smart agriculture (CSA) on farmers' livelihood. Keeping this fact in view, linear multiple regression analysis was used to assess the contribution of the independent variables on the dependent variable (Livelihood index) to find out the impact of climate smart agriculture (CSA) on farmers' livelihood.

Full model regression analyses were initially run by involving the following sets of independent variables with livelihood index (Y) as an impact of climate smart agriculture (CSA) on farmers' livelihood as the dependent variable. The independent variables were divided into two sets based on significance and non-significance.

Set – I: All the selected 13 variables i.e. age (X_1), education(X_2), family size (X_3), farm size (X_4), annual family income (X_5), agricultural extension media contact (X_6), innovativeness (X_7), organizational support (X_8), empowerment status (X_9), exposure to ICT Apps for agricultural information (X_{10}), knowledge on Climate Smart Agriculture practices (X_{11}), use of CSA technologies (X_{12}) and benefit obtained from CSA (X_{13}).

Set – II: Significant 12 variable by Pearson Product Moment correlation i.e. age (X_1), education (X_2), farm size (X_4), annual family income (X_5), agricultural extension media contact (X_6), innovativeness (X_7), organizational support (X_8), empowerment status (X_9), exposure to ICT Apps for agricultural information (X_{10}), knowledge on Climate Smart Agriculture practices (X_{11}), use of CSA technologies (X_{12}) and benefit obtained from CSA (X_{13}).

It was observed that the full model regression results of all the two sets were misleading due to the existence of interrelationship among the independent variables. It was evident from correlation matrix showing the interrelationships among the independent variables and existence of contradiction of correlation co-efficient and regression co-efficient. (Appendix-7 & 8).

Droper and Smith (1981) suggested running stepwise multiple regression analysis to insert variable in turn until the regression equation is satisfactory. Therefore, in order to avoid misleading results due to the problem of multi-collinearity and to determine the best explanatory variables, the method of step-wise multiple regression was employed by involving the above mentioned two sets of independent variables with the livelihood index as an impact of climate smart agriculture (CSA) on farmers' livelihood. The objective of the step-wise multiple regression models were to find out the contribution of the variables, which were significant only. The result of step wise multiple regression analyses are shown in Table 41.

Table 41. Summary of stepwise multiple regression analysis showing the contribution of the significant variables to the livelihood index as an impact of Climate Smart Agriculture (study group)

Variables entered	Standardized partial 'b' coefficient	Value of 't' (with probability level)	Adjusted R^2	Increase in R^2	Variation explained in percent
Knowledge on Climate Smart Agriculture practices (X_{11})	0.192	2.637 (0.009)	0.284	.284	28.4
Benefit obtained from CSA (X_{13})	0.201	3.169 (0.002)	0.390	.106	10.6
Empowerment status (X_9)	0.166	2.409 (0.017)	0.420	0.03	3.0
Use of CSA technologies (X_{12})	0.143	2.196 (0.029)	0.438	0.018	1.8
Education (X_2)	0.152	2.388 (0.018)	0.449	0.011	1.1
Organizational support (X_8)	0.133	2.086 (0.038)	0.459	0.01	1.0
		Total		0.459	45.9

Multiple R = 0.690

R-square = 0.476

Adjusted R - square = 0.459

F-ratio = 27.412 at 0.000 level of significance

The remaining variables i.e., age (X_1), family size (X_3), existing farm size (X_4), Annual family income (X_5) Agricultural extension media contact (X_6) innovativeness (X_7) and exposure to ICT Apps for agricultural information (X_{10}) were not entered into the regression equation.

Data presented in Table 41 indicated that the multiple R, R^2 and adjusted R in the steps in multiple regression analysis were 0.690, 0.476 and 0.459

respectively and the correspondents F- ratio of 27.412 was significant at 0.000 level. The regression equation so obtained is presented below:

$$Y = 0.039+0.192X_{11} +0.201X_{13} +0.166X_{9} +0.143X_{12}+0.152X_{2} + 0.133X_{8}$$

The step wise multiple regression analysis indicated that the whole model of 13 variables explained 45.9 percent of the total variation in the impact of climate smart agriculture on farmers' livelihood. Since the standardized regression co-efficient of 6 variables formed the equation and were significant, it may be assumed that whatever combination was there, it was due to these 6 variables.

From the results of stepwise multiple regression analysis it is obvious that Knowledge on Climate Smart Agriculture practices (X_{11}) of the farmers had strong (28.4%) positive influence upon their livelihood as an impact of climate smart agriculture. Benefit obtained from CSA (X_{13}) of the farmers was the important characteristic which remarkably contributed (10.6%) on livelihood changes. Empowerment status (X_9), Use of CSA technologies (X_{12}), Education (X_2) and Organizational support (X_8) of the respondent farmers had somewhat positive influence upon their livelihood as an impact of climate smart agriculture. Since the rest variables or characteristics of the farmers did not enter into the regression model, it can be inferred that these characteristics either had multi-co linearity problem or had minimum contribution to the total explained variation of 45.9 percent.

On the basis of stepwise regression analysis, contributions of significant 6 independent variables to the livelihood index (dependent variable) as an impact of climate smart agriculture are presented below in order of importance.

Knowledge on Climate Smart Agriculture practices (X_{11})

The co-efficient of correlation showed significant positive relationship between knowledge on Climate Smart Agriculture practices (X_{11}) of the respondent farmers and their livelihood index as an impact of climate smart agriculture.

Step-wise multiple regression analysis also indicated that knowledge on Climate Smart Agriculture practices of the farmers had strong and significant contribution (28.4%) on their livelihood as an impact of climate smart agriculture. Both the results confirmed that Knowledge on Climate Smart Agriculture practices of the respondent farmers were found to be the most important positive contributor on their livelihood as an impact of climate smart agriculture. Ali (2008),in a study find that ecological agricultural knowledge of the farmers had strongly significant and positive influence on their adoption of selected ecological agricultural practices and it was the topmost important contributor**.** Islam (2016), in his study on impact of flower cultivation on farmers' livelihood found that knowledge had a strong contribution that reflected as an impact.

It is a reliable fact that the person who has gained sufficient knowledge on a particular subject matter he can utilize the knowledge to receive more benefit towards an improve livelihood. Farmers of the study group who regularly attended in Climate Field School could gain more knowledge on CSA practices. Therefore, farmers having high knowledge on Climate Smart Agriculture practices could easily use the CSA technologies. Thus they could earn more income to improve their livelihood. This might be the reason for knowledge on Climate Smart Agriculture practices having the strong and positive influence on CSA practicing farmers' livelihood.

Benefit obtained from CSA (X_{13})

It is observed that co-efficient of correlation showed significant positive relationship between benefit obtained from CSA (X_{13}) of the respondent farmers and their livelihood index as an impact of climate smart agriculture.

Step-wise multiple regression analysis also indicated that benefit obtained from CSA of the farmers had remarkable (10.60%) significant and positive influence on their Livelihood as an impact of climate smart agriculture. Results obtained from both Correlation and step wise multiple regression analysis confirmed that benefit obtained from CSA of the respondent farmers' were the important positive contributor to their livelihood as an impact of climate smart agriculture.

It is quite logical that the farmers who received more benefit from climate smart agriculture practices would like to adopt the CSA technologies in a larger scale. This might be the reason for the existence of positive contribution to impact of climate smart agriculture on farmers' livelihood. Ali (2008), in a study find that benefit obtained from ecological agricultural practices by the farmers had a strongly significant and positive influence on their adoption of selected ecological agricultural practices and it was found to be the second important contributor.

Empowerment status (X_9)

The co-efficient of correlation showed significant positive relationship between empowerment status (X_9) of the respondent farmers and their livelihood as an impact of climate smart agriculture.

Step-wise multiple regression analysis also indicated that empowerment status of the farmers had significant and positive influence on farmers' livelihood. Both the analysis confirmed the significant contribution of empowerment status of the respondent farmers on their livelihood. It is found to be the most

important positive contributor to farmers' livelihood and acquired the third important position. Farmers' who practiced CSA upon participating CFS indicated positive impact on their livelihood. Mazumder (2014), find that intervention like receiving microfinance had a positive impact on empowerment status of the rural livelihood.

Reasons behind it might have the interpretation that CFS participating farmers became more enriched in income that might improve their social status and made them empowered as well.

Use of CSA technologies (X_{12})

The co-efficient of correlation showed significant positive relationship between the uses of CSA technologies (X_{12}) of the respondent farmers and their livelihood as an impact of climate smart agriculture.

Step-wise multiple regression analysis also indicated that use of CSA technologies of the farmers had significant and positive influence on their livelihood as an impact of climate smart agriculture. Both the results confirmed that Use of CSA technologies are the most important positive contributor on farmers' livelihood as an impact of climate smart agriculture. Islam (2016), in his study found significant contribution of duration of flower cultivation on farmers' livelihood as an impact of flower cultivation by the farmers. It can be assumed that flower cultivation by using the appropriate technologies since long can put positive impact. Thus practicing CSA technologies also can improve farmers' livelihood.

Education (X_2)

The co-efficient of correlation showed significant positive relationship between education (X_2) of the respondent farmers and their livelihood as an impact of climate smart agriculture.

Step-wise multiple regression analysis also indicated that education of the farmers had significant and positive influence on their livelihood as an impact of climate smart agriculture. Both the results confirmed that education of the respondent farmers is an important positive contributor on their livelihood as an impact of climate smart agriculture. Islam (2016), in a study on impact of flower cultivation on farmers' livelihood found same results.

Climate Field School (CFS) is a non-formal education system which made the participants educative on different technologies to be implemented properly. Thus they could improve their livelihood on different dimensions. This might be the reason behind the education became an important contributor.

Organizational support (X_8)

The co-efficient correlation showed significant positive relationship between organizational support (X_8) of the respondent farmers and their livelihood as an impact of climate smart agriculture.

Step-wise multiple regression analysis also indicated that organizational support of the farmers had significant and positive influence on their livelihood as an impact of climate smart agriculture. Both the results confirmed that organizational support of the respondent farmers was the most important positive contributor to their livelihood as an impact of climate smart agriculture.

Different Government and Non-government organizations have been providing physical and financial support to the climate change victim people since long. DAE had provided support under the project of DRR, LACC, ECRRP and DCRMA. Appropriate agricultural technologies have been introduced and advised to the CFS participating farmers. MOEFCC made a provision of trust fund for GO and NGOs to implement projects to support Climate Change

victims. BCAS, Grameen bank along with other public and private banks are also providing financial support as and when necessary.

Farmers having higher organizational support usually try to exploit income sources and they become able to involve themselves into diversified income generating activities. DAE provided participatory and season-long Farmer to Farmer Training (FFT) to the farmers with whole farm approach where Climate change adaptation technologies were included. Motivation and group dynamics was also in-built in the curriculum of DAE along with various aspects of agricultural as well as social issues. As a result, the organizational support could help the participants to be inspired. These might be the reasons that organizational support of the farmers had the positive influence on their livelihood as an impact of climate smart agriculture. Ali (2008), Mazumder (2014), also found significant contribution of the GO-NGO support receiving farmers' being enjoyed an improved livelihood.

6.3 Direct and Indirect Effects of the Selected Predictors of the CSA Farmers

It is observed from the above analysis that among the selected 13 predictors of the CSA farmers 6 predictors put influence on farmer's livelihood. It was not clear whether the common contributors have direct or indirect contribution. Whatever explanation is given for the common predictors, following analysis can make it clear which predictors had direct effect and which had indirect effects in the contribution level which put the positive influence on farmers' livelihood on CSA farmers.

