CLIMATE CHANGE ADAPTATION TO HOMESTEAD PRODUCTION SYSTEMS IN MANIKGONJ DISTRICT OF BANGLADESH

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BY

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CERTIFICATE

This is to certify that thesis entitled **'Climate Change Adaptation to Homestead Production Systems in Manikgonj District of Bangladesh'** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE IN AGROFORESTRY AND ENVIRONMENTAL SCIENCE**, embodies the result of a piece of bonafide research work carried out by **MONIRA RAHMAN**, Registration No. **15-07016** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Dated: June, 2017
Dhaka, Bangladesh

Dr. Nazmun Naher
Professor
Supervisor

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CLIMATE CHANGE ADAPTATION TO HOMESTEAD PRODUCTION SYSTEMS IN MANIKGONJ DISTRICT OF BANGLADESH

ABSTRACT

Bangladesh experiences extreme climatic disaster that causes serious threat to the country's environment with its potential negative aspects on ecosystems. In this situation the study was conducted in three Upazilas of Manikgonj district, Bangladesh to observe climate change adaptation on homestead production during August 2016 to January 2017. Objective based information was collected from 75 household-owners (respondent's) through random sampling by using a well-structured questionnaire. In the study area temperature, rainfall, flood and thunderstorm were increased. It was revealed that homestead owners of the study area were more positive attitude towards climate change adaptation in homestead production system. The maximum change in decrease was found in case of fallow land area (99.31 percent) followed by pond area due to utilization by the increased population. The only increase of cattle production was 10% while there were decreases of other household animals and poultry. Due to climate change there were several crops and vegetables subjected to change of planting dates over time. It was showed that 84.2% respondents agreed in changing of planting dates followed by using varieties and micro irrigation.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER I

INTRODUCTION

Bangladesh is a very rich alluvial agro-based country and agriculture accounts for the source of employment of 44.4% of its people (LFS, 2010) and 19.42% of country's GDP (BEC, 2013). About 85% of the total population of Bangladesh live in rural areas and are directly or indirectly engaged in a wide range of agriculture (WB, 2015). People depend upon agriculture for their employment, poverty alleviation, human resource development and food security and they have the opportunity of growing a wide range of agricultural crops. Agriculture supplies raw materials for industrial production and food-stuff for human and animal consumption. Bangladesh is a thickly populated country with an area of 147,570 km^2 and the population is 142.3 million with the growth rate of 1.34% (BBS, 2013).

To meet the demands of large number of populations a lot of crops are grown in our country both in the field and homestead areas. The country is proceeding toward self-reliance of food production. But out of this success many new issues have also appeared including rapid change of climate. Increasing agriculture production through expansion of cultivated area is no longer feasible, because practically all the available arable land is now being used for crop production.

Climate change is a statistically significant change in measurement of either the mean state or variability of the climate for a place or region over an extended period of time due to natural variability or as a result of different human interventions (Prevention consortium, 2007). Bangladesh is a disaster-prone country and the country experiences extreme climatic events frequently: flood, drought, cyclonic storm surges, riverbank erosion, salinity intrusion and water logging cause large-scale loss of life, damage to infrastructure and economic assets, adversely impact on food, water, health and energy security, and affect the lives and livelihoods of many people, the poor in particular (Alam *et al*., 2017; Alam, 2016; Jordan, 2015; Thomas *et al*., 2013; Pouliotte *et al*., 2009; Huq and Ayers, 2008). Thus, it is considered as one of the most serious threats to the country's environment with its potential negative aspects on homestead, human health, food security, agriculture, fisheries, biodiversity, water, economic activities and other natural resources (NCSA, 2007).

Almost every sector of socio-economic life in Bangladesh is likely to be affected by climate change (IFAD, 2008). The impacts of climate variability, change and extreme events will lead to severe stress on overall development, environment and human well-being. The most threatening story is that the level of salinity is also changing rapidly, which is leading an uncertain future of both human and other living species of this region. The capacity of households to adapt to the influence of climate change, which can affect households' resources and resilience, is uncertain due to poor socio-economic conditions (Wood *et al*., 2014; Lobell *et al*., 2008; IPCC, 2007). Hence, Adaptation Strategies are crucial to help the local communities to cope with extreme weather conditions and associated climatic variations (Rosenzweig *et al*., 2013; Adger *et al*., 2003).

The adaptive capacities of the people need to be gradually increased to understand the probabilistic climate vulnerabilities and its consequences over the country agriculture and agriculturally based livelihoods (CEGIS, 2005). Though several government programs have sought to address climate risks in Bangladesh, new ways and methods need to be developed that better inform farmers and help them to identify alternative, technically viable options for farm adaptation practices to mitigate the consequences of climate change. Utilization of climate information in a risk management framework could encourage farmers to adopt the diversified program including homestead production. Agricultural activities are largely hampered by different types of climatic hazard. So adaptation of farming practices is very much essential for this area for all the sectors of agriculture. Nevertheless, the farmers are very hopeful and enthusiastic in adapting various farming practices including homestead production system in response to climate change. In this situation, it is very necessary to conduct sort of research to find out whether the crop practices in homestead production system by the homestead owners due to climate change. So, the objectives of the study were-

a. To observe the climatic change in the study area of Manikgonj district, and
b. To find out the extent of adaptation of homestead production system in response to climate change.

CHAPTER II

REVIEW OF LITERATURE

Review of literature gives the clear and concise direction of the researcher for conducting the experiment. In this chapter, review of literatures relevant to the objectives of this study was presented. This was mainly concerned with 'adaptation of climate change in homestead production system.

2.1 Concept and importance of homestead

Homestead is a low-cost production system, which can contribute significantly to the house hold economy and food security. The homestead owners themselves consume a large proportion of the products and the rest of the products are sold in the market. The amount of income derived from homesteads is primarily determined by crop composition in the garden although livestock, poultry and fish ponds also contribute a lot. Income derived from homestead range from 0.8percent to 54percent of family's total income (Abdullah *et al.*, 1983).

The homestead systems contribute about 70 percent fruit, 40 percent vegetables, 70 percent timber and 90 percent firewood and bamboo requirement of the country. Due to shortage of agricultural land, homestead agroforestry practice may be a good strategy for survival and existence of the farmers by attaining food and income security (Miah and Hussain, 2001).

Halladay and Gilmour (1995) mentioned that the home gardens have multiple functions in relation to everyday human life and environment and also act as a bridge between all living beings and non-living environment. The main values derived from home garden are foods, energy for domestic use, source of nutrients, fodder for domestic animal, medicinal products, timber for house construction, and a pleasant environment for dwellers.

In the present context of Bangladesh, homestead agroforestry systems are most appropriate for resource poor farmers. They can earn immediate benefits from crops while waiting for long term benefits from trees. A unique combination of different species of fruit, timber and biomass yielding trees can generate high amount of earnings for the farmers of Bangladesh (Abedin *et al.*, 1990).

Hossain (1996) conducted a study which is based on information obtained from a field survey with 120 households in four selected villages in Bangladesh. The study showed that homestead forests were an important resource for the real poor to meet their contingency needs. The forests were facing increasing pressure from alternative uses, but their survival was crucial to the economic and social needs of the rural people, especially the poor.

The homestead enterprises such as vegetables and fruits cultivation, fish culture, forest, poultry rearing etc. can contribute to increased food availability and generate income of the rural farm families (Mazher, 1996).

Hasan *et al.* (2008) found most of the trees in homestead agroforestry system to be traditional varieties with less production potential. So, there is much scope to improve productivity of the system both in the homesteads and in the fields by replacing the existing tree species/varieties with the improved ones, planting trees in planned ways, using suitable tree-crop combination and by improving management practices.

2.2 Land use of homesteads

Haque (1996) reported that the area of the homestead varies from 0.1 to 1.0 ha depending on the locality or on the financial position of the house owner. He also stated that in Bangladesh, the housing occupies about 50-70 percent and 10-25 percent lands of the total area of homesteads in the rural and urban areas, respectively and the remaining space are used for production of trees and vegetables following the principles of agroforestry.

Miah *et al.* (1990) conducted an experiment at Ishurdi in Pabna district revealed that the average size of homestead was very small, and it varied from 0.06 to 0.40 ha). They also found a positive correlation between size of farm and homestead area i.e. homestead area increased with increase of farm size.

2.3. Species composition of homestead

Fernandes and Nair (1990) stated that the magnitude and rate of output of products as well as case and rhythm of maintenance of the home garden system depends on species composition. Though the choice of species is determined to a large extent by

environmental and socio-economic factors, as well as dietary habits and local markets demands.

Karyono (1981) found in a study of West Java home gardens in the Citarum watershed an excess of 500 species in 350 gardens, with Shannon diversity indices of greater than 2.7. In other areas of West Central Java, high species count and species diversities were also the norm, with the diversity indices higher (3.71) in Sundanse than in Javanese (2.79) home garden.

Miah *et al*. (1990) conducted an experiment on preferences of homestead plantation and found that farmers generally prefer fruit trees over fuel/timber species in their homestead.

2.4 Structure of the homesteads

Millat-e-Mustafa (1997) stated that the home gardens displayed a broadly consistent vertical structure throughout the country and many important species are typical in all the regions. The home gardens have a multistoried canopy configuration.

Fernandes and Nair (1990) mentioned that home gardens are characterized by high species diversity and by usually three to four vertical canopy strata, thus indicating the intimacy of plant associations. The layered canopy configuration and compatible species admixture are the most conspicuous characteristic of all home gardens. Contrary to the apparent appearance of random arrangement of species, the gardens are carefully structured systems with every component having a specific place and function.

Perera (1991) distinguished four canopy layers, the tallest being over 10 m of those studied, third layer 2.5-10 m, second layer 1-2.5 m and first layer is less than 1m in Kandyan home garden. In addition, over 70 percent of the Kandyan home gardens in Sri Lanka had 50 percent or more canopy cover. The home garden Agro ecosystem has often been compared to a natural forest ecosystem in structure and function. The stratified nature of the forest is due to the high species diversity and as the forest continuously grows and regenerates and all the species pass through all the growth stages before altering the mature form, the stratification may often become discontinuous.

2.5 Homestead plantation pattern and trends

Alam *et al.* (1996) observed that there were more young trees in the homestead of southern part of Bangladesh which signified a tendency of planting more trees on the homestead during recent years. Similar trend has also been observed by Chowdhury and Satter (1992) in the High Ganges River Floodplain region.

Miah *et al*. (1990) found that farmers generally prefer fruit trees over fuel/timber species in their homesteads.

Islam and Ahmed (1987) found landless, marginal and small farm household to concentrate primarily on vegetable and spices cultivation whole large and medium farm households cultivated more often fruit and timber trees.

2.6 Species richness in homestead

Identification is one of the important parts of plant taxonomy to document and characterized existing homestead plants in the south-western zones. Species richness is not an adequate measure of the biodiversity of organisms. It measures the number of species within an area, giving equal weight to each species (Heywood and Watson, 1995). Bashar (1999) observed wide variety of plant species in the homesteads of Sadar and Kapasia thana of Gazipur district. He found more than 136 useful species among which 44 species were recorded as fruit/food species either perennial or annual, 28 timber species, 15 medicinal, 31 vegetable species and 18 ornamental species.

Hasan (1999) stated that the homesteads in rural Bangladesh are clustered with nearly 25 species of fruit trees and 30 species of timber, fuel wood, and industrial wood trees. These are the habitats, for many herbs, shrubs and creeper species. Thus, homestead is a complex ecosystem and it varies from location to location with minor ecological changes.

Kabir and Edward (2007) investigated the floristic and structural diversity of 402 home gardens from six regions across southwestern Bangladesh. Each region contained a mean of 293 species in a mean of 67 home gardens. A total of 49,478 individuals (107) per home garden and 1003 per hectare of trees and shrubs were counted from 45.2 ha total sampled area.

Kumar (1994) revealed that there was tremendous variability both in number of tree and shrubs present and species diversity of the selected homesteads in different provinces. In total, 127 woody species (girth at breast height more than or equal to 15 cm.) were encountered. The mean number of woody taxa found in the home gardens ranged from 11 to 39.

2.7 Climate variability

Parry *et al.* (1999) mentioned that Climate variability and change are a major threat to food security in many regions of the developing world, which are largely dependent on rain fed and labor-intensive agricultural production. Winters *et al.* (1999) stated that although the issue of food security is directly linked to climate variability and change, it must be noted that climate is not the single determinant of yield, nor is the physical environment the only decisive factor in shaping food security.

McConnell and Moran (2000) mentioned that when conditions in the environment vary (e.g., climate, soil and water characteristics, and land use changes), this can place an additional stress on food production.

Arnell *et al.* (2002); Devereux and Edwards (2004) mentioned that the consensus of scientific opinion is that countries in the temperate, high, and mid-latitude regions are generally likely to enjoy increased agricultural production, whereas countries in tropical and subtropical regions are likely to suffer agricultural losses as a result of climate change in coming decades.

USAID (1992) stated that adequate food utilization is realized when "food is properly used, proper food processing and storage techniques are employed, adequate knowledge of nutrition and child care techniques exists and is applied, and adequate health and sanitation services exist.

2.8 Climate Change

Climate change refers to any change in climate over time, whether natural variability or human activity. This usage differs from that in the United Nations Framework Convention on Climate Change (UNFCCC), where climate change refers to a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable times (Beall, 2002).

