What Effects Does Climate Smart Agriculture (CSA) Practices have on Farmers' Livelihood Development Under Selected Areas of Lakshmipur District?

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What Effects Does Climate Smart Agriculture (CSA) Practices have on Farmers' Livelihood Development Under Selected Areas of Lakshmipur District?

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CERTIFICATE

This is to certify that the thesis entitled, **" What Effects Does Climate Smart Agriculture (CSA) Practices have on Farmers' Livelihood Development Under Selected Areas of Lakshmipur District? "** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfilment of the requirements for the degree of **Master of Science (MS) in Agricultural Extension**, embodies the result of a piece of bona-fide research work conducted by **RAHELA AKTHER, Registration no. 18-09285** under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, received during the course of this study has been dully acknowledgement by him.

Dated: December, 2020

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DEDICATED TO

MY AFFECTIONATE

YOUNGEST SISTER

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The researcher

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ABBREVIATION AND ACRONYMS

AEO	Agriculture extension officer
AWD	Alternate wet and drying
BDT	Bangladesh Taka
CSA	Climate-smart agriculture
CFS	Climate field school
CPF	Country planning framework
DAE	Department of agriculture extension
DCRMA	Disaster and Climate Risk Management in Agriculture
DFID	Department of Foreign and International Development
et al.	All others
etc.	et cetera, and the other
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GHG	Greenhouse gas emissions
GoB	Government of Bangladesh
HYV	Hybrid Yield Variety
SPSS	Statistical Package for Social Science
IPCC	Intergovernmental panel on climate change
IPM	Integrated Pest management
ICM	Integrated crop management

What Effects Does Climate Smart Agriculture (CSA) Practices have on Farmers' Livelihood Development under Selected Areas of Lakshmipur District?

RAHELA AKTHER

ABSTRACT

Climate-smart agriculture (CSA) is an effective approach of transforming and reorienting agricultural development under in the context of climate change. The present study was conducted to compare the effects of CSA practices on livelihood development by the farmers' under intervention among two groups (study & control group). The objectives of the study were to describe the selected socio - economic profile of the farmers'; to ascertain the effects of CSA practices on livelihood development, and to explore the relationship between the farmers socio-economic profile and their effects of CSA practices on livelihood development. Keeping in view the objectives, 75 respondents who involved with CSA project intervention were selected purposively as study respondents. Similar number of respondents (75) was also selected under control group by considering 1:1 method. Data were collected from the selected farmers during the period from August 15 to 30, 2020. Descriptive statistics, multiple regressions were employed for analysis. Effective farm size (0.004), annual family income (0.007), and agricultural training experience (0.003) were the most contributing factors significant at a 1% level to change in rural farmers livelihood development. Annual family income from CSA (0.010), agricultural extension media contact (0.047), knowledge on CSA practices (0.015) was the second contributing factors which was significant at 5% level to change their livelihood development status. Above all, a livelihood improvement was observed among the respondents after engaging themselves in CSA project intervention. To ascertain the effects of CSA practices on livelihood development, the policy makers could invest on improving capacity of farmers organizations (Climate Field Schools) and give some idea that their CSA practices might be very helpful to contribute on farmers livelihood development.

Key words: Climate Smart Agriculture (CSA), Livelihood

CHAPTER I

INTRODUCTION

1.1 General Background

Bangladesh economy draws its main strength from agriculture sector. Agriculture still plays a crucial role in sustainable socio - economic development of Bangladesh. Agriculture is the single largest producing sector of the economy since it comprises about 20% of the country's GDP and employs around 48.4% of the total labor force (Annon, 2013). In many developing countries, agriculture plays a vital role in the economy, and sustainability in the agricultural sector must address the issues of poverty alleviation, food security, and stable income generation for a rapidly growing population (Lee 2005; Bhutto and Bazmi, 2007). The statistics shows the share of agriculture in Bangladesh gross domestic product was averaged 10799.20 BDT (12.64%) in and GDP from agriculture in Bangladesh averaged 9150.64 BDT million from 2006 until 2020 reaching an all-time high of 11023.20 BDT million in 2020 and a record low of 7017.10 BDT million in 2006. The agricultural land is converted by the uncontrolled urbanization, industrialization as well as with the increasing of human activities (Ahmed, 2013). Agriculture of Bangladesh is constrained due to climate change induced hazards (drought, flood, salinity, riverbank erosion etc.) and by a number of challenges such as in adequate management practice, population growth, unfair crop price, insufficient credit facilities, loss of arable land, lack of investment in agricultural research (Mondal, 2010; Ghose, 2014).

Climate change is the mother of all environmental changes (Glantz, 2010). Bangladesh is one of the most vulnerable countries to climate change because of geographic exposure, low income and greater reliance on climate sensitive sectors, particularly agriculture. Climate change is emerging as a major threat on agriculture, food security and livelihood of millions of people in many places of the world (IPCC, 2014). The estimated impacts of both historical and future climate change on cereal crop yields in different regions indicate that the yield loss can be up to - 35% for rice, - 20% for wheat, - 50% for sorghum, - 13% for barley, and - 60% for maize depending on the location, future climate scenarios and projected year (Porter *et al.*, 2014). The country is currently experiencing sea level rise, saltwater intrusion, mean temperature increases, and higher rainfall variability. Floods, tropical cyclones, storm surges, and drought will become more frequent and more severe. Cyclone activity and saltwater intrusion will

impact the south, southwest, and southeast coastal regions in particular. The recent studies found that climate change causing the change in rainfall pattern will decrease 30.0% crop production in 2100 and 28.0% for rice and 68.0% for wheat respectively (Karim *et al.,* 2012). Rising maximum temperatures will negatively impact crop yields for aman and boro rice, both of which are major staple crops. By 2050, increasing storm surges will put almost 30 million people at risk. Climate change poses a serious threat to agricultural growth. With two-thirds of the country at an elevation of less than 5.

Climate Smart Agriculture (CSA)

CSA has therefore been defined as a form of agriculture that sustainably increases agricultural productivity and incomes; enhances adaptation and building resilience to climate change, reducing or removing Greenhouse Gases (GHGs) where possible, and enhancing the achievement of national food security and the sustainable development goals (FAO, 2014).

Climate-smart agricultural systems include different elements such as:

- the management of land, crops, livestock, aquaculture and capture fisheries to balance near-term food security and livelihoods needs with priorities for adaptation and mitigation;
- ecosystem and landscape management to conserve ecosystem services that are important for food security, agricultural development, adaptation and mitigation;
- services for farmers and land managers that can enable them to better manage the risks and impacts of climate change and undertake mitigation actions; and
- changes in the wider food system including demand-side measures and value chain interventions that enhance the benefits of climate-smart agriculture.

CSA should help to improve farm productivity, increase resilience to weather extremes and decrease greenhouse gas emissions wherever possible (FAO, 2010; Steen Werth *et al.*, 2014). Some argue that any agricultural practice that improves productivity or resource use efficiency can be considered as climate smart (Neufeldt *et al.*, 2013).

Table 1. 1: CSA practices and technology are key elements for food security

CSA PRACTICES	SECTORS
Salt tolerant variety cultivation	Boro rice, Oil seeds, Jute and spices
Sorjan method, Floating Beds, Creeping vegetables cultivation net over on ponds	Vegetables
Submerge resistant variety cultivation	Aman rice
Lodging resistant variety cultivation	Aus rice
IPM and Eco –Friendly management practices	Vegetables, Rice
Ribbon retting method	Jute
Drought resistant variety cultivation	Spices
Solar powered irrigation	Boro rice
Short duration and High yielding variety cultivation	Aman rice, Oil seeds Pulses
Use of Dwarf and early mature variety, conservation agriculture and disease resistant cultivar (BLAST) cultivation	Wheat
Proper use of Fertilizers	Boro rice
Direct seeding	Aus rice
Use of high yielding variety, conservation agriculture and intercropping with short duration crop	Maize
Use of mung bean biomass as brown manuring	Pulses
Compost and biogas production, Fodder crop production, and commercial livestock with fattening	Cattle
Rich fish culture, Year-round aquaculture, and Cultivation of indigenous fish species	Ponds and floodplain
Alternate wet and drying method	Rice
Integrated soil Fertility management, No tillage	Wheat, Maize

After following the program, farmers were expected to apply the climate information in setting up alternative crop management strategies (ADPC, 2007). Climate smart agriculture interventions are proposed by the agricultural extension experts. Eleven interventions are identified in Bangladesh by FAO. These are 1) Alternate wetting and drying (AWD) in rice cultivation, 2) Salt tolerant and high yielding variety 3) Solar powered irrigation, 4) Urea deep placement 5) Conservation agriculture, 6) Short

duration and high yielding variety, 7) Agro forestry practices, 8) Direct seeding of rice, 9) Biogas production, 10) Improved compost production and 11) Ribbon retting of jute. Specific climate-smart approaches to crop production include:

- increasing diversity and complexity within the agricultural ecosystem, which can be done in many ways (e.g expanding the diversity of crops or crop varieties), at many spatial scales (e.g., landscape level, within farms, and/or within the same crop) and over different timeframes;
- improving sustainable soil and land management (e.g., carefully channeling the expansion of crop and grazing land to mitigate the loss of carbon storage that results from land-use change);
- increasing energy use efficiency;
- promoting sustainable mechanization (e.g., increasing the availability of suitable machinery in combination with proper agronomic management to reduce greenhouse gas emissions from various farm and processing operations); and
- developing simple and robust scientific tools to guide the decision-making of farmers on a seasonal and long-term basis.

Livelihood

A livelihood is a means of making a living. 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.

The term 'sustainable livelihoods' relates to a wide set of issues which encompass much of the broader debate about the relationships between poverty and environment. Yet in the existing literature, there is often little clarity about how contradictions are addressed and trade-offs are assessed. As Carswell et al (1997: 10) point out: "definitions of sustainable livelihoods are often unclear, inconsistent and relatively narrow. Without clarification, there is a risk of simply adding to a conceptual muddle…" Drawing on Chambers and Conway (1992) among others, the IDS team's definition is as follows:

A livelihood comprises the capabilities, assets (including both 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, maintain or enhance its capabilities and assets, while not undermining the natural resource base.

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.

(DFID, 2000) DFID's biggest aim is the elimination of poverty in poorer countries. DFID, however, stresses that there are many ways of applying livelihoods approaches. Although the application of the livelihoods approach is flexible and adaptable to specific local settings and to objectives defined in participatory manner, it underlies a couple of core principle. One of the most widely used frameworks is the one used by the UK Department for International Development.

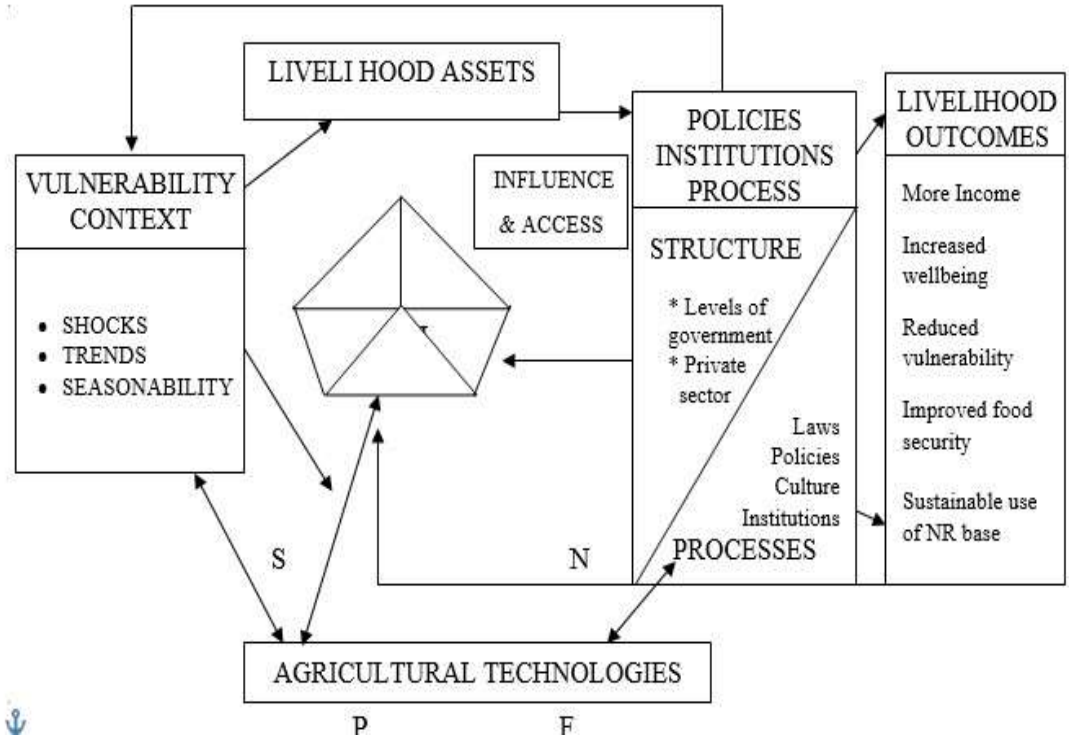


Figure 1.1: Livelihood framework as used by DFID (2000)

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

The DFID framework sets out to conceptualize:

- how people operate within a vulnerability context that is shaped by different factors – shifting seasonal constraints (and opportunities), economic shocks and longer-term trends
- how they draw on different types of livelihood assets or capital in different combinations which are influenced by:
- the vulnerability context
- a range of institutions and processes
- how they use their asset base to develop a range of livelihood strategies to achieve desired livelihood outcomes.

- The arrows in the framework try to show how the different elements 'all of which are highly dynamic'11 interrelate and influence one another. The framework is informed by certain core concepts:
- It is people-centred in the sense that it advocates that:
- development policy and practice should flow from an understanding of the poor and their livelihoods strategies
- the poor should directly contribute to determining development priorities and be able to influence the institutions and process that impact on their lives.

CARE is an international NGO that uses the livelihoods approach as its primary planning framework. CARE uses the Chambers and Conway livelihoods definition. It identifies three fundamental attributes of livelihoods:

- the possession of human capabilities accesses to tangible and
- intangible assets
- the existence of economic activities.

Oxfam uses a livelihoods framework 'semi-officially' that has a lot in common with the DFID framework. However, Oxfam emphasizes that there are no 'established rules. Oxfam says existing frameworks are still too abstract for field-level staff to understand, although they are valuable at programming and policy levels. Oxfam also draws on Chambers and Conway for its definition of sustainable livelihoods and emphasizes that sustainability has different dimensions:

- economic (for example, the functioning of markets and credit supply)
- social (networks of reciprocity, gender equity)

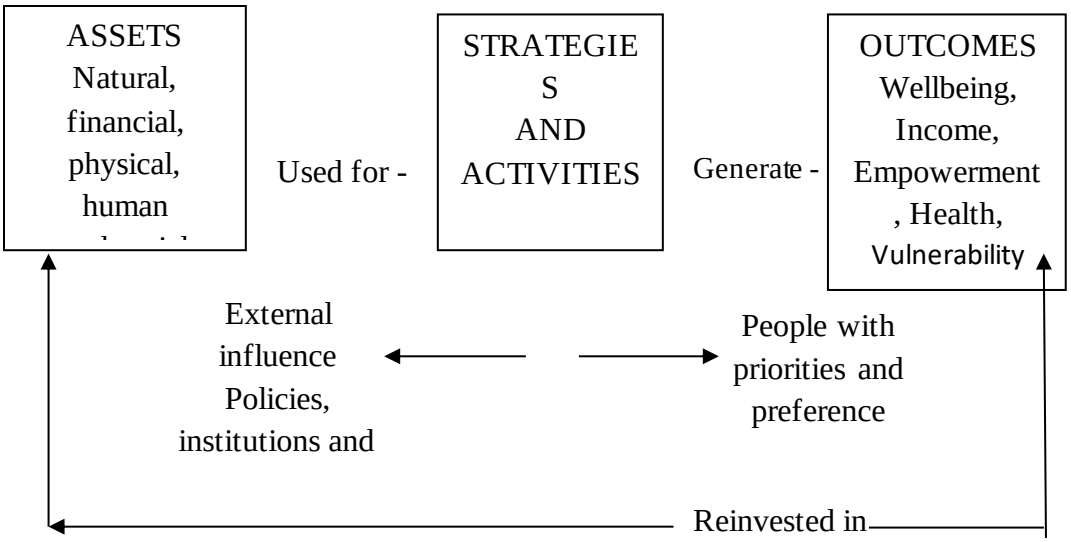


Figure 1. 2: Livelihood framework as used by Ashley (1999)

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.