Path coefficient is simply a standardized partial regression coefficient and as such measures the direct influence of one variable upon another and permits the separation of the correlation coefficient into components of direct and indirect effects (Dewey and Lu, 1959). This allows the direct effect of an independent

variable and its indirect effect through other variables on the dependent variable (Sasmal and Chakrabarty, 1978).

Direct effect of an independent variable on the dependent variable is the standardized beta co-efficient (value of 'b' of regression analysis) of the respective independent variable. Whereas indirect effect of an independent variable through a channeled variable is measured by the following formula:

$e = \sum bxr$

Where, e = Total indirect effect of an independent variable

b = Direct effect of the Variable through which indirect effect is channeled

r = Correlation co-efficient between respective independent variables through which indirect effect is channeled.

Path analysis was done involving the significant variables of step-wise multiple regression analysis. Path coefficients showing the direct and indirect effects of significant 6 independent variables in case of study group on their livelihood have been presented in Table 42. Analysis of data furnished in Table 42 indicated that among the independent variables, Benefit obtained from CSA (X_{13}) had the highest direct effect (0.201) in the positive direction followed by Knowledge on Climate Smart Agriculture practices (X_{11}) and Empowerment status (X_9) in the positive direction on impact of climate smart agriculture on farmers' livelihood and their direct effect were 0.192 and 0.166 respectively. Education (X_2), Use of CSA technologies (X_{12}), and Organizational support (X_8) had direct effect in the positive direction on impact of climate smart agriculture on farmers' livelihood and their direct effect were 0.152, 0.143 and 0.133 respectively.

It may be mentioned that without path co-efficient analysis, it is not possible to know the status of direct effect of an independent variable through combined effects of other variables on the dependent variable. Therefore, emphasis has

been given on the indirect effects which have been obtained from path co-efficient analysis (Table 42).

The variable, knowledge on Climate Smart Agriculture practices (X_{11}) had the highest (0.409) total indirect effect followed by Benefit obtained from CSA (X_{13}), Empowerment status (X_9), Use of CSA technologies (X_{12}) and Education (X_2). Organizational support (X_8) had negligible total indirect effects on farmers' livelihood.

During step wise multiple regression it was found that knowledge on Climate Smart Agriculture practices (X_{11}) was the topmost contributor on the livelihood of farmers. It is now clear that the contribution were channeled through combined indirect effects of other five independent variables entered in the regression table. Following Table represents the figures.

Table 42. Path coefficients showing the direct and indirect effects of 6 significant independent variables entered in stepwise multiple regression analysis (study group)

Independent variables	Variables through which indirect effects are channeled	Indirect effects	Total indirect effect	Direct effect
Knowledge on Climate Smart Agriculture practices (X_{11})	Benefit obtained from CSA (X_{13})	0.068	0.409	0.192
	Empowerment status (X_9)	0.090		
	Use of CSA technologies (X_{12})	0.095		
	Education (X_2)	0.081		
	Organizational support (X_8)	0.075		
Benefit obtained from CSA (X_{13})	Knowledge on Climate Smart Agriculture practices (X_{11})	0.071	0.367	0.201
	Empowerment status (X_9)	0.091		
	Use of CSA technologies (X_{12})	0.066		
	Education (X_2)	0.072		
	Organizational support (X_8)	0.067		
Empowerment status (X_9)	Knowledge on Climate Smart Agriculture practices (X11)	0.078	0.339	0.166

Independent variables	Variables through which indirect effects are channeled	Indirect effects	Total indirect effect	Direct effect
	Benefit obtained from CSA (X_{13})	0.075		
	Use of CSA technologies (X_{12})	0.052		
	Education (X_2)	0.062		
	Organizational support (X_8)	0.072		
Use of CSA technologies (X_{12})	Knowledge on Climate Smart Agriculture practices (X_{11})	0.071	0.252	0.143
	Benefit obtained from CSA (X_{13})	0.047		
	Education (X_2)	0.042		
	Empowerment status (X_9)	0.045		
	Organizational support (X_8)	0.047		
Education (X_2)	Knowledge on Climate Smart Agriculture practices (X_{11})	0.064	0.247	0.152
	Use of CSA technologies (X_{12})	0.045		
	Benefit obtained from CSA (X_{13})	0.055		
	Empowerment status (X_9)	0.057		
	Organizational support (X_8)	0.026		
Organizational support (X_8)	Knowledge on Climate Smart Agriculture practices (X_{11})	0.052	0.220	0.133
	Use of CSA technologies (X_{12})	0.043		
	Benefit obtained from CSA (X_{13})	0.044		
	Education (X_2)	0.023		
	Empowerment status (X_9)	0.058		

On the basis of path analysis, the independent variables having indirect effects on impact of climate smart agriculture on farmers' livelihood have been presented below in descending order:

Knowledge on Climate Smart Agriculture practices (X_{11})

Path analysis showed that knowledge on Climate Smart Agriculture practices (X_{11}) had the highest total indirect effect (0.409) with a positive direct effect of 0.192 (Table 42) on farmers' livelihood. The indirect effect was channeled positively through benefit obtained from CSA (X_{13}), empowerment status (X_9), use of CSA technologies (X_{12}), education (X_2) and organizational support (X_8).

It may be inferred that other variables remaining constant, knowledge on Climate Smart Agriculture practices (X_{11}) was a topmost determinant of the impact of climate smart agriculture on farmers' livelihood.

Benefit obtained from CSA (X_{13})

Path analysis showed that Benefit obtained from CSA (X_{13}) had the 2nd highest total indirect effect (0.367) with a positive direct effect of 0.201 (Table 42) on farmers' livelihood. The indirect effect was channeled positively through knowledge on Climate Smart Agriculture practices (X_{11}), empowerment status (X_9), use of CSA technologies (X_{12}), education (X_2) and organizational support (X_8).

It may be inferred that other variables remaining constant, benefit obtained from CSA (X_{13}) was the second important determinant of the impact of climate smart agriculture on farmers' livelihood.

Empowerment status (X_9)

Path analysis showed that empowerment status (X_9) had the 3rd highest total indirect effect (0.339) with a positive direct effect of 0.166 (Table 42) on farmers' livelihood. The indirect effect was channeled positively through knowledge on Climate Smart Agriculture practices (X_{11}), use of CSA technologies (X_{12}), education (X_2) and organizational support (X_8).

It may be inferred that other variables remaining constant, empowerment status (X_9) was third important determinant of the impact of climate smart agriculture on farmers' livelihood.

Use of CSA technologies (X_{12})

Path analysis showed that Use of CSA technologies (X_{12}) had the 4th highest total indirect effect (0.252) with a positive direct effect of 0.143 (Table 42) on farmers' livelihood. The indirect effect was channeled positively through

knowledge on Climate Smart Agriculture practices (X_{11}), benefit obtained from CSA (X_{13}), education (X_2), empowerment status (X_9) and organizational support (X_8).

It may be inferred that other variables remaining constant, Use of CSA technologies (X_{12}) was the fourth important determinant of the impact of climate smart agriculture on farmers' livelihood.

Education (X_2)

Path analysis showed that education (X_2) had the 5th highest total indirect effect (0.247) with a positive direct effect of 0.152 (Table 42) on farmers' livelihood. The indirect effect was channeled positively through knowledge on Climate Smart Agriculture practices (X_{11}), use of CSA technologies (X_{12}), benefit obtained from CSA (X_{13}), empowerment status (X_9) and organizational support (X_8).

It may be inferred that other variables remaining constant, education (X_2) was the fifth important determinant of the impact of climate smart agriculture on farmers' livelihood.

Organizational support (X_8)

Path analysis showed that organizational support (X_8) had the 6th highest total indirect effect (0.220) with a positive direct effect of 0.133 (Table 42) on farmers' livelihood. The indirect effect was channeled positively through knowledge on Climate Smart Agriculture practices (X_{11}), benefit obtained from CSA (X_{13}), use of CSA technologies (X_{12}), education (X_2) and empowerment status (X_9).

It may be inferred that other variables remaining constant, organizational support (X_8) was the 6th important determinant of the impact of climate smart agriculture on farmers' livelihood.

CHAPTER VII
PROBLEM FACED BY THE RESPONDENTS

7.1 Problem faced by the respondents (CSA farmers)

The respondents were asked to put their opinion about the extent of problem they have been facing during pre and post CSA periods. It was observed that the respondents faced various problems having different magnitudes. An attempt was made in this section to identify the major problems faced by the respondents with their magnitude.

Each problem faced by the respondents was rated against a 5-point rating scale: very high (score =4) high (score =3) medium (score =2), low (score =1) and not at all (score =0). A Problem Faced Index (PFI) was computed for each problem by summing up the weights. PFI (Problem Faced Index) of a problem indicated the extent of seriousness of a problem faced by the respondents. The higher the value of PFI of a problem, the greater was the magnitude of the problem. On the basis of PFI obtained, rank order were prepared and shown in Table 43**.**

Problem Faced Index (PFI) was computed for each problem by using the following formula:

$PFI = P_{vh} \times 4 + P_h \times 3 + P_m \times 2 + P_l \times 1 + P_n \times 0$

Where,

PFI = Problem Faced Index

P_{vh} = Number of respondents faced very high Problem

P_h = Number of respondents faced high Problem

P_m = Number of respondents faced medium Problem

P_l = Number of respondents faced low Problem

P_n = Number of respondents faced no Problem

Problem Faced Index (PFI) for each constraint strategies could range from 0 to 752 (188x4), where 0 indicating lowest extent of problem and 752 indicating

highest extent of Problem. Following Table represents the severity of the problems.

Table 43. Rank order of problems faced by the respondents

Sl. No.	Problems	Problem Index (PI)	Rank order
01.	Insufficient capital to recover the loss after disaster	548	1st
02.	Poor quality of pesticide	510	2nd
03.	Lack if quality seed	496	3rd
04.	Unavailability of proper pesticide for treatment of Pest and diseases	495	4th
05.	Poor storage facilities of inputs during disaster	474	5th
06.	Unavailability of inputs after disaster	454	6th
07.	Unavailability of farm machineries	449	7th
08	Reluctance of the Govt. agencies to renovate the old structures (sluice gate, bund, etc.)	448	8th
09.	Increasing water and soil salinity.	445	9th
10.	Declining soil fertility	444	10th
11.	Unavailability of inputs at suitable time.	415	11th
12.	Unavailability of labor	380	12th
13.	Unavailability of stress tolerant varieties	378	13th
14.	Unavailability of suitable technology	363	14th
15.	Scarcity of irrigation water	320	15th
16.	Lack of knowledge on adaptation practices.	318	16th
17	Marketing problems during and after disaster	298	17th
18	Limited access to information	273	18th
19	Lack of relevant training facilities	214	19th
20	Poor contact with extension media/agents	178	20th

Problems were cross checked by conducting three numbers of Focus Group Discussion (FGD) in three CFS areas. Eight (8) problems were identified as major those represented as follows.

Table 44. Rank orders of the major problems faced by the respondents in the study group (CFS) farmers

Sl. No.	Problems	Rank order
01.	Insufficient capital to recover the loss after disaster	1st
02	Lack if quality seed	2nd
03.	Poor storage facilities of inputs during disaster	3rd
04.	Reluctance of the Govt. agencies to renovate the old structures (sluice gate, bund, etc.).	4th
05.	Unavailability of inputs at suitable time.	5th
06.	Marketing problems during and after disaster	6th
07.	Unavailability of farm machineries	7th
08	Unavailability of labor	8th

7.2 Problem faced by the respondents (Non-CSA farmers)

The respondents were asked to put their opinion about the extent of problem they have been facing during the periods (2012-2014) and (2015-2017). It was observed that the respondents faced various problems having different magnitudes. An attempt was made in this section to identify the major problems faced by the respondents with their magnitude.