Again, Climate change refers to the statistically significant change in the measurements of either the mean state or variability of the climate for a place or region over an extended period of time either directly or indirectly due to the impact of human action on the composition of the global atmosphere or due to natural variability (Asia Society, 2009). When longer term and broader trends cause a shift in the average weather the climate changes. Places that were usually cool become warmer, places that were usually dry get more erratic rain, the intensity and track of cyclone change. IPPC (2007) asserted that the smallholder farmers are hit earliest and hardest by climate change related hazards. The head of the IPCC explains smallholder farmers are especially vulnerable to climate change. They tend to have more limited adaptive capacities, and are more dependent on climate-sensitive resources such as local water and food supplies. Sea level rise will affect the vast coastal area and low-lying river estuary zones of Bangladesh.

2.9 Climate change in the Bangladesh context

Bangladesh is located between $20^{o}34^{/}$ to $26^{o}38^{/}$ North latitude and $88^{o}01^{/}$ to $92^{o}42^{/}$ East longitude. Geologically it is a part of the Bengal basin which has been filled by sediments. Where Climate change hazards like severe floods are taking place frequently; cyclones, tornados are hitting every year; salinity and cold spell claims human lives. These are early signs of global warming effects. Sea level rise in the coming decades will create over 25 million climate refugees (Climate Change Cell, 2007). According to UNFCCC (2005) Bangladesh along with China became the top risked countries in terms of natural disaster in the world.

Ali (1999) identified several dimensions of adaptation of farming practices in Bangladesh where focus on human and ecological systems and socio-economic development activities were linked with the process of farming practices adaptation. They also identified several modes of adaptation and reviewed the Bangladesh context of climate change adaptations included to (i) Bear losses, (ii) Share losses, (iii) Modify threat, (iv) Prevent effects, (v) Change use and (vi) Change location. They suggested that the national level adaptation as well as local level measures of adaptations should be undertaken.

2.10 Adaptation to climate change

Adaptation to climate is the process through which people reduce the adverse effects of climate on their health and well-being and take advantage of the opportunities that their climatic environment provides. It is one of the policy options for reducing the negative impacts of climate changes. It also refers to the degree to which adjustments are possible in practices, processes, or structures of systems to projected or actual changes of climate (BBC, 1998). CEGIS (2005) reported that several socio-economic responses were adopted by the smallholder farmers to adapt with the climatic and associated non-climatic variability. Social responses for adaptation were to foster and enhance the activation of the physical measures of adaptation. Some of the social measures were taken by the smallholder farmers as preparedness activities to taking up adaptation measures. WARPO (2005) identified that the household domain several adaptive practices were found. People took domestic measures for collection of portable water which is a scarce resource in the dry days due to high rate of evapotranspiration. During the sunny heated days of the summer month local people become highly vulnerable to the availability of the safe drinking water as well as water for other basic human uses. For drinking water purposes uses of dug well was observed where the ground water level permitted to dig well.9

Iglesais (2004) reported that the positive and negative effect of the climate change on the Mediterranean rain fed agriculture was analyzed through the prediction of models and changing scenarios. Key question for the assessment of vulnerability and adaptation of farming practices to climate change were discussed. Smith and Skinner (2002) reported that most adaptation options are modifications to on-going farm practices and public policy decision-making processes with respects to a suite of changing climate (including variability and extremes) and non-climatic conditions (political, economic and social). Songcai *et al.*, (2001) worked on investment as an adaptation of farming practices in response to climate change. They concluded that optimized investment taking climate change into consideration effectively reduced the damage due to climate change and promoted the capacity to mitigate damage due to climate variability. ADB (2009) examined the possibilities, opportunities and challenges of adaptation to climate change for the people of Bangladesh. Issues discussed are vulnerability to climate change, response to climate change (Types of adaptation, anticipatory adaptation measures, possible actors and their respective

domains, opportunities for Bangladesh: an assessment; challenges of managing adaptation) and the way ahead. Muller (2009) reported that a practice of retaining water in the *kharies* a natural water storage in a part of canal) was found in the study. These *kharies* were used for retaining water near the crop fields. The *born* rice fully dependent on the irrigation water or the short duration variety of *aus* rice is often cultivated by local people taking water from the *kharies,* canals (locally called *khal)* and ponds.

Bembridge and Williams (1990) studied the personal, sociological, socio-psychological and communication characteristics that influence the adaptation of maize practice in Farmer Support Program in South Africa. The study revealed less than 50 percent of the farmers who adapted practices were implementing them according to recommendations and many did not have a clear concept that the practices were interrelated.

Rahman (2003) revealed that about half (47 percent) of the growers had medium adaptation 44 percent had low and I percent had high adoption of year round homestead fruit cultivation practices.

Adaptation refers to adjustment in systems in response to actual or expected climatic effects, which moderates harm or exploits beneficial opportunities. The main goals of climate change adaptation are to reduce vulnerability and build resilience to the impacts brought by climate change (IPCC, 2007).

Alam *et al*. (2017) stated that adaptation is a key strategy that can alleviate the severity of climate change impacts on agriculture and food production. Adaptation strategies are unlikely to be effective without an understanding of the farmers' perceptions of climate change. This paper explores the local knowledge of adaptation in response to the perceived impacts of climate change and climatic hazards using a survey of 380 resource-poor riverbank erosion-prone households in Bangladesh. The results indicate that the respondents' perceptions of changes in the climate and of extreme climatic events are similar to the observed climate data. Households have recognized the impacts on their livelihood and resources, resulting in an increased sense of vulnerability. To build resilience, households have undertaken a range of farming and non-farming adaptation strategies, which vary significantly among the farming groups. The important adaptation strategies include adopting new crop

varieties, changing planting time, homestead gardening, planting trees and migration. Improved access to finance and to information about appropriate strategies appears to be crucial to support adaptation processes locally and thus to enhance the resilience of vulnerable households.

2.11 Bangladesh, National Adaptation Program of Action (NAPA)

Bangladesh National Adaptation Program of Action (NAPA) has been prepared by the Ministry of Environment and Forest (MOEF, 2005). Policy makers of Government, local representatives of the Government (Union Parishad Chairman and Members), scientific community members of the various research institutes, researchers, academicians, teachers (ranging from primary to tertiary levels), lawyers, doctors, ethnic groups, media, NGO and CBO representatives and indigenous women contributed to the development of the NAPA for Bangladesh. The climate change related vulnerabilities and the future adaptation needs for Bangladesh is placed in the documents. The NAPA final report suggests that the adverse effects of climate stimuli including variability and extreme events in the overall development of Bangladesh are significant and highly related to change in the water sector. Most damaging effects of climate change are floods, salinity intrusion, and droughts that are found to drastically affect crop productivity almost every year. Climate change induced challenges are: (a) Scarcity of fresh water due to less rain and higher evapotranspiration in the dry season (b) drainage congestion due to higher water levels in the confluence with the rise of sea level (c) river bank erosion (d) frequent floods and prolonged and widespread drought (e) wider salinity in the surface, ground and soil in the coastal zone (MOEF, 2002). Low income strength, inadequate infrastructure, low level of social development, lack of institutional capacity and a higher dependency on the natural resources base make the country more vulnerable to climate stimuli include both variability as well as extreme events. Moreover, preparation for this on regular basis will reduce impacts but will not solve the problem. Insurance as a mechanism may be considered for which further analysis is necessary. The NAPA report suggested a number of adaptation measures for Bangladesh to address adverse effects of climate change including variability and extreme events based on existing adaptive mechanisms and practices.

2.12 Relationship between different respondent characteristics and their adaptation process

2.12.1 Age and adaptation

Hamid (1995) conducted a study on adoption of recommended sugarcane cultivation practices by the farmers. He found that age had a significant negative relationship with the adoption of recommended sugarcane cultivation practices.

Chowdhury (1997) observed that the age of the farmers had no significant relationship with their adoption of selected BINA technologies.

Sarkar (1997) observed that there was no significant relationship between age of the farmers and their adoption of improved potato cultivation practices. Rahman (1999) also found similar result in this study.

Rahman (2001) observed that there was no significant relationship between age and adoption of Aalok-6201 hybrid rice cultivation practices. Podder (1999) and Hossain (1999) are found similar results in their respective studies.

Hussen (2001) conducted a study, which concluded that age of the sugarcane growers had a significant negative relationship with their adoption of modern sugarcane cultivation practices.

Islam (2002) found that age of the farmers was not related to their adoption of modern agricultural technologies.

Aurangozeb (2002) conducted a study on adoption of integrated homestead farming technologies by the rural women in RDRS. He found that there was a significant negative relationship between age and adoption of integrated homestead farming Technologies.

Sardar (2002) conducted a study on adoption of IPM practices by the farmers under PETRRA project of RDRS. He found that age of the farmers had a negatively significant relationship with their adoption of IPM practices.

Islam (2003) concluded that the farmers had a positive and significant relationship with their adoption of organic manures.

Hossain (2003) revealed that farm size of the farmers had a significant and positive relationship with their adoption of modern Boro rice cultivation practices.

2.12.2 Education and adaptation

Sarker (1997) conducted a study to determine the relationship between selected characteristics of potato growers and their adoption of improved potato cultivation practices in five villages of Comilla district. He found that education of potato growers had significant relationship with their adoption of improved potato cultivation practices.

Hasan (1996) conducted a study on adoption of some selected agricultural technologies among the farmers perceived by the frontline GO and NGO workers. He observed that education has no significant relationship with the perceived adoption of selected agricultural technologies.

Muttaleb (1995) studied the relationship of education with adoption of improved potato technologies. The study observed that education had a positive relationship with their adoption potato technologies.

Hussen (2001) conducted a study on farmers' knowledge and adoption of modern sugarcane cultivation practices. He found that education of the growers had a positive significant relationship with their adoption of modern sugarcane cultivation practices.

Rahman (2001) conducted a study on knowledge, attitude and adoption of the farmers regarding AaIok-6201 hybrid rice in Sadar upazila in Mymensingh district. He found that academic qualification of the farmers had a significant positive relationship with their adoption regarding Aalok-6201 hybrid rice.

Islam (2002) conducted a study on adoption of modern agricultural technologies by the farmers of Sandwip. He found that education of the farmers had a positive significant relationship with their adoption of modern agricultural technologies.

Sardar (2002) conducted a study on adoption of IPM practices by the farmers under PETRRA project of RDRS. He found that education of the farmers had a positive significant relationship with their adoption of IPM practices.

2.12.3 Knowledge in crop production and adaptation

Sarker (1997) conducted a study to determine the relationship between selected characteristics of potato growers and their adoption of improved potato cultivation practices in five villages of Comilla district. He found that education of potato growers had significant relationship with their adoption of improved potato

cultivation practices. Muttaleb (1995) and Rahman (1995) observed similar results in their respective studies.

2.12.4 Economic benefit and adaptation

Islam (2002) observed that the annual income of the farmers had no relationship with their adoption of modern agricultural technologies.

Chowdhury (1997) found a significant and positive relationship between annual income and adoption of selected BINA technologies. Rahman (1986), Khan (1993), Sarker (1997) observed similar result in their respective studies.

Tolawar and Hirevenkaragouder (1989) studied on factors of adoption of poultry management practices. They revealed that the farmers having high income tend to own bigger size of poultry unit and possess more knowledge of improved practices leading to higher level of adoption.

2.12.5 Innovativeness and adaptation

Rahman (2001) revealed that the highest proportion (63 percent) at the farmers had low innovations as compared to 22 percent medium innovativeness and 15 percent very low innovativeness.

Aurangozeb (2002) observed that there was significant relationship between innovativeness and adoption of integrated homestead farming technologies.

Islam (2002) conducted a research study on adoption of modern agricultural technologies by the farmers of Sandwip. He found that innovativeness of the farmers had significant and positive relationship with their adoption of modern agricultural technologies.

Hossain (1999) found a positive significant relationship between innovativeness of the farmers and their adoption of fertilizer and also observed no relationship with adoption of pesticides.

2.12.6 Land possession and adaptation

Rahman (2001) conducted a study on knowledge, attitude and adoption of the farmers regarding Aalok 6201 hybrid rice in Sadar upazila of Mymensingh district. He found that farm size of the farmers had a significant and positive relationship with their adoption regarding Aalok 6201 hybrid rice.

Aurangozeb (2002) conducted a study on adoption of integrated homestead farming technologies by the rural women in RDRS. He found that there was no relationship between homestead area and adoption of integrated homestead farming technologies.

2.12.7 Training and adaptation

Islam (2002) found that agricultural training exposure of the farmers had no significant relationship with their adoption of ecological agricultural practices. Again Rahman (2001) observed that training received of the farmers had a significant and positive relationship with their adoption regarding hybrid rice.

2.12.8 Communication behavior and adaptation

Islam (2002) conducted a study on adoption of modern agricultural technologies by the farmers of Sandwip. He found that extension media, contact of the farmers had no significant relationship with their adoption of modern agricultural technologies.

Aurangozeb (2002) conducted a study on adoption of integrated homestead farming technologies by the rural women in RDRS. He found that there was a positive significant relationship between contact with extension media of the respondents and their adoption of integrated homestead farming technologies.

Nahar (1996) found that there was a significant positive relationship in agricultural knowledge on farm women in homestead farming and their level of contact with information sources.