Brock and Coulibaly (1999) as quoted 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.

The poverty level is a key criterion in the assessment of livelihoods. Various measures can be used to develop an absolute 'poverty line' measure based on income or consumption levels (Ravallion 1992; Baulch 1996). Alternatively, relative poverty and inequality can be assessed using Gini coefficient measures.

There are a range of pros and cons for each measure, as well as some major measurement challenges (Greeley 1994).

The notions of 'well-being' (cf. Chambers 1995; 1997) and 'capability' (Sen 1984; 1987) provide a wider definitional scope for the livelihoods concept. Sen sees capabilities as 'what people can do or be with their entitlements', a concept which encompasses far more than the material concerns of food intake or income. Such ideas represent more than the human capital which allows people to do things, but also the intrinsically valued elements of 'capability' or 'well-being'. Chambers (1997) argues that such a well-being approach to poverty and livelihood analysis may allow people themselves to define the criteria which are important. This may result in a range of sustainable livelihood outcome criteria, including diverse factors such as self-esteem, security, happiness, stress, vulnerability, power, exclusion, as well as more conventionally measured material concerns (Chambers 1989).

The ability of a livelihood to be able to cope with and recover from stresses and shocks is central to the definition of sustainable livelihoods. Such resilience in the face of stresses and shocks is key to both livelihood adaptation and coping (Davies 1996). Those who are unable to cope (temporary adjustments in the face of change) or adapt (longer term shifts in livelihood strategies) are inevitably vulnerable and unlikely to achieve sustainable livelihoods. Assessing resilience and the ability to positively adapt or successfully cope requires an analysis of a range of factors, including an evaluation of historical experiences of responses to various shocks and stresses. Different types of shock or stress, in turn, may result in different responses, including avoidance, repartitioning, resistance or tolerance mechanisms (Payne and Lipton 1994: 15).

Conway (1985), Holling (1993) and others, natural resource base sustainability refers to the ability of a system to maintain productivity when subject to disturbing forces, whether a 'stress' (a small, regular, predictable disturbance with a cumulative 7 effect) or a 'shock' (a large infrequent, unpredictable disturbance with immediate impact). This implies avoiding depleting stocks of natural resources to a level which results in an effectively permanent decline in the rate at which the natural resource base yields useful products or services for livelihoods.

Researcher would be tried to discuss the livelihood indicators in detail in the materials and methodology chapter.

Food consumption, clothing behavior, housing status, drinking water source, sanitation status and healthcare facilities which were used in my paper as a dependent variable. These discussions would be able to give a clear concept.

1.2 Statement of the Problem

Researcher selected Ramgoti upazila under Lakshmipur districts to find out the changes which were possible by the farmers in CSA project interventional period. This research information could be helpful to the policy maker, extension experts, Ministry of Agriculture DAE.

The present study has been undertaken to answer the following research questions

- What is the socio - economic profiles of farmers' living in the climate affected areas of Bangladesh?
- What effects does practice Climate Smart Agriculture have on livelihood development; and
- What are the differences in effects on livelihood development among the farmers' practicing Climate Smart Agriculture and non-practicing Climate Smart Agriculture?

1.3 Specific Objectives

The following specific objectives were set forth in order to proper direction to the study

a. To describe selected socio - economic profile of the farmers;
b. To ascertain effects of CSA practices on farmers' livelihood development, and
c. To explore the contributing relationship between the farmers' socio-economic profile and their effects of CSA practices on livelihood development.

1.4 Scope of the Study

Bangladesh is an innocent victim of climate change. CSA farming projects are conducted climate affected area. The main focus of the study is to ascertain effects of CSA practices on livelihood development. The findings of the study will be specifically applicable to Lakshmipur district. The socio- economic condition of the rural farmers' will be visible due to CSA practice through this research. Thus, the findings of the study will have great importance to analysis the livelihood condition of farmers. It also made a scope to review the emerging issues like benefits obtained from CSA and knowledge on CSA practices through this approach and helped to come up with some suggestions

for policy intervention for future activities**.** However, the findings will also have implications for other areas of the country having relevance to the socio-cultural context of the study area. The investigator believes that the findings of the study will reveal the phenomenon related to diffusion of innovation. These will be of special interest to the policy makers and planners in formulating and redesigning the extension programmes especially for climate smart agriculture. The findings are expected to be helpful to the field workers of different nation building departments and organizations to develop appropriate extension strategies for effective working with the rural people.

1.5 Justification of the Study

Disaster and Climate Risk Management in Agriculture (DCRMA) under Comprehensive Disaster Management Project (CDMP) Phase-II during the period from 2010-2015 was made a partnership with DAE. The project had been implemented 26 districts of Bangladesh covering all the climate change affected region Only a few researches have so far been conducted in Bangladesh on farmers' livelihood condition. From the extension and overall national development point of view, a research study on farmers' better livelihood condition is important to understand and to get schematic knowledge about farmers' position in this society. The researcher intended to make an attempt to realize how the farmers' socio-economic condition could uplift their better livelihood status. The researcher also aimed to know present condition of CSA project intervention how they play a crucial role in change farmers' livelihood. Therefore, the study **"**What Effects Does Climate Smart Agriculture (CSA) Practices have on Farmers' Livelihood Development Under Selected Areas of Lakshmipur District**?** has been undertaken.

1.6 Assumptions of the Study

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

- The respondents included in the sample were capable of furnishing proper responses to the questions of the interview schedule.
- Views and opinions furnished by the respondents were the representative views and opinions of the whole population of the study.

- The responses furnished by the respondents were reliable and they truly expressed their opinions on the climate smart agriculture related practices into the northern part of Bangladesh.
- The data collected by the researcher were free from bias.
- The researcher who acted as the interviewer was well adjusted to the social and cultural environment of the study area. Hence, the respondents furnished their correct opinions without any hesitation.
- The respondents had almost similar background and seemed to be homogenous to a great extent
- Distribution of data provides a parameterized mathematical function which will calculate the probability of any individual observation from the sample size.
- The information sought by the researcher revealed the real situation to satisfy the objectives of the study.

1.7 Limitations of the Study

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

- ✓ Population for the present study were kept confined within the heads of the climate smart agriculture families as because they were the major decision makers to ascertain effects of CSA practices on livelihood development.
- ✓ There were many characteristics of the farmers but in the study only 12 of them were selected in this study. This was done to complete the study within limited resources.
- ✓ For information about the study, the researcher depended on the data furnished by the selected respondents during their interview with him.
- ✓ The study was confined mainly to ascertain effects of CSA practices on livelihood development.
- ✓ Facts and figures were collected by the investigator applied to the present situation in the selected area.

Further work might also be needed to cross check the reliability of respondents, since this study is limited in that respect. Another variable should be under considerations for further research.

1.8 Definition of the Terms

Climate Field School

Climate Field School may be defined as an innovative extension approach using climate information and forecast application for agriculture which helps to build capacity and decision-making ability among the farmers.

IPM

IPM is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties.

Research gap

A research gap is a question or a problem that has not been answered by any of the existing studies or research within your field.

ICM

ICM is a holistic approach to improved crop production and protection, including pest and disease, soil fertility, water and post-harvest management practices. These could include using fertilizer, planting in rows, regular weeding or mixing with other crops.

Quasi-experimental designs (QEDs)

Quasi-experimental designs (QEDs) are a type of design commonly used in communication research, allows researchers to have a moderate degree of control in establishing causality and is usually used in the field.

Intervention

Intervention is the action of becoming intentionally involved in a difficult situation in order to improve the socio –economic status of the respondents whose are engaged in this activity.

Non-CSA farmers

Non- CSA farmers may be defined those respondents who never heard about CFS & have no idea its activity which become helpful to adapted climate affected area.

CSA farmers

CSA farmers may be reflecting the respondents who participated in the CFS.

Control group

The respondents who had never been participated in any Climate Field School & have no knowledge how to adapt in the climate affected region by practicing innovative agricultural farming method.

Climate change

Climate change is the global phenomenon of climate transformation characterized by the changes in the usual climate of the planet (regarding temperature, precipitation, and wind) that are especially caused by human activities.

CHAPTER II

REVIEW OF LITERATURE

Researchers from different sectors teachers, students, NGO workers started study on CSA practices and its effects on different sector. No study till documented on CSA and its effects 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 her best to collect needed information through searching relevant studies, journals and periodicals. This chapter comprises with four sections.

- Section 1: Socio - economic profiles and its relation with livelihood
- Section 2: Effects of CSA practices on livelihood
- Section 3: Research gap of the Study
- Section 4: Conceptual framework of the Study

2.1 Socio - economic Profiles and its Relation with Livelihood

A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base" (DFID, 2000). The objective of the Sustainable Livelihood Program is to reduce poverty and inequality by generating employment among poor households and by moving highly vulnerable households into sustainable livelihoods and toward economic stability. How livelihood would become sustainable and which factors were related to influences the develop livelihood status. These were discussed briefly in this section.

The World Summit on Food Security, held in Rome in 1996, aimed to renew a global commitment to the fight against hunger. The Food and Agriculture Organization of the United Nations (FAO) called the summit in response to widespread under-nutrition and growing concern about the capacity of agriculture to meet future food needs. The conference produced two key documents, the Rome Declaration on World Food Security and the World Food Summit Plan of Action. The WHO states that there are three pillars that determine food security: food availability, food access, and food use and misuse. The FAO adds a fourth pillar: the stability of the first three dimensions of food security over time.

In 2009, the World Summit on Food Security stated that the "four pillars of food security are availability, access, utilization, and stability. Food security is food utilization, which refers to the metabolism of food by individuals. Food security can be measured by calories to digest out to intake per person per day, available on a household budget. Food security encompasses three elements: availability, accessibility and utilization (USAID, 1996). Food security is built on three pillars: 1) food availability, defined as having sufficient quantities of food available on a consistent basis; 2) food access, defined as having sufficient resources to obtain appropriate foods for a nutritious diet; and 3) food use, defined as appropriate use based on knowledge of basic nutrition and care, as well as adequate water and sanitation (FAO, 2013). we will go into more detail about each one of the core concepts and pillars of food security. Food availability refers to the physical presence of food at various levels from household to national level, be that from own production or through markets. Food availability relates to the supply of food through production, distribution, and exchange. Food access refers to the affordability and allocation of food, as well as the preferences of individuals and households.

The UN committee noted that the causes of hunger and malnutrition are often not a scarcity of food but an inability to access available food , usually due to poverty . Poverty can limit access to food, and can also increase how vulnerable an individual or household is to food price spike. Food utilization refers to the proper use of food, which includes the existence of proper food processing and storage practices, adequate knowledge and application of nutrition and childcare, and adequate health and sanitation services (FANTA, 2006). Sanitation can also decrease the occurrence and spread of diseases that can affect food utilization. Education about nutrition and food preparation can affect food utilization and improve this pillar of food security.

However, the concept has evolved; during 1970s, the concern was regarding national and global food supplies while since the 1980s the focus shifted to the household and individual levels such shift was caused by Amartya Sen's entitlement theory (Maxwell & Smith, 1992). FAO (1995) reported that the lack of adequate incomes and purchasing power of large parts of the population is expected to slow down world agricultural growth. Quisumbing *et al.* (1995) cited that household food security depends on both the level of household income and who earns it.

Nutrition is the science that interprets the nutrients and other substances in food in relation to maintenance, growth, reproduction, health and disease of an organism. It includes ingestion, absorption, assimilation, biosynthesis, catabolism and excretion (NDA, 2011). The seven major classes of human nutrients are carbohydrates, fats, fiber, minerals, proteins, vitamins, and water. About one-third of global cereal production is fed to animals (FAO, 2014).

But currently, one of the major challenges to the food system is the rapidly increasing demand for meat and dairy products that has led, over the past 50 years, to a 1.5% increase in the global numbers of cattle, sheep, and goats, with equivalent increases of 2.5% and 4.5%-fold for pigs and chickens, respectively (FAOSTAT, 2009). As developing countries consume more meat in combination with high-sugar and - fat foods, they may find themselves having to deal with obesity before they have overcome under nutrition, leading to an increase in spending on health that could otherwise be used to alleviate poverty. About half of the population cannot reach the minimum dietary energy requirement (2122 kcal/capita/day) and one quarter of them subsist in extreme shortage of energy consuming less than 1800 kcal/capita/day (GOB, 2000a). Apart from the prevailing deficit in total calorie intake, the normal diet of Bangladeshi people is seriously imbalanced, with inadequate shares of fat, oil and protein (GOB, 2000b). About 70% of the total calorie comes from cereal of which rice alone contributes 62 % (HIES, 2010). Although the share of cereal in the total calorie intake decreased from 73% in 2005 to 70% in 2010, according to nutritional norm the share should not exceed 60% (FPMU,2014). The dietary imbalance reflects insufficient domestic production of non-cereal foods (pulses, oilseeds, fruits, meat, milk and eggs), low incomes, food preferences and lack of nutrition knowledge. Past studies suggest that consumed cereal diets meet nutritional demand in terms of energy needs as well as protein requirements (Mehta, 1982). Indeed, many vitamins and mineral deficiencies would also be reduced if sufficient calories were consumed (Greer and Thornback, 1986). The cereals particularly rice (currently over 470 g/person/day) in the diet is so high that their contribution to total dietary energy nears about 75-80% in Bangladesh (Yusuf, 1997). And over the period, the supply of cereals (mainly rice) increased (despite consumption of cereals even in excess of the set amount of 454 gm/person/day (Hossain et al., 2005), but the country suffers sufficient consumption of balanced food which indicates the inadequateness of diet from nutritional point of view.

On July 28, 2010, the UN General Assembly adopted a non-binding resolution calling on states and international organizations "to scale up efforts to provide safe, clean, accessible and affordable drinking-water and sanitation for all". As a result, drinking-water and sanitation are now enshrined as basic human rights (Lancet, 2010). Adequate sanitation is essential for the protection and promotion of individuals' and community health and enables a productive and dignified live. Access to basic sanitation, linked to proper 'use and disposal', can substantially reduce diarrheal disease, intestinal worm infections and vector-borne disease. The reduction in incidence of diarrheal infection has been estimated to be up to 32% (WHO, 2008). In contrast, lack or improper use of sanitary installations, as well as inadequate containment, treatment or handling of the resulting excreta and wastewater will impact on both human disease incidence and mortality, via multiple routes of exposure. Inadequate disposal also contributes importantly to the degradation of the environment. The World Bank is contributing a US$40 million loan to the Bangladesh Water Supply Program Project, designed to support Bangladesh in achieving the MDGs in water supply and sanitation by 2015 through safe water free from arsenic and pathogens in small towns and rural areas. In 1993, the country's groundwater, the source of drinking water for 97% of the rural population and a significant share of the urban population, was contaminated with arsenic. However, in 2004, 98.5% of the population already has access to an improved water source , a very high level for a low-income country. This has been achieved through the construction of hand pumps with the support of external donors. Bangladesh has a low level of cost recovery due to low tariffs and poor economic efficiency, especially in urban areas where revenues from water sales do not cover operating costs.

