# Coping with Extreme Climatic Variability: A case of Rice based Farming in Assam


## ABSTRACT

Assam has been experiencing the adverse effects of climate change and its most common manifestation is the increasing frequency of extreme flood in the pre-monsoon, monsoon and post-monsoon seasons. Lakhimpur and Dhemaji are the two districts that have been subjected to severe flood every year and in recent years have been experiencing soil erosion, sand-silt deposition in rice growing areas. The present study was therefore attempted in these two districts to find out the impact of extreme events in agriculture and social activities of the farmers in flood affected areas and to find out their responses and coping mechanisms during extreme climate variability. The result of the study revealed that both men and women farmers have been experiencing changes in the weather patterns with longer duration of hotter days and shorter duration of cold days. They have been experiencing frequent drought and frequent flood accompanied by soil erosion, sand and silt deposition in their rice fields affecting their farming activities. The area and production of rice/pulses/oilseeds had decreased to a great extent due to sand-silt deposition. During extreme flood livestock and fish production also decreased due to diseases and decreasing swampy areas/ponds. Availability of food, fodder and fuel had been affected for which the time taken for collecting fodder and fuel has increased. The impact of extreme climate events resulted in increasing indebtedness, wage labour, migration of young men in search of employment and school dropout of children. In response to such extreme climate events farmers had learned to adapt themselves through diversified farming by branching out into livestock production, change in cropping pattern, increasing the area of rabi crops cultivation, adopting non-farm activities such as wage labour in neighbouring districts/states, shop keeping, fishing and selling dry fish etc. women have adopted non-farm activities such as weaving, fishing and selling local brew. The priority adaptation needs of these men and women farmers are stress tolerant varieties of rice in flood affected areas, stress tolerant crops in sand deposited areas, training on scientific crop and livestock production, poultry etc. Women need training on improved techniques of loom and designing so as to fetch good price of their products as well as livestock and poultry production.



***Key Words :***Extreme climate variability, flood, livelihood, coping mechanisms.




## Introduction

Agriculture constitutes the primary sector in Assam economy. The socio-economic condition of Assam largely depends on its agricultural production. It plays the chief role of revenue earning in Assam economy. This sector continues to support more than 75 per cent population of the State directly or indirectly providing employment to more than 53 per cent of the workforce. Agriculture in the state is purely rain fed. One of

the most serious problems adversely affecting the State's agricultural sector is the recurrence of devastating floods almost every year. The flood was aggravated by down streaming of water from the neighbouring hilly states due to incessant rainfall experienced by the region during the period, which posed a great threat to the economy of the State. Thousands of hectares of agricultural land have been rendered infertile by the gradual accumulation and expansions of large-scale deposit of silts and sand in the flourishing rice fields.

Climate change is considered a major driving force, triggering alterations in the regional and local weather and climate systems all over the globe. These changes have, in turn, affected the socioeconomic, cultural, and political spheres of human societies (IPCC 2007b). Farming households are obviously realizing that temperature is rising gradually in recent years; extreme events such as unexpected incidence of flash floods, submergence, drought, incidence of pest and diseases have increased year by year in last decades. These extreme events affect crops, and livestock which ultimately influence the livelihoods of farming households in stress-prone areas. The effect of climatic variation is more visible in severe stress-prone areas where farmers are entirely dependent on rains.

So far as climate change in northeast India is concerned, Meteorologists have observed rising temperatures in the region as a whole and decreasing rainfall in the eastern and southern areas (Das 2004). They also refer to recent drought-like situations in the years 2001, 2005, 2006, 2008, and 2009 as indicators of climate change in the region (IPCC 2007b). References quoted other symptoms, such as increasing spells of intense rainfall in the pre-monsoon and monsoon seasons in some places causing severe flood in the low-lying areas of the plains, as well as lack of rainfall in post-monsoon and winter seasons in others, both affecting agriculture adversely (ICIMOD 1996).

**Objectives:**

1) Find out the perceptions and experiences of climate shifts by men and women farmers and how this is linked to food security and sustainable livelihoods;
2) Find out the impact of extreme climate variability on agriculture and social activities of farming community.
3) To identify the coping mechanisms of farmers during extreme climate variability

## Methodology

### Definitions:

**Climate variability** refers to variations in the mean state of the climate and variations in other statistics (such as the occurrences of extremes) on all temporal and spatial scales beyond that of individual weather events. The average range of temperature for a location, as indicated by minimum, maximum and average temperature values, is an example of a measure of climate variability. This differs from climate change which refers to a long-term change in the state of the climate and which is identified by changes in the means and/or changes in the variability, or changes in the frequencies or intensities of extreme events.

**Coping and adapting**: The study distinguishes between farmers' short-term and long-term responses to climate variability and food insecurity. It defines short-term responses to a decline in food availability and income in abnormal years as coping or coping strategies and defines longer-term, or permanent changes in the ways in which food and income are acquired as adapting or adaptation strategies, after the work of Davis 1993.

**Adaptation** aims to reduce the vulnerability and improve the adaptive capacity, or resilience, of people who rely on climate-dependent resources for their livelihoods.

In the agriculture sector, adaptation requires the use of good agricultural, forestry and fisheries practices to meet changing and more difficult environmental conditions. Examples of adaptation practices in agriculture included changing timing of planting or sowing, applying new technologies and promoting agro-diversity.