CHAPTER III

MATERIALS AND METHODS

This chapter deals with the procedures for the collection of valid information as well as procedure of data coding and also data analysis. For conduction a research work smoothly, proper methodology is an obligatory one and it is very difficult to address the study objectives with a scientific manner without a define methodology. A sequential description of the methodologies that was followed in conducting this research work has been presented in this chapter under the following headings-

3.1 Locale of the study

The study was conducted in the Malshi, Horgage, Patilapara, Nogao and Kaunnara village of Saturia upazila; Shidhunagar, Shridhornagar, Pohela, Kushta, Baliakhura village under Ghior upazila; Krishnapur, Rajibpur, Mokimpur, Gajipara, Moddho Krishnapur village under sadar upazila of Manikgonj district. These 15 villages which was selected purposively as the study area. Thus, through multistage random sampling method locale of the study was selected. Maps of Manikgonj district showing area of Saturia, Ghior and Manikgonj sadar upazila are presented in Figure 3.1.1.

3.2 Sample size

The household owners of Saturia, Ghior and Manikgonj sadar upazila under Manikgonj district constituted the population of the study. An update list of household owners was collected from the union parishad of these respective villages. Randomly 5 number of homestead owners from 15 villages of 3 upazilas were selected as the sample of the study by using random sampling method. Thus, 75 household owners constituted the sample of the study. A reserve list of 15 household owners was also prepared by the same method so that the respondents of this list could be used for interview if the respondents included in the original sample were not available at the time of conduction of interview.

Figure 3.1.1 A map of Manikgonj district showing Saturia, Ghior and Manikgonj Sadar upazila as study area

3.3 The research instrument

A well-structured interview schedule was developed based on objectives of the study for collecting information with containing direct and simple questions in open form and close form keeping in view the dependent and independent variables. Appropriate scales were developed to measure both independent and dependent variables.

The questionnaire was pre-tested with 5 homestead owners in actual situation before finalized it for collection of data. Necessary corrections, additions, alternations, rearrangements and adjustments were made in the interview schedule based on pretest experience. The questionnaire was then multiplied by printing in its final form. A copy of the interview schedule is presented into Appendix I.

3.4 Data collection procedure

The researcher herself collected the data from the sample respondents through personal contact with the help a pre-tested interview schedule. Whenever any respondent faced difficulty in understanding questions, more attention was taken to explain the same with a view to enabling the respondent's homestead owners to answer properly. No serious problem was faced by the investigator during data collection but obtained cooperation from the respondents. Data collection was started in 10 January, 2018 and completed in 28 January, 2018.

3.5 Measurement of variables

The variable is a characteristic, which can assume varying, or different values in successive individual cases. A research work usually contains at least two important variables viz. independent and dependent variables. An independent variable is that factor which is manipulated by the researcher in his 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). In the scientific research, the selection and measurement of variable constitute a significant task. Following this conception, the researcher reviewed literature to widen this understanding about the natures and scopes of the variables relevant to this research. At last he had selected 11 independent variables and one dependent variable. The independent variables were: age, level of education, family size, farm size, annual Income, organizational

participation, communication exposure, years of homestead production experiences, knowledge in homestead production system, usefulness of training for climate adaptive homestead production system and problem confrontation in homestead production due to climate change. The dependent variable of this study was the 'Climate Change Adaptation to Homestead Production Systems in Manikgonj District of Bangladesh'. The methods and procedures in measuring these variables are presented below:

3.6 Measurement of independent variables

The 11 characteristics of the household owners mentioned above constitute the independent variables of this study. The following procedures were followed for measuring the independent variables.

3.6.1 Age

Age of the respondent homestead owners was measured by the period of time from their birth to interview and it was measured in terms of complete years on the basis of their response. A score of one (1) was assigned for each year age. If a homestead owner was 45 years old his age score was assigned as 45.

3.6.2 Level of education

Level of education was measured in terms of class passed by respondent homestead owner. If a respondent received education from the school, their education was assessed in terms of year of schooling, i.e. one score was given for one year of schooling. For example, if the respondent of a homestead owner passed the final examination of class V, their education score was taken as 5. If the respondent had education outside school and the level of education was equivalent to class V of the school than his education score was taken as 5. Each illiterate person was given a score of zero.

3.6.3 Family size

The family size of a respondent of homestead owner was measured in terms of actual number of members in his family including himself, spouse, children, brothers, sisters, parents and other person who jointly live and ate together during the period of interviewing.

3.6.4 Farm Size

Farm size of respondent homestead owner referred to the total area of land on which his family carried out farming operation and received full benefit for his family.

It was measured in hectares for each respondent using the following formula:

$$FS = A + B + {}^{1}/_{2} (C + D) + E$$

Where,

FS = Farm size

A = Homestead area with pond

B = Own land under own cultivation

C = Area taken by a respondent from others on borga system

D = Area given by a respondent from others on borga system

E = Cultivated area taken as lease by respondent from other

3.6.5 Annual income

The term annual income refers to the annual gross income of respondent's homestead owner and the members of his family from different sources. It was expressed in taka. In measuring this variable, total earning in taka of an individual respondent was converted into score. A score of one was given for every one thousand taka. The method of ascertaining income form involved two phases. Firstly, the income from agricultural sector like the income from crops, livestock, poultry and fishery in the preceding year was noted and converted into taka. Secondly, non-agricultural sector income included earning form small business, service, other family members' income, day labourer, fishing and others if any.

3.6.6 Organizational participation

Organizational participation of respondent homestead owner was measured on the basis of the nature of their participation in a selected organization. Score was computed by adding all the score of selected organization.

Following scores were assigned for nature of participation (N):

Nature of participation	Scores assigned
No participation	0
Participation as ordinary member	1
Participation as executive member	2
Participation as president/secretary	3

The nature of participation seems ranged from 0 to 3, where, 0 indicated no participation and 3 indicated very high nature of participation.

3.6.7 Communication exposure

Communication exposure of respondents' homestead owner was measured by computing a 'communication exposure score' on the basis of their frequency of contact with 20 selected information sources within a given time frame. The selected homestead owner was asked to mention the frequency of contact with each of the 20 selected information sources and their responses were assigned weights in the following manner. Thus, the communication exposure seems ranged from 0 to 80, where, 0 indicated no communication exposure and 80 indicated very high communication exposure. Scoring of communication exposure is shown as follows.

Scoring of communication exposure

Sl.	Communication media	Basis of score on communication frequency (time)				
		0	1	2	3	4
1	SAAO[1] (Quarterly)	≠ 1 time	1 time	2 times	3 times	4 or more
2	UAO[2]/AAO[3]/AEO[4] (half yearly)	≠ 1 time	1 time	2 times	3 times	4 or more
3	Neighbour (monthly)	≠ 1 time	1-2 times	2-3 times	5-6 times	7 or more
4	Friends (monthly)	≠ 1 time	1-2 times	3-4 times	5-6 times	7 or more
5	Relatives (monthly)	≠ 1 time	1-2 times	3-4 times	5-6 times	7 or more
6	Experienced farmer (monthly)	≠ 1 time	1-2 times	3-4 times	5-6 times	7 or more
7	Model farmer (monthly)	≠ 1 time	1-2 times	3-4 times	5-6 times	7 or more
8	Agri-inputs dealer (Quarterly)	≠ 1 time	1 time	2 times	3 times	4 or more

Scoring of communication exposure (cont'd)

9	Dev. worker (Quarterly)	≠ 1 time	1 time	2 times	3 times	4 or more
10	Group discussion mtg. (yearly)	≠ 1 time	1 time	4-7 times	8-11 times	12 or more
11	Result demo.[5]/Field days (half yearly)	≠ 1 time	1 time	2-3 times	4-5 times	6 or more
12	Method demo.[5] (half yearly)	≠ 1 time	1 time	2-3 times	4-5 times	6 or more
13	News paper (weekly)	≠ 1 time	1-2 times	2-3 times	5-6 times	7 or more
14	Agricultural poster (half yearly)	≠ 1 time	1 time	2 times	3 times	4 or more
15	Agricultural leaflet (yearly)	≠ 1 time	1 time	2 times	3 times	4 or more
16	Agricultural booklet (yearly)	≠ 1 time	1 time	2 times	3 times	4 or more
17	Agri-Magazine/periodics; yearly	≠ 1 time	1 time	2 times	3 times	4 or more
18	Agril. Fair (yearly)	≠ 1 time	1 time	2 times	3 times	4 or more
19	Agril. Radio program(monthly)	≠ 1 time	1-7 times	8-14 time	15-20 times	21 or more
20	Agril. TV program (monthly)	≠ 1 time	1 time	2 times	3 times	4 or more

[1]SAAO= Sub Asst Agri Officer; [2]UAO= Upazila Agri. Officer; [3]AAO= Addl. Agri. Officer; [4]AEO= Agri. Extension Officer; [5]Demo. =Demonstration

3.6.8 Years of homestead production experiences

Years of homestead production experiences of a respondent homestead owner was determined by the total number of years has been involved in homestead production. A score of one (1) was assigned for each year experiences. Data obtained in response to item number 8 of the interview schedule. Scoring was done according to survey results and was categorized into 3 levels as no, low, medium and high homestead production experiences.

3.6.9 Knowledge on homestead production system

Knowledge of the homestead owners in homestead production system referred to the knowledge gained by the respondent in the different aspects of homestead production. Twenty (20) questions on different aspect of homestead production were asked to the respondents to ascertain their knowledge score. The score was assigned as 2 for full correct answer and zero (0) for incorrect or no answer for each question. Partial score 1 was assigned for partial answers. Thus, knowledge on homestead production scores

of the respondents could range from 0 to 40, where, zero (0) indicated no knowledge and 40 indicated very high knowledge in homestead production system.

3.6.10 Usefulness of training for climate adaptive homestead production system

Usefulness of training for climate adaptive homestead production system of respondent household owners was measured on the basis of degree of usefulness of the subject taught during training. Score was computed by adding all the score of training that they received on selected homestead production system. Usefulness of training was calculated using the following formula:

$$\frac{\sum D \times T}{N}$$

Where,

D = Degree of usefulness

T = No. of days for training

N = No. of subjected taught

Suppose, a homestead owner was obtained high score of 24 from six selected subject from total 6 days of training duration and his usefulness of training score would be $24 \times 6/6 = 24$.

Following scores were assigned for degree of usefulness (D):

Degree of usefulness	Scores assigned
Very low	1
Low	2
Medium	3
High	4

The duration of training (T) for the specific subject of training and its degree of usefulness (D) for a homestead owner was obtained by using the following formula:

Usefulness of training score = $\sum\{(N) \times (T) \times (D)\}$

Where,

N = Subject of training

T = Duration of training

D = Degree of usefulness of different training

3.6.11 Problem confrontation in homestead production due to climate change

Problem confrontation in homestead production due to climate change was measured by computing severity of problems in homestead production. Degree of severity of problem was computed in the following way:

Level of the problem	Weights assigned
High	4
Medium	3
Low	2
Very low	1

Degrees of severity of all problems were summated and classified accordingly.

3.7 Measurement of dependent variable

Climate change adaptation to homestead production system by the household owners was measured by using adaptation quotient (AQ). The procedure of AQ calculation is stated below:

1. A list of homestead production source species as type of vegetables, fruits, species, trees and animals was made first (30).
2. Land allocated for these production sources of each species was assessed for successive years of 2007-2010, 2011-2014 and 2015-2017 (l).
3. Potential land for production of each sources was assessed (L).
4. The average land allotted was calculated (l/L).
5. Total average land allotted for all the listed production sources = $\sum \overline{x}$
6. Adoption of homestead production component $\frac{\sum \overline{x}}{30} \times 100$

3.8 Hypothesis of the study

In the present study the following null hypotheses were formulated:

“There are no relationships between each of 11 selected characteristics of the homestead owners and their ‘Climate Change Adaptation to Homestead Production Systems.’

3.9 Data processing

For data processing and analysis, the following steps followed:

3.9.1 Compilation of data

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

3.9.2 Categorization of respondents

For describing the various independent and dependent variables the respondents were classified into various categories. In developing categories, the researcher was guided by the nature of data and general consideration prevailing on the social system. The procedures have been discussed while describing the variable in the sub-sequent sections of next chapter.

3.10 Data analysis

Data collected from the respondents were complied, coded, tabulated and analyzed in accordance with the objectives of the study. Various statistical measures such as frequency counts, percentage distribution, average, and standard deviation were used in describing data. SPSS (version 17.5) computer program were used for analyzing the data. The categories and tables were used in describing data. The categories and tables were also used in presenting data for better understanding.

For determining the association of the selected characteristics of the homestead owners with their climate change adaptation to homestead production systems, Pearson Product Moment Correlation was used. Five percent (0.05) level of probability was used as the basis for rejecting any null hypothesis. In order to find out the relationship between the selected dependent and independent variables correlation co-efficient was done.