On the other hand, 56% of the population was estimated to have access to adequate sanitation facilities in 2010. But a new approach to improve sanitation coverage in rural areas, namely the community-led total sanitation concept, was introduced in Bangladesh and is credited for having contributed significantly to the increase in sanitation coverage . The government has adopted policies that could remedy the challenges in the sector. These include the National Policies for Safe Water Supply and Sanitation, National Water Management Plan, the National Policy for Arsenic Mitigation[1] which gives preference to surface water over groundwater and the National

Sanitation Strategy of 2005. These policies emphasize decentralization, user participation, the role of women, and appropriate pricing rules.

According to world Bank, Poverty is pronounced deprivation in well-being, and comprises many dimensions . It includes low incomes and the inability to acquire the basic goods and services necessary for survival with dignity. Poverty also encompasses low levels of health and education, poor access to clean water and sanitation, inadequate physical security, lack of voice, and insufficient capacity and opportunity to better one's life. The World Bank forecasted in 2010 that 702.1 million people were living in extreme poverty, down from 1.75 billion in 1990. According to Chen and Ravalli on, about 1.76 billion people in developing world lived above $1.25 per day and 1.9 billion people lived below $1.25 per day in 1981. This is the first time since independence that the rate of extreme Poverty in Bangladesh has come down to one digit. At the end of June 2019, the extreme poverty rate was 9.7 percent, according to the General Economics Division of the Planning Commission. Various analysis has confirmed that in the last 10 years, nearly one crore people of Bangladesh have won the battle to end their poverty. According to the SDGs, it will be possible to reduce the poverty rate in Bangladesh to zero by 2030 if the multi-dimensional plan that has already been adopted at the public and private levels can be implemented. Every country in the world has a different national poverty line. At the end of the 2018-19 financial years, the poverty rate in Bangladesh was below 20% (19.8%). According to the latest figures released by BBS in May 2019, there are now 17 crore 46 lakh people in Bangladesh. Among them, the number of extremely poor people is about one crore sixty lakhs. In all, about three crores twenty-five lakh people live below the poverty line. According to the Planning Commission, the Government has taken various initiatives in the Seventh and Eighth Five-Year Plans to reduce the poverty rate to zero before 2030. Added to that are various financial and social security strategies based on the life cycle of the private sector. In the current situation, the per capita income of Bangladesh in the current financial year will exceed USD 2000. The financial year-based analysis shows that per capita income has increased by an average of USD 123 per year over the last 10 years. The World Bank has made the following observations on the overall poverty situation in urban areas of Bangladesh has decreased (2010-2018). The poverty rate in the city has dropped from 21.3 percent to 19.3 percent in those eight years.

On the other hand, in those eight years, poverty in rural areas has come down from 35.2 percent to 26.7 percent. In other words, the tendency to reduce poverty has increased in rural areas. Not only is Bangladesh one of the top countries in South Asia in terms of poverty reduction, it is also one of the top countries in socio-economic development Bangladesh has been putting needed policies in place. For example, national development plans such as the Government's 7th Five-Year-Plan (FY 2016-2020) emphasize affordable urban housing. Moreover, the Government has approved the 'National Housing Policy 2017' to address the fragmented policy response to housing challenges. NHA Housing Model National Housing Authority (NHA), with the World Bank's support, is undertaking a USD 50 million project to develop housing for the urban poor by 2021. 24,000 urban poor who live in informal and low-income settlements will directly benefit from this project. From 2008 to 2015, the Government of Bangladesh, UNDP and DFID ran the flagship initiative, "Urban Partnerships for Poverty Reduction (UPPR)'' project, to meet the needs of marginalized and poor urban communities. In 2009, with UPPR's support, Gopalganj municipality undertook a housing programme through which the municipality collaborated with the private sector and community to offer tenure security to 346 evicted families. Take Dhaka, the world's most crowded city. Over 17.4 million people reside in Dhaka and more are moving in. At least one in every three people live in informal settlements. The situation is rooted in a fragmented housing delivery system: the government meets only 7 percent of the annual housing demand and relies heavily on the private sector to fill in the giant gap.

The researcher showed the relation of the socio -economic characteristics with livelihood factors which influences sustainable livelihood. Researcher would be tried to show the relation based on past and present review findings which would be able to give clear concept how livelihood indicator influenced by socio -economic character.

Bhuiyan (2002a) in his study found a positive and significant relationship between age of the farmers and their constraint in banana cultivation. Similar finding was obtained by Haque (1995a) and Rahman (1996) in their respective study. Contradictory results were found by Barasker *et. al* (2018a). They showed that Age had non- significant relationship with employment generation through vermicompost technology. Baten (2014) found that there was no relationship between age of the landless laborers and

their problem confrontation. Basak (1997) showed that the age of rural women under BRAC had no significant relationship with their impact of involvement in BRAC Rural Development activities. Islam (2016a) showed that there is neither any significant relationship between the age of the farmers' and age has no contribution to improve the sunflower cultivation farmers. Similar findings were obtained by Rahman (1995a).

Kisar (2018a) found that there was a significant contribution of the farmer level of education of climate change to change in food availability status and food stock ability. Bairagi *et.al* (2018a) reported that education is the driving factors to adopt Sub1 variety cultivation. Alam (1997a) observed that the level of education of the farmer had a positive and significant relationship with the use of improved farm practices. Islam (2016b) showed that level of education has contribution to change their livelihood status. Khan *et.al* **(**2017a) literacy level plays a vital role in efficient management and operation as well as successful production for any business enterprise.

Haque (1995b) reveals that significant negative relationship between education of members and their problem confrontation. Similar finding was obtained by Bhuiyan (2002b) respective studies.

Farm size has contribution to change the livelihood status that was observed by the researcher review work**.** Wekesa *et.al* (2018a) observed that adoption of CSA packages was positively influenced by farm size. Makate *et.al* (2016a) reported that land size holding had a positive and significant influence on the decision to diversify crops. Podder (2015a) found that there was a significant contribution of the respondent farm size on livelihood to change in quality of life or poverty level. Muttalab (1995) observed that farm size of the farmers had a positive relationship with the adoption of improved potato farmers and showed positive and significant effect. Alam (1997b) showed that the farm size had a significant relationship with their use of improved farm practices in rice cultivation. But contradictory results were found by Hasan (2005) in his study found that there was no relationship between farm size of the farmers and their problem confrontation in crop production activities.

Rahman (1995b) found that farm size of the farmers had a significant negative relationship with their problem confrontation in cotton cultivation.

Kisar (2018b) found that family size had significant positive relationship to change in food availability status. Wekesa *et.al* (2018b) observed that adoption of CSA packages

was positively influenced by gender of the household head. Podder (2015b) reported that there was a significant contribution of the respondent family size to change in basic rights and quality of life and basic rights. But contradictory results were observed by Begum (2004) family size had no significant relationship with their poverty alleviation owing to involvement in ASA activities.

Kobir (2007b) showed that the family size of the small farmers had strong negatively significant relationship with their farming enterprises towards the household food security. Barasker *et. al* (2018b) found that family type had non-significant relationship through employment generation through vermicompost technology.

Kisar (2018c) found that farmers' perception had significant positive relation to change in food availability status. From the review paper, researcher might be said that farmers' perception of climate change has contribution to change their livelihood status

Barasker *et.al* (2018c*)* showed that annual income had positively significant relationship with employment generation through vermicompost technology. Braun (1995) showed the fact that cash crops contribute only a portion of household food security and household income. Islam (2016c) highlighted that annual income has contribution to change their livelihood status. Hossain (1999) found a positive significant relationship between family income and effectiveness of agricultural activities. Khan *et.al* (2007b) found that family income has positive impacts on farmers livelihood. Rahman (2007a) observed that the income of the rural farmers had strongly positive significant relationship with their average per day per family vegetable consumption. Hossain (2005) found that the annual income had positive significant relationship with their adoption of modern sugarcane cultivation practices. Simillar results were observed by Hossain, 1995. Otherwise, Karim (1996) found that annual family income of the farmers had a negative significant relationship on their problem confrontation in Kakrol cultivation.

Imran *et.al* (2018a) demonstrated a result that show higher access to extension service have positive association of increase gross value of cotton production. Extension service has played a significant role to improvement the cotton production.

Makate *et.al* (2016b) showed that access to extension services had a positive and significant influence on the decision to diversify crop. Imran *et.al* (2018b) demonstrated

a result that show higher access to extension service have positive association of increase gross value of cotton production.

Podder (2015c) found that there was a significant contribution of the respondent media contact on livelihood to change in quality of life or poverty level. Alam (1997c) in his study entitled "Impact of Food Security Project on Crop Production" showed that the extension contact of the rural people had strongly positive significant relationship with their crop production after involvement with food security project.

Ali (1978) observed that extension contact of the contact and non-contact farmers had significant contribution towards their agricultural knowledge. Similar finding was - observed by Aurangozeb (2002). kobir (2007a) showed that the exposure of farming information of the family members had insignificant relationship with their farming enterprises towards the household food security.

But contradictory results were found by Rahman (1995c) in his study conducted that extension contact of the farmer had significant negative relationship with their problem confrontation. Rahman (2007b) showed that the extension contacts of the rural farmers had insignificant relationship with their average per day per family vegetable consumption.

Kisar (2018d) also showed that knowledge on food security had significant positive relationship change in nutritional security status. Podder (2015d) found that there was a significant contribution of the respondent, knowledge on climate change and knowledge on livelihood to change in quality of life or poverty level. Greenly *et al.* (1992a) observed in their study that increased knowledge of rural women about BRAC had significant positive relationship with their improved living condition like use of tube well. Greenly *et. al* (1992b) observed in their study that increased knowledge of rural women about BRAC had significant positive relationship with their improved living condition like sanitary latrines.

Barasker *et. al* (2018e) showed that *exposure* of training had positively significant relationship with employment generation through vermicompost technology.

Barasker *et. al (*2018d) revealed that mass media exposure had positively significant relationship with employment generation through vermicompost technology. Bairagi *et.al* (2018b) reported that show access to information is the driving factors to adopt Sub1 variety cultivation.

From the above review discussions, researcher might be concluded that those journal paper reflects farmers' socio - economic characteristics has significant impacts on livelihood status. Unfortunately researcher never found any specific paper of CSA project intervention which effects on farmers' livelihood and have found a few paper that reflects training exposure, knowledge, farmers' perception, mass media exposure etc.

2.2 Effects of CSA Practices on Livelihood

The Intergovernmental Panel on Climate Change (IPCC)'s report on "Climate Change (2014a): Impacts, Adaptation, and Vulnerability" says: "Climate change without adaptation could potentially affect the farm livelihood and all aspects of food security including food access, utilization, and price stability. Climate-smart agriculture (CSA) is an approach for transforming and reorienting agricultural systems to support food security under the new realities of climate change.

Climate Smart Agriculture (CSA) has been presented as an alternative form of agriculture for conserving the environment while addressing the food needs of the world's population (Food and Agriculture Organization, FAO, 2014). Widespread changes in rainfall and temperature patterns threaten agricultural production and increase the vulnerability of people dependent on agriculture for their livelihoods, which includes most of the world's poor. Climate change disrupts food markets, posing population-wide risks to food supply. Threats can be reduced by increasing adaptive capacity of farmers' as well as increasing resilience and resource use efficiency in agricultural production systems. A wide variety of CSA options has been proposed to reduce the negative impacts of climate change, build climate resilient agricultural production systems, and harness the benefits of global warming. These options range from a simple adjustment in crop management practices (e.g., changes in sowing time, application of water and fertilizers, tillage practices and intercultural operations) to the transformation of agricultural production systems (e.g., change in cropping systems and land uses) to adjust to new climatic conditions in a particular location (Vermeulen *et al.*, 2012b; How den *et al.,* 2007). It provides a conceptual basis for enhancing agricultural adaptation and mitigation to support food security under a changing climate (Warner *et al.*, 2015). Collier and Deacon (2014) opine that it is an approach to develop technical, policy and investment conditions to achieve sustainable development and food security. The concept was originally put forth in 2010 by FAO after the Hague

Conference on Agriculture , A 2020 report found that nearly 690 million people--or 8.9 percent of the global population-- are hungry, up by nearly 60 million in five years . The food security challenge will only become more difficult, as the world will need to produce about 70 percent more food by 2050 to feed an estimated 9 billion people. Food Security and Climate Change in 2009 (FAO, 2010; World Bank, 2010).

Broadly, the CSA focuses on developing resilient food production systems that lead to food and income security under progressive climate change and variability (Vermeulen *et al.,* 2012a; FAO, 2013a; Lipper *et al.,* 2014). Climate change alters agricultural production and food systems, and thus the approach to transforming agricultural systems to support global food security and poverty reduction.

According to the report "Climate-smart agriculture improves livelihoods of rural women in Mali '' reveals that the women's show their view that climate smart agriculture practices not only bring additional income, but also help improve nutrition at home and reduce malnourishment in their children. The project on mitigating the impact of Covid-19 on food and nutrition security using Climate Smart Technologies, which is funded by the European Union (EU) through the Southern African Development Community (SADC), may be useful in providing alternative livelihood sources in Zambia.

Scaling up the project, launched in the country by the Centre for Coordination of Agriculture Research and Development for Southern Africa (CCARDESA), may reduce the area cleared for cultivation, provide training and information services that encourage afforestation resulting in more children gaining consistent access to education, contributing to the broader social development agenda. CCADESA, with technical support from Bembani Group, launched the projects to mitigate the impact of Covid-19 on food and nutrition security using Climate Smart Technologies in Eswatini, Mozambique, Zambia and Zimbabwe in November and December last year. Lack of access to sufficient nutritious food due to high cost is a key factor contributing to food insecurity and malnutrition in Sri Lanka. The impacts of climate risks, food production variability, and rising food prices are clearly visible in recent national and global food security indicators.

Average of 2014-2016 data indicates that nearly 4.6 million people, equivalent to 22 percent of the total population in Sri Lanka, are estimated to be undernourished. The

Global Nutrition Report 2016 ranks Sri Lanka among the countries with the highest wasting (low weight for height) prevalence (21.4 percent). While Sri Lanka is trying to move in the right direction to achieve Sustainable Development Goals (SDGs) by 2030, challenges posed by climate shocks have made it difficult to reach the goals pertaining to sustainable agriculture and food security. Since climate change is the current reality, agricultural systems must adapt accordingly, to avoid the harmful consequences of climate risks. CSA can prevent the worst impacts of climate change on farm livelihoods and help make people less vulnerable to food insecurity and poverty. UN report provides evidence that adoption of climate-smart practices, such as the use of nitrogen-efficient and heat-tolerant crop varieties, zero-tillage and integrated soil fertility management would boost productivity and farmers' incomes. Widespread adoption of nitrogen-efficient practices alone would reduce the number of people at risk of undernourishment by more than 100 million.

" Growth in agriculture is 2–4 times more effective in lifting people out of poverty than comparable growth in other sectors ," Allaster Cox, deputy head of the Australian mission in Jakarta , told the 5th Climate-Smart Agriculture Conference (8–10 October). Leslie Lippen , natural resource economist and visiting fellow at Cornell University, said agriculture is often seen in terms of food supply or food security, setting aside the well-being of those who grow the crops . "It's the livelihood of people, and a lot of them are still living in extreme poverty." From the above discussion, researcher said that climate smart agriculture influences the livelihood indicator.

With the increased production of nutritious and high-value crops like pulses and oilseeds, farmers can assure food security along with combating poverty at the grass root-level (Ahmed et al., 2012). CSA adoption has the greatest effects to increase food security among the smallholder farmers (Wekesa *et.al* (2018c). Similar opined was conducted by Makate *et.al* (2016c). Wet (aman) season rice technology has a robust and positive effect on farmers' welfare in rural Bangladesh, which decreases poverty gap and squared poverty gap significantly over time (Islam, 2017). Kumar (2017) commented that poverty was decreased in case of integrated farming compared to mixed farming. Uddin *et.al* (2015a) also suggested the same results that poverty was decreased in case of integrated farming compared to mixed farming. Uddin *et.al* (2015b) opined that integrating farming increase the farmers employment status. Roy (1989) evaluated his conduct study that Grameen Bank play a crucial role to improve

the livelihood. Baraskar *et.al* (2018e) suggested that employment status had changed with relationship with employment generation through vermicompost technology. Mohiuddin *et.al* (2018) viewed that all kinds of livelihood assets of the selected farmers increased significantly through black gram farming.