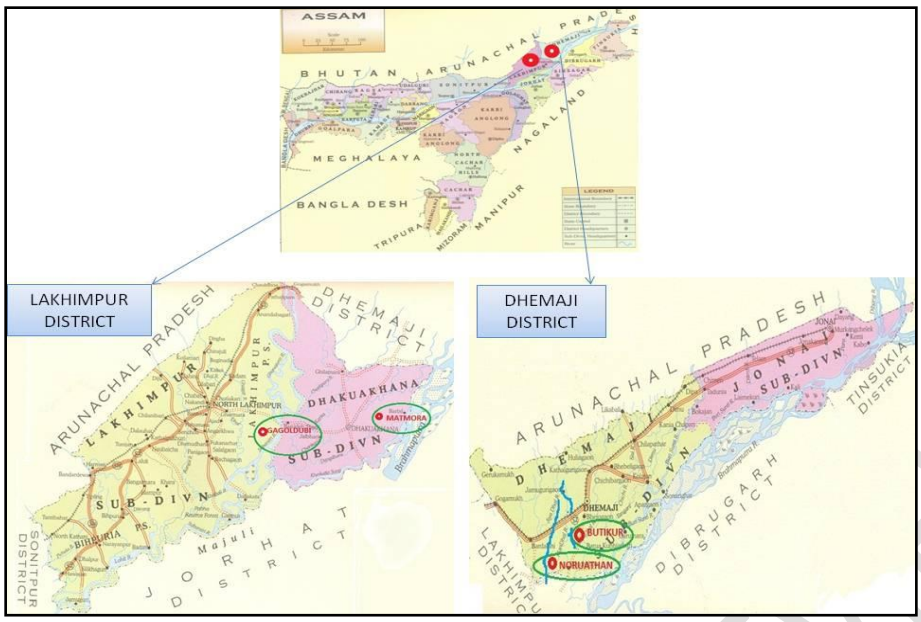


Figure 1. Map showing the Project sites in Lakhimpur and Dhemaji districts

**Sample selection (sampling methods, selection of respondents)**

Altogether four villages were selected to examine men and women farmers'responses to climate variability, particularly in the conditions of severe flood, to secure their livelihoods and food security. These villages were known for a high level of flood -induced emigrant labour (PRA results). From each district, two villages were chosen in consultation with the Officers from State Department of Agriculture, North Lakhimpur Krishi Vigyan Kendra, Assam Agricultural University, Lakhimpur and local NGOs whichare active in the villages. In each district, two villages which are most prone to flood, with limited natural resources and poor communication facilities were selected. Out of four villages a PVS village viz. GagoldubiBorkhelia in Lakhimpur district (Participatory Varietal Selection for Stress Tolerant Rice in submergence area) under Bill and Melinda Gates Foundation Project during 2010-2011 was included in the study.Another village in Lakhimpur district is Matmora which was selected purposively as it is the worst affected village due to flood since 1998 while inDhemaji district two villages viz. Butikur and Noruathan were selected for the study. From each village 30 households which were severely subjected to extreme climate variability were selected and from each household two samples including both male and female were selected to elicit information on their perceptions on extreme climate variability, the impacts and

their coping strategies. The total samples in each village comprised of 60 numbers of households constituting a total of 120 samples in each district. Hence, the total samples for the present study comprised of 240 samples.

The present study included the primary data collected from the sample households which combined both qualitative and quantitative methods of data collection.

The next step is to elicit information on men and women's perceptions of climate variability, the impacts on their livelihoods, and their coping strategies for dealing with food shortages. Participatory Rural Appraisal (PRA) tools such as timeline when normal and extreme climate variability occurred, seasonal calendars (livelihood, fuel, food, availability) transects and resources, gender analysis, Venn diagrams, problem tree, spider diagram, etc were used for the purpose.

In order to map the institutional context in which farmers make their decisions and to cross-reference information provided by farmers, key informant interviews were carried out with representatives of institutions and local enumerators in the two districts.

To quantify the trends described in the focus group discussions, an extensive and well structured and pre-tested questionnaire developed by IRRI, Philippines was used. The questionnaire was administered to a representative, but not random, selection of 240 men and women farmers.

**Data analysis**

The data collected was analysed using appropriate statistical tools for both male and female responses. The quantitative information was complemented by the qualitative responses gathered from the remarks included in the questionnaire.

**Research results**

Men and women's perception on extreme climate variability

This part of this section juxtaposed a simple analysis of qualitative survey on extreme climate variability of the districts under study as per the descriptions of both men and women through their experiences in the last two decades. According to both men and women's perceptions on climate variability for the last two decades rainfall

occurred at normal time in the first decade (1990-2000while in the next decade (2002 - 2010) they perceived that rainfall occurred late than usual during 2002 to 2008 and occurred early than usual in the last two years i.e. during 2009 and 2010 (Table 1). The years 1990, 2000, 2002 to 2006 and 2009 experienced flooding as perceived by both men and women in Lakhimpur and Dhemaji districts while the year 2008 experienced drought and the year 2010 was a normal year. Women farmers responded that in recent years severe flooding due to frequent cloudbursts triggering landslides in the upper reaches of the river Brahmaputra and other major tributaries which caused a major catastrophe in rice farming due to sand deposition which destroyed the whole crop (Wang et al. 2014; Mayowa et al. 2015; Malla et al. 2020). They reported that this catastrophe of sand deposition occurred since the late ninety nineties i.e. 1998 onwards. The description on the amount and pattern of rainfall is similar to the recorded data though their recall memories on the specific years of flooding and drought may not directly coincides with the recorded data.