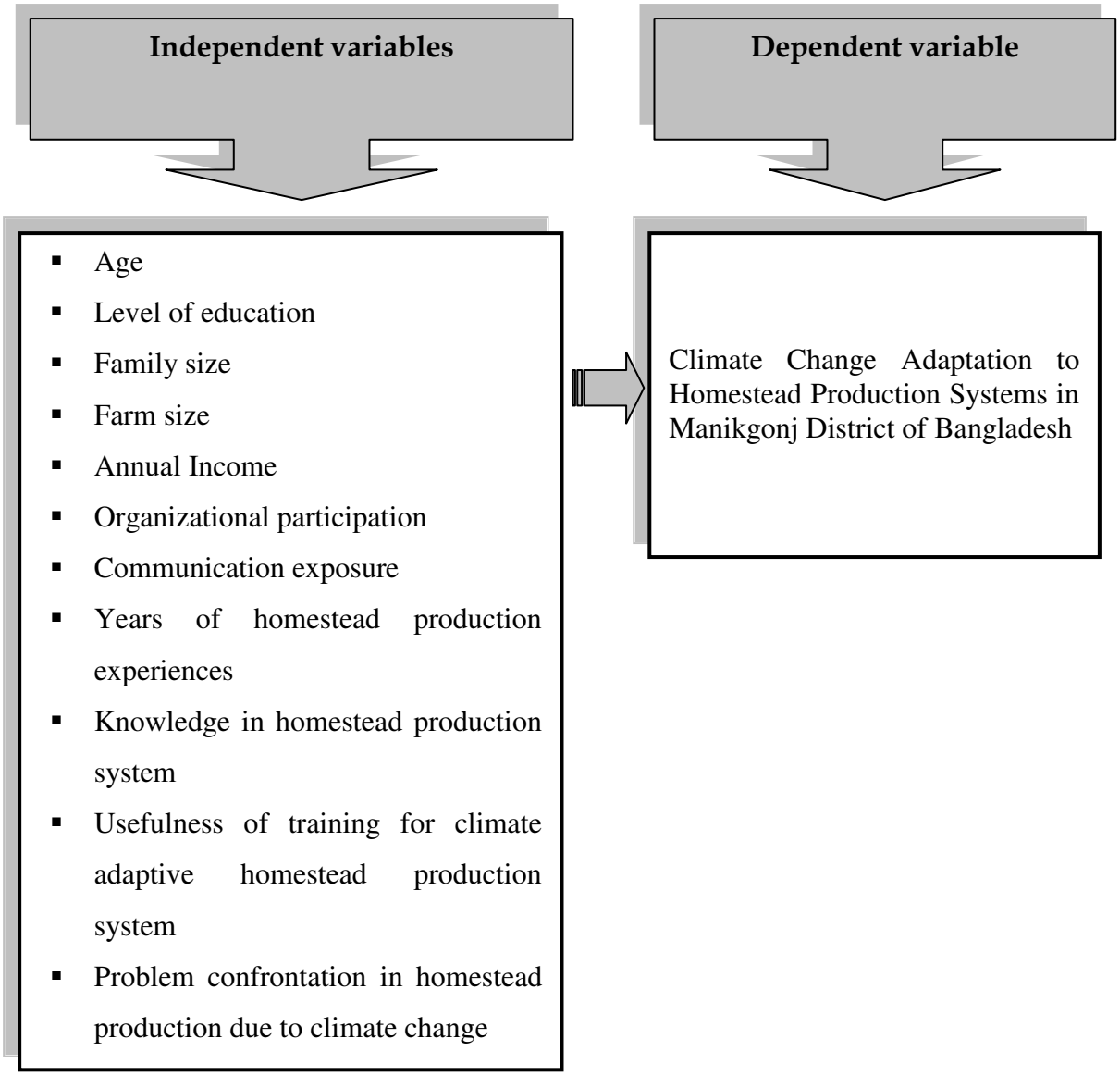
3.11 Conceptual framework of the study

In scientific research, selection and measurement of variables constitute an important task. The hypothesis of a research while constructed properly consist at least two important elements i.e. a dependent variable and an independent variable. A dependent variable is that factor which appears, disappears or varies as the researcher introduces, removes or varies the independent variables (Townsend, 1953). An independent variable is that factor which is manipulated by the researcher in his attempt to ascertain its relationship to an observed phenomenon. Variables together are the causes and the phenomenon is effect and thus, there is cause effect relationship everywhere in the universe for a specific events or issues.

This study is concerned with the 'Climate Change Adaptation to Homestead Production Systems in Manikgonj District of Bangladesh'. Thus, the climate change adoption to homestead production system by the household owners of Saturia, Ghior and Manikgonj Sadar upazila of Manikgonj district was the dependent variable and 11 selected characteristics of the homestead owners were considered as the independent variables. Adoption of climate change by the household owners in homestead production system may be affected through interacting forces of many independent variables. It is not possible to deal with all of the independent variables in a single study. It was therefore, necessary to limit the independent variables, which include age, level of education, family size, farm size, annual Income, organizational participation, communication exposure, years of homestead production experiences, knowledge in homestead production system, usefulness of training for climate adaptive homestead production system and problem confrontation in homestead production due to climate change for this study.

Considering aforesaid discussion, a conceptual framework has been developed for this study, which is diagrammatically presented on the following page.

The conceptual framework of the study



CHAPTER IV

RESULTS AND DISCUSSION

The recorded observations in accordance with the objective of the study were presented and discussion was made with justifiable and relevant interpretation under this chapter in three sections. The first section deals with the characteristics of the homestead growers. The second section deals with the climate change adaptation in the study area. The third section deals with the contribution between individual characteristics of the homestead owners with their climate change adaptation to homestead production systems.

4.1 Characteristics of the homestead owners

For assess the climate change adaptation to homestead production systems by the homestead owners, various interrelated characteristics were collected under the present study. It was therefore, hypothesized that the characteristics of the homestead owners correlated with their climate change adaptation to homestead production systems. However, the 11 selected salient features of the homestead owners such as age, level of education, family size, farm size, annual income, organizational participation, communication exposure, years of homestead production experiences, knowledge in homestead production system, usefulness of training for climate adaptive homestead production system and problem confrontation in homestead production due to climate change that might be greatly influences the climate change adaptation to homestead production systems by the homestead owners are presented below:

4.1.1 Age

The age of the homestead owners has been varied from 22 to 68 years with a mean and standard deviation of 40.57 and 11.54, respectively. Age of homestead owners were classified into three categories namely ‘young’, ‘middle’ and ‘old’ aged following Rashid *et al.* (2014). The distribution of the homestead owners in accordance of their age are presented in Table 4.1.1.1.

Table 4.1.1.1 Distribution of the homestead owners according to their age

Category	Range (Years)		Homestead owners (Respondents')		Mean	Standard deviation
	Score	Observed	Number	Percent		
Young aged	Up to 35	22-68	29	38.67	40.57	11.54
Middle aged	36-50		32	42.67		
Old aged	Above 50		14	18.67		
Total			75	100		

From Table 4.1.1.1 it was revealed that the middle-aged homestead owners comprised the highest proportion (42.67 percent) followed by young aged category (38.67 percent) and the lowest proportion were made by the old aged category (18.67 percent). Data also indicates that the middle and young aged respondents constitute almost 81 percent of total. The young and middle-aged respondents were generally more involved in homestead production system than the older

4.1.2 Level of education

The level of educational scores of the homestead owners ranged from 0 to 14 with a mean and standard deviation of 6.81 and 4.03, respectively. Based on the educational scores, the respondents were classified into five categories such as 'can't read of sign' (0), 'can sign only' (0.5), 'primary education' (1 to 5), 'secondary education' (6 to 10), above secondary (above 10). The distributions of the respondents according to their level of education are presented in Table 4.1.2.1.

Table 4.1.2.1 Distribution of the respondents' according to their level of education

Category	Range(School years)		Respondents'		Mean	Standard deviation
	Score	Observed	Number	Percent		
Can't read and sign	0	0-14	5	6.67	6.81	4.03
Can sign only	0.5		7	9.33		
Primary education	1-5		19	25.33		
Secondary education	6-10		32	42.67		
Above secondary	>10		12	16.00		
Total			75	100		

Table 4.1.2.1 shows that respondents under secondary education category constitute the highest proportion (42.67 percent) followed by primary education (25.33 percent),

above secondary (16.00 percent) and can sign only category (9.33 percent). The lowest respondents (6.67 percent) are in the category of can't read and sign. Education broadens the horizon of outlook of homestead owners and expands their capability to analyze any situation related to climate adaptive technology of homestead production. An educated homestead owner is likely to be more responsive to the modern facts and ideas of homestead production system. To adjust with the same, they would be progressive minded to adapt with modern climate adaptive technology of homestead production.

4.1.3 Family size

Family size of the respondent homestead owners ranged from 2 to 9 with the mean and standard deviation of 4.84 and 1.68, respectively. According to family size the respondents were classified into three categories viz. 'small', 'medium' and 'large' family. The distribution of the respondents according to their family size is presented in Table 4.1.3.1.

Table 4.1.3.1 Distribution of the respondents' according to their family size

Category	Range (Number)		Respondents'		Mean	Standard deviation
	Score	Observed	Number	Percent		
Small family	Up to 3	2-9	16	21.33	4.84	1.68
Medium family	4-6		45	60.00		
Large family	Above 6		14	18.67		
Total			75	100		

Data in Table 4.1.3.1 indicate that the medium size family constitute the highest proportion (60.00 percent) followed by the small size family (21.33 percent). Only 18.67 percent respondents had large family size. Such finding is quite normal as per the situation of Bangladesh. The findings from Table 4.1.3.1 indicated that average family size of the study area was similar with the national average which is 4.85 (BBS, 2014).

4.1.4 Farm size

The farm size of the respondent's homestead owners ranged from 0.12 ha to 2.65 ha with a mean and standard deviation of 0.91 and 0.58, respectively. Based on their farm size, the respondents were classified into three categories following the categorization of DAE. These categories were marginal farm holder (up to 0.2 ha),

small farm holder (0.201 to 1.0 ha) and medium farm holder (1.01 ha to 3.0 ha). The distribution of the homestead owners according to their farm size is presented in Table 4.1.4.1.

Table 4.1.4.1 Distribution of the respondents' according to their farm size

Category	Range (Hectare-ha)		Respondents'		Mean	Standard deviation
	Score	Observed	Number	Percent		
Marginal	Up to 0.2 ha	0.12-2.65 ha	3	4.05	0.91	0.58
Small	0.201-1.0 ha		43	58.11		
Medium	1.01 to 3.0 ha		28	37.84		
Total			75	100		

Table 4.1.4.1 indicates that the small farm holder constitutes the highest proportion (58.11 percent) followed by medium farm holder (37.84 percent), while the lowest 4.05 percent marginal farm holder. The findings of the study reveal that majority of the homestead owners were small to medium sized farm holder. The average farm size of the homestead owners of the study area (0.91 ha) was higher than that of national average (0.60 ha) of Bangladesh (BBS, 2014). The farmer with marginal farm size has very little scope to experiment about new technologies as their earnings depend on mainly in agriculture.

4.1.5 Annual income

Annual income of the respondent homestead owners ranged from 54 to 224 thousand taka with a mean and standard deviation of 103.37 and 34.22, respectively. Based on annual income, the homestead owners were classified into three categories, viz. low, medium and high annual income. The distribution of the homestead owners according to annual income are presented in Table 4.1.5.1.

Table 4.1.5.1 Distribution of the respondents' according to their annual income

Category	Range ('000 Taka)		Respondents'		Mean	Standard deviation
	Score	Observed	Number	Percent		
Low income	Up to 70	54-224	5	6.67	103.37	34.22
Medium income	71-140		56	74.67		
High income	Above 140		14	18.67		
Total			75	100		

Data revealed that the homestead owners having medium annual income constitute

the highest proportion (74.67 percent), while the lowest proportion in low income (6.67 percent) followed by high income (18.67 percent). Overwhelming majority (81 percent) homestead owners have low to medium level annual income.

4.1.6 Organizational participation

Organizational participation score of the homestead owners ranged from 10 to 25 with a mean and standard deviation of 16.11 and 3.89, respectively. Based on their organizational participation score, the respondent homestead owners were classified into three categories as low, medium and high participation. The distribution of the homestead owners as per their organizational participation is presented in Table 4.1.6.1.

Table 4.1.6.1 Distribution of respondents' as of their organizational participation

Category	Range		Respondents'		Mean	Standard deviation
	Score	Observed	Number	Percent		
Low participation	Up to 13	10-25	22	29.33	16.11	3.89
Medium participation	14-20		43	57.33		
High participation	Above 20		10	13.33		
Total			75	100		

Data revealed that the highest proportion (57.33 percent) of the respondents had medium organizational participation, while 29.33 percent had low organizational participation and the lowest 13.33 percent had high organizational participation.

4.1.7 Communication exposure

Communication exposure score of the respondent ranged from 17 to 50 with a mean and standard deviation of 35.63 and 9.52, respectively. Based on the communication exposure score, the respondents were classified into three categories as 'low', 'medium' and 'high' exposure. The distribution of the homestead owners according to their communication exposure is presented in Table 4.1.7.1.

Table 4.1.7.1 Distribution of the respondents' according to their communication exposure

Category	Range		Respondents'		Mean	Standard deviation
	Score	Observed	Number	Percent		
Low exposure	Up to 24	17-50	17	22.67	35.63	9.52
Medium exposure	25-43		39	52.00		
High exposure	>43		19	25.33		
Total			108	100		

Table 4.1.7.1 indicates that the highest proportion (52.00 percent) of the respondents had medium communication exposure compared to 25.33 percent in high communication exposure category and the lowest proportion (22.67 percent) had low communication exposure.