From the above discussions, researcher might be said that few review papers were found which helps to change the farmers' livelihood with CSA practices. So, this is the gap of researcher study paper.

2.3 Research Gap of the Study

Above reviews represents that some of study have been conducted on the impacts of CSA practices, farmers' livelihood. Most of the paper reflects that CSA practices have an positive impact for improving farmers livelihood condition. Notwithstanding, many types of research have analyzed the livelihood indicator.

For that reason, it is necessary to assess how climate smart agriculture practices effects the livelihood. The outputs of this study may layout proper directions to the researchers and policymakers about the considerable factors for livelihood upliftment of the CSA practices farmers' of the Ramgoti upazila . Alongside, the comparative discussion CSA practice farmers' between non - CSA practice farmers' will provide an entire scenario of their livelihood status. CSA project interventions which improve farmers livelihood condition related paper are found very difficult puts on effects & impacts. This paper was conducted for fulfill the gap of previous studies.

2.4 Conceptual framework of the Study

The conceptual framework for information and that entrepreneurial innovation in this study is presented in Figure 2.1. This illustrates the field may help to change economically which effects the farmers livelihood.

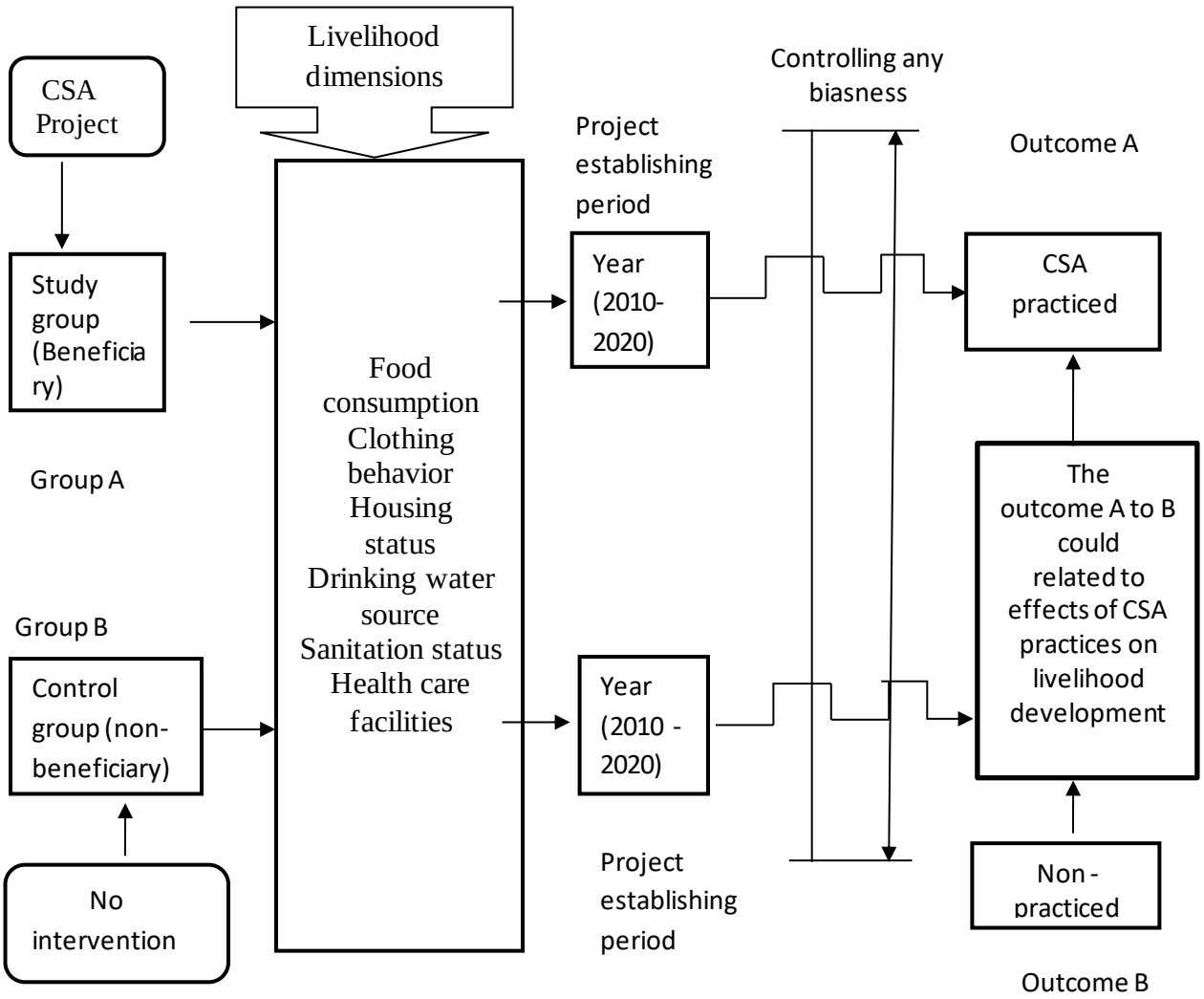


Figure 2. 1: Conceptual framework of the Study

CHAPTER III

MATERIALS AND METHOD

A researcher should do work very carefully in formulating methods and procedures. Methodology gives clear direction to a researcher about her works and activities during the whole period of the study. Appropriate procedures for collecting data were taken by the researcher to collect valid and reliable information. Scientific approach requires a close understanding of the subject matter. This paper mainly depends on primary data. Methods of analysis were appropriate to arrive at correct conclusion. Various methods, tools and techniques were used during different stages of this research work and compilation of data. The purpose of this chapter was to describe the setting, methods and procedures used in conducting this study.

3.1 Locale of the Study

The researcher applied purposive sampling technique to determine the location form where the data were collected. The study was conducted Ramgoti Upazila under Lakshmipur districts (One of the districts of Bangladesh) where the government of Bangladesh has been implemented a multidoor project by 2010-2015 titled "Disaster and Climate Risk Management in Agriculture (DCRMA)" in three union with the help of foreign aids through Department of Agricultural Extension (DAE). The project period has been expanded and still now, project activity has been running in those unions. Integrated crop management project (ICM) was operated for giving and sharing knowledge among the farmers how to cultivate crops without harm environment, reduce risk of health and quality food produce. The researcher considers those respondents whose were involved in the project work under 2010-2020 to know what changes being observed in the livelihood of the CFS participating farmers after the interventions made by the project.

Figure 3. 1: Map of Lakshmipur District showing Ramgoti Upazila

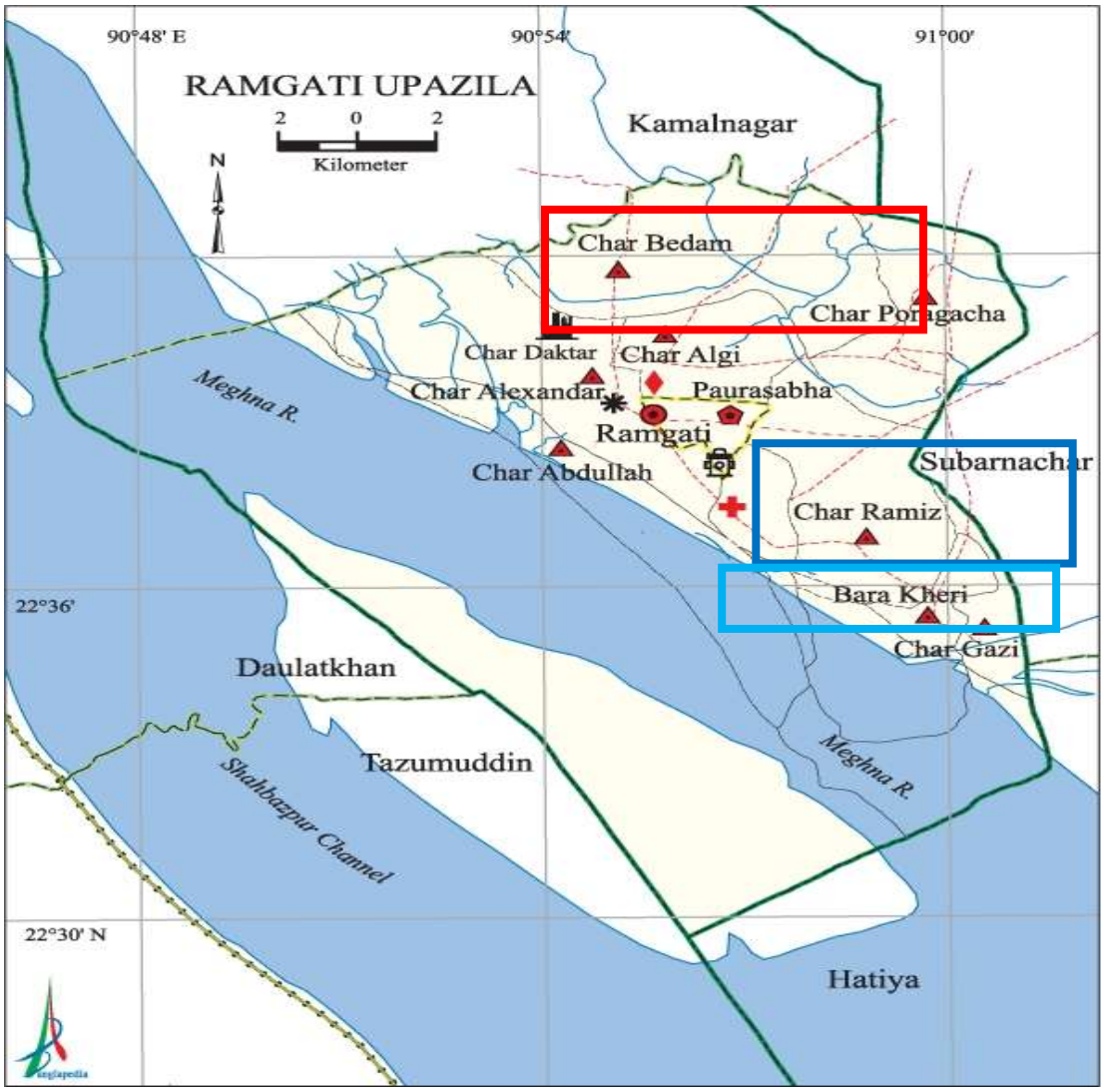


Figure 3.2: Map of Lakshmipur District showing Ramgoti Upazila showing Char Bedam, Char Ramiz, & Bara kheri union

3.2 Population and Sampling procedure

For the purpose of this study, the farmers (within these unions) those who engaged in CSA practices were considered as the study group and the farmers those who did not involve in CSA practices such (within these unions) were considered as the control group. Participants of the Climate Field School (CFS) conducted in the one upazila were the study group. Those population (75 farmers') were the sample size in this research. Total numbers of farming households of the three villages were 110, 90 and 50 which constituted the total population of 250 farming households. DAE records revealed that there were three CFS in each of the upazila participating 25 farmers. Therefore, total number of populations under three CFS in this study group stands as 25 x 3=75 number of farmers. A reserve list was maintained to fill in the gaps if any respondent in the original list was found missing as the same respondent in the interview period. Ten percent of the population was selected through proportionate random sampling procedure to include in the reserve list for study group and control group of the respondents. Thereafter, the desired respondent's size of the control group was determined as 75. Researcher used 1:1 method for selecting control respondents (selection techniques were described in the next under minimizing spill -over effects).

Table 3.1: **Distribution of the population and sample for the Study**

<table>
<tr><th>Name of the villages</th><th>Participants of CFS</th><th>Total CFS</th><th>Population of CFS</th><th>Sample size</th><th>Reserve list</th></tr>
<tr><td>East char sita</td><td>25</td><td rowspan="3">3</td><td rowspan="3">25 x 3=75</td><td rowspan="3">75</td><td>4</td></tr>
<tr><td>Adorsso para</td><td>25</td><td rowspan="2">2</td></tr>
<tr><td>North & south bara kheri</td><td>25</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>1</td></tr>
</table>

Table 3.2: Distribution of the population, sample and reserve list for the Control group

Name of the villages	Population	Sample size	Reserve list
West char sita	110	33	3
Moulobibazar	90	27	3
Rougunatpur	50	15	2
Total	250	75	8

Minimizing spill-over effects

The study used a quasi-experimental survey design to resolve the problems of endogeneity both at location level and participant level. 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. Researcher selected separate villages such as East char sita, Adorsso para , North & south bara kheri as a study area to avoid the problem of information flow from CSA farmers to Non CSA farmers . To reduce spill-over effect i.e. to overcome the transmission /contamination of information or knowledge from climate smart agricultural practice farmers to non - practiced farmers', i.e. diffusion of treatment, and to avoid downward bias, all control respondents were selected from those villages where climate smart agricultural practices services had not introduced at all. The study and control group villages were kept separate with a remarkable distance of about 3-5 km (Mazumder , 2015; Hulme , 2000) . To reduce information distortion, one farmer from each of the farming family was included in the survey. With the help of the two-way stratified random sampling procedure, homogeneous / similar categories of control and testing group respondents were selected. Furthermore, to ensure similar socio-economic conditions for both the control and test groups, a two-way stratified random sampling technique was used, in which education and farm size were considered as two individual strata. 75 control respondents (not involved in CSA practices) were selected in 1:1 ratio of the test respondents. Education was categorized into three groups: group 1 (denoted E1), respondents are illiterate or can sign only;

group 2 (denoted E2), respondents have primary education, and group 3 (denoted E3), respondents have secondary or higher education. After that, Farm size was also categorized into three groups: group 1(denoted as F1), small farm group (farm size up to 0.5 hectors); group 2 (denoted as F2), medium-farm group (farm size 0.51–1.0 hector, and group 3 (denoted as F3), large farm group (farm size above 1.0 hector). The two-way stratified random table is given as Table 3.3.

Table 3. 3: Two ways stratified random data of the study and control group respondents

Category	% respondents	Study	Control
E_1 XF1	8.53	4	4
E1 xF2	20.56	15	15
E1 xF3	8.93	8	8
E_2 X F3	22.72	20	20
E_2 XF1	6.26	3	3
E_2 XF2	16 .02	12	12
E_3 X F2	5.00	4	4
E_3X F1	3.50	2	2
E_3X F3	8.48	7	7
Total	100	75	75

3.3 Data Collection Instrument

An interview schedule was prepared keeping in mind the objectives of the study. Direct questions and different scales were kept in the questionnaire to get the desired information. After preparation of data collection instrument pre- test was conducted on CSA practiced non - practiced farmers) from the population. Necessary correction, addition and alternation were made in the interview schedule based on the pre-test. After correction, the interview schedule was finalized for the data collection.

3.4 Data Collection

Data were collected personally by the researcher herself through personal interview schedule from the sampled farm families of the selected areas. Before starting the collection of data, the researcher met the respective Upazila Agriculture Officer (UAO), Agriculture Extension Officer (AEO) and the concerned SAAOs. The researcher also discussed the objectives of the present study with the respondents and officers and requested them to provide actual information. A rapport was established with the rural

farmers' so that they feel easy to answer the questions. The researchers took all possible care to establish rapport with the respondents so that they would not feel any indecision while starting the interview. A very good cooperation was obtained from the field extension workers. No serious difficulty was faced by the researchers during the collection of data. The interviews were made individually in the houses of respondents. Questions were asked in different ways so that the respondents could easily understand the questions. Whenever a respondent faced difficulties in understanding any questions, care was taken to explain the same clearly with a view to enabling him to answer it properly. Before going to the respondents' home for interviewing they were informed verbally to ensure their availability at home as per schedule date and time. In the case of failure to collect information from the respondents due to their other business, a revisit was made with prior to appointments. If any respondent failed to understand any question, the researchers took great care to explain the issue. If the respondents could not clear about what was wanted to know then supplementary questions were asked for further clarification. The data were collected from January 2 to 20 January, 2021.