Each problem faced by the respondents was rated against a 5-point rating scale: very high (score =4) high (score =3) medium (score =2), low (score =1) and not at all (score =0). A Problem Faced Index (PFI) was computed for each problem by summing up the weights. PFI (Problem Faced Index) of a problem indicated the extent of seriousness of a problem faced by the respondents. The higher the value of PFI of a problem, the greater was the magnitude of the problem. On the basis of PFI obtained, rank order were prepared and shown in Table 45**.**

Table 45. Rank order of problems faced by the respondents

Sl. No.	Problems	Problem Index (PI)	Rank order
01.	Insufficient capital to recover the loss after disaster	591	1st
02.	Unavailability of proper pesticide for treatment of Pest and diseases	585	2nd
03.	Poor storage facilities of inputs during disaster	580	3rd
04.	Declining soil fertility	566	4th
05.	Increasing water and soil salinity	547	5th
06.	Unavailability of farm machineries	538	6th
07.	Lack of quality seed	536	7th
08	Unavailability of inputs at suitable time	534	8th
09.	Poor quality of pesticides	532	9th
10.	Unavailability of inputs after disaster	519	10th
11.	Reluctance of the Govt. agencies to renovate the old structures (sluice gate, bund, etc.)	488	11
12.	Lack of knowledge on adaptation practices	472	12
13.	Unavailability of suitable technology	428	13
14.	Unavailability of stress tolerant varieties	427	14
15.	Unavailability of labor	385	15
16.	Limited access to information	317	16
17	Marketing problems during and after disaster	309	17
18	Scarcity of irrigation water	298	18
19	Lack of relevant training facilities	212	19
20	Poor contact with extension media/agents	143	20

Problems were cross checked by conducting three numbers of Focus Group Discussions (FGD) in three Non-CFS areas. Twelve problems were identified as major those represented as follows.

Table 46. Showing major problem faced by the respondents in the Non-CFS areas

Sl. No.	Problems	Problem Index (PI)	Rank order
01.	Insufficient capital to recover the loss after disaster		1st
02	Lack of knowledge on adaptation practices		2nd
03.	Unavailability of proper pesticide for treatment of Pest and diseases		3rd
04.	Poor storage facilities of inputs during disaster		4th
05.	Increasing water and soil salinity		5th
06.	Unavailability of farm machineries		6th
07.	Lack of quality seed		7th
08	Unavailability of inputs at suitable time		8th
09.	Poor quality of pesticides		9th
10.	Unavailability of inputs after disaster		10th
11.	Reluctance of the Govt. agencies to renovate the old structures (sluice gate, bund, etc.)		11th
12.	Declining soil fertility		12th

The above Table's represents that the problem faced by both the CFS and non CFS areas are more or less same in magnitude and dimensions. Some problems are common. One issue is remarkable that in both cases, the problem, poor contact with extension agent ranked last but livelihood changes in both the cases are different over each other. CFS farmers are enjoying a better livelihood over the non CFS farmers. This might be due to the variation in knowledge level among the CSA and non CSA farmers.

7.3 Suggestions to overcome the aforesaid problems (CSA and non CSA farmers)

The respondents were asked to put their suggestions regarding possible ways to overcome the obstacles they were facing currently. Opinions were also taken

from various sections of farmers during FGD. Views regarding these issues are presented in Table 47.

Table 47. Suggestions to overcome the problems of both the CSA and non-CSA areas

Sl. No.	Nature of problems	Suggestions
1	Insufficient capital to recover the loss after disaster	GO, NGOs and banks should take care of this matter
2	Unavailability of proper pesticide for treatment of Pest and diseases	DAE should properly administer the regulatory affairs on pesticides marketing
3	Poor storage facilities of inputs during disaster	Mini cold storage or storage facilities at rural level should be developed under GO or NGO initiatives.
4	Declining soil fertility	Farmers should be developed expertise to keep soil fertility corresponding to the productivity
5	Increasing water and soil salinity	Government concerned agency especially WDB should take care of this matter
6	Unavailability of farm machineries	DAE and concerned research organizations BARI/BRRI should take the initiative to make rural level availability of farm machineries.
7	Lack of quality seed	BADC/DAE should take care of this matter
8	Unavailability of inputs at suitable time	BADC/DAE should take care of this matter
9	Poor quality of pesticides	DAE should properly administer the regulatory affairs on pesticides marketing
10	Unavailability of inputs after disaster	Mini cold storage or storage facilities at rural level should be developed under GO or NGO initiatives .So that inputs could be available at shortest possible time after disaster.

CHAPTER VIII
SUMMARY, CONCLUSION AND RECOMMENDATIONS

8.1 Introduction

DAE made a partnership with multidonor UN financed project titled “Disaster and Climate Risk Management in Agriculture (DCRMA), under Comprehensive Disaster Management Project (CDMP) Phase-II during the period from 2010-2014.Donors (UNDP, UK AID, EU, Norwegian Embassy, Sweden and Australian AID)were involved with the Government of Bangladesh for conducting several projects. The specific objective of DCRMA project was to increase DAE capacity to cope with climate change impacts. The project had been implemented 26 districts of Bangladesh covering all the climate change hotspots. During this period, Union Disaster Management Committee (UDMC) was established at local level.

One of the main achievements of the project was to conduct Climate Field Schools (CFS) at the targeted 52 Upazilas. CFS is such a Non-Formal Educational (NFE) arrangement to capacitate the farmers as to improve their socio-economic conditions by acquiring expertise on combating the effects of climate change in agriculture. In this connection, 156 IPM/ICM clubs were selected where there was participation of 25 male-female farmers in each club.
Objectives of CFS were:

- To make aware of the farmers to keep the impacts of climate change at minimum level,
- To capacitate the farmers to address the challenges of climate change
- To increase the self-confidence of farmers on the face of adverse effects of climate change
- To prepare the farmers to understand the forecast of disasters and climate change
- Learning by doing, and
- To help the farmers to be cooperative and socialistic.

Four stages of CFS implementation are baseline survey, input supply, technology demonstration and conduction of session. Sessions were conducted in the drought prone, flood, flash flood prone and salinity areas following a definite schedule and lesson plan.

There are some hot spots where the people are more victimized under the threats of climate change. A little research has been found on the contribution of approaches made under CSA. Identification of interventions already provided by extension services and future need of interventions in the climate change hotspots is an important task. Assessment of CSA knowledge, levels of adoption of adaptation technologies by the farmers and reviewing their opinion on the climate change issue is also important. Climate Smart Agriculture (CSA) first introduced by FAO-UN in 2010 is importantly a new approach to be implemented by the extension service providers. Its dimension is to address production, productivity, livelihood improvement, food security through adaptation and mitigation practices. All those issues got a little importance in the previous research works so far. In the above circumstances, conduction of this study was well justified by the researcher for the following reasons:

1. The study will reflect the CSA interventions impacts in some hotspots who are the victims of different disasters.
2. It would make a comparison of change in livelihood between CSA and non CSA practicing farmers.
3. Through this study, livelihood improvement and food security status measurement before and after the CSA interventions would be synthesized.
4. The study would identify the strengths and weaknesses of the given interventions and may formulate new strategies and opportunities for future interventions.

In the backdrop of the mentioned justification the study were undertaken to satisfy the following specific objectives

Specific objectives:

1. To describe the selected predictors of the farmers;
2. To assess the impact of Climate Smart Agriculture on farmers' livelihood;
3. To make a comparative analysis among the livelihood of Climate Smart Agriculture and non- Climate Smart Agriculture practicing farmers;
4. To determine the contribution of selected predictors of the farmers on their Livelihood under the impact of practicing Climate Smart Agriculture;
5. To analyze the problems faced by the climate change victim farmers and to Suggest their remedial measures.

8.2 Materials and methods

Four southern districts namely Patuakhali, Barguna, Pirojpur and Barisal were selected considering the vulnerabilities to climate change effects on agriculture and food security. Out of which Patuakhali and Pirojpur were the study group farmer's areas, Barguna and Barisal were control areas respectively.

Participants of the Climate Field School (CFS) conducted in the three upazila were the study group population of this study. DAE records revealed that there were three CFS in each of the Upazila participating 25 farmers' that constitute a total number of 75 farmers in each of the study(CFS conducting) Upazila. Therefore total number of population under three Upazila in this study for study group stands as 75x3=225 numbers of farmers.

On the other hand, one village from each of Amtali, Banaripara and Babugonj Upazila, had randomly been selected for control group study. Those villages were selected with the help of Upazila Agriculture officers of the respective Upazila. The villages were Shakharia, Krishnapur and Maddhya rakudia respectively. Total number of farming households of the three villages were 393, 320 and 370 which constituted the total population of 1083 farming

households. Among the 1083 farming households, firstly a screening had been conducted by using a simple question yes or no based on the source of income agriculture(crop) or non-crop, to identify the farmers having the profession of absolutely agricultural farming. Within the same questionnaire the farmers either received any climate related training or ever heard about CSA had been excluded. It was found that among the 1083 farm families 83, 78 and 90 farmers from Shakharia, Krishnapur and Maddhya Rakudia villages were not absolutely engaged in crop agriculture and somhow heard about CSA or CFS. Excluding those farmers from the population list, a total population of 832 (310+242+280) farmers had been selected for the study under control group. Within the 832 farmers a pretest had been conducted taking 5% (15+12+13) farmers from each of the upazila to justify the validity of the instrument. Thus the total number of population of non CSA farmers in the control group under study stands as 792. The population from Shakharia, Krishnapur and Maddhya Rakudia were 295, 230 and 267 respectively. A reserve list of 5% farmers from each Upazila had also been maintained keeping 15, 12 and 13 farmers to fill the gap of any missing farmer those had not been included in the sample. Thus the population for the control group study stands as 752 farmers.

Farmers participating CFS were treated as CSA farmers. Since the number of CSA farmers were a small quantity in each upazila, so the total 225 numbers of populations from the three treatment upazila were considered as sample. A pretest of the questionnaire had been administered among the 5% of the sample respondent to test the validity of the instrument .A number of 15 farmers, 05 from each upazila had been kept in the reserve list to fill the gap of absence of any respondents during the interview period. As a result 27 farmers had been excluded among the sample. Moreover a screening had been conducted among the sample respondent with a question whether their earning source had been shifted other than agricultural farming? Under a yes no question it was evident that 10 (4+3+3) farmers shifted their profession from Agriculture, so they were

dropped from the list. Thus the absolute CSA farmers stands as 188 that had been treated as sample respondents.

Farmers never participated in any climate related group activities or never heard about CFS or never received any training on climate change, had been treated as non CSA farmers. Among the 752 population of the three villages 25% farmers had been selected as sample. Proportionate random sampling technique had also been followed based on the number of population of the three villages to satisfy the number of sample as equal to the sample size of treatment group. Thus the sample stands as 70, 54 and 64 farmers respectively from the selected three villages those made a total sample size of 188 farmers. Following table represents the population and sample size of both the treatment and control group.

The present study is an *ex-post-facto* investigation and was conducted to compare the pre- and post- CFS livelihood change of the respondents' farmers.

In order to collect relevant information from the respondents, interview schedule was used. The schedule was carefully designed keeping the objectives of the study in view. The interview schedule contained both open and close-ended questions. The questions were arranged systematically so that the sample respondents can easily understand during its usage.