Table1 :Men and women perceptions on rainfall patterns over the twenty years

| Rainfall Pattern/ Sex | 1990s | 2000 | 2002-2006 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|
| Occurence of rainfall | | | | | | |
| Husband | normal time | normal time | late than usual | late than usual | early than usual | early than usual |
| Wife | normal time | Early than usual | late than usual | late than usual | early than usual | early than usual |
| Average rainfall | | | | | | |
| Husband | more rains than usual and flooding | More rains than usual and flooding | more rains than usual and flooding | drought | more rains than usual and flooding | normal |
| Wife | more rains than usual and flooding | More rains than usual and flooding | more rains than usual and flooding | drought | more rains than usual and flooding | normal |
| Climate | | | | | | |
| Husband | flood year | Flood year | flood year | normal year | flood year | normal year |
| Wife | flood year | Flood year | flood year | normal year | flood year | normal year |

**Gender perception differences on the definition of extreme climate variability**

From their experiences in the last two decades both men and women farmers have realized that climate change has taken place in the last two decades. They perceived that temperature has increased in recent years (100% men and 97% women). Men responded that the intense heat with erratic distribution of rainfall has led to an increase in pest infestations on their crop fields. Women however opined that they can feel that there in an increase in temperature because their number of working hours in the field has been reduced. They described that in recent years they used to go early in the morning hours and come back early as they cannot stand the burning heat in the afternoon hours. Both men and women respondents were also aware that there has been a change in the occurrence and rainfall distribution which varies from year to year in the past 20 years (Figure 2). They narrated that occurrence of both pre monsoon and monsoon rainfall occurred either early or late in the last one decade with an erratic pattern of distribution. In other words, either heavy or low rainfall occurred in both the seasons causing either frequent flood or drought which have greatly affected their farming activities related with rice cultivation. Due to erratic distribution of rainfall the sowing/transplanting time have to be changed which resulted in late harvesting of rice crop. However, there are gender differences on the perception of occurrences of unexpected flood or drought. Men perceived that unexpected flood occurred in recent years while women perceived that unexpected drought occurred in both the pre monsoon and monsoon period. Women also opined that due to unexpected drought in these seasons delayed sowing and planting of rice has resulted in lower productivity of rice which ultimately affect the total production. Besides, women who have larger size of land described that due to the delay in planting they could not cover the whole rice area and the leftover land is left as fallow. The above descriptions of men and women on the definition of extreme climate variability revealed that these farmers through their experience in farming activities do have knowledge on climate shifts. This climate change has led them to adapt with these changes by changing their crop calendar related with farming activities.

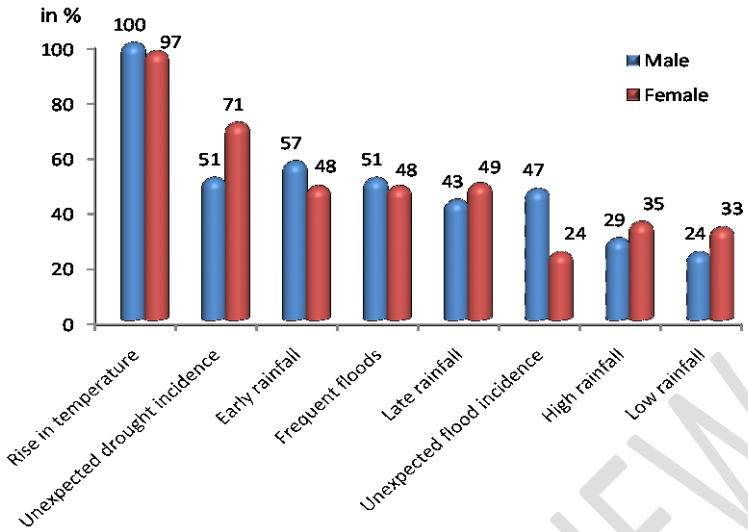


Figure2 : Perception of men and women on the definition of Extreme Climate Variability

**Impact of extreme climate variability on Agricultural and social key components**

Based on the extreme climate variability of climate change as perceived by the farmers in the study area during PRA and Focus Group Discussions, the farmers were asked to describe the changes in their agricultural activities and how does this affects their food and livelihood security. Both men and women expressed that their agricultural activities are solely dependent on rainfall; therefore, adequate and sufficient rainfall played an important role in their livelihood security. They opined that no rain/high intensity rainfall/untimely rain and inadequate rain were the major primary risks facing rice production as "Rice is their Life". Women farmers described that extreme climate variability like severe flood caused a devastating loss in rice cultivation as compared to two decades ago. Severe flood nowadays resulted in sand-silt deposition in rice areas which destroyed the rice crop totally or decrease the productivity of rice and other crops. The decrease in area under rice was due to delayed transplanting, damage of the crop at seedling stage and sand-silt deposition resulting in land situation unfit for cultivation (Table 2). The decrease in pulse area was mainly due to standing water at the time of sowing and sand-silt deposition. However, in the case of oilseed crop both male and female farmers reported that the area has increased because oilseed was cultivated as a compensatory crop due to occurrence of extreme climate variability resulting in loss of rice crop production. Women also reported that due to sand deposition in the river banks has also led to shift in the river courses which in turn affected their agricultural land.