3.5 Variables of the Study

A variable is any characteristic, which can assume varying, or different values in successive individual cases (Ezekiel and Fox, 1959). In a descriptive research, the selection and measurement of variables constitute an important task. The hypothesis of a research, constructed properly, contains at least two important variables viz., independent and dependent variables. An independent variable is that factor which is maintained by the researcher in her attempt to ascertain its relationship to an observed phenomenon.

A dependent variable is that factor which appears, disappears or varies as the researcher introduces, removes or varies the independent variable (Townsend, 1953). It is very difficult to deal with all the factors in a single study. It was therefore, necessary to limit the independent variables the researcher went through the past studies as far as available and also discussed with teachers, experts, supervisor.

According to the relevant research area, the researcher selected 12 characteristics of the CSA farmers as the independent variable and effects of CSA practices on livelihood development as the dependent variable.

Table 3.4: Measuring units and Operational technique of measuring independent and dependent variables

Variables	Measuring unit	Operational technique
Independent variables		
Age	Actual years	Direct question
Level of education	Schooling years	Direct question
Family size	No. of members	Direct question
Effective farm size	Ha	Direct question
Annual family income	Thousand ('000,) taka	Direct question
Annual family income from CSA	Thousand ('000,) taka	Direct question
Agril. extension media contact	Score	Scale developed by Poddar'2015
Innovativeness	Score	Scale developed by Poddar'2015
CSA experience	Score	Scale developed for this study
Agril.training experience	No. of days	Scale developed for this study
Access to agricultural credit	Thousand ('000,) taka	Scale developed for this study
Knowledge on CSA Practices	Score	Scale developed for this study
Dependent variables		
Effects on livelihood	Score	Score developed for this study

3.6 Measurement of the Independent variables

The independent variables of the study were 12 selected characteristics of the CSA growers. These were Age, Level of education, Family size, Effective farm size, Annual family income, Annual family income from CSA, Agricultural extension media contact, Innovativeness, CSA experience, Agricultural training exposure, Access to agricultural credit, Knowledge on CSA practices. The procedures followed in the independent variables are briefly discussed below.

3.6.1 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. This variable appears in item number (1.1) in the interview schedule as presented in Appendix-I.

Based on the available information cited by the farmers they were classified into three categories (MoYS, 2012).

Category (age)	Years
Young	≤ 35
Middle	36 to 50
Old	> 50

3.6 .2 Level of education

Education was measured by assigning score against successful years of schooling by a farmer. One score was given for passing each level in an educational institution (Rashid, 2014). For example, if a farmer passed the final examination of class five or equivalent examination, his/her education score has given five (5).

A score of (0) were assigned for never schooling or illiterate. A person not knowing reading or writing but being able to sign only was given a score of 0.5. If a farmer did not go to school but took non-formal education, his educational status was determined as the equivalent to a formal school student. Non - formal Education equivalent score was calculated as stated by the respondent. This variable appears in item number (1.2) in the interview schedule as presented in Appendix-I.

According to Reza (2007) the level of education of a respondent were classified as:

Category	Education (Year of schooling)
Illiterate	O
Can sign only	.5
Primary education	1-5
Secondary education	6-10
Above secondary education	≥11

3.6. 3 Family size

Family size of a farmer was determined by the total number of members in his family including him, children and other dependents. The scoring was made by the actual number of family members expressed by the farmers. For example, if a farmer had five

members in his family, his score was given as 5. This variable appears in item number (1.3) in the interview schedule as presented in Appendix-I.

According to Haque (2002) based on their total family size, the respondents were classified into three categories:

Category	Family members
Small	1-4
Medium	5-8
Large	Above 8

3. 6 .4 Effective farm size

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

-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

C=Land given to others as borga,

D=land taken from other as borga,

E=Leased in and

F= leased out.

The data was first recorded in terms of local measurement unit i.e., bigha, or decimal and then converted into hectare. The total area, thus, obtained is considered as his farm size score (assigning a score of one for each hectare of land). This variable appears in item number (1.4) in the interview schedule as presented in Appendix-I. Based on their total farm size, the farmers were classified into three categories (Rashid *et.al.* 2016a).

Category	Area (Hectare)
Small	Up to 0.5
Medium	0.51 – 1.0
Large	Above 1.0

3 .6. 5 Annual family income

Annual family income refers to the total financial return from different financial activities in one year. Annual family income of a respondent was 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: main crop, secondary crop, business, labor, service etc. It was expressed in Taka. One score was given for 1000 taka. For an amount less than Tk.1000, a fraction score was computed and added with the main score. Based on their total annual family income, the farmers were classified into three categories: small, medium and large income. This variable appears in item number (1.5) in the interview schedule as presented in Appendix-I.

3.6. 6 Annual family income from CSA

Annual family income of a respondent was 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: homestead gardening, short duration crop cultivation, floating vegetables cultivation etc. One score was given for 1000 taka. A score of 1 was assigned for Tk. 1000. For an amount less than Tk.1000, a fraction score was computed and added with the main score. Based on their total annual family income from CSA, the farmers were classified into three categories: small, medium and large income. This variable appears in item number (1.6) in the interview schedule as presented in Appendix-I.

3. 6.7 Agricultural extension media contact

It was defined as one's extent of exposure to different communication media related to farming activities. Agricultural extension media contact of a farmer was measured by computing agricultural extension media contact score on the basis of their nature of contact with ten agricultural extension media. Respondents were asked to indicate how frequently they have contact with 10 selected information sources to be replied as not at all, rarely, occasionally and regularly. Scores were assigned as 0 for not at all, 1 for rarely, 2 for occasionally and 3 for regularly contact. Based on their extension media contact, (Podder, 2015) classified the respondents into three categories as low contact, medium contact, high contact. This variable appears in item number (1.7) in the interview schedule as presented in Appendix-I.

3.6 .8 Innovativeness

According to Rogers (1983) 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. In this research, Farmers` categories were identified on the basis of innovativeness of the respondents.

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. Based on their innovativeness, the respondents were classified into three categories as low, medium and high innovativeness. This variable appears in item number (1.8) in the interview schedule as presented in Appendix-I.

3.6 .9 CSA experience

Experience is the process or fact of personally observing, encountering, or undergoing something. It was assumed by the respondent's involvement of CSA practices. The respondents indicate the nature of his /her contact by putting a tick against involvement of CSA practices within a year any of the following responses. In a measuring score of one (1) was assigned for each year of working experience of a respondent. According to their CSA experience, the respondents were classified into 3 categories: low, medium and high CSA experience. This variable appears in item number (1.9) in the interview schedule as presented in Appendix-I.

3.6.10 Agricultural training experience

Agricultural training experience of a respondent was measured by the total number of days for which a respondent attended in different training programs on agriculture. If a respondent takes training for 5 days, he will get scores of 5. One score was assigned for each day of training received by the respondent and one score given for every sponsoring agency. According to training received the respondents` farmer were categorized as low training, medium and high training. This variable appears in item number (1.10) in the interview schedule as presented in Appendix-I.

3.7 Access to agricultural credit

Access to agricultural credit of a respondent was measured on the basis of the farmers taken of amount of credit of selected 4 items such as Bank, microfinance/ other training organization, credit from person(s) and friends. It was expressed in Taka. One score was given for 1000 taka.

Based on their access to agricultural credit, the respondents were classified into three categories as low, medium and high access. This variable appears in item number (1.11) in the interview schedule as presented in Appendix-I.

3.7.1 Knowledge 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 questions related to adaptation and mitigation technology of climate change. It was measured assigning two (2) for each question. So, the total assigned scores for all the questions became twenty. The score was given according to response at the time of interview.

Answering a question correctly an individual could obtain full score while for wrong answer or no answer he obtained zero (0) score. Partial score was assigned for partially correct answer. Thus, the CSA knowledge score of a farmer could range from zero (0) to twenty (20), where zero indicates no knowledge and twenty indicates highest knowledge on CSA. According to their knowledge the respondents were classified into three categories: poor, moderate and good knowledge. This variable appears in item number (1. 12) in the interview schedule as presented in Appendix-I.

3.8 Measurement of the Dependent Variables (Selected livelihood parameters)

Housing condition, sources of drinking water, treatment and cloth value indicator were used to measure the livelihood indicator by Podder (2015). Livelihood status of Farmers in areas of Sylhet Division were observed by using housing and sanitation facilities by (Mamun, 2019). Kamaruddin and Samsuddin (2014) were used sanitation facilities, food consumption, wearing better clothes indicator in their paper for research purposes.

This is the first paper where researcher summarized livelihood sub components such as food consumption (nutrition uptake**),** clothing behavior, housing status , drinking water source, sanitation status , health care facilities to analysis the effects of CSA practices on livelihood development by the farmers'. Yet, any researcher have not been conducted a complete paper with following above all livelihood subcomponents. So, this is the research gap of researcher study paper.

I. Food consumption

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 measured calorie following a standard chart. Scores were assigned for up to 800 kcal (1), 801-1600 kcal (2), above 1600 kcal (3) nutrient consumption ability per head per day. Based on their food consumption the respondents were categories into low, medium and high intake. This variable appears in item number 2.1 in the interview schedule as presented in Appendix-I. It may be concluded that the food consumption of the farmers has improved to some extent after the involvement with the CSA interventions.

II. Clothing behavior

Respondents were asked how many set of cloths they use. Based on the respondents answers scores were assigned as 2 cloths (1), 3 cloths (2), 4 cloths (3). This variable appears in item number 2.2 in the interview schedule as presented in Appendix-I. It may be concluded that the clothing behavior of the farmers has improved to some extent after the involvement with the CSA interventions.

III. Housing status

Score were assigned as Tin shed with tin wall (1), Tin shed with brick wall (semi-pucca) (2), Tin shed high-rise house (3). This variable appears in item number 2.3 in the interview schedule as presented in Appendix-I. It may be concluded that the housing status of the farmers has improved to some extent after the involvement with the CSA interventions.

IV. Drinking water source

Score was assigned as, Pond/river with simple treatment-1, Arsenic free tubewell-2 , Own tube well normal base-3.This variable appears in item number 2.4 in the interview schedule as presented in Appendix- I. It may be concluded that the drinking water

source of the farmers has improved to some extent after the involvement with the CSA interventions.

V. Sanitation status

Respondent's having latrine with bush(1) , sanitary ring slab latrine(2) , pucca latrine upon normal base (3). This variable appears in item number 2.5 in the interview schedule as presented in Appendix-I. It may be concluded that the sanitation status of the farmers has improved to some extent after the involvement with the CSA interventions.

VI. Health care facilities

The respondents were directly asked to mention the healthcare facilities that their family members availed in after intervention periods. b Scores were assigned for using different types of Medicare services are: pir/fakir (1), homeopath (2), trained village doctor (3). This variable appears in item number 2.6 in the interview schedule as presented in Appendix-I. It may be concluded that the health care facilities of the farmers has improved to some extent after the involvement with the CSA interventions.

3.9 Statistical analysis

Data collected from the respondents were analyzed and interpreted in accordance with the objectives of the study. The analysis of data was performed using statistical treatment with SPSS (Statistical Package for Social Sciences) computer program, version 22. Statistical measures as a number, range, mean, standard deviation was used in describing the variables whenever applicable. Data were coded, tabulated, compiled, and analyzed according to the objectives of the study.

The sample sizes in the two groups (study group and control group) were equal and multiple regression analysis was conducted to examine the contribution of the independent variables to the climate smart agricultural practices effects on livelihood development. Paired t - test were used to assess differences between means. Five percent (0.05) and one percent (0.001) level of significance was used as the basis for rejecting any null hypothesis.

3.10 Statement of hypothesis

According to Kerlinger (1973), a hypothesis is a conjectural statement of the relation between 2 or more variables. Hypothesis are always in declarative sentence form and

they relate either generally of specifically variables to sentence form and they relate either generally or specifically variables to variables. Hypothesis may be broadly divided into two categories, namely, research hypothesis and null hypothesis.

3.11 Research hypothesis

Each of the 12 selected characteristics were age, level of education, effective farm size, family size, annual family income, annual family income from CSA, innovativeness, access to agricultural credit, agricultural training exposure, agricultural extension media contact, CSA experience, knowledge on CSA practices of the respondents has significant contribution to the change in different indicators of dependent variable in study group**.**

3.12 Null hypothesis

A null hypothesis states that there was no contribution to the concerned variables. The following null hypothesis was undertaken for the present study "There was no contribution of the selected characteristics of rural farmers to the climate change effects on their livelihood." The selected characteristics were age, level of education, effective farm size, family size, annual family income, annual family income from CSA, innovativeness, access to agricultural credit, agricultural training exposure, agricultural extension media contact, CSA experience, knowledge on CSA practices.

CHAPTER IV

RESULTS AND DISCUSSION

The recorded observations in accordance with the objective of the study were presented and probable discussion was made of the findings with probable justifiable and relevant interpretation under this chapter. The chapter content in three (3) sections.: a) Selected characteristics of the respondents b) The effect of CSA practices on rural farmers' livelihood c) Contribution of the selected characteristics of the respondents on the CSA practices effects on their livelihood.

4.1 Selected Characteristics of The Farmers

The findings of the twelve characteristics of the respondents have been discussed in twelve subsections.

4.1.1 Age

Age of the farmers ranged from 35 to 70 years with a mean of 43.7 years and standard deviation of 10.2. Data furnished in the table 4.1 shows that the middle-aged respondent's group was higher than old aged and young aged group. Based on the available information cited by the farmers, they were classified into three categories (MoYS, 2012).

Table 4.1: Distribution of the CSA farmers according to their age

Categories (Years)	Farmers		Mean	SD
	Number	Percent		
Young (up to 35)	15	20	43.7	10.2
Middle aged (36-50)	**55**	**73.33**		
Old (Above 50)	5	6.66		
Total	75	100		

It was found that 73.33 percent of the respondents were middle-aged, 6.66 percent of the respondents were old and rest 20 percent were young. Podder (2015) found that 46.7 percent of the respondents were middle-aged, 28.3 percent of the respondents were old and rest 25 percent were young. Kisar (2018) indicates that the highest proportion (46.2 percent) of the respondents fell in the middle age category, while 40.9 percent and 12.9 percent belonged to old and young age categories respectively. However, data also revealed that 87.1 percent of the respondents in the study area were middle to old aged. Ahmed *et.al (*2009) found that middle aged (70.01%) was higher than that of

young aged (6.71%). Different result was observed by Nasreen *et al.,* (2013) in different study area where young aged respondents group was higher than the middle and old aged respondents' group. Afrin *et.al* (2017) found that old aged person (51.01%) was higher than that of middle aged (13.7%). From the above discussion, researcher might be concluded that middle aged respondents were increased in a study areas because they have sound knowledge of CSA farming practice.

4.1.2 Level of education

The level of education of the respondents ranged from 0 to 15, the average being 4.21 with a standard deviation of 3.62. Results showed that highest number of the respondents had in primary education level where lowest number of the respondents had higher secondary level. Reza (2007) based on the level of education of the respondent were classified as illiterate, can sign only, primary education, secondary education and higher secondary education.