After preparing the final interview schedule data were collected through face to face interview during July, 2018 to December, 2018 by the researcher himself. To get valid and relevant information, the researcher made all possible efforts in explaining the purpose of the study to the respondents. Appointments with the interviewee were made in advance. In case of failure to collect information from the respondents due to their other business, re-visits were made with prior appointments.

While interviewing any respondent, the researcher took all possible care for establishing rapport with him/her so that the respondent did not feel any hesitation to furnish proper response to the questions and statements as included in the schedule. Questions were asked in multiple ways so that the respondents could easily understand the content of the questions. If the respondents were not clear about what was wanted to know, supplementary questions were then asked for further clarification. Data were also collected through focus group discussion, from available published and unpublished secondary sources on related aspects for comparison of the conditions prevailed before and after intervention of CFS.

After collection of data, all the information contained in the interview schedule was edited. All the collected data were then checked and cross checked, compiled, coded and entered into the XL sheets of computer for analysis and interpretation using SPSS program. Qualitative data were converted into quantitative by means of suitable scoring. Data were presented mostly in tabular forms, Statistical measures like number, range; mean and standard deviation were calculated in describing the selected characteristics of the respondents and changes in livelihood dimensions after involvement in CFS program. Parametric statistics such as t-test, analysis of variance, simple correlation, stepwise multiple regression and path analyses were used for exploring comparison between pre and post-CFS changes of the livelihood dimensions and relationships between the dependent and independent variables.

8.3 Major findings

8.3.1 Predictors

Age: Highest proportions of the respondents of study group were middle aged (51.60%) followed by control group (45.21%). Young aged percentage is very close in both the cases (19.68%) and (18.09%) respectively.

Educational qualification: In both the study and control areas observed educational categories ranges from (0-16) to (0-14) respectively. In the study group areas, highest percentage (39.89%) of the respondents belongs to secondary education categories followed by primary education (38.83%), where illiterate percentage were in a very minimum percentage (7.45%). In comparison the highest percentage 54.26%) of respondents belongs to the primary education level, followed by secondary education (31.92%).In control group illiterate percentage of educational level were very minimum (10.63%).

Family size: Family sizes in all the study area were centered within 4-6 members.

Existing farm size: The average farm sizes in both the groups are 0.999 ha and 1.19 ha respectively with standard deviation of 0.658 and 0.719.

Annual family Income: Maximum farmers (48.94%) and (53.73%) from both the group belongs to the medium income category followed by low income (14.36%) and (22.87%)). In the control group low income respondents percentage is higher than that of the study group. On the other hand high income farmers percentage (36.70%) is higher that of control group (23.40%).

Agricultural extension media contact: Maximum respondent (59.57%) in the study group occasionally keep contact with extension media where in control group it is slightly lower (50%).

Innovativeness: Early majority are belonging to the highest percentage (37.2%) and (36.17) % respectively in both the case of study and control group. On the other hand, innovator and early adopter categories are higher in the study group in comparison to control group.

Organizational support: High support receiving percentage (14.36%) is greater in the study area in comparison to the control area (10.64%).

Empowerment status: Considering all economic and social dimensions, extent of empowerment status is so high in the study group that 71.28% respondents belong to high status category. On the other hand only 21.28% in the control group respondents could achieve high status in all dimensions.

Exposure to ICT Apps: It is found that maximum percentage of respondents 68.08% and 83.51% respectively in both the area have low exposed to ICT apps. Medium exposure percentage (30.32%) in study group is higher than that of control group (15.95%).

Knowledge on CSA: No respondents had been found having no knowledge or low knowledge on climate smart agriculture. Observed range was 21-58 against the possible range of 0-60.

Use of CSA technologies: Maximum respondents 86.17% uses the adaptation technology occasionally.

Benefit obtained from CSA: All the respondents (100%) were moderately to highly benefitted by adopting CSA approach.

8.3.2. Impact of CSA on farmers' livelihood

In the study group high intake of calorie was 17% higher than before CSA approach whereas in the control group the change in high intake is only 1.03%. All the respondents (100%) were in the category of having 90 to >90 meals stock after CSA whereas in the control group 80.85% having the stock of 90->90 meals during the post CSA period (2015-17).

The food stock change in the study group over the control group was 19.15%. Respondents, having complete balance diet has been increased (19.15%-37.23%) =18.08% over pre- CSA period in the study group. On the other hand increasing percentage of the respondents in the same dimension being found as (17.02%-20.21%) =3.19%. High rise base house adaptable to disaster especially flood 7.97% of respondents has been found to hold in the study group whereas 3.72% respondents have the same category house in the control group.

The change over control group has been being found as 4.25%. Own tube well with high-rise base had been found in 9.58 % respondents after adopting CSA among the study group whereas no respondents has been found in the same category during the year 2015-2017. High-rise base pucca sanitary latrin were found in 8.51% respondents in the study group households. Whereas, in the control group, 3.73% respondents households had have the same category latrin. Among the study group respondents 14.37% could achieve the ability to very high value clothing whereas this percentage is only 2.12% in the control group.

After adopting CSA approach 85.11% respondents in the study group could either achieve the ability or understood the importance to visit MBBS/ specialist doctors in case of health care. On the other hand this percentage is 57.44% in the control group where the visible rate of change is 27.67%.

Post CSA mean difference value was higher than those of pre CSA mean difference value. All those were significant at 0.001 levels. These results established the fact that farmers livelihood were significantly changed at higher level due to practicing CSA.

8.3.3 Contribution of the selected predictors of the farmers (study group)

The stepwise multiple regression analysis revealed that out of 13 individual variables, namely, age (X_1), education(X_2), family size (X_3), farm size (X_4), annual family income (X_5), agricultural extension media contact (X_6), innovativeness (X_7), organizational support (X_8), empowerment status (X_9), exposure to ICT Apps for agricultural information (X_{10}), knowledge on Climate Smart Agriculture practices (X_{11}), use of CSA technologies (X_{12}) and benefit obtained from CSA (X_{13}) only six (6) independent variables entered into regression equation such as knowledge on Climate Smart Agriculture practices (X_{11}), benefit obtained from CSA (X_{13}), empowerment status (X_9), use of CSA technologies (X_{12}) and organizational support (X_8) with livelihood index(Y) the dependent variable showing the contribution to the farmers livelihood as an impact of climate smart agriculture.

The result indicated that the whole model of 13 independent variables explained 45.9 percent of the total variation in of climate smart agriculture on farmers' livelihood. But since the standardized regression coefficient of 6 variables formed the equation and were significant, it might be assumed that whatever contribution was there, it was due to these 6 variables.

8.3.4 Direct and Indirect Effects of the selected predictors of climate smart agriculture on farmers' livelihood (study group)

The knowledge on Climate Smart Agriculture practices (X_{11}) had the highest total indirect effect (0.409) followed by benefit obtained from CSA (0.367) (X_{13}) 2nd, Empowerment status (0.339) 3^{rd,} use of CSA technologies (0.391) (X_{12}) 4th, education (0.247) (X_2) 5th and Organizational support (0.220) (X_8) stands in the 6th position. The direct effects were channeled positively through other variables.

8.4 Conclusions

Based on the findings, discussion and logical interpretation, the following conclusions were drawn:

1. Overwhelming majority (86.60%) of the Climate Smart Agriculture (CSA) farmers in the CSA group had medium to high improvement in livelihoods whereas the only 26.60% non-CSA farmers changed their livelihood. Therefore, it may be concluded that CSA practice can improve the livelihood of the farmers.
2. Knowledge on Climate Smart Agriculture practices of the farmers had the highest contribution on their livelihood as an impact of Climate Smart Agriculture. Therefore, it may be concluded that in order to lead an improved livelihood, farmers have to be gain knowledge on the CSA practices.
3. Benefit obtained from CSA of the farmers had remarkable (2^{nd} highest) significant and positive influence on their Livelihood as an impact of climate smart agriculture. Therefore, it may be concluded that for getting more benefit, farmers should practice CSA.
4. Empowerment status of the farmers had the 3^{rd} highest significant and positive contribution to their impact in livelihood status. Therefore, it may be concluded that farmers who practiced CSA after learning from Climate Field School (CFS) had positive impact on their livelihood.
5. Use of CSA technologies of the farmers had significant and positive contribution to their livelihood as an impact of climate smart agriculture. This finding led to the conclusion that framers using CSA technologies had an improved livelihood status.
6. Education of the farmers had significant and positive contribution to their livelihood as an impact of Climate Smart Agriculture. Therefore, it led to the conclusion that educated farmers learned better on CSA and led an improved likelihood.

7. Organizational support of the farmers had significant and positive contribution to their livelihood as an impact of Climate Smart Agriculture. Therefore, conclusion may be drawn that in order to lead an improved livelihood, farmers need some support either cash or in kind from either Government or Non-Government. Organizations.
8. Insufficient capital to recover the loss after disaster, lack of quality seed, poor storage facilities of inputs during disaster, reluctance of the Government agencies to renovate the old structures (sluice gate, bund, etc.), unavailability of inputs at suitable time were the topmost five problems among 20 problems faced by the farmers of the study areas. Therefore, concluding statement would be drawn to give emphasis to remove all those problems for the betterment of the farmers.

8.5 Recommendations for policy implications

Based on findings and drawn conclusions, following recommendations may put forward for policy implications:

1. More CSA farmers improved their livelihoods than non-CSA farmers. Therefore, it is recommended that Ministry of Agriculture (MOA) should give emphasis on formulating policy to implement CSA practices by the farmers. DAE can take initiative for rapid dissemination of validated CSA technologies among the farmers.
2. Knowledge on Climate Smart Agriculture practices found to be the most important positive contributor. It is recommended that appropriate initiative should be taken to improve farmers' knowledge on CSA. Non formal Education program to be undertaken by GOs and NGOs. Activities of Climate Field School introduced by DAE should be strengthened.
3. Benefit obtained from CSA stood the second position as a contributor of improving farmers' livelihood. Initiative could be made to disseminate the CSA technology across the country so that all the farmers be

benefited from practicing CSA. DAE can arrange motivational tour for the farmers of non-CSA areas to visit the CSA practicing farmers areas.

4. Empowerment status of the farmers had significant and positive influence on farmers' livelihood. It is evident that CSA farmers having more income than non- CSA farmers and hold a high status. Initiative to disseminate CSA technology in the non-CSA areas can minimize this discrimination. Agricultural extension policy should be revised considering the empowerment status of the farmers.
5. Use of CSA technology of the farmers had a good contribution to their livelihood an impact of climate smart agriculture. MOA can revise the national Agricultural extension policy emphasizing on the modality as to how to increase the use of CSA technologies among the farmers.
6. Education of the farmers had significant and positive influence to their livelihood as an impact of Climate Smart Agriculture. Educated farmers were well aware about the CSA technologies which led to improve their likelihood. Therefore, it is recommended that DAE and other agricultural extension service providing organizations should arrange formal and non-formal training to educate farmers on CSA technologies.
7. Organizational support of the farmers had significant and positive contribution to their livelihood as an impact of Climate Smart Agriculture. Government and Non- Government agricultural advisory service providing organization should come forward to support farmers either in financial or physical form.
8. To mitigate the problems of the farmers, Agricultural Advisory Service Providing organizations should come forward by arranging credit to farmers from different Banks and financial institutions, improvement of agricultural infrastructures (sluice gate, polders, etc.), and other means.

8.6 Recommendations for further study

Further study could be undertaken considering the statements mentioned bellow:

1. Present study was carried out in small area of four districts. Similar studies should be conducted in other parts of the country to get more authentic picture of the whole CSA approach which would be helpful for generalizing the recommendations towards effective policy formulation.