They described that high intensity of rainfall has resulted in erosion of their rice areas and get carried away by the river leading to a decrease in their crop areas. Some others opined that they have left their land as fallow because the areas are unfit for cultivation due to sand deposition.

Besides, decreased in the livestock and by-products has also been reported by higher percentage of both men and women (Table 2). Decreased in livestock production was due to distress sale, occurrences of diseases, decreases in fodder and animals washed away by flood during extreme climate variability. Availability of food, fodder, fuel drinking water decreased as reported by both men and women. Regarding human health both responded that problems such as skin diseases, malaria, gastroenteritis etc increased during extreme flood condition. Fish production has also been reported to be decreasing due to decrease in swampy areas and ponds as these areas has been either washed away by flood and in some areas due to sand deposition.

Table 2 :Changes in various social and agricultural key components due to severe flood

| **Changes** | **Both Male & Female (%)** | | | |
|---|---|---|---|---|
| | Increased | Decreased | No Change | Not Applicable |
| Area | | | | |
| Rice | 5 | 93 | 2 | |
| Wheat | | | | 100 |
| Pulses | 1 | 52 | 2 | 45 |
| Oilseeds | 60 | 36 | 4 | |
| Fallow | 43 | 36 | 9 | 12 |
| Yield | | | | |
| Rice | 10 | 88 | 2 | |
| Wheat | | | | 100 |
| Pulses | 1 | 44 | 16 | 39 |
| Oilseeds | 53 | 28 | 16 | 3 |
| Livestock production | 25 | 66 | 9 | |
| Meat | 9 | 85 | 5 | |
| Milk | 3 | 83 | 14 | |
| Fodder | | 64 | 36 | |
| Fish production | 1 | 72 | 26 | 1 |
| Availability of irrigation water | 4 | 22 | 74 | |
| Availability of drinking water | 11 | 46 | 43 | |

| | | | | |
|---|---|---|---|---|
| Food availability | | 85 | 15 | |
| Fuel availability | 6 | 57 | 38 | |
| Human health problems | 84 | | 16 | |

**Crop Productivity**

Another important factor that contributes towards production and income of the farmers is productivity of the crops. According to the farmer's (regardless of their sex) perception, the productivity of important crops decreased during severe flood year as compared to normal years. According to both men and women the productivity of rice, pulses and oilseeds has declined up to the extent of 55 per cent, 33 per cent and 9 per cent respectively due to extreme climate variability as compared to normal years (Figure 3).The productivity of rice decreased by more than half (55 per cent) from 2692 kg per hectare in normal year to 1221 kg per hectare during flood year. The decrease in yield of pulses was recorded to be 32 per cent, from 741 kg per hectare to 500 kg per hectare. Though the area under oilseeds showed an increase during flood year, however, its productivity has decreased by 9 per cent from 750 kg in normal year to 680 kg per hectare during flood year. The decrease in productivity of crops as perceived by the farmers was because of delayed transplanting of rice and sand deposition.Some women opined that in times of extreme flood condition the crop damage was to the extent of 70 – 80%.

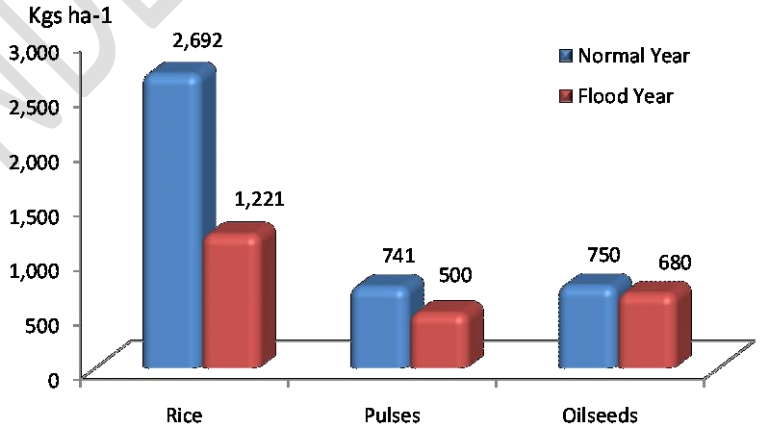


Figure 3 : Change in crop productivity due to extreme climate variability

As discussed above the availability of fodder was one of the important factors that contribute towards decline in the number of livestock. Decreased in grazing land due to sand deposition and erosion as a result of extreme climate variability resulted in the increased in number of hours for collecting fodder. According to the perceptions of women the number of hours spent for collecting fodder increased from 1.65 hours per day to 2.94 hours per day. Male respondents reported that the number of hours for collecting fodder increased from 1.76 hours per day to 3.13 hours per day (Figure 4). Women respondents reported thatdue to unavailability of fodder in the vicinity area they had to go to the market which is atdistance of 6-7km for collecting the waste/throw away vegetables which wereused as fodder.