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

Categories (Schooling of years)	Farmers		Mean	SD
	Number	Percent		
Illiterate (o)	15	20	4.21	3.62
Can sign only (.5)	12	16		
Primary education (1-5)	**35**	**46.7**		
Secondary education (6-10)	12	16		
Higher secondary education (above 11)	1	1.3		
Total	75	100		

Podder (2015) showed that level of education of the respondents ranged from 0 to 12, the average being 4.668 with a standard deviation of 4.197. Results presented that highest number of the respondents were in secondary education level where lowest number of the respondents were higher secondary level. Similar results were observed by Reza (2007) where the highest number of respondents were educated up to secondary level education. But contradictory result was observed by Nasreen *et al.* (2013) where highest number of respondents were completed up to primary education level. According to the national standard of classification, among the respondents of rural farmer, 20 percent had no education, 16 percent could sign only, 46.7 percent had education at primary level, 16 percent had education at secondary level and 1.3 percent had education at higher level. On the other hand, the lowest (13.3%) above secondary education and (23.8%) illiterate category. Bose *et.al* (2014) reveals that

moderate educated (63.81) was higher than that of highly educated. Afrin *et.al* (2017) showed that primary education (51.0%0) was higher than that of secondary education.

It may be concluded that education broadens the horizon of outlook of farmers and expands their capability to analyze any situation related to climate smart agriculture. The study areas respondents were not conscious of education so education sector is not highlighted. It seems that due to lack of available support from family they were unable to continue their higher study.

4.1.3 Family size

Data presented in the Table 4.3 show that the respondents having medium sized family were higher than the respondents having small and large sized family respectively. Family size of the respondents ranged from 2 to 9 members, having an average of 4.93 and standard deviation 1.446. Based on the family size score the respondents were classified into three categories namely 'small family', 'medium family', and 'large family' by Kisar (2018). Researcher may be included this category for categoring the family size.

Table 4.3: Distribution of the CSA farmers according to their family size

Categories (No. of members)	Farmers		Mean	SD
	Number	Percent		
Small farm (up to 3)	12	16	4.93	1.446
Medium farm (4-6)	**50**	**66.66**		
Large farm (Above 6)	13	17.33		
Total	75	100		

Table indicated that 66.66 percent of the farmers had medium family size, while 16 percent of the farmers were small family and 17.33 percent had large family size. Podder (2015) found that 63.0 percent of the farmers had medium family size, while 15.2 percent of the farmers were small family and 21.7 percent had large family size. Afrin *et.al* (2017) reveals that medium family size (62%) was higher than large family. Ahmed *et.al* (2009) found that medium family (53.33%) was higher than that of large family (33%). Kisar (2018) showed that study area was higher than the national average of 4.85 persons (BBS, 2015).

This may be due to the prevalence of joint family system in the study area. The study showed that the study area was in a remote village where family bonding was very 43

common and they wanted to live together so that their family size was bigger. From the above discussion researcher might be concluded that medium family size family is present in the study areas because they are not eager to use the family planning process and they have no idea of better enjoyment facilities of life which will be possible by their consciousness of family size control progress.

4.1.4 Effective farm size

Data presented in the Table 4.4 indicate that most of the respondents had medium farm size where medium and large farm size was higher than small farm size. Based on their total farm size, the farmers were classified into three categories small, medium and large farm (Rashid *et.al.*, 2016).

Table 4.4: Distribution of the CSA farmers according to their farm size

Categories (ha.)	Farmers		Mean	SD
	Number	Percent		
Small farm (up to .5)	8	10.66	1.67	1.32
Medium farm (.51-1.0)	**50**	**66.66**		
Large farm (Above 1.0)	17	22.66		
Total	75	100		

Farm size of the respondents ranged from 0.44 to 4.04 having an average of 1.67 and standard deviation 1.32. Results presented in Table 4.4 indicate that 10.66 percent of the farmers had small farm size, while 66.66 percent of the farmers had medium and 22.66 percent had small farm size. Rashid *et.al* (2016) showed that farm size (0.04 %) variation in empowering farmers through e-Agriculture. Afrin *et.al* (2017) reveals that medium farm size (17.06%) was higher than that of small farm size (1.96%). On the other hand, different results were observed by some researchers. Podder (2015) reveals that most of the respondents had small farm size where medium and large farm size was lower than small farm size. Similar result was observed Nasreen *et al.* (2013) where highest respondents were small farm sized. Bose *et.al* (2014) found that small family size (45.71%) was higher than that of large family size (10.48%).

Researcher might be concluded that from the above results discussion medium farm size was found higher amount because their farm land was not affected by river erosion in that areas.

4.1.5 Annual family income

Data presented in the Table 4.5 shows that the respondent having medium annual family income were higher than the respondents of low and high annual family income respectively. On the basis of observed range, the respondents were classified into three categories namely "low income", "medium income", and "high income" as shown on the table 4.5. This category was conducted by Kisar (2018).

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

Categories ('000, taka)	Farmers		Mean	SD
	Number	Percent		
Small family income (up to 40)	10	13.33	78.0	38.3
Medium family income (41-116)	**49**	**65.33**		
Large family income (Above 116)	16	21.33		
Total	75	100		

In this Table presented that 65.33 percent respondent had medium income, 13.33 percent had low income and 21.33 had high income. The average of income of the respondents were 78.0 and standard deviation of 38.3. Podder (2015) found that the respondent having medium family income were higher than the respondents of low family income and high annual family income respectively. It seems that rural farmers are involved in different income generating activities due to the climate change effects. Reza (2007) found the similar result where highest number of respondents were medium annul income. But contradictory results were found. Kisar (2018) indicate that the highest proportion (77.4 %) of the respondents had low annual income, while 20.4 percent had medium income and 2.2 percent had high income. As a result, the most (97.2 percent) of the respondents in the study area were medium to low-income earners.

From the above discussion, researcher seems that most of respondents were from in medium income group. Researcher added that they were involved in various activities such as dairy farm, labor, service and business.

4.1.6 Annual family income from CSA

Data presented in the figure 4.1 shows that the respondent having medium annual family income were higher than the respondents of low Annual family income and high

Annual family income respectively. On the basis of observed range, the respondents were classified into three categories namely "low income", "medium income", and "high income" (Ahmed *et.al,* 2009).

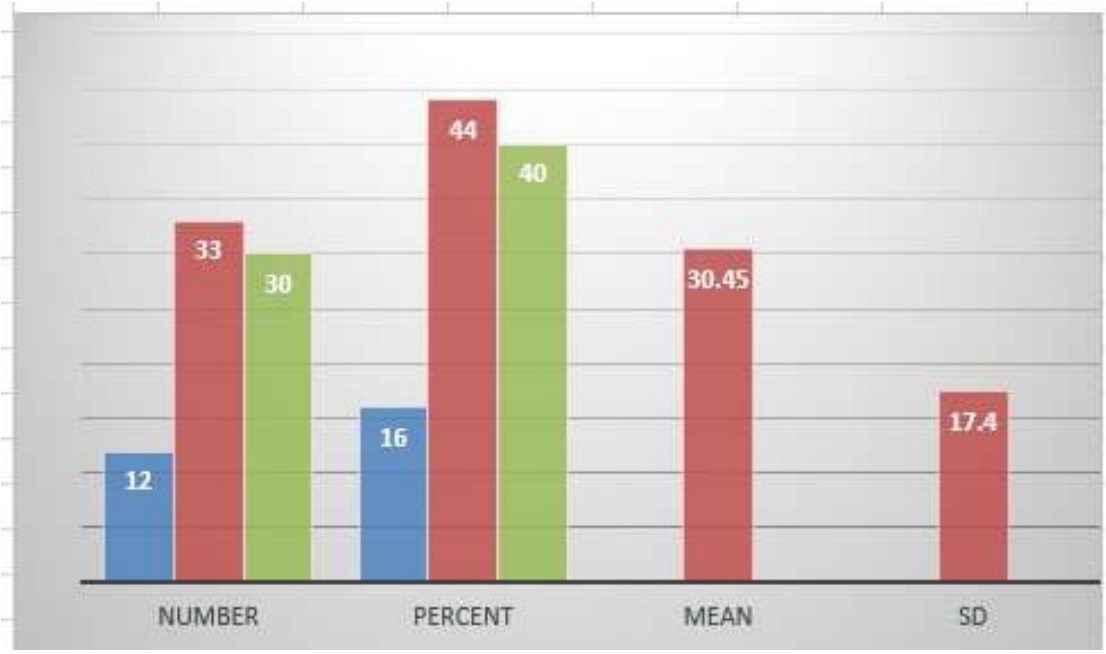


Figure 4.1: Distribution of CSA farmers according to their annual family income from CSA

In this figure presented that 44 percent respondent had medium income, 16 percent had low income and 40 had high income. The average score of income of the respondents were 30.45 and standard deviation of 17.4. Ahmed *et.al* (2009) showed that medium family income (58.3%) was higher than that of high-income group. Contradictory results were discussing by Afrin *et.al* (2017) showed that low-income group (57.8%) was higher than that of medium as well as high income group.

Researcher seems that most of the respondents were involved in CSA farming so their income was increased. Their annual family income respondents were observed in medium level. Researcher may be concluded that this progress will be increased by their engaging in this farming system.

4.1.7 Agricultural extension media contact

Data presented in the Table 4.6 amplify that the respondents having medium contact were higher than the respondents having low and high contact respectively. It may be indicated that most of the rural farmers were conscious about CSA practices effects on

their livelihood. Researcher categorized the respondents low, medium and high to follow the Kisar (2015).

Table 4.6: Distribution of the CSA farmers according to their agricultural extension media contact

Category	Basis of Categorization (Score)	Observed range (Score)	Farmers		Mean	SD
			Number	Percent		
Low contact	≤19	12-39	11	14.66	27.91	8.261
Medium contact	20-35		**47**	**62.66**		
High contact	> 35		17	22.66		
Total			75	100		

Among the respondent's 14.66 percent have maintained in low contact, 62.66 percent having medium contact, 17 percent were involved in high contact. Mean and S.D were 27.9 and 8.2 respectively. Kisar (2018) indicated that the highest proportion (62.6%) of the respondents had medium extension media contact as compared to (18.3%) and (19.4%) having low and high extension media contact respectively. But contradictory results were observed. Podder (2015) found that the respondents having low contact on climate change were higher than the respondents having no contact, medium contact and high contact respectively. Afrin *et.al (*2017) showed that low contact (57.8%) was higher than that of medium and high respectively. Bose *et.al* (2014) reveals that medium contact (75.24) was higher than that of low contact. From the above results discussion that most of the respondents have primary education so their communication eagerness is also developed.

4.1.8 Innovativeness

Data presented in the Table 4.7 amplify that the highest percent of the respondents having medium innovativeness researcher followed the Mean ± SD formula for categoring the innovativeness of the respondents. On the basis of the innovativeness of the farmers, they were classified into three categories where 33.33 percent were low, 48 percent were medium and, 18.6 percent were high having an average of 32.13 and standard deviation 4.897. Podder (2015) showed that that the highest percent of the respondents having early adopter and early majority. It may be indicated that most of the farmers were educated up to secondary level that's why they adopted any innovation quickly than others.

Table 4.7: Distribution of table the CSA farmers according to their innovativeness

Categories (Score)	Farmers		Mean	SD
	Number	Percent		
Low (up to 28)	25	33.33	32.13	4.897
Medium (29 to 36)	**36**	**48**		
High (Above 36)	14	18.6		
Total	75	100		

Researcher might be concluded that medium innovativeness shows that most of the respondents have primary education and their basic knowledge helps to develop their eagerness towards new innovation.

4.1.9 CSA experience

CSA experience scores of the respondents computed as how many years of involving CSA based farming practices. The mean and standard deviation were 4.28 and 1.74 respectively. On the basis of experience, the respondents were classified into three categories namely, 'low experience', 'medium experience' and 'high experience by Kiser (2018). The researcher selected this category for her research purpose.

Table 4.8: Distribution of the CSA farmers according to their experience

Category	Basis of Categorization (Score)	Observed range (Score)	Farmers		Mean	SD
			Number	Percent		
Low experience	≤ 3	1.00-8.00	**29**	**38.66**	4.28	1.74
Medium experience	4-5		23	30.66		
High experience	> 5		23	30.66		
Total			75	100		

Information furnished in the Table 4.8 amplify that the respondent having low CSA experience were higher than the respondents having high and medium respectively. 38.66 percent respondents had low experience while 30.66 percent respondents had medium and high experience respectively. But different results were observed by the researchers. From the above discussion, researcher seems that rural farmers were not involved in CSA practices due to their unconsciousness and lack of proper communication with SAAOS and the farmers leader.

4.1.10 Agricultural training experience

Agricultural training experience scores of the respondents computed as days of participating training, which ranged from 0 to 10 days. The mean and standard deviation were 5.37 and 1.82 respectively. Bose *et.al* (2014) have categorized the training exposure low, medium and high respectively. Information furnished in the Table 4. 9 amplify that the respondents having low training experience and medium training experience percent was same. It seems that rural farmers were involved in training experience due to their consciousness and proper communication day by day as a result 34.66 percent respondents had high training experience.

Table 4.9: Distribution of the CSA farmers according to training experience

Categories (No. of days)	Farmers		Mean	SD
	Number	Percent		
Low (up to 4)	23	30.66	5.37	1.82
Medium (5 -6))	23	30.66		
High (Above 6)	26	34.66		
Total	75	100		

Afrin *et.al* (2019) reveals that not received training (60.8%) was higher than that of received training (39.2%). Different results were revealing that Hossain *et.al* (2019) found that medium training experience (49.60%) was higher than that of no, low and high training experience. Bose *et.al* (2014) reveals that medium (51.43) training experience was higher than that of low training experience (39.05). From the above discussion, researcher might be concluded that maximum training was given for 1 days by agriculture office and 2 days training in a week was given by Netherland government (they suggest the farmers how to cultivate soyabean crop in their land). So low to medium training experience percent was observed same in this paper.

4.1.11 Access to agricultural credit

Range is needed for judging the categorization of the respondents. The average mean and standard deviation were 77.63 and 47.1 respectively. Researcher followed the Mean ± SD formula for catering the access to credit based on the respondents. Among the respondents 20 percent had involved low access , 57.33 percent having in medium access , 22.66 percent had involved in high access to credit.. But contradictory results observed by Afrin *et.al* (2017). They showed that not credit recipient (71.6%) was higher than credit received respondents. From the above discussion reseracher may be concluded that medium access was more higher than that of low to high access respectively. The researcher seems that most of the respondents have medium farm so this farm will effect their loan sanction from bank . The government bank never show attention to give credit those farmers whose farm size amount was low. So the farm size ensure the banks authority that if the farmers will fail into pay their credit then they take their land. Farmers take credit from their friends in any time where farm size never effect.

Table 4.10: Distribution of the CSA farmers according to their access to Agricultural credit

Categories ('000, taka)	Farmers		Mean	SD
	Number	Percent		
Low (up to 30)	15	20	77.63	47.1
Medium (31- -124)	**43**	**57.33**		
High (Above 124)	17	22.66		
Total	75	100		

4.1.12 Knowledge on CSA practices

Knowledge on CSA practices scores of the farmers ranged from 8 -20 against the possible range of 0-20. Average mean and standard deviation were 17.36 and 2.97 respectively. Researcher followed the categories poor, moderate and good knowledge respectively by Podder (2015).

Table 4.11: Distribution of the CSA farmers according to knowledge

Categories (Score)	Farmers		Mean	SD
	Number	Percent		
Poor (up to 15)	14	18.66	17.36	2.97
Moderate (16-18)	**36**	**48**		
Good (>18)	25	33.33		
Total	75	100		

Results presented in the Table 4.11 indicates that 48 percent respondents having moderate knowledge which were higher where 33.33 percent and 18.66 percent respondents had good knowledge and poor knowledge respectively.