2. This study examined the changes in livelihood in some of the dimensions. Further research could be undertaken to evaluate the improvements in other dimensions.
3. This study has covered only the crop sub-sector under the agriculture sector. Further study could be undertaken covering the fisheries, livestock and poultry sub-sectors.
4. Different NGOs like BCAS, Christian Aid, Action aid, CCDB etc. have been receiving foreign aid in connection to the climate change adaptation and development. Evaluative study should be undertaken to find out the effectiveness of those aids in terms of agricultural development.
5. GOB has developed a climate change trust fund with BDT. 7000 million to implement different projects relevant to climate change adaptation and mitigation practices. Study on impact of any of those projects towards improving trends of farmers' livelihood could be undertaken for identifying the corrective measures to remove the weaknesses of the projects.

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APPENDIX

Appendx-1: Interview Schedule (for CSA farmers participating CFS) [Study Group]
[This information will only be used in research purpose]
Department of Agricultural Extension and Information System
Sher-e-Bangla Agricultural University, Dhaka.

Impact of Climate Smart Agriculture (CSA) on farmers' livelihood

Sample No. Date of interview:

Name: .....Father's/Husband's name:……..…….....

Mobile.....

Village.....Union……Upazila.....District.....

1. Age

How old are you? ……Years

2. Educational qualification

a) Illiterate.
b) Can sign only.
c) I read up to class……
d) I took non-formal education and it is equivalent to class…….

3. Family size: How many family members do you have?----------persons.

4. Existing farm size:

Please furnish information about your firm size:

Sl. No.	Land type	Area	
		Local unit(Decimal)	Hectare
1.	Homestead area including pond (A)		
2.	Own land under own cultivation (B)		
3.	Land given to others as borga (C)		
4.	Land taken from others as borga (D)		
5.	Land taken from others as lease (E)		
Total= A+B+1/2(C+D)+E			

5. Annual family income: Please mention your yearly family income from each of the following sources.

a) Agriculture	Amount (TK.)	b) non- agriculture	Amount (TK.)	Total(a+b),TK.
Field crop		labor		
Homestead crop		Service		
Fruit tree		Business		
Timber tree		Foreign remittance		
Gulpata		Other(Specify)		
Bamboo		1.		
Livestock		2.		
Fisheries		3.		
Poultry		4.		
Grand total		Grand total		

6. Agricultural extension media contact: Please indicate the nature of your contact to the following media:

Sl. No.	**Communication media**	**Extent of Communication**			
		Regularly (3)	**Occasionally (2)**	**Rarely (1)**	**Not at all (0)**
A. Personal Contact					
1	Meet with contact growers /ideal farmers(times/ 3 months)	≥6 ( )	3-5 ( )	1-2 ( )	0 ( )
2	Meet with Input dealers (times/per 3 months)	≥6 ( )	3-5 ( )	1-2 ( )	0 ( )
3	Meet with SAAOs (times/per 3 months)	≥6 ( )	3-5 ( )	1-2 ( )	0 ( )
4	Meet with NGO worker deals with agril input/technologies (times/per 3 months).	≥6 ( )	3-5 ( )	1-2 ( )	0 ( )
5	Meet with Agriculture Extension Officer/UAO (times/per year)	≥6 ( )	3-5 ( )	1-2 ( )	0 ( )
B. Group Contact					
6	Participation in farmer's Information Need Assessment session (FINA)/Problem census (PC)/FGD (times/per year)	3 ( )	2 ( )	1 ( )	0 ( )
7.	Participation in agricultural result demonstration program/Field day (times/per year)	3 ( )	2 ( )	1 ( )	0 ( )

Sl. No.	Communication media	Extent of Communication			
		Regularly (3)	Occasionally (2)	Rarely (1)	Not at all (0)
8	Participation in farmers rally e,g. tree plantation campaign /farmers day(times/per year).	3 ( )	2 ( )	1 ( )	0 ( )
9	Involvement in farmers' cooperative discussion meeting (times/3 months).	≥6 ( )	3-5 ( )	1-2 ( )	0 ( )
C. Mass Media Contact					
10.	Listening agricultural program on Radio (times/week)	≥4 ( )	2-3 ( )	1 ( )	0 ( )
11.	Watching agricultural program on Television (times/week)	≥4 ( )	2-3 ( )	1 ( )	0 ( )
12.	Reading agricultural news from daily newspaper(times/week)	≥4 ( )	2-3 ( )	1 ( )	0 ( )
13.	Reading agricultural features from krishi biplob, krishikotha, leaflet, booklet, magazine, etc. (times/per year)	≥4 ( )	2-3 ( )	1 ( )	0 ( )
Total					

7. Innovativeness: Please indicate your position from the following categories;

a) Innovator (willing to take risk any time to adopt innovations having high financial ability) (5):.....
b) Early adopter (adopt innovations immediate after a check of risk having opinion leadership) (4):.....
c) Early majority (deliberate willingness to adopt innovations having seldom leadership) (3):.....
d) Late majority (do not adopt until most others have done so, little leadership) (2):.....
e) Laggard (suspicious of innovations, cautious to reject the traditional and late to adopt new) (1):.....

8. Organizational support: Please indicate the number of organizations those support your agricultural activities;

Sl no.	Supporting facilities	Number of GOs	Number of NGOs	Pesticide/seed/fert./ relevant companies	How many

1	Receiving awareness building training on adaptation to climate change				
2	Receiving information on innovations				
3	Receiving input support				
4	Receiving credit support				
5	Receiving technical assistance				
	GT				

9. Empowerment status: Please indicate your access to right in the following issues:

Issues	Level of access		
	Own decision (3)	Decision influenced by spouse/ f. members (2)	Decision influenced by outsiders (1)
Economic			
Spending money			
Purchasing agril inputs			
Selling agril products			
Purchasing household materials			
Family/Social			
Education for family members			
Celebrating family events			
Selecting family planning methods			
Family healthcare			
Hosting relatives			
Political			
Voting power			
Attending political meeting			
Choosing leadership			

Issues	Level of access		
	Own decision (3)	Decision influenced by spouse/ f. members (2)	Decision influenced by outsiders (1)
Protesting unfair means/corruption			

10. Exposure to ICT Apps for agricultural information. : How many times do you use the following ICT Apps/month for receiving agricultural information?

Mobile	call centre	face book	U tube	Video call	Miss call reply	Total
…….times/m	…….times/m	…….times/m	…….times/m	…….times/m	…….times/m	

Score (1) will be assigned for one time use.

11. Knowledge on Climate Smart Agriculture (CSA) practices: Please answer the following questions.

Sl no.	Items	Correct Ans.	WA**	Marks obtained
	Remembering			
1	Mention any three important CSA technologies.	02	0	
2	Mention any two stress tolerant variety of rice.	02	0	
3	What crop needs less water?	02	0	
4	Which crop can tolerate drought?	02	0	
5	Which crop can grow in water?	02	0	
6	Mention any two pulse variety	02	0	
	Understanding			
7	Do you understand Climate Smart Agriculture?	02	0	
8	Do you know about the use of AWD	02	0	

Sl no.	Items	Correct Ans.	WA**	Marks obtained
9	What do you mean by drought?	02	0	
10	How can you identify salinity effects/Soil salinity?	02	0	
11	What do you mean by crop rotation?	02	0	
12	What do you mean by Zero tillage?	02	0	
	Applying			
13	How can you preserve rain water?	02	0	
14	How can you prepare green manure?	02	0	
15	How can you conserve soil fertility?	02	0	
16	How can you prepare compost?	02	0	
17	How can you use Guti urea?	02	0	
18	How balanced use of fertilizer can be ensured?	02	0	
	Analyzing			
19	Why do you use guti urea?	02	0	
20	Why do you use sarjan method?	02	0	
21	Why do you use saline or stress tolerant variety?	02	0	
22	Why do you use floating bed cultivation method?	02	0	
23	Why do you use zero tillage cultivation?	02	0	
	Evaluating			
24	What is the demerit of using broadcasted urea	02	0	
25	What are the demerits of high temperature for crop production?	02	0	
26	What benefit do you get from relay/intercropping Aman/+Kheshari?	02	0	
27	What is the benefit of adjusting planting	02	0	

Sl no.	Items	Correct Ans.	WA**	Marks obtained
	time?			
	Creating			
28	How can you increase soil fertility	02	0	
29	How can you save the misuse of irrigation water?	02	0	
30	How can you control pest in low cost?	02	0	
	Total			

** WA- Wrong answer.

12. Use of CSA technologies: Please mention the extent of your use of the following CSA technologies in the last three years (2015-2017) by putting tick (√) mark in appropriate column.

Sl no.	Dimensions	Items of CSA technologies	Never used (0)	Extent of use		
				Rarely (1)	Occasionally (2)	Frequently (3)
1	Flood/ Tidal surge	Floating cultivation				
2		Change in cropping pattern				
3		Cultivation of short duration varieties				
4		Homestead gardening				
5		Cultivation of late varieties				
6		Adjustment of planting time.				
7		Cultivation of flood tolerant varieties				
8		intercropping of grass pea(kheshari) with Aman				
9		Zero tillage cultivation				
10		Crop rotation				
11		Creepers cultivation				
12	Salinity	Rain water harvesting/Minipond for fresh water irrigation				
13		Raised bed or sarjan method of cultivation				
14		Cultivation of saline tolerant variety				
15		Use of organic manure/compost to improve soil quality.				
16		Cultivation of watermelon				
17		Sunflower cultivation				
18		Felon cultivation				
19		Alternate wetting and drying				

20	Drought	Cultivation of drought tolerant varieties				
21		Dry seed bed for T aman rice				
22		Supplementary irrigation.				
23		Solar power irrigation				
24		LLP irrigation				
25		Drip irrigation				
26		Hose pipe irrigation				
27		Tight bund irrigation				
28		Pucca drain irrrigation				
29		Excavation of minipond near crop field				
30		Mungbean cultivation				
31		Sesame (Til) cultivation				
32	High temperature	IPM practices				
33		Mulching practices for soil moisture conservation.				
34		Mixed cropping				
35		Perching.				

13. Benefit obtained from CSA: Please mention the extent of benefits obtained by you by using CSA practices

Sl No.	Items	Extent of benefits			
		Largely benefitted (3)	Moderate benefitted (2)	Low benefitted (1)	Not at all (0)
	Social benefits				
1	Development of organizational participation				
2	Increased extension contact				
3	Development of leadership				
4	Increased social bonding				
	Economic benefits				
5	Increased family income				
6	Low production cost				
	Technical benefits				
7	Improved capacity on new technology implementation				
8	Development of technical knowledge and				

	skill				
9	Increased crop production and productivity				
10	Increased cropping intensity				
11	Increased crop yield				
	Psychological benefits				
12	Positive mental state to adopt new technology				
13	Positive attitude towards change in food habit				

14. Impact of CSA on your Livelihood

14.1. Change in food consumption (in terms on nutrition): Please state daily average food consumption/person among your family members.

Sl no.	**Meal time**	**Menu and amount(kg)**		**Total nutrition value(calorie)**		**Change** amount
		Before adopting CSA (12-14)	After adopting CSA (15-17)	Before adopting CSA	After adopting CSA	Calorie
1	Breakfast					
2	Lunch					
3	Supper/dinner					
4	Others (if any)					
	Total					

*** Score (1) will be assigned for each 100 kcal food consumption**

14.2. Food stock availability: Please mention how many meals generally you maintain as your food stock for survival.

Time period	Number of meals		**Change kg**
	Before adopting CSA (12-14)	After adopting CSA (15-17)	
For one day (3 meals)--kg			
For one week (21meals--kg			
For one month (90 meals)--kg			
For more than one months ((>90 meals)			
Total			

14.3. Access to Food (balance diet): Please mention the percentage of food intake in terms of balance diet by your family members.