4.1.8 Years of homestead production experiences

Years of homestead production experience of the respondent homestead owners could range from 5 to 50 with mean and standard deviation of 20.13 and 10.61, respectively. On the basis of years of homestead production experience scores, the respondents homestead owners were classified into three categories namely, 'low, 'medium' and 'high' experience. The distribution of the respondent's homestead owners according to their years of homestead production experience is given in Table 4.1.8.1

Table 4.1.8.1 Distribution of the respondents' according to their farming experiences

Category	Range (Years)		Respondents'		Mean	Standard deviation
	Score	Observed	Number	Percent		
Low experience	Upto 10	5-50	10	13.33	20.13	10.61
Medium experience	11-35		57	76.00		
High experience	>35		8	10.67		
Total			75	100		

Data of Table 4.1.8.1 reveals that the majority (76.00 percent) of the respondents fell in medium years of homestead production experience category, whereas only 10.67 percent in high experience category followed by 13.33 percent in low experience category. The findings of the present study reveal that around 90 percent of the respondent homestead owners in the study area had low to medium years of homestead production experience.

4.1.9 Knowledge on homestead production system

Knowledge on homestead production system scores of the homestead owners varied from 10 to 25 with the mean and standard deviation of 16.68 and 4.00, respectively. On the basis of knowledge on homestead production system scores, the respondents were classified into three categories namely, 'low, 'medium' and 'high' knowledge. The distribution of the respondents according to their knowledge on homestead production system is given in Table 4.1.9.1.

Table 4.1.9.1 Distribution of the respondents' according to their knowledge on homestead production system

Category	Range		Respondents'		Mean	Standard deviation
	Score	Observed	Number	Percent		
Low knowledge	Upto 15	10-25	29	38.67	16.68	4.00
Medium knowledge	15-20		30	40.00		
High knowledge	>20		16	21.33		
Total			75	100		

Table 4.1.9.1 revealed that the majority (40.00 percent) of the homestead owners fell in medium knowledge category followed by 38.67 percent in low knowledge category, whereas the lowest is 21.33 percent in high knowledge category. The findings of the present study reveal that around 79 percent of the homestead owners had low to medium knowledge on homestead production system.

4.1.10 Usefulness of training for climate adaptive homestead production system

Usefulness of training for climate adaptive homestead production system score of the respondent ranged from 0 to 22 with a mean and standard deviation of 11.20 and 5.60, respectively. Based on the usefulness of training for climate adaptive homestead production system score, the respondents were classified into four categories as 'no training', 'low' and 'medium' and 'high' level usefulness. The distribution of the homestead owners according to their usefulness of training for climate adaptive homestead production system is presented in Table 4.1.10.1

Table 4.1.10.1 Distribution of the respondents' according to usefulness of training for climate adaptive homestead production system

Category	Range (days)		Respondents'		Mean	Standard deviation
	Score	Observed	Number	Percent		
No training	0	0-18	15	20.00	8.80	5.65
Low exposure	Up to 8		22	29.33		
Medium exposure	9-12		20	26.67		
High exposure	>12		18	24.00		
Total			75	100		

Table 4.1.10.1 indicates that the highest proportion (29.33 percent) of the respondents had low usefulness of training for climate adaptive homestead production system followed by 26.67 percent in medium usefulness and 24.00 percent in high training usefulness category, respectively and the lowest proportion (20.00 percent) had no

training. Training makes anyone skilled and helps them to acquire knowledge on respected subject. Trained person can face any kind of challenges about the adverse situation in different production system. So, they show positive attitude towards climate change adaptation to homestead production systems.

4.1.11 Problem confrontation in homestead production

The scores of problem confrontation in homestead production of the homestead owners ranged from 10 to 24 with an average of 16.23 and standard deviation of 4.47. Based on the observed individual scores, the respondents were classified into the three categories i.e. low, medium and high problem confrontation in homestead production. The distribution has been shown in the Table 4.1.11.1.

Table 4.1.11.1 Distribution of the respondents' according to their problems confrontation in homestead production

Category	Range (days)		Respondents'		Mean	Standard deviation
	Score	Observed	Number	Percent		
Low confrontation	Up to 15	10-24	32	42.67	16.23	4.47
Medium confrontation	16-20		23	30.67		
High confrontation	>20		20	26.67		
Total			75	100		

The highest (about 42.67 percent) of the respondents faced low problem confrontation in homestead production, while 26.67 percent faced high problem confrontation followed by 30.67 percent faced medium problem confrontation in homestead production.

4.2 Climate change and adaptation in the study area

4.2.1 Change of temperature, rainfall and Humidity

Temperature is a vital element of climate. During 2007-2016, mean maximum temperature of Manikgonj district shows slightly increasing trend (Figure 4.2.1.1). The maximum temperature reached 36.8 ^{0}C. R^2 value is found to be 0.002 which does not indicate significant increase of present mean temperature.

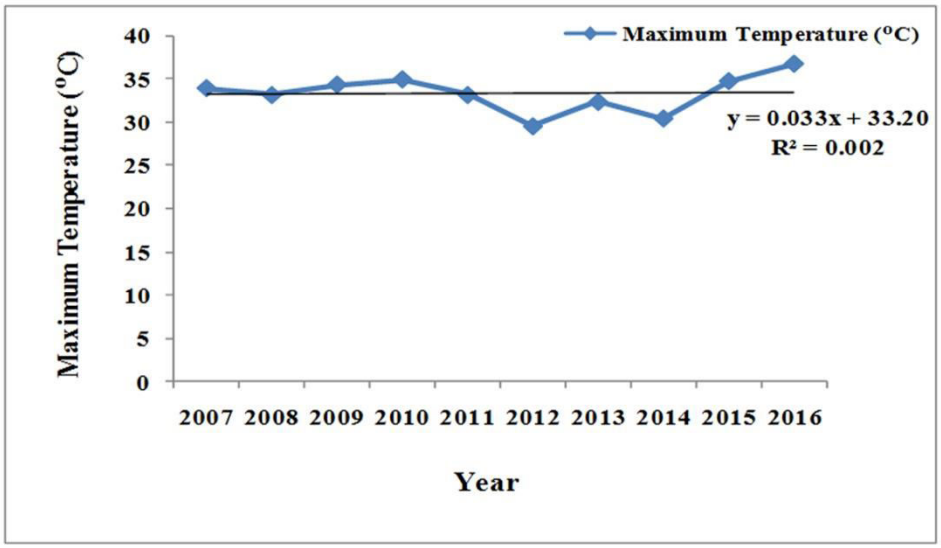


Figure 4.2.1.1 Mean maximum temperature (2007-2016) in the study area

The minimum temperature shows increasing trend (Figure 4.2.1.2). The minimum temperature reached 11^0C in 2007. The R^2 value is found to be 0.183 which indicates significant increase in the study area.

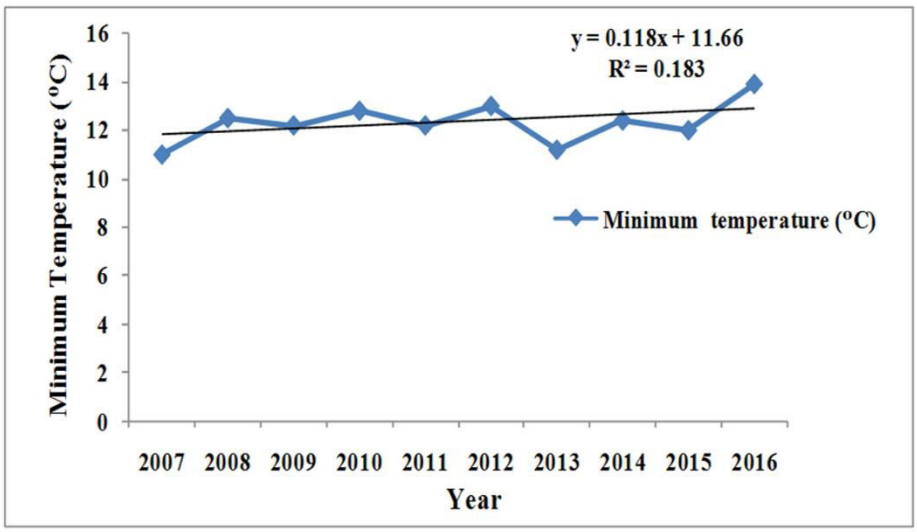


Figure 4.2.1.2 Mean minimum temperature (2007-2016) in the study area

Rainfall is also a vital element of climate which changed during 2007-2016 (Figure 4.2.1.3). The average rainfall was recorded in 2008 (2197 mm) in the study area. The lowest peak average rainfall was 1181mm in the year 2009. R^2 value was 0.02 which indicates insignificant decrease of the average rainfall.

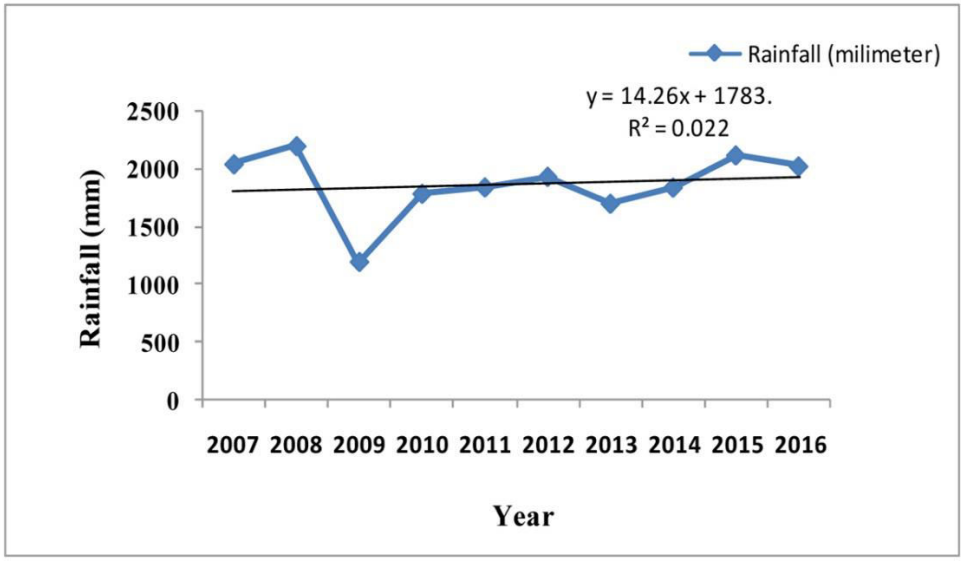


Figure 4.2.1.3 Average rainfall (2007-2016) in the study area

During 2007-2016 mean maximum humidity of Manikgonj district shows slightly decreasing trend. The maximum humidity reached 73 (%) in 2007 and lowest in 2011 (Figure 4.2.1.4). R^2 value is found to be 0.174 which indicate significant increase of present mean humidity.

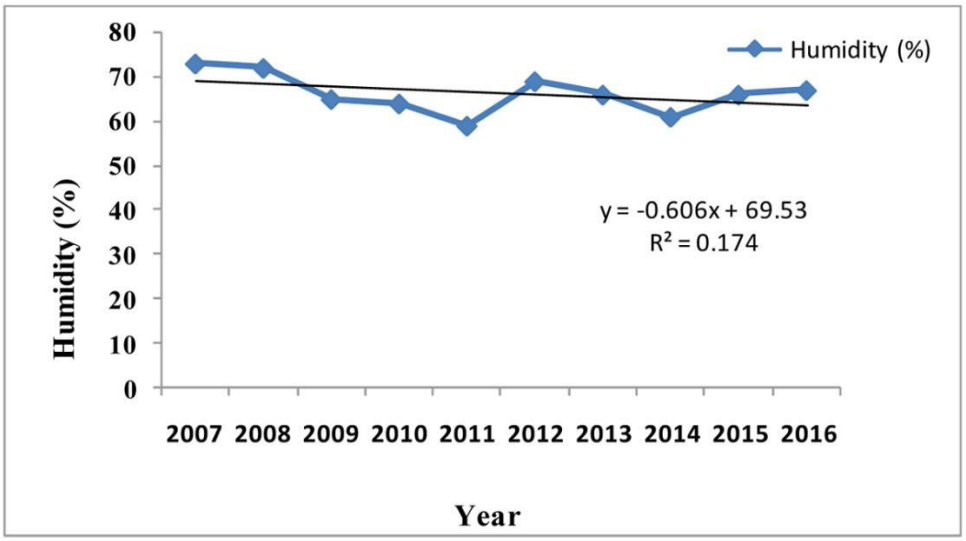


Figure 4.2.1.4 Average humidity (2007-2016) in the study area

4.2.2 Different types of hazard occurred at present and 10 years ago

In the present situation different types hazards occurred in the study area namely flood, thunderstorm and insect infestation are presented in Table 4.2.2.1 All of the respondents (100%) cited that flood is the most terrific type hazard. Tornado was the second devastating type according to the 80% respondent's opinion. Insect infestation

(76%) also became serious hazard due to climate change followed by heat wave (72%) on the basis of respondent's opinion (Table 4.2.2.1).

Table 4.2.2.1 Different types of natural hazards occurred at present in the study area

Name of the Hazards	Citation No.	Percentage
Flood	50	100
Thunderstorm	40	80
Tornado	22	44
Heat wave	38	76
Insect infestation	32	72

According to the opinion of the respondent's flood was also the predominant type of hazard in the past (Table 4.2.2.2). The ruinous nature of tornado, thunderstorm, heat waves and insect infestation were not as much of present time. But, the damaging nature of tornado was more in the past. Some respondents said that, they actually forgot in some of the past-occurring hazards and others told, many times two or more types of hazard worked together and they did not identify clearly.