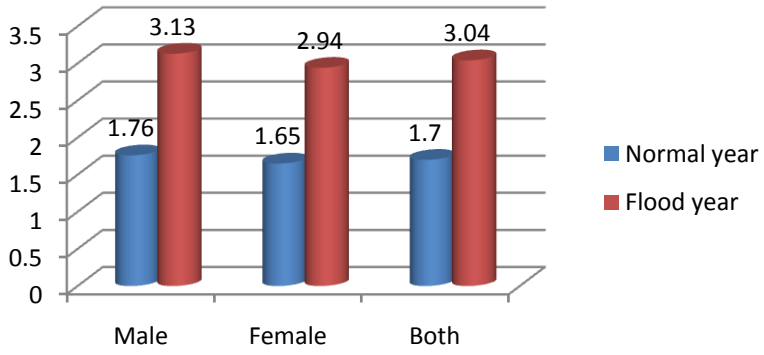


Figure 4 : Change in the number of hours for collecting fodder

**Change in income**

During the year of severe flooding the income of the farmers is greatly affected as compared to normal years. The farmers narrated that due to crop loss or crop damage of rice crop due to severe flooding the income earned from the sale of rice was almost nil during flood year as compared to normal year (Figure). As described by women above the expenditures for purchasing rice and medicines increased so the problem for earning income from other sources also increased. The farmers described that during severe flood they either cultivate non rice crop such as oilseed crop or potato or winter or summer vegetable crop for income. For some farmers who followed double cropping they increased the area under these crops for higher income. Therefore, the income earned from non ricecrop increased during flood year as compared to normal year. Some other

farmers described that they used to grow summer and autumn rice in small area for consumption and the marketed surplus which is very low was sold for income. The income from rice during flood year therefore was very less as compared to normal year. Women farmers expressed that the income earned from non rice crop was not sufficient to meet the increased household expenditures so to compensate the loss they had to resort to distress sale of either large or small farm animals for purchases of food items and medical facilities. In sand deposited areas women expressed that crop cultivation could not be totally done since the year 2000. Therefore, they have completely changed their income activity from crop to livestock rearing. This activity was not a new enterprise for them as in earlier years they used to rear small animals for their own consumption purpose or for earning extra income. Hence the income from the sale of animals increased in flood year than normal year. Other farmers opined that in earlier years they used to go for wage labour during the off season only but due to loss in rice production in flood year they had to do more wage labour for earning more cash income. While others described that due to the risks in crop production, they adopted non farm income activity such as shop keeping. For those family members whose member had migrated for job outside used to receive remittances from them. Men and women especially who used to go for fishing for leisure purpose had adopted fishing as an income generating activity during flood year. Sometimes the surplus fish which cannot be sold in the market were dried in the sun and then sold later on. The total income as a whole showed an increase during flood year as compared to normal year because of the increased household expenditures (Figure 5). Elder women who cannot do any wage labour, fishing or weaving used to prepare local brew and sold it in the weekly market or local market for earning income.

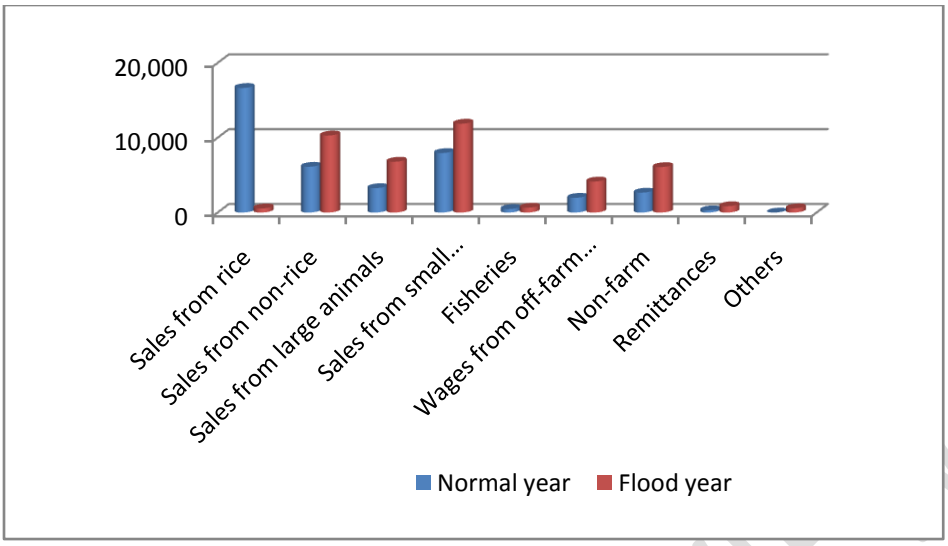


Figure 5 : Change in income during extreme climate variability

Source wise income revealed that the income from sale of rice declined up to the extent of 97 per cent. The sale from non rice crop showed an increase by 68 per cent as these crops were cultivated to compensate loss from rice crop. For other respondent's sale of animals increased by 108 per cent and 49 per cent respectively. The farmers were compelled to sale the animals so as to earn income for purchasing food and medicines etc. Similarly, income earned by wages from off farm income and non-farm activities increased by 110 per cent and 129 per cent respectively especially in sand-silt deposited area. During normal years these farmers work as wage labour only during the off-season period but during severe flood, they had to work more as wage labour to meet the extra expenditure on food and medicine. Harvesting of wild fish, which was a leisure work for the farmers has become an alternative activity for earning additional income. The income from this activity has increased by 38 per cent for the farmers.