Food items	Intake kg/month (calorie)		Change(calorie)
	Before CSA (12-14)	After CSA (15-17)	
Carbohydrates (25%)			
Rice			
Wheat			
Tuber			
Sugar			
Proteins (25%)			
Pulses			
Fish			
Egg			
Meat			

Fats and oils (10%)			
Edible oil			
Milk			
Vitamins and minerals (40%)			
Fresh vegetables(own)			
Vegetables from market			
Fresh fruits(own)			
Fruits from market			

14.4. Housing status: Please mention the status of your shelter:

Types of houses	Before adopting CSA (12-14)	After adopting CSA (15-17)	Change
Katcha/mud wall with gulpata roof (1)			
Tin shed with tin/mud/bamboo wall (2)			
Tin shed with tin wall (3)			
Tin shed with brick wall (semi-pucca) (4)			
Tin shed high-rise house (5)			
High-rise with brick wall & roof (6)			

*** Change in different types of housing status.**

14.5. Drinking water source: Please mention your drinking water source.

Drinking water source	Before adopting CSA (12-14)	After adopting CSA (15-17)	Change

Pond/river without treatment (1)			
Pond/river with simple treatment (2)			
Tube well not exam Arsenic (3)			
Tube well with Arsenic (4)			
Arsenic free tube well (5)			
Common/Others' tube well (6)			
Own tube well normal base (7)			
Own tube well upon high rise base (8)			

*** Change in different types of drinking water source.**

14.6. Sanitation status: Please mention your toilet facilities.

Types of latrine	Before adopting CSA (12-14)	After adopting CSA (15-17)	Change
No latrine/bush/field(0)			
Open pit/ kacha latrine (1)			
Sanitary ring slab latrine (2)			
Pucca latrine upon normal base (3)			
Pucca latrine upon high rise base (4)			

*** Change in sanitation status.**

14.7. Clothing behavior: Please mention the used number cloths/person/year. Score 1 for equivalent 1000/= TK. value of cloths.

Cloth type	**Before CSA (12-14)**			**After CSA (15-17)**			**Change**	
	No.	**Value (TK.)**	**Score**	**No.**	**Value (TK.)**	**Score**	**Value**	**Score**
Ordinary set								

Medi. value coarse set								
High value fine set								
Warm set								
Total								

14.8. Health care: Please mention your health care facilities.

Medicare	Before adopting CSA (12-14)	After adopting CSA (15-17)	Change
Pir/Fakir (1)			
Homeopath (2)			
Trained village doctor (3)			
MBBS/specialist (4)			
Total			

*** Change in health care facilities.**

15.1: To what extent are you facing the following Problems in agricultural practices due to climate change?

Sl no.	**Problems**	**Degree of severity**				
		No (0)	**Low (1)**	**medium (2)**	**High (3)**	**Very high (4)**
1	Scarcity of irrigation water					
2	Unavailability of stress tolerant varieties					
3	Lack of knowledge on adaptation practices.					
4	Unavailability of suitable technology					
5	Unavailability of inputs after disaster.					
6	Unavailability of inputs at suitable time.					
7	Poor storage facilities of inputs during disaster					
8	Declining soil fertility					

9	Increasing water and soil salinity.					
10	Reluctance of the Govt. agencies to renovate the old structures (sluice gate, bund, etc).					
11	Limited access to information					
12	Poor contact with extension media/agents					
13	Lack of relevant training facilities					
14	Marketing problems during and after disaster					
15	Unavailability of labor					
16	Unavailability of farm machineries					
17	Lack of quality seed					
18	Unavailability of proper pesticides					
19	Poor quality of pesticides					
20	Insufficient capital to recover the loss after disaster					

15.2 Please give your suggestions to overcome the aforesaid problems

Sl. No.	**Problems**	**Suggestions to overcome the problems**
01.	Scarcity of irrigation water	
02.	Unavailability of stress tolerant varieties	
03.	Lack of knowledge on adaptation practices.	
04.	Unavailability of suitable technology	
05.	Unavailability of inputs after disaster.	
06.	Unavailability of inputs at suitable time.	
07.	Poor storage facilities of inputs during disaster	
08	Declining soil fertility	
09.	Increasing water and soil salinity.	
10.	Reluctance of the Govt. agencies to renovate the old structures (sluice gate, bund, etc).	
11.	Limited access to information	

12.	Poor contact with extension media/agents	
13.	Lack of relevant training facilities	
14.	Marketing problems during and after disaster	
15.	Unavailability of labor	
16.	Unavailability of farm machineries	
17	Lack if quality seed	
18	Unavailability of proper pesticide for treatment of Pest and diseases	
19	Poor quality of pesticide	
20	Insufficient capital to recover the loss after disaster	

Thank you for your cooperation

_____

Signature of the Interviewer Date:

Appendix-2

List of experts for validity/reliability test of Interview schedule.

Sl no.	Name and Designation	Organization	Email/phone
1	Prof. Dr. Nazmunnahar	Dept. of Agro forestry and Env. science, SAU	01712700186
2	Prof. Dr. Kausar Hossain	Dept. of Agro forestry and Env. science, SAU	01701777941
3	Prof. Dr. Md. Nazrul Islam.	GTI, BAU, Mymensingh	01711362652
6	Dr. Mahbubul Alam	Dept. of Agricultural Extension and Information System, SAU	mmahbubul_22@yahoo.com
7	Dr. Ranjan Roy	Dept. of Agricultural Extension and Information System, SAU	ranjansau@yahoo.com
8	Dr. Humayun kabir	Dept. of Agricultural Extension and Information System, SAU	mhumayunsau@yahoo.com
9	Kh. Zulfiker Hossain	Dept. of Agricultural Extension and Information System, SAU	zulfikaraeissau@gmai.com
10	Kh. Md. Mainuddin	Director, Bangladesh Centre for Advanced Studies (BCAS), Climate Change Expert	Khandaker.mainuddin@bcas.net 01713023856.
11	Dr. Dijen Mallik	Director, Bangladesh Centre for Advanced Studies (BCAS), Climate Change Expert	
12	Md. Amir Hossain	Professor, Department of Agriculture Extension and Rural Development, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur- 1706, Bangladesh	
13	Dr. Md. Enamul Haque	Professor & Head, Department of Agriculture Extension and Rural Development, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur-1706, Bangladesh	
14	Dr. Md. Korban Ali	Director (Research and Programme), Research Initiatives of Bangladesh, Banani, Dhaka	

Sl no.	Name and Designation	Organization	Email/phone
15	Dr. Shaharuk Ahmed	Ex Deputy Director, Department of Agriculture Extension, Khamarbari, Dhaka	
16	Dr. A.N.M Wali Ullah	Ex, Deputy Director (Soil), Department of Agriculture Extension, Khamarbari, Dhaka	
17	Dr. Md. Abdur Razzaque	Ex-Director (TTMU), Bangladesh Agricultural Research Council, Dhaka	
18	Dr. M.A Mueed	Additional Director, Dhaka region. Department of Agriculture Extension, Khamarbari, Dhaka	01716940311
19	Md. Motiuzzaman	District Training officer, Department of Agriculture Extension, Netrokona	01712228826
20	Dr. Jahanjgir Alam	Director, Agriculture Information service, khamarbari, Dhaka	01715111486
21	Md. Badrul Alam, UAO	Upazila Agriculture Office, Amtali Barguna	01718365612
22	Md. Mashiur Rahman, UAO	Upazila Agriculture Office, kalapara, patuakhali	01740894828
23	Dig bijoy Hazra,UAO	Upazila Agriculture Office, Najirpur, Pirojpur	01753169251
24	Md. Aliul Alam, UAO	Upazila Agriculture Office, Banaripara, Barisal	01728328086
25	KBD SM Nazrul Islam (Retd.) Additional Director	Climate Change Expert	01712172674
26	Md. Badrul Alam Talukder, Coorinator	Climate Tech. Park, Climate Change unit, CCDB	badrulalam03@gmail.com
27	Dr. Md.Shariful Islam	PhD fellow, Gifu University, Japan	mobas14@yahoo.com.18036201465
28	Dr. Zakiuzzaman	UNIDO, country representative in Bangladesh	Zakiuz@gmail
29	Dr. Rasheed Sulaiman, Director	Centre for Research on Innovation and Science Policy (CRISP), India	crispindia@gmail.com

Sl no.	Name and Designation	Organization	Email/phone
30	MS. Farah kabirm, Country Director	Action Aid Bangladesh	farah.kabir@actionaid.org
31	Dr. Abu Wali Ragib hasan,Retd. Director	Planning wing, DAE	hassan58_dae@yahoo.com 01711224573
32	Dr. Md. Arifur Rahman, Senior Research associate	Bangladesh Unnnayan Parishad (BUP)	bup@citech.bd.com

Appendix-3

Pictorial presentation on Impacts of Climate Change and showing relevant technology on Climate Smart Agriculture.

(A) Climate change effects:

(B) Adaptation: Photograph showing AWD adaptation and mitigation technology as CSA

Appendix-4

Dependent Variable Value for Regression (study and control group)

Dependent Variable Value for Regression (CSA for study group Index X 100)					
46.8	30.1	29.5	38.3	48.1	36.9
44.4	44.4	22.4	44.3	49.4	44.4
46.4	35.6	31.0	27.1	53.5	41.8
45.6	39.7	20.5	32.3	44.6	41.6
45.7	37.5	18.4	39.3	43.3	40.7
38.1	44.5	10.0	31.1	34.0	39.6
46.5	34.2	12.4	20.5	31.6	33.5
38.2	41.1	10.0	33.5	34.9	29.9
38.8	33.9	20.3	38.0	39.4	42.4
34.0	54.7	36.0	19.1	23.2	35.9
27.3	42.8	33.5	11.0	41.3	45.4
38.2	40.3	38.6	14.2	37.0	34.2
47.3	34.5	34.5	22.9	41.8	40.3
40.9	42.7	35.3	39.5	32.9	34.5
30.2	40.3	36.3	32.2	23.1	42.7
40.1	38.2	26.9	41.0	34.2	40.3
35.5	53.9	36.2	43.2	30.3	38.2
33.2	48.1	30.3	30.1	36.2	64.8
38.2	55.0	29.1	44.4	36.0	27.1
30.4	47.7	32.2	35.6	41.4	32.3
44.8	43.2	29.0	39.7	39.2	39.3
54.3	30.1	40.7	37.5	38.0	31.1
41.9	44.4	32.4	44.5	36.3	20.5
28.2	35.6	40.9	36.1	46.7	33.5
41.7	39.7	31.0	30.1	29.8	38.0
31.4	37.5	29.1	27.3	16.9	19.1
40.9	44.5	31.7	24.3	37.8	12.0
48.5	36.1	36.3	31.7	23.5	34.0
36.8	30.1	29.1	32.8	40.0	
42.4	27.3	29.0	30.1	34.8	
39.2	24.3	29.3	42.5	28.2	
34.30	26.60	36.00	49.70	32.50	