Table 4.2.2.2 Different types of natural hazards occurred at past in the study area

Name of the Hazards	Citation No.	Percentage
Flood	50	100
Thunderstorm	12	24
Tornado	32	64
Heat wave	28	56
Insect infestation	18	36

4.2.3 Farmers perceptions on experiencing climate change

All of the respondents were asked a dichotomous question about whether or not they had experienced changes to regional climate within the previous years. After their initial response, they were asked about their perceived experience in relation to a series of climatic events. Table 4.2.3.1 reports their responses for individual climatic events. Here, all respondents indicated that they had experienced increases in temperature, rain fall, flood, tornado and thunderstorm. 100% respondents said that temperature was increased and 90% mentioned that flood and tornado were also increased than past 10 years. According to the respondents both summer and winter season was decreased and rainy season increased. Across all events, at least 85% or

more reported having experienced climatic shifts which are likely to have a negative impact on agricultural activity.

Saha (2016) found that the climatic variability, cyclone intensity, intensity of storm surges and temperature were increased. About 30 percent of the respondents said that the climatic variability was increased. About 30 percent of the respondents said that, cyclone intensity and intensity of storm surges were increased.

Table 4.2.3.1 Distribution of responses to perceived changes in specific climatic events

Climatic events	Percent of respondents indicating to what level they have experienced the climatic events			
	Increased	No change	Decreased	Don't know
Temperature	100	-	-	-
Rainfall	87	5	8	-
Occurrence of flood	90	13	7	-
Occurrence of Tornado	90	5	5	-
Short winter season	89	4	-	7
Long Summer season	85	5	-	10
Changes of monsoon season	85	4	-	11

4.2.4 Change of homestead production systems of the respondent's households (land resources)

The size of homestead area of the respondents varied over time. The average higher area was found in crop land (180.05 decimal) followed by homestead area (12.95 decimal), pond area (5.65 decimal), housing area (4.16 decimal), vegetable cultivating area (4.10 decimal) and fallow land (0.04 decimal). With the increase of population, the farm area was decreased. Data presented in Table 4.2.4.1 shows that the area was decreased in all the cases except housing area and vegetable plot compared to ten years ago. The maximum change in decrease was found in case of fallow land area (99.31 percent) followed by pond area (46.19 percent). On the other hand, increase was found in case of housing area (18.85 percent). Vegetable cultivating area (26.15percent) increased because due to population increase demand of vegetable consumption also increased.

Table 4.2.4.1 Changing scenario in utilization of land resources in the study area compared to 10 years ago

Land use	Decimal/Farm		Change (percent)
	At Present	10 years ago	
Housing	4.16	3.50	+18.85
Home garden	12.95	14.35	-9.75
Crop land	180.50	217.5	-37.68
Vegetable plot	4.10	3.25	+26.15
Pond	5.65	10.5	-46.19
Fallow land	0.04	5.85	-99.31

4.2.5 Integrated farming practices in the homestead of the study area

In most of the homestead (35 %) integrated Tree-Crop (T-C) was practiced followed by Tree-Crop-Animal (T-C-A) (30%) and Tree-Animal (T-A) model (23%). Figure 4.2.5.1 showed that only 3.0 % respondents were practicing Tree-Crop-Animal-Aquaculture (T-C-A-Aq) and 2% Tree-Crop-Aquaculture (T-C-Aq) model in their homesteads. In the study area Tree-Crop (T-C) model is the best due to sandy and silty alluvium soil.

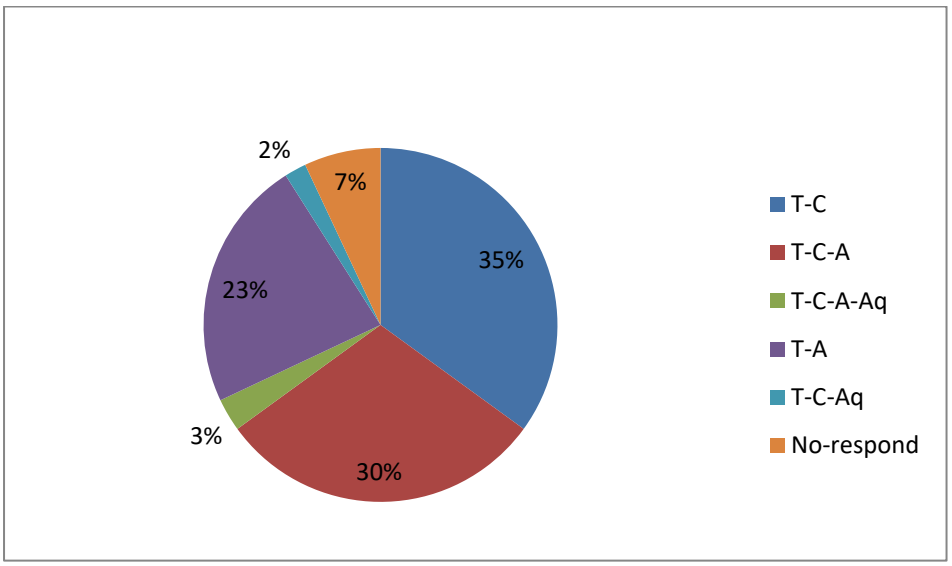


Figure 4.2.5.1 Pie chart showing different integrated farming practices

4.2.6 Livestock and poultry population

Livestock is a vital component of farming systems practiced by the farmers especially in homesteads. The result shows a sharp decline in the productivity of livestock and poultry in the study area (Table 4.2.6.1) except cattle.

Data presented in Table 4.2.6 shows that the average numbers of cattle, goat, sheep, poultry, duck and pigeon were 5, 1.2, 0.1, 5.2, 1.7 and 3 respectively. Besides, the highest change in decrease was found in buffalo (100 percent) followed by sheep (97.40 percent), goat (70 percent), pigeon (70.29 percent), poultry (65.33 percent), cattle (10 percent) and duck (46.87 percent) in the study area compared to ten years ago.

Table 4.2.6.1 Changing scenario of livestock population compared to 10 years ago in the study area

Category	Population of livestock/Farm		Change (percent)
	At Present	10 years ago	
Cattle	5	4.5	10
Buffalo	0	2	-100.00
Goat	1.2	4	-70
Sheep	0.1	3.85	-97.40
Poultry	5.2	15	-65.33
Duck	1.7	3.2	-46.87
Pigeon	3	10.1	-70.29

The present study showed that the total population of domestic animal (livestock) such as cattle was increased and buffaloes, goats, sheep and poultry (hen and duck) decreased remarkably than ten years ago. The finding is good agreement with Karim (2006); Miah *et al*., (2002).

Decline in the livestock population results many management problems for agricultural production. The production of milk has increased some homestead in this area.

4.2.7 Tree and crop species in the homestead area

The number of fruit trees per homestead area increased with the increase of farm size and the maximum number of fruit trees per homestead was observed in large farm (9.83), which was followed by medium (7.0), small (6.10), marginal (5.90) and landless (3.17) farmers (Table 4.2.7.1). The highest number of changes in decrease compared to ten years ago was found in large farm (48.53 percent) followed by medium farm (45.73 percent) and landless farm (36.60 percent).

In case of timber tree, the highest number of changes in decrease compared to ten years ago was found in large farm (40.90 percent) followed by marginal farm (37.99 percent) and medium farm (36.5 percent).

The study revealed that the number of vegetables grown in homestead increased with the increase of farm size. The highest number of vegetables was recorded in large farm category (11.0) and the lowest number was in landless farm category (3.40). The vegetable production was not changed very markedly because the population is increasing day by day and their demand was also increased. Vegetable cultivation is a supplementary farming enterprise and grow more quickly than other crops and contribute to family consumption, malnutrition and as well as household income.

It may be concluded that climate change affected all the categories of farmers but medium and large farmers are affected more than other farm categories.

Table 4.2.7.1 Changing scenario on the abundance of tree and vegetable species in the study area as compared to 10 years ago

Farm category	At Present			10 years ago			Change (percent)		
	Fruit spp.	Timber spp	Vegetables spp	Fruit spp	Timber spp	Vegetables spp	Fruit spp	Timber spp	Veg. spp
Landless	3.17	4	3.4	5	5.9	4	-36.60	-32.20	-15.00
Marginal	5.9	4.9	5.5	10	7.9	6.1	-41.0	-37.99	-9.84
Small	6.10	7	4.7	8.2	10.9	7.1	-25.61	-35.77	-33.80
Medium	7	8.85	8	12.9	14	8.5	-45.73	-36.79	-5.88
Large	9.83	11.13	11	19.1.	21.17	12.4	-48.53	-47.43	-11.29

From the table it was found that the number of fruit trees grown in homestead changed within ten years. Jujube was the most dominant fruit tree in the study area before ten years ago but now it decreased (66.66%). Banana, guava, lemon, coconut and papaya production was increased. It was found that in case of banana the production was increased (100%) very markedly in the study areas. On the other hand, jack fruit and hogplum production was decreased 37.50 and 57.14 % respectively (Table 4.2.7.2).

Table 4.2.7.2 Changing scenario of fruit tree production in the study area as compared to 10 years ago

Fruit tree	10 years ago	At Present	Change (percent)
Jujube	30	10	-66.66
Banana	15	23	+53.33
Guava	10	15	+50
Mango	10	10	0
Lemon	9	18	+100
Coconut	8	10	+25
Jackfruit	8	5	-37.5
Hog plum	7	3	-57.14
Papaya	3	6	+100

4.2.8 Adaptation technology for climate change in the study areas

Farmers have been trying to readjust the planting dates of crops and trees in homestead under as an adaptation technology for climate change. Data presented in Table 4.2.8.1 shows that 84.2% respondents agreed in changing of planting dates followed by using varieties, micro irrigation and sprayers. Least respondents were agreed in using new varieties (11.67%), while micro irrigation (15%) and insect and pest management (16.67 %) are also used by the farmers under the changing condition to get desirable production.

Table 4.2.8.1 Type of changes made to the crops and trees in homestead during the past 10 years in the study area

Changes made	Homestead making changes (% of total change)
Changing Planting dates	84.20
Using new varieties	11.67
Insect and pest management	16.67
Micro irrigation	15
Total	100.00

There are several crops and vegetables subjected to change of planting dates due to climate change over time. Table 4.2.8.2 showed that the highest number of respondents agreed in changing planting dates of bean (20 %) compared to bottle gourd (16 %) and patshak (14.66 %). Few respondents were also agreed in changing planting dates of cabbage (2.66 %). From this figure it is also said that tomato (10.66 %) and okra (10.66 %) shows no differences in changing of their planting dates.

Table 4.2.8.2 Crop species subjected to change of planting dates in the study area

English name of the crop/tree	Number	Percent of homestead who made any change
Bean	15	20
Patshak	11	14.66
Bottle gourd	12	16
Chilli	7	9.3
Tomato	8	10.66
Okra	8	10.66
Red amaranth	7	9.33
Brinjal	3	4
Cabbage	2	2.66
Cauliflower	2	2.66

There are some reasons for changing planting dates of crops. It was observed 29.5, 24 and 15, 14% respondents opined that change of flood, rainfall pattern, insects and scarcity of irrigation water supply were the major reasons, respectively, for changing planting dates of crops (Table 4.2.8.3).

Table 4.2.8.3 Reasons for changing planting dates of crops in the study area

Reason for changing planting dates	Percent Homestead
Flood	29.5
Change on-set of rainfall	24
Insects	15
Lack of timely irrigation water supply	14
Higher production	3
No timely availability of seed	6.3
Increase in temperature	8.2
Total	100.00

Changes have been observed in animal population over last 10 years. Number of animals has been decreased remarkably as mentioned by 60% respondents, no animal at homestead (14%), and introduction of new breeds (9%). However, few respondents (7%) opined that number of animals increased in homestead during the past 10 years (Table 4.2.8.4). The reason for decreasing the number of animals was lack of grazing land, labor management, less profit and high management cost. Additional income from milk and meat production and resistant to pest and disease were responsible for increasing animal number.

Table 4.2.8.4 Type of changes made to the animals in homestead during the past 10 years in the study area

Changes made	Changes (percent)
Increase in number	10
Reduce in number	60
Introduction of new breed	9
No animal at Homestead	14
Disease infestation increase	7
Total	100

Climate change adaptation to homestead production systems by the homestead owners is the dependent variable of this study and it was measure by computing scores according to extent of adaptation with each of 10 selected production systems. Climate change adaptation to homestead production systems by the homestead owners

scored varied from 9 to 27 with the mean and standard deviation of 16.25 and 3.11, respectively. On the basis of climate change adaptation to homestead production systems scores, the respondents were classified into three categories namely, low, medium and high climate change adaptation to homestead production systems. The distribution of the respondents according to their climate change adaptation to homestead production systems score by the homestead owners under the study is given in Table 4.2.8.5.