**Change in gender components**

Extreme climate variability not only affects the agricultural and social key components of the sample farmers but also greatly affected their economic and gender components as well.

The gender decision for selling of livestock showed a variation between normal and flood year (Figure 6 & 7). The decision for selling large animals is normally done by

men while the decision for selling small animals is done by women. However, 20 per cent of women took the decision to sell large animals like cows and female buffaloes during normal year but their decision making for selling these animals declined by 10 per cent during flood year. The men's decision for selling cow during flood year was more (83 per cent) as compared to normal year (64 per cent) while the decision making of women decreased from 21 per cent to 11 per cent and the decision taken by all members also decreased from 14 per cent to 11 per cent in flood year.

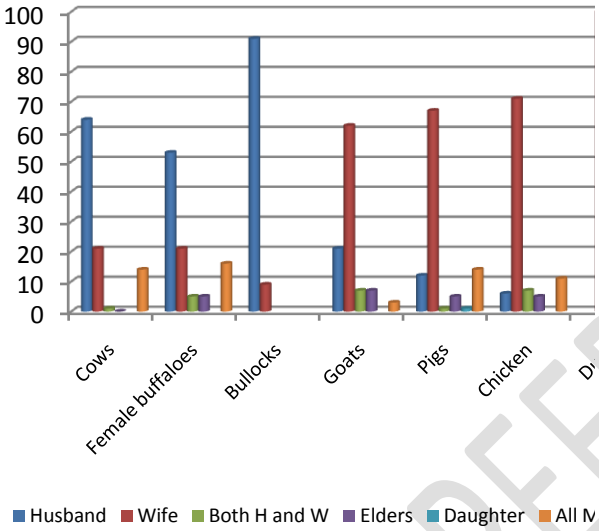


Figure 6 :Gender decision making in selling of animals during normal year

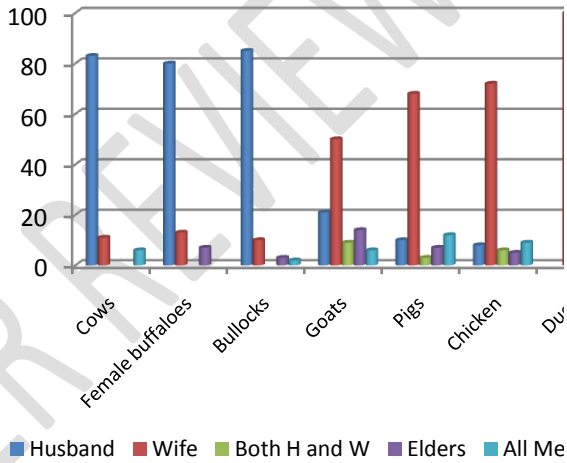


Figure 7 :Gender decision making in selling of animals during flood year

On the other hand, in the case of small animals like pigs and chicken, women were the main decision maker for selling during flood and normal situation for about 70% of the female respondents. For selling of goats, the decision making though lies with women but during severe flood, the decision was taken in consultation with the elders for 14% of female respondents. In the study area, women were found to have played an important role in decision making for the sale of small animals.

**Impact of severe flooding and farmers' response**

The impact of severe flooding may affect not only the agricultural activities of the farmers but also might have an effect on the livelihood and food security of the

farmers. The impact of severe flood was therefore examined in the present study and the results is given in Table 3. From the findings it was found that women responded that crop loss (73 per cent) and food insecurity (54 per cent)were the major impact of severe flood. Men reported the same impact as women but the percentage of men reporting was lower than that of women. Thirty two per cent reported that there has been an increase in indebtedness and 17 per cent of responded that severe flooding has compelled them to work as wage labourer. Low yield was another impact as reported by 38 per cent of men and 37 per cent of women.

Table 3 : Impacts of severe flooding on regular activities

| Impact | Per cent (%) | | |
|---|---|---|---|
| | Husband | Wife | Both |
| Low yields | 38 | 37 | 38 |
| Food insecurity | 45 | 54 | 50 |
| Increase indebtedness | 31 | 32 | 31 |
| Crop loss | 70 | 73 | 72 |
| Agricultural wage laborer | 13 | 17 | 15 |

There are multiple responses.

Due to the negative impact of severe flooding as discussed above the farmers of Lakhimpur and Dhemaji districts had to adapt themselves to such situation by adopting different mechanisms for the security of their livelihood. Thirty seven per cent of the respondents reported that they cultivate more area under cash crops like toria and vegetables like potato etc. while 30 per cent reported that out migration of men especially young men has increased in recent years due to the negative impact of severe flooding. Acquisitions of loan and wage labor were the other alternatives taken by 28 per cent of men and 27 per cent and 23 per cent of men and women respectively for food and livelihood security. Women also reported that muga silk rearing (15 per cent), fishing (6 per cent) and selling of dry fish and rice beer (6 per cent) were the other alternatives that they responded to negative impacts of flooding.