Control group

Dependent Variable Value for Regression (CSA for control group Index X 100)					
39.7	23.2	33.6	29.2	22.1	5.6
44.1	28.6	40.1	28.3	23.7	5.6
39.6	23.2	24.8	31.8	25.1	5.6
39.6	27.6	32.7	32.3	27.4	5.6
56.2	31.0	32.8	37.0	8.5	5.6
35.8	25.8	32.8	28.8	29.8	5.6
37.7	33.4	45.6	41.6	23.6	5.6
30.9	26.8	23.7	29.1	19.4	5.6
39.6	36.7	29.4	32.3	19.2	5.6
41.6	36.8	28.9	32.2	17.6	5.8

37.9	37.1	28.5	24.5	27.1	5.8
35.7	37.4	23.7	26.8	24.7	24.9
26.0	39.9	31.8	23.6	27.7	16.3
34.0	34.3	31.2	25.5	12.5	9.1
53.3	36.1	22.2	19.0	22.9	9.1
38.6	26.7	29.6	33.0	19.3	19.7
33.8	30.2	30.6	29.6	28.3	9.9
53.1	39.5	28.4	32.8	35.1	9.9
50.4	35.8	32.4	24.3	20.5	9.9
28.4	32.4	32.9	23.9	15.9	10.3
34.9	36.9	40.4	27.9	17.6	27.8
31.9	28.8	33.6	5.2	22.9	11.6
61.7	35.6	26.4	13.0	14.6	11.8
36.4	26.5	37.4	25.1	28.7	11.8
44.3	31.7	31.7	22.7	33.2	11.8
50.9	34.9	28.2	25.2	29.6	13.0
51.4	26.6	28	31.3	28.7	31.9
34.2	32.9	22.4	31.9	32.2	32.9
43.0	32.2	24.6	31.8	32.7	
51.6	27.5	29.8	27.1	15.2	
32.2	34.3	28.3	28.2	5.4	
25.9	36.5	32.8	22.6	5.4	

Appendix-5

Regression model

Study group

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.709[a]	.502	.465	.06522

a. Predictors: (Constant), Bebefit.CSA, family.size, age, income, innovativeness, ext.medi.con, org.support, education, CSA.Techno, Empowerment, farm.size, Knowledge, ICT

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.747	13	.057	13.507	.000[b]
	Residual	.740	174	.004		
	Total	1.487	187			

a. Dependent Variable: Index
b. Predictors: (Constant), Bebefit.CSA, family.size, age, income, innovativeness, ext.medi.con, org.support, education, CSA.Techno, Empowerment, farm.size, Knowledge, ICT

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.077	.048		-1.614	.108
	age	.001	.000	.073	1.319	.189
	education	.005	.002	.257	2.520	.013
	family.size	.003	.003	.045	.769	.443
	farm.size	-.006	.010	-.042	-.578	.564
	income	-3.244E-5	.000	-.028	-.405	.686
	ext.medi.con	.001	.001	.039	.613	.541
	innovativeness	.009	.006	.095	1.430	.155
	org.support	.002	.001	.116	1.776	.077
	Empowerment	.003	.001	.152	2.084	.039
	ICT	-.002	.001	-.168	-1.640	.103
	Knowledge	.001	.001	.170	2.279	.024
	CSA.Techno	.001	.000	.176	2.509	.013
	Bebefit.CSA	.004	.001	.197	3.005	.003

a. Dependent Variable: Index

Control group

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.702[a]	.493	.465	.08142

a. Predictors: (Constant), ICT, farm.size, age, Family.size, org.support, Empowerment, income, innovative, education, contact

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.143	10	.114	17.240	.000[b]
	Residual	1.173	177	.007		
	Total	2.316	187			

a. Dependent Variable: Index
b. Predictors: (Constant), ICT, farm.size, age, Family.size, org.support, Empowerment, income, innovative, education, contact

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.181	.051		-3.536	.001
	age	.000	.001	.036	.640	.523
	education	.006	.002	.175	2.470	.014
	Family.size	.003	.004	.049	.884	.378
	farm.size	.013	.010	.084	1.264	.208
	income	7.476E-5	.000	.044	.726	.469
	contact	.010	.002	.410	5.349	.000
	innovative	.006	.006	.062	.881	.380
	org.support	.005	.002	.128	2.118	.036
	Empowerment	.003	.001	.148	2.466	.015
	ICT	.001	.001	.039	.570	.570

a. Dependent Variable: Index

Appendix-6

T-Test (Study group)

One sample t statistics						
	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Age	62.598	187	.000	46.543	45.08	48.01
Edu.	26.476	187	.000	6.957	6.44	7.48
Fa.	47.073	187	.000	5.117	4.90	5.33
Far.	20.759	187	.000	.9976064	.902805	1.092408
Inc(000)	28.458	187	.000	157.457	146.54	168.37
AEC	90.310	187	.000	26.080	25.51	26.65
Inv.1	5.231	187	.000	.638	.40	.88
Inv.2	10.294	187	.000	1.447	1.17	1.72
Inv.3	11.501	187	.000	1.239	1.03	1.45
Inv.4	4.419	187	.000	.197	.11	.28
TINV	57.704	187	.000	3.521	3.40	3.64
OSGO	39.752	187	.000	6.293	5.98	6.60
OSNgO	16.210	187	.000	2.197	1.93	2.46
OSo	12.044	187	.000	1.362	1.14	1.58
TOS	27.287	187	.000	9.851	9.14	10.56
EmSE	72.950	187	.000	9.473	9.22	9.73
EmF	94.596	187	.000	10.404	10.19	10.62
EmP	59.427	187	.000	9.266	8.96	9.57
TEmS	94.963	187	.000	29.144	28.54	29.75

ICTcall	12.897	187	.000	2.191	1.86	2.53
ICTFB	14.714	187	.000	7.096	6.14	8.05
ICTu int.	15.153	187	.000	2.457	2.14	2.78
T ICT	18.973	187	.000	11.745	10.52	12.97
knw	62.661	187	.000	43.154	41.80	44.51
AFL	46.393	187	.000	16.154	15.47	16.84
ASL	33.471	187	.000	8.511	8.01	9.01
Adr	46.032	187	.000	16.085	15.40	16.77
Atm	63.554	187	.000	7.511	7.28	7.74
TAD	59.182	187	.000	48.261	46.65	49.87

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
BNFTS	73.319	187	.000	9.670	9.41	9.93
BEC	67.769	187	.000	4.340	4.21	4.47
BT	75.506	187	.000	10.915	10.63	11.20
BPSY	62.900	187	.000	4.707	4.56	4.86
TBNFT	101.312	187	.000	29.633	29.06	30.21
FckgB	58.430	187	.000	.7788830	.752586	.805180
FckgA	56.030	187	.000	.9247340	.892175	.957293
Fcch.	1.000	187	.319	.005	-.01	.02
Fc.CaloB	58.557	187	.000	2713.660638	2622.240265	2805.081012

Fc.CaloA	56.028	187	.000	3226.393617	3112.793747	3339.993487
F.Cal.Ch	22.895	187	.000	512.745	468.56	556.93
Score	22.865	187	.000	4.989	4.56	5.42
FA21.B	3.948	187	.000	5.059	2.53	7.59
FA90.B	13.695	187	.000	80.691	69.07	92.32
FA>90.B	8.270	187	.000	118.617	90.32	146.91
Tfa.B	17.970	187	.000	203.941	181.55	226.33
FA90.A	4.139	187	.000	18.112	9.48	26.74
FA>90.A	20.412	187	.000	400.819	362.08	439.56
TFa.A	23.163	187	.000	418.931	383.25	454.61
TFA.ch	22.659	187	.000	214.989	196.27	233.71
FCaR.B	87.064	187	.000	58.601	57.27	59.93
Fcar.A	95.450	187	.000	63.745	62.43	65.06
Fcar.ch	32.127	187	.000	5.144	4.83	5.46
Fp.B	49.349	187	.000	13.505	12.97	14.05
Fp.A	51.051	187	.000	16.8910	16.238	17.544
Fp.ch	24.565	187	.000	3.3856	3.114	3.658
Ff.B	40.893	187	.000	6.5612	6.245	6.878
Ff.A	44.755	187	.000	9.298	8.89	9.71
Ff.ch	31.688	187	.000	2.7367	2.566	2.907

	Test Value = 0				
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference

					Lower	Upper
Fv.B	59.250	187	.000	15.617	15.10	16.14
Fv.A	64.389	187	.000	19.085	18.50	19.67
Fv.ch	35.970	187	.000	3.468	3.28	3.66
Tbd.B	84.053	187	.000	94.2846	92.072	96.497
Tbd.A	94.207	187	.000	109.018	106.736	111.302
Tbd.ch	53.195	187	.000	14.729	14.18	15.27
h.B	46.007	187	.000	2.463	2.36	2.57
h.A	69.178	187	.000	3.691	3.59	3.80
h.ch	27.310	187	.000	1.229	1.14	1.32
d.B	60.777	187	.000	4.707	4.55	4.86
d.A	83.798	187	.000	5.931	5.79	6.07
d.ch	22.868	187	.000	1.223	1.12	1.33
San.B	44.535	187	.000	1.904	1.82	1.99
San.A	63.614	187	.000	2.787	2.70	2.87
San.ch	31.613	187	.000	.883	.83	.94
Cl.OB	40.479	187	.000	714.628	679.80	749.45
Clo.0A	38.731	187	.000	1092.28	1036.65	1147.92
Clo.ch	21.320	187	.000	377.660	342.72	412.60
Cl.MB	33.323	187	.000	1218.61	1146.48	1290.76
Cl.MA	29.896	187	.000	1827.66	1707.06	1948.26
Cl.M.ch	17.613	187	.000	609.043	540.83	677.26
Cl.hB	17.782	187	.000	1246.27	1108.02	1384.54
Cl.hA	21.966	187	.000	2199.46	2001.93	2397.00
Cl.h.ch	16.164	187	.000	953.191	836.86	1069.52
ClW.B	23.402	187	.000	639.628	585.71	693.55
ClW.A	24.096	187	.000	1043.35	957.93	1128.77

Clw.ch	15.065	187	.000	403.723	350.86	456.59
tcl.B	31.222	187	.000	3819.14	3577.84	4060.46
Tcl.A	31.111	187	.000	6162.76	5771.98	6553.55

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Tcl.ch	21.527	187	.000	2343.617	2128.85	2558.38
Score	21.438	187	.000	2.351	2.13	2.57
hc.B	75.543	187	.000	2.739	2.67	2.81
hc.A	147.91	187	.000	3.851	3.80	3.90
hc.ch	35.409	187	.000	1.112	1.05	1.17
Chf.con.	22.865	187	.000	4.989	4.56	5.42
Ch.fA	22.733	187	.000	215.521	196.82	234.22
Ch.bd	51.313	187	.000	14.644	14.08	15.21
ch.H	27.310	187	.000	1.229	1.14	1.32
Ch.D	22.832	187	.000	1.218	1.11	1.32
ch.S	31.115	187	.000	.888	.83	.94
ch.clo	20.796	187	.000	2.362	2.14	2.59
Ch.hc.	35.644	187	.000	1.106	1.05	1.17
TCHNg	25.404	187	.000	242.112	223.31	260.91
P1	17.916	187	.000	1.702	1.51	1.89
P2	41.637	187	.000	2.011	1.92	2.11
P3	28.242	187	.000	1.691	1.57	1.81
P4	37.321	187	.000	1.931	1.83	2.03

P5	37.520	187	.000	2.415	2.29	2.54
P6	31.118	187	.000	2.207	2.07	2.35
P7	25.909	187	.000	2.521	2.33	2.71
P8	32.571	187	.000	2.367	2.22	2.51
P9	29.809	187	.000	2.367	2.21	2.52
P10	28.285	187	.000	2.388	2.22	2.55
P11	20.041	187	.000	1.452	1.31	1.60
P12	14.926	187	.000	.947	.82	1.07
P13	16.350	187	.000	1.138	1.00	1.28
P14	17.463	187	.000	1.585	1.41	1.76
P15	22.899	187	.000	2.021	1.85	2.20