Table 4.2.8.5 Distribution of the respondents' according to their climate change adaptation to homestead production systems

Category	Range		Respondents		Mean	Standard deviation
	Score	Observed	Number	Percent		
Low adaptation	Up to 13	9-27	11	14.67	16.25	3.11
Medium adaptation	14-19		55	77..33		
High adaptation	>19		9	12.00		
Total			75	100		

Table 4.2.8.5 indicates that among the respondents the highest 77.33 percent homestead owners belongs to the group of medium score of climate change adaptation to homestead production systems and the lowest percentage 12.00 percent in high score followed by low score (14.67 percent) by the homestead owners in climate change adaptation to homestead production systems. Among the respondent most of the respondent (89 percent) of homestead owners have low to medium climate change adaptation to homestead production system.

4.3 Relationship of the selected characteristics of homestead owner with the climate change adaptation to homestead production system

Pearson Product Moment Correlation Co-efficient was computed in order to find out the extent of relationship between the dependent variable and independent variables. To reject or accept the null hypothesis at 0.05 and 0.01 level of probability was used. Results of correlation have been shown in Table 4.3.i.

Table 4.3.i Pearson's product moment co-efficient of correlation showing relationship between dependent and independent variables

Dependent variable	Independent variables	Tabulated value		Value of co-efficient of correlation
		0.05 level	0.01 level	
Climate change adaptation to homestead production system	Age	0.197	0.271	0.045
	Level of education			0.436**
	Family size			-0.153
	Farm size			0.100
	Annual income			-0.004
	Organizational participation			0.548**
	Communication exposure			0.301**
	Years of homestead production experiences			0.260*
	Knowledge in homestead production system			0.506**
	Usefulness of training for climate adaptive homestead production system			0.609**
	Problem confrontation in homestead production due to climate change			-0.361**

** significant at the 0.01 level; * significant at the 0.05 level

4.3.1 Age and climate change adaptation to homestead production system

Relationship between age of the homestead owners and climate change adaptation to homestead production system was determined by Pearson product moment correlation coefficient. The coefficient of correlation between age of the homestead owners and climate change adaptation to homestead production system is presented in Table 4.3.i. The coefficient of correlation between the concerned variables was found 0.045. The following observations were made on the basis of the value of correlation coefficient between the two concerned variables of the study under consideration. The observed value between the concerned variables "*r*" (0.045) was found to be smaller than the tabulated value (r = 0.197) with 73 degrees of freedom at 0.05 level of probability. So, the null hypothesis could not be rejected and the relationship between the

concerned variables was statistically non-significant at 0.05 level of probability. However, the relationship showed a positive trend between the concerned variables. Based on the above findings it could be concluded that age of homestead owners had non-significant positive relationships with the climate change adaptation to homestead production system. This represents that age of the respondent homestead owners was not an important factor in climate change adaptation to homestead production system but with the increases of age of the respondents' climate change adaptation to homestead production system will also increase.

4.3.2 Level of education and climate change adaptation to homestead production system

Table 4.3.i. shows the coefficient of correlation between the concerned variables was 0.436. The observed value between the concerned variables *"r" (0.436)* was found to be greater than the tabulated value (r = 0.271) with 73 degrees of freedom at 0.01 level of probability. So, the null hypothesis could be rejected and the relationship between the concerned variables was statistically significant at 0.01 level of probability. The relationship showed a positive trend between the concerned variables. It could be concluded that level of education of homestead owners had significant positive relationships with the climate change adaptation to homestead production system.

4.3.3 Family size and climate change adaptation to homestead production system

The coefficient of correlation between the concerned variables was found -0.153 (Table 4.3.i.). The observed value between the concerned variables "*r*" (-0.153*)* was found to be smaller than the tabulated value (r = 0.197) with 73 degrees of freedom at 0.05 level of probability. So, the null hypothesis could not be rejected and the relationship between the concerned variables was statistically non significant at 0.05 level of probability. The relationship showed a negative trend between the concerned variables. The findings represent that family size of the respondent homestead owners was not an important factor in climate change adaptation to homestead production system and with the increases of family size of the respondent climate change adaptation to homestead production system will decrease.

4.3.4 Farm size and climate change adaptation to homestead production system

According to the Table 4.3.i the coefficient of correlation between the concerned variables was 0.100. The observed value between the concerned variables "*r*" (0.100) was found to be smaller than the tabulated value (r = 0.197) with 73 degrees of freedom at 0.05 level of probability. So, the null hypothesis could not be rejected and the relationship between the concerned variables was statistically non significant at 0.05 level of probability.

4.3.5 Annual income and climate change adaptation to homestead production system

The coefficient of correlation between the concerned variables was found -0.004 (Table 4.3.i.). The following observations were made on the basis of the value of correlation coefficient between the two concerned variables of the study under consideration. The observed value between the concerned variables "*r*" (-0.004) was found to be smaller than the tabulated value (r = 0.197) with 73 degrees of freedom at 0.05 level of probability. So, the null hypothesis could not be rejected and the relationship between the concerned variables was statistically non-significant at 0.05 level of probability. The relationship showed a negative trend between the concerned variables.

4.3.6 Organizational participation and climate change adaptation to homestead production system

Table 4.3.i. shows that the coefficient of correlation between the concerned variables was 0.548. The relationship showed a positive trend between the concerned variables. On the basis of the findings it could be concluded that organizational participation of homestead owners had significant positive relationships with the climate change adaptation to homestead production system. This represents that organizational participation of the respondent homestead owners was an important factor in climate change adaptation to homestead production system and with the increases of organizational participation of the respondent climate change adaptation to homestead production system will also increase.

4.3.7 Communication exposure and climate change adaptation to homestead production system

The coefficient of correlation between communication exposure of the homestead owners and climate change adaptation to homestead production system is presented in

Table 4.3.i. The coefficient of correlation between the concerned variables was found 0.301. The observed value between the concerned variables "*r*" (0.301) was found to be greater than the tabulated value (r = 0.271) with 73 degrees of freedom at 0.01 level of probability. The null hypothesis could be rejected. The relationship between the concerned variables was statistically significant at 0.01 level of probability. The relationship showed a positive trend between the concerned variables.

4.3.8 Years of homestead production experiences and climate change adaptation to homestead production system

As per the Table 4.3.i., the coefficient of correlation between the concerned variables was found 0.260. The following observations were made on the basis of the value of correlation coefficient between the two concerned variables of the study under consideration. The relationship showed a positive trend between the concerned variables. Based on the above findings it could be concluded that years of homestead production experiences of homestead owners had significant positive relationships with the climate change adaptation to homestead production system. This represents that years of homestead production experiences of the respondent homestead owners was an important factor in climate change adaptation to homestead production system and with the increases of years of homestead production experiences of the respondent climate change adaptation to homestead production system will also increase.

4.3.9 Knowledge in homestead production system and climate change adaptation to homestead production system

Table 4.3.i. represents the coefficient of correlation between the concerned variables was 0.506. The observed value between the concerned variables "*r*" (0.506) was found to be greater than the tabulated value (r = 0.271) with 73 degrees of freedom at 0.01 level of probability. The null hypothesis could be rejected. The relationship between the concerned variables was statistically significant at 0.01 level of probability. The relationship showed a positive trend between the concerned variables. From the findings it could be concluded that knowledge in homestead production system of homestead owners had significant positive relationships with the climate change adaptation to homestead production system.

4.3.10 Usefulness of training for climate adaptive homestead production system and climate change adaptation to homestead production system

Table 4.3.i. shows that the coefficient of correlation between the concerned variables was 0.609. The following observations were made on the basis of the value of correlation coefficient between the two concerned variables of the study under consideration. The null hypothesis could be rejected. The relationship between the concerned variables was statistically significant at 0.01 level of probability. The relationship showed a positive trend between the concerned variables.

4.3.11 Problem confrontation in homestead production due to climate change and climate change adaptation to homestead production system

The coefficient of correlation between the concerned variables was found -0.361 (Table 4.3.i.). The observed value between the concerned variables "*r*" (-0.361) was found to be greater than the tabulated value ($r = 0.271$) with 73 degrees of freedom at 0.01 level of probability. So, the null hypothesis could be rejected and the relationship between the concerned variables was statistically significant at 0.01 level of probability. As per the findings it could be concluded that problem confrontation in homestead production due to climate change of homestead owners had significant negative relationships with the climate change adaptation to homestead production system.

Pearson Product Moment Correlation Co-efficient between dependent and independent variable revealed that level of education, organizational participation, communication exposure, years of homestead production experiences, knowledge in homestead production system, usefulness of training for climate adaptive homestead production system had significant positive relationship with climate change adaptation to homestead production system. Age and farm size had non-significant positive relationship with climate change adaptation to homestead production system. On the other hand, problem confrontation in homestead production due to climate change had significant negative relationship and family size and annual income had non-significant negative relationship with climate change adaptation to homestead production system under the present study.

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATIONS

SUMMARY

Most of the farmers of Bangladesh depend on agriculture from their homestead agriculture which is most vulnerable to climate change. The study was conducted in the Malshi, Horgage, Patilapara, Nogao and Kaunnara village of Saturia upazila; Shidhunagar, Shridhornagar, Pohela, Kushta, Baliakhura village under Ghior upazila; Krishnapur, Rajibpur, okimpur, Gajipara, Moddho Krishnapur village under sadar upazila of Manikgonj district. The homestead owners of these localities constituted the population of the study. Randomly 5 number of homestead owners from 15 villages of 3 upazilas were selected as the sample of the study by using random sampling method. Thus, 75 household owners constituted the sample of the study. A well-structured interview schedule was developed based on objectives of the study for collecting information. The researcher herself collected data through personal contact. The independent variables were: age, level of education, family size, farm size, annual Income, organizational participation, communication exposure, years of homestead production experiences, knowledge in homestead production system, usefulness of training for climate adaptive homestead production system and problem confrontation in homestead production due to climate change. The dependent variable of this study was the climate change adaptation to homestead production system. Data collection was started in 10 August to January 2017. Various statistical measures such as frequency counts, percentage distribution, average, and standard deviation were used in describing data. Co-efficient of correlation test was used to explore relationship between the concerned variables. The major findings of the study are summarized below:

The middle-aged homestead owners comprised the highest proportion (42.67 percent), whereas the lowest proportion were made by the old aged category (18.67 percent). The respondent under secondary education category constitute the highest proportion (42.67 percent), whereas the lowest 6.67 percent in can't read and sign category. The medium size family constitutes the highest proportion (60.00 percent) and the lowest only 18.67 percent respondents had large family size. The small farm holder constitutes the highest proportion (58.11 percent), while the lowest 4.05 percent was

in marginal farm holder. The homestead owners having medium annual income constitute the highest proportion (74.67 percent), while the lowest proportion in low income (6.67 percent). The highest proportion (57.33 percent) of the respondents had medium organizational participation and the lowest 13.33 percent had high organizational participation. The highest proportion (52.00 percent) of the respondents had medium communication exposure and the lowest proportion (22.67 percent) had low communication exposure. The majority (76.00 percent) of the respondents fell in medium years of homestead production experience category, whereas only 10.67 percent in high experience category. The majority (40.00 percent) of the homestead owners fell in medium knowledge category, whereas the lowest is 21.33 percent in high knowledge category. The highest proportion (29.33 percent) of the respondents had low usefulness of training for climate adaptive homestead production system and the lowest proportion (20.00 percent) had no training. The highest about (42.67 percent) of the respondents faced low problem confrontation in homestead production, while 26.67 percent faced high problem confrontation

Temperature, rainfall and humidity increased day by day which caused many changes in homestead production. Most of the respondents opined that temperature, rainfall flood and thunderstorm has increased in the study area. Among the respondents the highest 77.33 percent homestead owners belong to the group of medium score of climate change adaptation to homestead production systems and the lowest percentage 12.00 percent in high score followed by low score (14.67 percent) by the homestead owners in climate change adaptation to homestead production systems. The average higher area was found in crop land (180.05 decimal) followed by homestead area (12.95 decimal), pond area (5.65 decimal), housing area (4.16 decimal), vegetable cultivating area (4.10 decimal) and fallow land (0.04 decimal). With the increase of population, the farm area was decreased. The maximum change in decrease was found in case of fallow land area (99.31 percent) followed by pond area (46.19 percent). On the other hand, increase was found in case of housing area (18.85percent). Vegetable cultivating area (26.15percent) increased because due to population increase demand of vegetable consumption also increased. The present study showed that the total population of domestic animal (livestock) such as cattle was increased and buffaloes, goats, sheep and poultry (hen and duck) decreased remarkably than ten years ago. The highest number of changes in decrease compared to ten years ago was found in large

farm (48.53 percent) followed by medium farm (45.73 percent) and landless farm (36.60 percent).

In case of timber tree, the highest number of changes in decrease compared to ten years ago was found in large farm (40.90 percent) followed by marginal farm (37.99 percent) and medium farm (36.5 percent).

The study revealed that the number of vegetables grown in homestead increased with the increase of farm size. The highest number of vegetables was recorded in large farm category (11.0) and the lowest number was in landless farm category (3.40). Jujube was the most dominant fruit tree in the study area before ten years ago but now it decreased (66.66%). Banana, guava, lemon, coconut and papaya production was increased. It was found that in case of banana the production was increased (100%) very markedly in the study areas. On the other hand, jack fruit and hogpulm production was decreased 37.50 and 57.14 % respectively. It was showed that 84.2% respondents agreed in changing of planting dates followed by using varieties, micro irrigation and sprayers. Least respondents were agreed in using new varieties (11.67%), while micro irrigation (15%) and insect and pest management (16.67 %) are also used by the farmers under the changing condition to get desirable production.