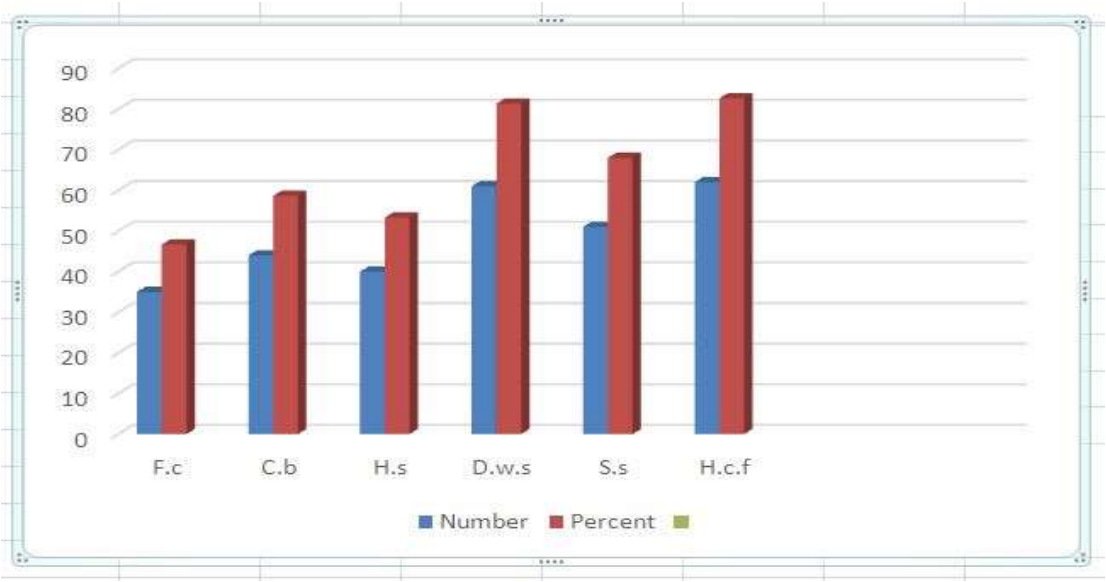
Podder (2015) indicates that 82.6 percent of the respondents had moderate knowledge which were higher where 7.6 percent and 9.8 percent respondents had poor knowledge and good knowledge respectively. It may be indicated that most of the rural farmers had secondary level of education and that's why they had moderate knowledge on climate change. Podder (2015) also found that that 79.3 percent of the respondents having moderate knowledge which were higher where 13.0 percent and 7.6 percent

respondents had poor knowledge and good knowledge respectively. It seemed that livelihood knowledge was moderate due to most of their educational background were secondary level. Kisar (2018) showed that the majority (57%) of the respondents had medium knowledge on climate change while (29%) had high knowledge and (14%) of the farmers had low knowledge on climate change. The majority of the farmers (86%) have medium to high knowledge on climate change.

From the above discussion, researcher could concluded that it might be indicated that most of the rural farmers had primary level of education and that's why they had moderate knowledge on CSA practices.

4.2 CSA Practices Effects on Rural Farmers` Livelihood

CSA practices effects on rural farmers` livelihood had one selected dimension as livelihood development indicators of life.



F.C=Food Consumption, C. B=Clothing Behavior, H. S=Housing Status, D.W.S =Drinking Water Source, S. S=Sanitation status, H.C F =Healthcare Facilities

Figure 4.2: Distribution of farmers livelihood changes in a study areas

From the figure , researcher can concluded that medium intake percentage (46.66%) of the rural farmers in a study areas was more higher than that of control groups farmers (26%). 3 cloths use farmers percent (58.66) was higher in a study group farmers than control groups (26.66%). Housing status of the study groups farmers was higher than

that of control group farmers. The percent of the tin shed with brick wall status of housing condition was 53.33% in a study group farmers. Arsenic free tube well use farmers (81.33%) was higher than that of control groups (73.33%).

Sanitary ring slab latrine using farmers percent (68%) was higher than that of control group farmers percent (56%). Trained village doctor percent (82.66%) was higher than that of control (58.66%) farmers.

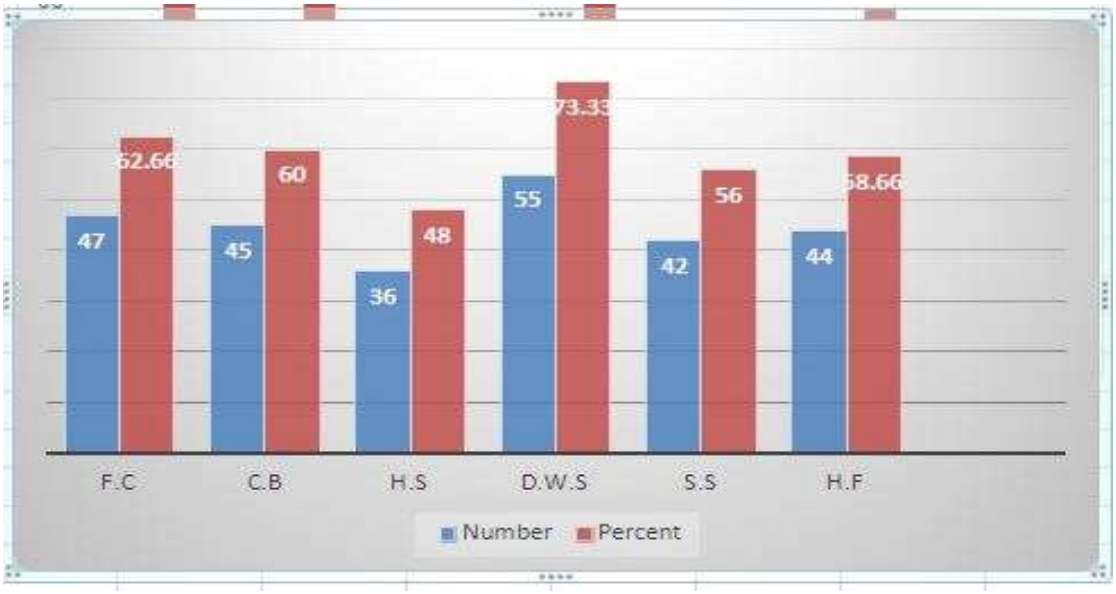


Figure 4.3: **Distribution of farmers livelihood changes in a control areas**

Podder (2015) showed in his paper that majority of the respondents (48.9%) were low changes in their clothe value. Poor housing conditions was present among majority of the farmers (71.7 %) . The mean difference value was .178 and t-value was 1.734. It implies that the respondents did not concentrate more for fashionable housing as majority of them were economically less sound. Among the respondent's (79.3) percent had low changes, 20.7 percent respondents had medium changes and there were no high changes among the respondents.

It is mentionable that the study area, The existing condition of sources of drinking water were good. Therefore, it was less space to uplift their sources of drinking water. 58.7 percent respondents made low changes in treatment, 41.3 percent had medium changes in treatment and there were no high changes in treatment. It seems that low changes in treatment of the respondents were high due to the location of the study area

and climate change effects on their livelihood using condition of the respondents was high due to the climate change effects the study area.

From the above discussion, researcher concluded that farmers livelihood changes in a study area was comparatively better than control areas. In a study area most of the farmers have primary education and they have medium annual family income from CSA that influences to change their livelihood condition.

Changes in rural farmers` livelihood

Results contained in the Table 4.12 show that majority of the respondents (54.66%) lead medium changes in their livelihood condition. Podder (2015) showed that majority of the respondents (49.5+43.0) lead either low changes or medium changes in their livelihood condition. The low changes of farmers` livelihood were 49.5 percent compare to medium and high changes were 43 and 7.5 percent respectively.

Table 4.12: Distribution of the respondents according to their perceived changes in rural farmers` livelihood

Categories	Study groups		Categories	Control groups	
	Number	Percent		Number	Percent
Low (up to 11)	11	14.66	Low (up to 7.9)	5	6.66
Medium (12-15)	**41**	**54.66**	Medium (8-12.5)	**60**	**80**
High (above 15)	23	30.66	High (above 12.5**)**	10	13.33
Total	75	100	Total	75	100

From the above Table, researcher might be concluded that medium changes were observed between two groups. But contradictory in a study groups medium changes was lower (54.66%) than 80 % changes in a control group. Overall, this Table shows that medium changes was observed among two groups. Otherwise, high to low percent was comparably better than control groups. This change may be occurred among the respondents in a study area because there have CSA experience and extra income from CSA practice.

Comparative test (t- test) with CSA practice farmers between non - CSA practice farmers

The comparative CSA practice and non-CSA practice farmers in Bangladesh was tested by using the following null hypothesis. The calculated "t" value was 7.68 which were significant at 1% levels. The result of 't' value supported to reject the null hypothesis and clearly indicated that improvement of CSA practice farmers more than of non – CSA farmers.

Table 4.13: Results of t-test showing the mean of present CSA practice and non-CSA farmers in Bangladesh

Items	N	Mean	SD	t- value
CSA practice	**75**	13.68	2.94	7.68**
Non - CSA practice	**75**	10.2	2.33	

Hence, it was concluded that more livelihood changes is done in CSA practice farmers than that of non- CSA practice farmers.

4.3 The Contribution of the selected characteristics of the respondents to their livelihood development by practice climate smart agriculture

In order to avoid the misleading results and to determine the best explanatory variables, the method of stepwise multiple regressions was administered and independent variables were fitted together in step-wise multiple regression analysis. For this study twelve characteristics of the respondents were selected and each of the characteristics was treated as independent variable. The final null hypothesis: There is no contribution of the selected characteristics (age, level of education, family size, effective farm size, annual family income, annual family income from CSA, CSA experience, agricultural training exposure, innovativeness, access to agricultural credit, agricultural extension media contact, knowledge on CSA practices of the farmers in changes their livelihood status. It was observed that out of 12 variables only 6 independent variables namely effective farm size, annual family income, agricultural training exposure, annual family income from CSA, agricultural extension media contact, knowledge on CSA practices were entered into the regression equation which contribute the farmers livelihood development. The regression model shows that effective farm size (0.004), annual family income (0.007), and agricultural training exposure (0.003) were the most contributing factors significant at a 1 % level. Otherwise, annual family income from CSA (0.010) , agricultural extension media contact (0.047) knowledge on CSA practices (0.015) was the second contributing factors which was significant at 5% level. The multiple adjusted R^2 values and R^2 value were found 0.69 and 0.74 and the corresponding F value was 9.3 which were significant at 0.000 levels. In order to estimate the farmers livelihood development by practice climate smart agriculture, the multiple regression analysis was used which is shown in a Table 4.14. Rashid *et.al* (2016) revealed that the factors i.e., usages of e-Agriculture, attitude towards e-Agriculture, organizational participation, cosmopolitans and farm size were contributed to change farmers empowerment significantly due to the involvement of e-Agriculture. Finally, it indicated that usage of e-Agriculture alone contributed 84 % of the variation of empowerment.

Table 4.14: Multiple regression of the contributing variables related to the rural farmers livelihood development

Dependent variables	Independent variables	β	*P*	R^2	Adj. R^2	F
Rural farmers livelihood development	Age	0.050	0.125	**0.74**	**0.69**	**9.3**
	Level of education	0.045	0.202			
	Family size	0.021	0.533			
	Effective farm size	0.194	**0.004****			
	Annual family income	0.207	**0.007****			
	Annual family income from CSA	0.121	**0.010***			
	Agricultural extension media contact	0.124	**0.047***			
	Innovativeness	0.018	0.756			
	CSA experience	0.021	0.766			
	Access to agricultural credit	0.018	0.774			
	Agricultural training exposure	0.251	**0.003****			
	Knowledge on CSA practices	0.131	**0.015***			

*** Significant at .000 -.009 (1% level) * Significant at .010 -.049 (5% level)*

Podder (2015) revealed that there was a significant contribution of respondent's education, family size, media contact, training experience and knowledge on climate change in changing their livelihood of the respondents. Among these, education and knowledge on climate change was the most important contributing factor (significant at the 1% level of significance) and family size and training experience were the second most contributing factor (significant at the 5% level of significance).

Media contact related to change in rural livelihood due to the climate change effects (significant at the 1% level of significance).

There was a significant contribution of the farmers' level of education, farmers' perception of climate change and knowledge on climate change their food stock ability status through which was 51.6% and significant contribution of the farmers age, family size, agricultural extension contact and knowledge on food security to change in nutritional security status through which was 35.9%. Researcher observed in the Raihan (2011) research paper that the researcher showed age, service length, job facilities and job satisfaction of the respondents had significant positive relationships with their job performance. On the other hand, Hossain (2016) showed age, service length, extension media contact was the most important contributing factors (significant at the 1% level of significance). Farmer's problem awareness were also the important contributing factors (significant at the 5% level of significance). Salim (2006) found that the age and service length of SAAOs had significant relationship with their job performance at 5% level based on correlation coefficient analysis. The researcher applied multiple regression analysis that showed that job performance had significant relationship with level of education, academic achievement and job satisfaction. The R^2 statistics indicate that the model as fitted explain 62.8% of the variability in job performance. From the above review, researcher may be concluded that multiple regression is a general and flexible statistical method for analyzing associations between two or more independent variables and a single independent variable. The process of performing a regression allows us to confidently determine which factors matter most, which factors can be ignored, and how these factors influence each other. To uplift the food security condition, the government should take more initiatives through increasing awareness of the farmers about convenience of the food security so that they can lead their life safely from adverse future effect. (Kisar, 2018). Farm size may play an important role on both capabilities of investment and risk orientation issues (Arun *et. al.*, 2017). From the above discussion, researcher seems that government should take necessary steps to give the facilities to enlighten 56 the ignorance farmers by establishing adult education program. DAE should give attention in a Ramgoti upazila for conducting new project which influence the farmers livelihood development. The government bank should give loan in easy terms to those farmers whose farm size was small in size. Agriculture extension office should arrange need based training courses so that farmers versus

SAAOS communication gap would be reduced. If these policies should be maintained, researcher seems that the livelihood condition of the farmers would be changed in a locality of Bangladesh.

CHAPTER V

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

This Chapter presents summary of major findings, conclusion and recommendation of the study.

5.1 Summary of Findings

5.1.1 Selected characteristics of the farmers

The major findings of the study are summarized below:

Age

Age of the farmers ranged from 35 to 70 years with the average of 43.7 years and the standard deviation was 10.2. Highest proportion (73.33 percent) of the farmers was under middle aged category.

Level of education

Education score of the respondents ranged from 0 to 15 with the average of 4.21 and the standard deviation was 3.62. Highest proportion (46.7 percent) of the farmers was under primary education.

Family size

Above the half (66.66%) of the respondent had medium family size compare to 16 % and 13% had small and large family size respectively.

Effective farm size

The medium farm size constituted the highest proportion (66.66%), whereas the only 22.66% 0f the farm holder was large farm size.

Annual family income

The highest proportion (65.33 %) of the respondents had medium annual income, while13.33% percent had low income and 21.33 percent had high income.

Annual family income from CSA

The highest proportion (44 percent) of the respondents had medium income, while 16 percent had small income and 40 percent had high income.

Agricultural extension contacts

The highest proportion (62.6%) of the respondents had medium extension media contact as compared to (14.66%) and (22.66%) having low and high extension media contact respectively.

Innovativeness

Medium innovativeness constituted the highest proportion (48%) as compared to low (33.33%) and high (18.6%) respectively.

Access to agricultural credit

The highest proportion (57.33%) of the respondents had medium access as compared to (20%) and (22.66%) having low and high access to credit respectively.

Agricultural training experience

The high training experience constituted the highest proportion (34.66%), whereas the only 30.66% of the training experience was low to medium.

CSA experience

Low experience constituted the highest proportion (38.66%) as compared medium to high respectively.

Knowledge on CSA practices

The highest proportion (48%) of the respondents had moderate knowledge on CSA practices while (18.66) %) had poor knowledge and (33.33%) of the farmers had good knowledge on CSA practices respectively.

5.1.2 Effects of CSA practices on rural farmers livelihood development

Food consumption

Medium intake percentage (46.66%) of the rural farmers in a study areas was higher than that of control groups (26%) farmers.

Clothing behavior

3 cloths use farmers percent (58.66) was higher in a study groups farmer than control group (26.66%).