Table4: Response of farmers to negative impacts of severe flooding

| Response | Percent | | |
|---|---|---|---|
| | Husband | Wife | Both |
| Migrate | 29 | 30 | 30 |
| Wage labor | 27 | 23 | 25 |
| Go to neighboring villages for labor work | 18 | 19 | 18 |
| Shop keeping | 11 | 11 | 11 |
| Acquire loan | 28 | 28 | 28 |
| Children drop-out from school | 13 | 15 | 14 |
| Sell assets | 1 | 1 | 1 |
| Cultivate more area under cash crop | 38 | 36 | 37 |
| Growing and selling of livestock | 13 | 16 | 14 |
| Change in cropping pattern | 43 | 40 | 41 |
| Muga production | 3 | 15 | 9 |
| Fishing | | 6 | 3 |
| Selling of goods (dried fish and rice beer) | | 6 | 3 |

There are multiple responses.

As described above severe climate variability has resulted in out migration for 30 per cent of the farmers in the study area in search of alternative livelihood. The respondents were enquired on who among the family members were left behind if migrated. Women (55 per cent) than men (49 per cent) responded that both husband and wife were left behind. Elders were the most sympathetic ones as they were left behind to cope up with and adapt themselves to such situation as responded by 69 per cent men and 65 per cent women.

**Increased Indebtedness during extreme climate variability**

In times of extreme climate variability farmers have to face financial crisis due to low production or crop loss, therefore to meet the required expenditures they are compelled to take a loan from either institutional or non-institutional sources. For those farmers who were cultivating winter crops as a source of alternative income capital is one of an important resource for investment. The source of capital for the farmers in the study areaduring extreme flooding was to acquire loan from either institutional or non-

institutional sources (Figure 8).Bahta and Myeki (2021) reported that access to credit had a positive impact on households' resilience to agricultural drought.

In the present study 39 per cent of the total respondents reported that they acquired loan during severe flooding. Higher percentage of men than women reported that they took a loan. However, equal percentage of men and women reported that they took a loan for crop cultivation and purchase of livestock. Higher percentage of the respondents took a loan for crop cultivation (96 per cent) and the rest for purchasing livestock.

Institutional sources formed the major source of loan for the farmers in the study area providing fund to more than 80 per cent. Among institutional sources commercialised bank constituted the major source of fund to 65 per cent of the respondents. More women than men responded that they obtained loan from institutional sources while men responded that non institutional sources were the main source of loan for them. Both men and women (22 per cent) responded that co-operative was their main source of fund. Non-institutional sources such as family/relatives, friends and co-farmers were the sources of loan for 29 per cent, 23 per cent and 11 per cent of both men and women respondents (Figure 9).

Repayment of loan and the source of income for its repayment are important for the farmers as failure to repay the loan deemed these farmers as defaulters which in turn creates difficulties in acquisition of loan in the future. Selling of large animals (Figure 10) was the major source of income for repayment of loan as reported by majority of women (46 per cent) as compared to men (44 per cent). However, a greater number of men than women reported that sale of small animals (38 per cent), crop sale (36 per cent) and 31 per cent of men sold their land for repayment of loan.

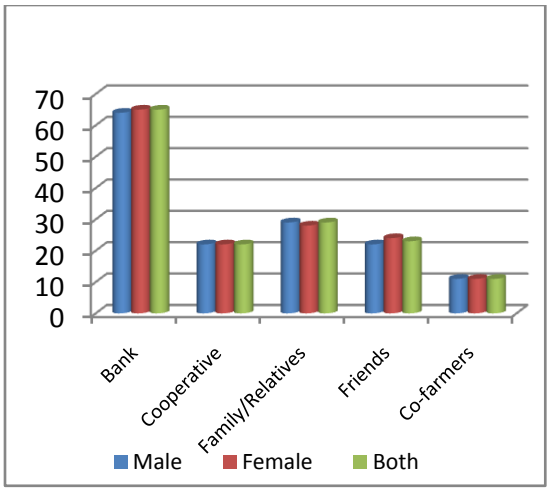


Figure 8: Source of loan and income source for repayment of loan

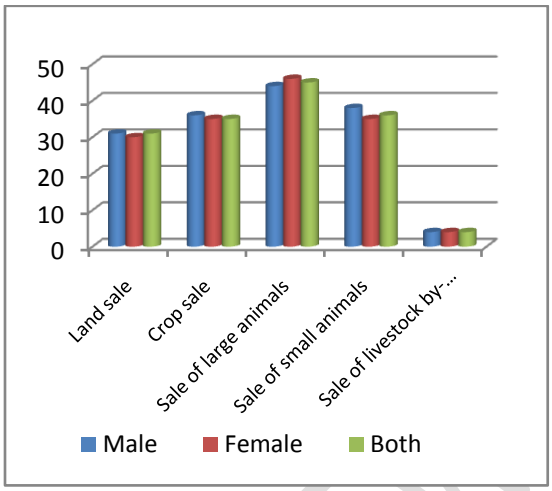


Figure 9: Income Source for repayment of loan

**Change in farming activities and farm decision making**

The changes in farming activities during severe flooding was also studied.Table revealed that 50 per cent of the total respondents changed their cropping pattern. Earlier these farmers used to cultivate mono-cropping only but extreme climate variability has compelled them to cultivate double crops in a year. This is because production of rabi crops like oilseed or vegetables ensured them a good income for the loss in kharif season. While 36 per cent of the households has shifted from crops to livestock enterprise and 24 per cent left their farm land as fallow due to sand deposition. Their land has been converted to sand dunes which makes cultivation difficult for them due to moisture stress. Sixteen per cent of both men and women farmers reported that they grow more cash crops or more kinds of crops respectively. These farmers cultivate two crops in a year. During extreme flood they increased the area under cash crops during the rabi season to make up for the loss in kharif season. About 7 per cent of the households increased the production of muga silk production and other one per cent goes for fishing for earning income. Women were more likely than men to report that during severe flooding a change in the cropping pattern, selling of large animals, left their farm land as fallow and fishing activity has increased.