T-Test (Control group)

One sample t statistics						
	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Age	72.409	187	.000	49.165	47.83	50.50
Edu.	25.721	187	.000	5.457	5.04	5.88
Fa.	45.588	187	.000	5.426	5.19	5.66
Far.	22.651	187	.000	1.2253723	1.118650	1.332094
Income	30.408	187	.000	135.878	127.06	144.69
AEC	77.653	187	.000	26.133	25.47	26.80
Inv.1	7.033	187	.000	1.037	.75	1.33

Inv.2	5.721	187	.000	.596	.39	.80
Inv.3	10.760	187	.000	1.144	.93	1.35
Inv.4	7.344	187	.000	.468	.34	.59
Inv.5	2.483	187	.014	.032	.01	.06
TINV	39.524	187	.000	3.277	3.11	3.44
OSG	45.158	187	.000	3.745	3.58	3.91
OSNgo	34.568	187	.000	2.580	2.43	2.73
OSo	16.147	187	.000	1.218	1.07	1.37
TOS	38.452	187	.000	7.543	7.16	7.93
EmSE	43.565	187	.000	8.069	7.70	8.43
EmSF	43.923	187	.000	8.569	8.18	8.95
EmSP	35.905	187	.000	6.676	6.31	7.04
TEmS	50.267	187	.000	23.314	22.40	24.23
ICTcall	23.899	187	.000	4.106	3.77	4.45
ICT fb	9.619	187	.000	3.154	2.51	3.80
ICT U	9.577	187	.000	1.372	1.09	1.66
TICT	18.310	187	.000	8.633	7.70	9.56
FckgB	49.238	187	.000	.6601064	.633659	.686554
FckgA	48.467	187	.000	.8072872	.774429	.840146
Fcch.	16.822	187	.000	.1498404	.132268	.167413
Fc.CaloB	50.906	187	.000	2311.19680	2221.631	2400.762
Fc.CaloA	50.082	187	.000	2826.71436	2715.370	2938.058

	Test Value = 0				
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference

					Lower	Upper
F.Cal.Ch	18.073	187	.000	515.5175532	459.245808	571.789298
Score	17.628	187	.000	5.037	4.47	5.60
FA3.B	2.016	187	.045	.128	.00	.25
FA21.B	5.948	187	.000	11.011	7.36	14.66
FA90.B	11.499	187	.000	65.505	54.27	76.74
Fa>90 .B	8.539	187	.000	92.128	70.84	113.41
T FAB	20.327	187	.000	168.771	152.39	185.15
FA3.A	1.418	187	.158	1.436	-.56	3.43
FA21.A	1.708	187	.089	2.186	-.34	4.71
FA90.A	6.478	187	.000	44.043	30.63	57.46
Fa>90 .A	20.093	187	.000	262.926	237.11	288.74
Tfa.A	33.128	187	.000	310.590	292.10	329.09
TFA.ch	17.368	187	.000	141.819	125.71	157.93
FCaR.B	106.974	187	.000	54.963	53.95	55.98
Fcar.A	104.345	187	.000	58.793	57.68	59.90
Fcar.ch	9.946	187	.000	3.830	3.07	4.59
Fp.B	34.837	187	.000	8.420	7.94	8.90
Fp.A	40.433	187	.000	10.090	9.60	10.58
Fp.ch	17.799	187	.000	1.670	1.49	1.86
Ff.B	27.688	187	.000	4.3617	4.051	4.672
Ff.A	32.410	187	.000	5.6941	5.348	6.041
Ff.ch	19.630	187	.000	1.3324	1.199	1.466
Fv.B	39.750	187	.000	9.894	9.40	10.38
Fv.A	47.770	187	.000	11.963	11.47	12.46
Fv.ch	18.087	187	.000	2.069	1.84	2.29

Tbd.B	80.877	187	.000	77.644	75.75	79.54
Tbd.A	88.721	187	.000	86.532	84.61	88.46
Tbd.ch	16.174	187	.000	8.899	7.81	9.98
h.B	36.258	187	.000	2.245	2.12	2.37

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
h.A	57.175	187	.000	3.420	3.30	3.54
h.ch	20.901	187	.000	1.176	1.06	1.29
d.B	33.700	187	.000	3.346	3.15	3.54
d.A	55.421	187	.000	4.606	4.44	4.77
d.ch	17.189	187	.000	1.266	1.12	1.41
San.B	43.187	187	.000	1.628	1.55	1.70
San.A	58.680	187	.000	2.420	2.34	2.50
San.ch	20.430	187	.000	.793	.72	.87
Cl.OB	34.771	187	.000	866.755	817.58	915.93
Clo.0A	26.551	187	.000	1272.606	1178.05	1367.16
Clo.ch	13.368	187	.000	405.851	345.96	465.74
Cl.MB	27.618	187	.000	992.287	921.41	1063.16
Cl.MA	23.876	187	.000	1390.160	1275.30	1505.02
Cl.M.ch	12.576	187	.000	397.872	335.46	460.28
Cl.hB	14.011	187	.000	620.213	532.89	707.53
Cl.hA	14.374	187	.000	800.798	690.89	910.70

Cl.ch	7.058	187	.000	180.585	130.11	231.06
ClW.B	11.846	187	.000	293.085	244.28	341.89
ClW.A	11.773	187	.000	446.809	371.94	521.67
Clw.ch	6.596	187	.000	153.723	107.75	199.70
tcl.B	43.622	187	.000	2772.340	2646.97	2897.71
Tcl.A	37.589	187	.000	3910.372	3705.15	4115.60
Tcl.ch	15.068	187	.000	1138.032	989.04	1287.03
Score	14.644	187	.000	1.138	.98	1.29
hc.B	62.105	187	.000	2.617	2.53	2.70
hc.A	92.211	187	.000	3.559	3.48	3.63
hc.ch	26.327	187	.000	.947	.88	1.02
Chf.con.	17.605	187	.000	5.011	4.45	5.57
Ch.fA	17.649	187	.000	136.261	121.03	151.49

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Ch.bd	16.234	187	.000	8.910	7.83	9.99
ch.H	21.006	187	.000	1.191	1.08	1.30
Ch.D	17.027	187	.000	1.277	1.13	1.42
ch.S	20.193	187	.000	.819	.74	.90
ch.clo	14.644	187	.000	1.138	.98	1.29
Ch.hc.	24.622	187	.000	.952	.88	1.03
TCHNg	19.124	187	.000	155.617	139.56	171.67
P1	21.469	187	.000	1.585	1.44	1.73
P2	43.203	187	.000	2.271	2.17	2.37

P3	45.944	187	.000	2.511	2.40	2.62
P4	32.211	187	.000	2.277	2.14	2.42
P5	46.441	187	.000	2.761	2.64	2.88
P6	50.054	187	.000	2.840	2.73	2.95
P7	50.227	187	.000	3.085	2.96	3.21
P8	45.790	187	.000	3.011	2.88	3.14
P9	38.059	187	.000	2.910	2.76	3.06
P10	30.703	187	.000	2.596	2.43	2.76
P11	21.008	187	.000	1.686	1.53	1.84
P12	13.229	187	.000	.761	.65	.87
P13	15.464	187	.000	1.128	.98	1.27
P14	18.062	187	.000	1.644	1.46	1.82
P15	19.787	187	.000	2.048	1.84	2.25
P16	35.979	187	.000	2.862	2.70	3.02
P17	37.443	187	.000	2.851	2.70	3.00
P18	45.469	187	.000	3.112	2.98	3.25
P19	41.874	187	.000	2.830	2.70	2.96
P20	59.203	187	.000	3.144	3.04	3.25
TP	99.822	187	.000	47.952	47.00	48.90

Appendix 7

Correlation Matrix (study group)

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	Y
X_1	1													
X_2	.022	1												
X_3	.168*	.060	1											
X_4	.059	.090	.235**	1										
X_5	.045	.109	.192**	.592**	1									
X_6	.059	.245**	.157*	.078	.094	1								
X_7	.151*	.393**	.078	.249**	.183*	.131	1							
X_8	.110	.171*	-.031	.109	.171*	.346**	.251**	1						
X_9	.084	.374**	.005	.208**	.184*	.215**	.504**	.434**	1					
X_{10}	-.012	.834**	.061	.047	.109	.330**	.327**	.177*	.388**	1				
X_{11}	.164*	.421**	.015	.290**	.249**	.361**	.376**	.392**	.467**	.416**	1			
X_{12}	.094	.293**	-.018	.399**	.352**	.305**	.221**	.328**	.314**	.331**	.495**	1		
X_{13}	.085	.360**	.055	.183*	.104	.362**	.302**	.333**	.452**	.391**	.353**	.330**	1	
Y	.182*	.444**	.057	.196**	.166*	.312**	.423**	.408**	.517**	.373**	.487**	.425**	.474**	1

Legend

X_1 = Age	X_8= Organizational support
X_2 = Educational qualification	X_9= Empowerment status
X_3 = Family size	X_{10} = Exposure to ICT Apps for agricultural information
X_4 = Existing farm size	X_{11} = Knowledge on Climate Smart Agriculture (CSA) practices
X_5 = Annual family income	X_{12} = Use of CSA technologies
X_6= Agricultural extension media contact	X_{13} = Benefit obtained from CSA
X_7 = Innovativeness	Y = Impact of CSA on farmers' Livelihoods

Appendix-8

Correlation Matrix (control group)

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	Y
X_1	1										
X_2	.049	1									
X_3	.098	.099	1								
X_4	-.019	-.073	.075	1							
X_5	.044	.074	.182*	.363**	1						
X_6	-.112	.391**	.093	.405**	.091	1					
X_7	.110	.496**	.113	.101	.081	.531**	1				
X_8	.065	.193**	.051	.000	.179*	.072	-.003	1			
X_9	-.011	.172*	.130	.027	.035	.237**	.136	.371**	1		
X_{10}	-.084	.538**	.047	-.016	.080	.397**	.377**	.234**	.259**	1	
Y	.014	.441**	.157*	.266**	.172*	.610**	.422**	.268**	.351**	.389**	1

Legend

X_1 = Age	X_7 = Innovativeness
X_2 = Educational qualification	X_8= Organizational support
X_3 = Family size	X_9= Empowerment status
X_4 = Existing farm size	X_{10} = Exposure to ICT Apps for agricultural information
X_5 = Annual family income	Y = Impact of CSA on farmers' Livelihoods
X_6= Agricultural extension media contact	

Appendix-9: Conversion per Kg food into calorie

Food items	Calorie contents (Kcal/Kg)	Food items	Calorie contents (Kcal/Kg)
Rice	3,490	Fish	1,360
Wheat	3,410	Egg	1,730
Tuber	970	Meat	1,090
Pulse	3,430	Milk	670
Vegetable	430	Sugar	3,980
Fruit	200	Edible Oil	9,000

Source: Dr. Shin Imai (2003), Livelihood Survey Forms, SPFS, FAO

Appendix-10: Calorie need /person/day

Male (age, Yrs.)	Needed calorie	Male (age, Yrs.)	Needed calorie
2-25	1000-2400	2-25	1000-2000
26-50	2400-2200	26-50	1800
51-75	2200-2000	51-75	1600
76 and above	2000	76 and above	2000

Source: Anonymous (2017)