Pearson Product Moment Correlation Co-efficient between dependent and independent variable revealed that level of education, organizational participation, communication exposure, years of homestead production experiences, knowledge in homestead production system, usefulness of training for climate adaptive homestead production system had significant positive relationship with climate change adaptation to homestead production system. Age and farm size had non-significant positive relationship with climate change adaptation to homestead production system. On the other hand, problem confrontation in homestead production due to climate change had significant negative relationship and family size and annual income had non-significant negative relationship with climate change adaptation to homestead production system under the present study.

CONCLUSION

The Study findings indicated that total 92 percent of homestead owners have low to medium climate change adaptation to homestead production system and it was adopted by the homestead owners as their necessity. Increasing trend of different type of hazards i.e. flood, tornado, thunderstorm, heatwave and insect infestation occured in the study area. The maximum change in decrease was found in case of fallow land area (99.31 percent) followed by pond area (46.19 percent). Vegetable cultivating area (26.15percent) increased because due to population increase demand of vegetable consumption also increased. The highest change in decrease was found in buffalo (100 percent) followed by sheep (97.40 percent), goat, pigeon, poultry, cattle and duck. Most of the respondents were agreed in changing of planting dates followed by using varieties and micro irrigation. Level of education, organizational participation, communication exposure, years of homestead production experiences, knowledge in homestead production system, and usefulness of training for climate adaptive homestead production system had significant relationship with climate change adaptation to homestead production system. Homestead owners of the study area found to be more favorable attitude towards climate change adaptation in homestead production system.

RECOMMENDATIONS

On the basis of scope and limitations of the present study the recommendations are given below:

i. Similar studies like this are required to be conducted in other areas of Bangladesh where similar environmental, socio-economic and physical conditions exist to compare the findings.
ii. Other factors might have influenced the climate change adaptation to homestead production system, which need to be identified through further study.
iii. The study investigated the direct and indirect effects of certain variables. Further studies should be conducted to explore the direct and indirect effects of all the variables under investigation.

CHAPTER VI

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APPENDIX I. A COPY OF AN INTERVIEW SCHEDULE

DEPARTMENT OF AGROFORESTRY AND ENVIRONMENTAL SCIENCE
SHER-E-BANGLA AGRICULTURAL UNIVERSITY
DHAKA 1207

An interview schedule for a research study entitled
'Climate Change Adaptation to Homestead Production Systems in Manikgonj District of Bangladesh'

Respondent Name : Serial No.....

Village : Union: Upazila:

Contact Number :

[Please provide following information. Your information will be kept confidential and will be used for research purpose only]

1. Age

What is your present age? ..... Years

2. Level of Education

What is the level of your education?

a) Illiterate ( ) b. Can sign only ( ) c. Have passed class.....

d. Did not read in School/Madrasha but can read and write and level of education is equivalent to class ..... as non-formal education

3. Family Size

State the number of your family members.....

4. Farm Size

Please mention the area of your land according to use

Sl. No.	Type of land use	Area of land	
		Local unit (Decimal/Bigha/others)	Hectare
A	Homestead area with pond		
B	Own land under own cultivation		
C	Area taken by a respondent to others on borga system		
D	Area Given by a respondent to others on borga system		
E	Cultivated area taken as lease by respondent from other		
Total = A+B+1/2(C+D)+E			

5. Annual Income

Please mention the income of your family in last year

Sl.No	Source of income	Total Income (Tk.)/Year
A	**Agricultural Sector**	
	Crops	
	Livestock	
	Poultry	
	Fishery	
	Sub-Total (A)	
B	**Non-agricultural Sector**	
	Small Business	
	Service	
	Other family members' income	
	Day labourer	
	Fishing	
	Others (if any, please specify)	
	Sub-total (B)	
	Total (A+B)	

6. Organizational Participation

Please mention the nature of your participation with the following organizations (Tick mark in right place)

Sl. No	Organizations	No. of Participation (01)	Nature and duration of participation		
			Ordinary Member (1)	Executive Member (2)	President/ Secretary (3)
1.	NGO Organized Group				
2.	Rural Arbitration Committee				
3.	Ansar/VDP				
4.	School Committee				
5.	Madrasha/Temple Committee				
6.	Farmer Co-operative Society				
7.	Mosque/Puja Committee				
8.	Hat/Bazaar Committee				
9.	Youth Club/Committee				
10.	Others (Please specify)				

7. Communication Exposure

Indicate communication with the following media (How much)

Sl	Communication media	Basis of score on communication frequency (time)				
		0	1	2	3	4
1	SAAO[1] (Quarterly)	≠ 1 time	1 time	2 times	3 times	4 or more
2	UAO[2]/AAO[3]/AEO[4] (half yearly)	≠ 1 time	1 time	2 times	3 times	4 or more
3	Neighbour (monthly)	≠ 1 time	1-2 times	2-3 times	5-6 times	7 or more
4	Friends (monthly)	≠ 1 time	1-2 times	3-4 times	5-6 times	7 or more
5	Relatives (monthly)	≠ 1 time	1-2 times	3-4 times	5-6 times	7 or more
6	Experienced farmer (monthly)	≠ 1 time	1-2 times	3-4 times	5-6 times	7 or more
7	Model farmer (monthly)	≠ 1 time	1-2 times	3-4 times	5-6 times	7 or more
8	Agri-inputs dealer (Quarterly)	≠ 1 time	1 time	2 times	3 times	4 or more
9	Dev. worker (Quarterly)	≠ 1 time	1 time	2 times	3 times	4 or more
10	Group discussion mtg. (yearly)	≠ 1 time	1 time	4-7 times	8-11 times	12or more
11	Result demo.[5]/Field days (half yearly)	≠ 1 time	1 time	2-3 times	4-5 times	6 or more
12	Method demo.[5] (half yearly)	≠ 1 time	1 time	2-3 times	4-5 times	6 or more
13	Newspaper (weekly)	≠ 1 time	1-2 times	2-3 times	5-6 times	7 or more
14	Agril- poster (half yearly)	≠ 1 time	1 time	2 times	3 times	4 or more
15	Agricultural leaflet (yearly)	≠ 1 time	1 time	2 times	3 times	4 or more
16	Agricultural booklet (yearly)	≠ 1 time	1 time	2 times	3 times	4 or more
17	Agri-Magazine/periodics; yearly	≠ 1 time	1 time	2 times	3 times	4 or more
18	Agril. Fair (yearly)	≠ 1 time	1 time	2 times	3 times	4 or more
19	Agril.Radio prog. (monthly)	≠ 1 time	1-7 times	8-14 time	15-20 times	21or more
20	Agril. TV program (monthly)	≠ 1 time	1 time	2 times	3 times	4 or more

[1]SAAO= Sub Asst Agri Officer; [2]UAO= Upazila Agri. Officer; [3]AAO= Addl. Agri. Officer; [4]AEO= Agri. Extension Officer; [5]Demo. =Demonstration

8. Years of Homestead Production Experience

Mention the age of your homestead production experience? .....Years

9. Knowledge in Homestead Production System

Please answer the following questions:

Sl. No.	Questions	Score	
		Full	**obtained**
01	Give a list of homestead cultivable vegetable crops in present climatic condition?	2	
02	Give a list of homestead cultivable fruit crops in present climatic condition?	2	
03	Give a list of homestead cultivable spice crops in present climatic condition?	2	
04	Give a list of homestead tree species in present climatic condition?	2	
05	Give a list of homestead animal species in present climatic condition?	2	
06	Mention the cultivation practices of homestead vegetable crops	2	
07	Mention the cultivation practices of homestead fruit crops	2	
08	Mention the cultivation practices of homestead spice crops	2	
09	Mention the cultivation practices of homestead tree species	2	
10	Mention the cultivation practices of homestead animal species	2	
11	How do you add value to crops production in present climatic condition?	2	
12	What do you mean by crop diversification?	2	
13	What is the benefit of the crop diversification?	2	
14	How do you control insects of your homestead species?	2	
15	Mention what is balanced fertilizer for crop cultivation?	2	
16	Mention the method of application of fertilizers?	2	
17	Mention the method of application of irrigation?	2	
18	Mention the major methods of control insect infestation	2	
19	What is IPM?	2	
20	What is the difference of Local Variety, HYV and Hybrid?	2	
Total		40	

10. Usefulness of Training for Climate Adaptive Homestead Production System

(a) Have you received any training on climate adaptive homestead production system?

Yes ☐ No ☐

(b) If yes, please give detail information on usefulness of the training……

Sl.No.	Subject of training	Duration (day)	Degree of usefulness			
			High (4)	Medium (3)	Low (2)	Very low (1)
01						
02						
03						
04						
05						
06						

11. Problem Confrontation in Homestead Production Due to Climate Change

Please mention the level of problem confronted by you in homestead production system due to climate change:

Sl. No.	Description of the problem	Level of the problem			
		High	Medium	Low	Very low
01					
02					
03					
04					
05					
06					
07					
08					
09					
10					

12. Climate Change Adaptation to Homestead Production System

Component	Name of crop species	Suitable land (L)	Land allotted for 2007-2010	Land allotted for 2011-2014	Land allotted for 2015-2017	Average land allotted/ Year
Vegetables						
Fruits						
Spices						
Trees						
Animals						

Thanks for Your Co-operation.

Signature of the Interviewer with Date

APPENDIX II. Correlation Matrix

Characters	A	B	C	D	E	F	G	H	I	J	K	L
A	1.00											
B	-0.032	1.00										
C	0.038	-0.337**	1.00									
D	0.032	-0.016	0.115	1.00								
E	0.027	0.121	0.065	0.057	1.00							
F	0.069	0.457**	-0.337**	0.251*	-0.097	1.00						
G	-0.171	0.062	-0.032	0.107	0.075	0.152	1.00					
H	0.871**	0.032	0.032	0.118	0.071	0.146	-0.005	1.00				
I	0.030	0.144	-0.020	-0.004	0.025	0.227	0.308**	0.178	1.00			
J	0.007	0.323**	-0.066	0.083	-0.008	0.216	0.215	0.166	0.362**	1.00		
K	0.020	-0.052	0.009	-0.225	0.094	-0.265*	-0.182	-0.111	-0.104	-0.160	1.00	
L	0.045	0.436**	-0.153	0.100	-0.004	0.548**	0.301**	0.260*	0.506**	0.609**	-0.361**	1.00

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

A: Age B: Level of education C: Family size D: Farm size

E: Annual Income F: organizational participation G: Communication exposure H: Years of homestead production experiences

I: knowledge in homestead production system J: usefulness of training for climate adaptive homestead production system

K: Problem confrontation in homestead production L: Climate change adaptation to homestead production systems

APPENDIX III. Identification of homestead plant species including local name, English name, scientific name and family name

1. Horticultural species

Local Name	English Name	Scientific Name	Family
Aam	Mango	*Mangifera indica*	Anacardiaceae
Amra	Hogplum	*Spondias pinnata*	Anacardiaceae
Boroi/Kul	Jujube	*Zizyphus mauritiana*	Rhamnaceae
Jam (Deshi)	Jamun	*Syzygium cumini*	Myrtaceae
Kathal	Jackfruit	*Artocarpus heterophyllus*	Moraceae
Lebu (kagoji)	Citrus lemon	*Citrus aurantifolia*	Rutaceae
Litchu	Litchi	*Litchi chinensis*	Sapindaceae
Narikel	Coconut	*Cocos nucifera*	Palmaceae
Peyara	Guava	*Psidium guajava*	Myrtaceae
Papaya	Papaya	*Carica papaya*	Caricaceae
Kola	Banana	*Musa paradisiaca*	Musaceae

2. Forest species

Local Name	English Name	Scientific Name	Family
Bash	Bamboo	*Bambusa spp*	Gramineae
Mahogany	Mehagani	*Swietenia macrophylla*	Miliaceae
Neem Deshi	Neem	*Azadirachla indica*	Meliaceae
Patabahar	Croton	*Codiaeum variegatum*	Euphorbiaceae
Bokul	Indian Medlar	*Mimusops elengi*	Sapotaceae
Khoir	Cutch	*Acacia catechu*	Fabaceae
Raktojoba	Red rose	*Hibiscus rosa sinensis*	Malvaceae
Bot gas	Bengal Fig	*Ficus benghalensis*	Moraceae
Bain	Bean	*Avicennia officinalis*	Verbanaceae
Krisnochura	Peacock flower	*Delonix regia*	Caesalpiniaceae
Anaras	Pine apple	*Annonas squamosa*	Annonaceae

APPENDIX IV. Identification of vegetables including local name, English name, scientific name and family name

Local Name	**English Name**	**Scientific Name**	**Family**
Lau/kadu	Bottle gourd	*Lagenaria vulgars*	Cucurbitaceae
Bandhakapi	Cabbage	*Brassica oleracea*	Cruciferae
Phulkopi	Cauliflower	*Brassica oleracea*	Cruciferae
Seem	Country bean	*Dolichos lablab*	Fabaceae
Darosh	Ladies Finger	*Hibiscus esculentu*	Malvaceae
Tomato	Tomato	*Lycopersicon esculentum*	Solanaceae
Brinjal	Egg plant	*Solarium melongena*	Solanaceae
Lal sak	Red amaranth	*Amaranthus gangeticus*	Cruciferae
Pat sak	Jute	*Corchorus capsularis*	Tiliaceae
Marich	Chilli	*Capsicum sp.*	Solanaceae