Table 5. Changes in farming activities during severe flooding

| Change | Flooding | | |
|---|---|---|---|
| | Husband | Wife | Both |
| Cropping pattern | 49 | 50 | 50 |
| Shift from crops to livestock | 39 | 33 | 36 |
| Grow more cash crops | 16 | 16 | 16 |
| Grow more kinds of crops | 16 | 17 | 16 |
| Leave as fallow | 23 | 25 | 24 |
| Selling of small and large animals | 10 | 23 | 16 |
| Increase muga production | 11 | 3 | 7 |
| Fishing | | 3 | 1 |

There are multiple responses.

**Coping mechanisms in times of severe flooding**

Studies on the coping mechanisms/strategies adopted by the farmers during extreme climate variability are very crucial for the survival and livelihood security particularly of the marginalized communities. The adverse impacts of severe flood have forced 52 per cent of the total respondents to change their livelihood form farm to non-farm and off farm for income earning (Table), 45 per cent were adopting other non-crop income strategies such livestock and fishing while others either change their cropping pattern (41 per cent) or increase area under non-rice crop (37 per cent)

Table 6. Coping mechanisms in response to adverse impacts of severe flooding

| Coping mechanism | Percent Response | | |
|---|---|---|---|
| | Husband | Wife | Both |
| Increase area under non-rice | 38 | 36 | 37 |
| Change in cropping pattern | 43 | 40 | 41 |
| Non-farm and off-farm income | 54 | 50 | 52 |
| Non-crop income (livestock, fishing and weaving) | 52 | 38 | 45 |

There are multiple response

## IV. Conclusion

The present study was carried out with the objective to find out the gender roles in the perception of climate change, their experience of climate shifts and how this is linked to their food security and sustainable livelihood as well as their coping strategies. The results from the research findings revealed that both men and women perceived and experienced similar extreme climate variability in terms of increased temperature and occurrence of rainfall but they differed in the perceptions on the occurrence of rainfall pattern. Both men and women respondents also have similar perceptions on the effect of extreme climate variability in food and livelihood security. The evidence that emerged from the gender roles in decision making showed that women in the study area do have an important role in decision making but their participation in decision making decreased during extreme climate variability. The results of the findings also showed that both men and women have complementary strategies with respect to farm activities but they also have different mechanisms with respect to non-farm and off-farm income to cope up with the changing climate for food and sustainable livelihood. In times of extreme climate variability only three-fourths and one-fourth of men and women received the support from institutional sources indicating that men have more access to institutional support than women.

To sum up a whole it can be concluded that though the gender roles is different by the type of definition i.e. male and female yet both had similar observations on the climate changes. It can also be concluded that the role of women in the participation of decision making is reduced during the extreme climate variability and the access to information and institutional support is quite low as compared to men. Hence, there is a need for improving the role of women in the study area by empowering them through capacity building, skill development and exposure visits.

## VI. Recommendations

1. Planning for adaptation to long term strategies in flood prone areas must be based on men and women farmers' specific knowledge and experiences on climate shifts and their choices for adaptation in an uncertain climate.
2. Future plans and policies must take in to consideration of the reality of rice-based farming situations today including migration and what the implications will be for long term community and sustainable food and livelihood security.
3. The consequences of climate change led to crop loss, decrease in area and productivity of crops, increase in fallow land due to sand-silt deposition. Therefore, with the rising concerns in climate change in recent years such type of consequences is more likely to increase in the next few years. Hence, research needs is the most priority in these flood prone areas for identifying the crops suitable and acceptable to the farmers. Besides, soil testing and improving the quality of soil through integrating of livestock enterprises would also help in shortening the period of being left as fallow and bring back the land to normal rice cultivation.
4. Training, capacity building and exposure visits of both men and women on the different coping strategies adopted by them would help to improve the food security and sustainable livelihood in the long run through better marketing of their products.
5. Introduction of stress tolerant rice varieties as well as High yielding non-rice crop varieties suitable in the flood affected and sand-silt deposited areas would further help in raising the income level of the farmers.
6. As seeing is believing training and demonstration of scientific method of integrated rice cum fish culture in the farmers field especially for those men and women farmers adopting fishing as a coping strategy would help in reducing the time spent on this activity as well as increase their profitability.
7. Training of men and women on the source of information with regard to information on suitable cropping pattern/agronomic practices would help in the easy access for such type of information.
8. Proper and weekly dissemination of information on weather forecasting through distribution of leaflets by the agro-meteorology advisory services along with

information on agronomic practices of different crops would help the farmers to carry out their agricultural farm activities timely or delay as per forecast weather.

9. Training on scientific crop and livestock management, entrepreneurship is the requisite for the farmers in the study area.

10. Training and provision of improved loom and designing to women group can help them get a better price and market for their products.

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