Housing status

Housing status of the study groups farmers was higher that of control group farmers the percent of the tin shed with brick wall status of housing condition was 53.3% in the study groups farmer.

Drinking water source

Arsenic free tube well use by the farmers (81.33%) was higher than that of control groups (73.33%).

Sanitation status

Sanitary ring slab latrine using farmers percent (68%) was higher than that of control group farmers percent (56%).

Healthcare facilities

Trained village doctor percent (82.66%) was higher than that of control (58.66 %) group farmers.

Changes in rural farmers livelihood

Medium changes were observed between two groups. But contradictory in a study groups medium changes percent was lower (54.66%) than 80 % changes in a control group. Otherwise, high to low percent was comparably better in a study area than that of control groups.

5.1.3 Contribution of the selected characteristics of the respondents

- There was a significant contribution of the farmers effective farm size (0.004) annual family income (0.007), and agricultural training exposure (0.003) were the most contributing factors significant at a 1 % level to change in rural farmers' livelihood development.
- There was a significant contribution of annual family income from CSA (0.010), agricultural extension media contact (0.047) knowledge on CSA practices (0.015) was the second contributing factors which was significant at 5% level to change their livelihood development.

5.2 Conclusions

Findings of the study enabled the researcher to formulate the following conclusions;

- Findings reveal that medium intake percentage (46.66%) of the rural farmers in a study area was higher than that of control groups (26%) farmers.
- Findings reveal that 3 cloths use farmers percent (58.66) was higher in a study groups farmer than control groups (26.66%).
- Finding reveals that housing status of the study groups farmers was higher that of control group farmers. The percent of the tin shed with brick wall status of housing condition was 53.3% in a study groups farmer.
- Finding reveals that arsenic free tube well use farmers (81.33%) was higher than that of control groups (73.33%).
- Finding reveals that sanitary ring slab latrine using farmers percent (68%) was higher than that of control group farmers percent (56%).
- Finding reveals that trained village doctor percent (82.66%) was higher than that of control (58.66%) farmers.
- Finding reveals that medium changes was observed between two groups.
- Finding reveals that there was a significant contribution of the farmer effective farm size, annual family income and agricultural training exposure were the most contributing factors significant at a 1 % level and annual family income from CSA, agricultural extension media contact, knowledge on CSA practices was the second contributing factors which was significant at 5% level to change their livelihood development status.

5.3 Recommendations

5.3.1 Recommendations for policy implications

On the basis of the findings and conclusion of the research some recommendations have been formulated. These are following-

- Government should take necessary steps to give the facilities to enlighten the ignorantly farmers by establishing adult education program.
- DAE should give attention in Ramgoti upazila for conducting new project which might influences the farmers livelihood development.
- The government bank should give loan in an easy term to those farmers who have lowed small farm size.

- Agriculture extension office should arrange training courses /programmes so that farmers versus SAAOS communication gap would be reduced.
- Governments with different NGOS should start new innovative programs which develop knowledge among the women farmers so that they properly preserve the seed of soyabean, bittergourd ,bottlegourd, and country bean etc.

5.3.2 Recommendations for further study

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

I. The present study was conducted in Ramgoti Upazila under Lakshmipur district. It is recommended that similar studies should be conducted in other areas of Bangladesh.

II. This study investigated the contribution of 12 characteristics of the farmers with the CSA practices on farmers' livelihood development. Therefore, it is recommended that further study should be conducted with other characteristics of their CSA practices on farmers' livelihood development.

III. The present study was concern only with the extent of CSA practices on farmers' livelihood development. It is therefore, suggested that further studies should be included more reliable use of concerned variable is necessary for further study.

IV. In this study, contribution of the selected characteristics of the farmers has been examined with the CSA practices on farmers' livelihood development. Further research is necessary to examine the contribution with other agricultural activities of the farmers.

V. Further research should be conducted with women farmers how CSA practices develop their empowerment status in Ramgoti upazila under Lakshmipur distict.

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APPENDIX- I

A draft interview schedule (For CSA practiced)

[This information will only be used in research purpose]

Department of Agricultural Extension and Information System

Sher-e-Bangla Agricultural University, Dhaka-1207

An Interview Schedule for the Study Entitled

What Effects Does Climate Smart Agriculture (CSA) Practices have on Farmers' Livelihood Development under Selected Areas of Lakshmipur District?

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

Village: ……..…… Contact No. …….....

Union: …….
Upazila:……...

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

Section A: Farmers Socio-economic Profile

1.1 Age

How old are you? _____Years.

1.2 Level of education

Please mention your level of education.

a) I cannot read and write ☐

b) I can sign only ☐

c) I have passed……class.

d) I took NFE that equivalent to …….formal class.

1.3 Family size

Please mention the number of your family member

a) Male….....

b) Female……Total…….

1.4 Effective farm Size

(Please mention the area of your land possession)

SI. No.	Use of land	Land possession	
		Local unit	Hectare
1.	Homestead area (A)		
2.	Own land own cultivation (B)		
3.	Land taken from others on Borga system(C)		
4.	Land given to others on Borga system (D)		
5.	Land taken from others on lease (E)		
Total=A+B+$\frac{1}{2}$(C+D)+E			

1.5 Annual family income

Please mention your yearly family income from each of the following sources

SI. No.	Sources of income	Total price (Taka)
1.	Main crop (……., etc.)	
2.	Secondary crop (…...……..., etc.)	
3.	Labor	
4.	Service	
5.	Business	
6.	Others (specify) please……	

1.6 Annual family income from CSA ……...Taka / Year

1.7 Agricultural extension media contact

(Please indicate the extent of contact in following sources)

SI. No.	Communication media	Extent of contact			
		Regularly (3)	Sometimes (2)	Rarely (1)	Not at all (0)
1.	Meet with contact growers/model Farmers				
2.	Meet with agricultural input (seed/fertilizer/pesticide/fish feed/poultry feed/equipment) dealers				
3.	Meet with SAAOs				
4.	Meet with social worker				
5.	Meet with NGO worker deals with agril input/technologies				
6.	Meet with Agriculture Extension officer/UAO				
7.	Agricultural program through electronic media (radio/TV)				
8.	Involvement in farmers' cooperative discussion meeting				
9.	Participation in FINA/Problem census(PC)/FGD				
10.	Participation in agricultural result demonstration program/Field day				

1.8 CSA experience

How many years are you involved in Climate smart agriculture practices?

Ans:……Years

1.9 Innovativeness

Please indicate your position from the following categories

SI. No.	Items	Extent of damage				
		Innovator (5)	**Early adopter (4)**	**Early majority (3)**	**Late majority (2)**	**Laggard (1)**
1.	Are you willing to take risk any time to adopt innovations?					
2.	How do you adopt IPM practice?					
3.	Adopt innovations immediate after a check of risk					
4.	Show deliberate willingness to adopt innovations					
5.	Are you adopt vermi compost use in your field within in 2 years?					
6.	Are you adopt new cultivation technique within in 1 year?					
7.	Are you do not adopt until most others have done so?					
8.	Show suspicious of innovations					
9.	Are you late to adopt high yielding variety cultivation?					
10.	Others (if any)					

1.10 Access to agricultural credit

(Please indicate your opinion on the following statements)

SI. No.	Sources of credit	Amount (Taka)
1.	Bank	
2.	Microfinance /other financing organization	
3.	Credit from person (s)	
4.	Friends	

1.11 Agricultural training experience

Have you received any training related to Climate smart agriculture practices?

(Please put a tick mark) 1. Yes……. 2. No……..

If yes, please mention the following information:

SI. No.	Name of the training course	Organization	Days
1.			
2.			
3.			
4.			
5.			

1.12 Knowledge on CSA practices

(Please answer the following questions)

SI. No.	Questions	Full Marks (2)	Marks obtained
1.	Have any knowledge about sunflower cultivation?	2	
2.	Why do you use sarjan method?	2	
3.	Are you use balanced fertilizer for Boro rice cultivation?	2	
4.	What is the benefit of soybean cultivation?	2	
5.	Mention any two salt tolerant variety	2	
6.	How can you prepare green manure?	2	
7.	Which method is suitable for vegetables cultivation?	2	
8.	How can you increase soil fertility?	2	
9.	What is the benefit of a vermicompost production?	2	
10.	Have any advantage of ICM practice?	2	
	Total	20	

Section B: Effects on livelihood Development: (please select your choice from following each items)

2) Effects on livelihood subcomponents

2.1 Food consumption (in terms on nutrition):

Please state daily average food consumption/person among your family members

Sl. No.	Name of Meal	Menu and amount (gm)	Nutrition value (calorie)
1.	Breakfast		
2.	Lunch		
3.	Supper/dinner		
	Total		

2.2 Clothing behavior: Please mention the used number cloths/person/year

SI. No.	Cloths	Score
1.	2 cloths (1)	
2.	3 cloths (2)	
3.	4 cloths (3)	
	Total	

2.3 Housing status: Please mention the status of your shelter

SI. No.	Types of houses	Score
1.	Tin shed with tin wall (1)	
2.	Tin shed with brick wall (semi-pucca) (2)	
3.	Tin shed high-rise house (3)	

2.4 Drinking water source: Please mention your drinking water source

SI. No.	Drinking water source	Score
1.	Pond/river with simple treatment (1)	
2.	Arsenic free tube well (2)	
3.	Own tube well normal base (3)	
	Total	

2.5 Sanitation status: Please mention your Sanitation status

SI. No.	Types of Sanitation status	Score
1.	Latrine with bush (1)	
2.	Sanitary ring slab latrine (2)	
3.	Pucca latrine upon normal base (3)	
	Total	

2.6 Health care facilities

Please mention your health care facilities

SI. No.	Medicare	Score
1.	Pir/Fakir (1)	
2.	Homeopath (2)	
3.	Trained village doctor (3)	
	Total	

Thank you for your kind co-operations …….

Signature of the interviewer

APPENDIX-II

A draft interview schedule (For Non - CSA practiced)

[This information will only be used in research purpose]

Department of Agricultural Extension and Information System

Sher-e-Bangla Agricultural University, Dhaka-1207

An Interview Schedule for the Study Entitled

What Effects Does Climate Smart Agriculture (CSA) Practices have on Farmers' Livelihood Development by the Farmers under Selected Areas of Lakshmipur District?

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

Village: ……..……..…Contact No. …….....

Union: …….Upazila:……

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

Section A: Farmers Socio-economic Profile

1.1 Age

How old are you? _____Years.

1.2 Level of education

Please mention your level of education.

a) I cannot read and write ☐

b) I can sign only ☐

c) I have passed……class.

d) I took NFE that equivalent to …….formal class.

1.3 Family size

Please mention the number of your family member

a) Male….....

b) Female……Total…….

1.4 Effective farm Size

(Please mention the area of your land possession)

SI. No.	Use of land	Land possession	
		Local unit	Hectare
1.	Homestead area (A)		
2.	Own land own cultivation (B)		
3.	Land taken from others on Borga system(C)		
4.	Land given to others on Borga system (D)		
5.	Land taken from others on lease (E)		
	Total=A+B+$\frac{1}{2}$(C+D)+E		

1.5 Annual family income

Please mention your yearly family income from each of the following sources

SI. No.	Sources of income	Total price (Taka)
1.	Main crop (……., etc.)	
2.	Secondary crop (…...……..., etc.)	
3.	Labor	
4.	Service	
5.	Business	
6.	Others (specify) please……	

1.6 Agricultural extension media contact

(Please indicate the extent of contact in following sources)

SI. No.	Communication media	Extent of contact			
		Regularly (3)	Sometimes (2)	Rarely (1)	Not at all (0)
1.	Meet with contact growers/model Farmers				
2.	Meet with agricultural input (seed/fertilizer/pesticide/fish feed/poultry feed/equipment) dealers				
3.	Meet with SAAOs				
4.	Meet with social worker				
5.	Meet with NGO worker deals with agril input/technologies				
6.	Meet with Agriculture Extension officer/UAO				
7.	Agricultural program through electronic media (radio/TV)				
8.	Involvement in farmers' cooperative discussion meeting				
9.	Participation in FINA/Problem census(PC)/FGD				
10.	Participation in agricultural result demonstration program/Field day				

1.7 Innovativeness

Please indicate your position from the following categories

SI. No.	Items	Extent of damage				
		Innovator (5)	**Early adopter (4)**	**Early majority (3)**	**Late majority (2)**	**Laggard (1)**
1.	Are you willing to take risk any time to adopt innovations?					
2.	How do you adopt IPM practice?					
3.	Adopt innovations immediate after a check of risk					
4.	Show deliberate willingness to adopt innovations					
5.	Are you adopt vermi compost use in your field within in 2 years?					
6.	Are you adopt new cultivation technique within in 1 year?					
7.	Are you do not adopt until most others have done so?					
8.	Show suspicious of innovations					
9.	Are you late to adopt high yielding variety cultivation?					
10.	Others (if any)					

1.8 Access to agricultural credit

(Please indicate your opinion on the following statements)

SI. No.	Sources of credit	Amount (Taka)
1.	Bank	
2.	Microfinance /other financing organization	
3.	Credit from person (s)	
4.	Friends	

1.9 Agricultural training experience

Have you received any training related to Climate smart agriculture practices?

(Please put a tick mark) 1. Yes……. 2. No……..

If yes, please mention the following information:

SI. No.	Name of the training course	Organization	Days
1.			
2.			
3.			
4.			
5.			

Section B: Effects on livelihood Development: (please select your choice from following each items)

2) Effects on livelihood subcomponents

2.1 Food consumption (in terms on nutrition):

Please state daily average food consumption/person among your family members

Sl. No.	Name of Meal	Menu and amount (gm)	Nutrition value (calorie)
1.	Breakfast		
2.	Lunch		
3.	Supper/dinner		
	Total		

2.2 Clothing behavior: Please mention the used number cloths/person/year

SI. No.	Cloths	Score
1.	2 cloths (1)	
2.	3 cloths (2)	
3.	4 cloths (3)	
	Total	

2.3 Housing status: Please mention the status of your shelter

SI. No.	Types of houses	Score
1.	Tin shed with tin wall (1)	
2.	Tin shed with brick wall (semi-pucca) (2)	
3.	Tin shed high-rise house (3)	

2.4 Drinking water source: Please mention your drinking water source

SI. No.	Drinking water source	Score
1.	Pond/river with simple treatment (1)	
2.	Arsenic free tube well (2)	
3.	Own tube well normal base (3)	
	Total	

2.5 Sanitation status: Please mention your Sanitation status

SI. No.	Types of Sanitation status	Score
1.	Latrine with bush (1)	
2.	Sanitary ring slab latrine (2)	
3.	Pucca latrine upon normal base (3)	
	Total	

2.6 Health care facilities: Please mention your health care facilities

SI. No.	Medicare	Score
1.	Pir/Fakir (1)	
2.	Homeopath (2)	
3.	Trained village doctor (3)	
	Total	

Thank you for your kind co-operations

……

Signature of the interviewer

APPENDIX -III

Food Consumption (Calorie Intake in Lunch and Supper items)

Items of foods	Calorie (Kcal/Kg)	Items of foods	Calorie (Kcal/Kg)
Carbohydrates		**Proteins**	
Rice	3,490	Fish	1,360
Wheat	3,410	Egg	1,730
Tuber	970	Meat	1,090
Vitamins and minerals		Pulse	3430
Vegetables	430	**Fats and oils**	
Fruit	20	Edible Oil	9,000
		Milk	670
		Soyabean oil	884

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

APPENDIX- IV

Food Consumption (Calorie Intake in Breakfast items)

Items of Breakfast	Amount (Per 100 gm)	Calorie (Kcal/Kg)
Muri	1 cup	50
Chanachur	28gm	144
Mixed vegetables	1 cup	27
Partha	1 piece (79 gm)	238
Tea with sugar and milk	1 cup	37
Biscuit	1 piece	116

Source: National food and nutrition institute, Dhaka, Bangladesh