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Climate Variables, Rice Yield and Farmers Perception- A Study in Nalbari District of Assam

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ABSTRACT

Climate is one of the main determinants of agricultural production. In Assam, agricultural production is affected by climatic variables. Nalbari district of Assam experiences the effect of climate change both in the form of flood due to excessive rain and draught resulting from scanty rainfall. Farmers of the district try to cope with the change by adopting different strategies at their level. An attempt was made in this paper to measure the effect of some climatic variables on rice yield for last seventeen (2001-2017) and how the farmers react to the climate change in Nalbari district. Both primary and secondary data were used for the study. A sample of 120 rice growers of Pub-Nalbari Block (Sariahtali and Chengnoi villages) and Barkhetri block(Adabari and Loharkatha villages) was interviewed to assess their perception towards climate change. It was observed that rice yield in the district was influenced by climatic variables. With heavy rainfall during crop growth period and deviated rainfall from normal rainfall were found to affect the rice yield negatively while temperature and relative humidity were found to affect the rice yield positively. The study observed that sample farmers were aware of climate change with increased frequency of flood and droughts, changes in the timing of rains, observed trends of temperature and precipitation. Further some strategies such as introduction of new crop varieties, change towards other professions and use of KCC *etc*. were found to adopt by the farmers to mitigate the climatic effect. The results of this paper are expected to help in further research on effect of climate change on agriculture, farmer's perception towards climate change in the study area and in the state as a whole.

Keywords: Climate variability, farmers' perception, Nalbari district, rice production.

INTRODUCTION

Agriculture and its allied activities played an important role in the socio- economic development of the State of Assam as this sector is the major contributor to the State economy as well as providing livelihood to a significant proportion of the population of the State. Over 70 per cent of the state's population relies on agriculture as farmers, as agricultural laborers, or both for their livelihood. In Assam, compared to various other sectors of economy, agriculture is unique, whose output is largely dependent on weather conditions. However, in the state 23 per cent of the net sown area either flood or drought prone. The declining trend of growth rate of agricultural sector is due to the adverse weather condition experienced by the state. Global warming is projected to have significant impacts on conditions affecting agriculture, including temperature, carbon dioxide, glacial run-off, precipitation and the interaction of these elements .It indirectly affects agriculture by influencing emergence and distribution of crop pests and livestock diseases, exacerbating the frequency and distribution of adverse weather conditions, reducing water. The climate change is any change in climate over time that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere in addition to natural climate variability observed over comparable time periods (IPCC, 2007). Studies have shown a significant effect of change in climatic factors on the average crop yield (Dinar *et al.* (1998), Seo and Mendelsohn (2008), Mall *et al.* (2006) and Cline (2007). Many studies in the past have shown that India is likely to witness one of the highest agricultural productivity losses in the world in accordance with the climate change pattern observed and scenarios projected. Various studies have indicated a probability of 10 to 40 per cent loss in crop production in the country due to the anticipated rise in temperature by 2080. Studies conducted by Indian Agricultural Research Institute (IARI) have pointed to a possible loss of 4 to 5 million tones in the overall wheat production with every 1 degree

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centigrade increase in temperature throughout the growing period of the crop. Agricultural-based livelihood systems that are already vulnerable to food insecurity also face risks such as crop failure, new patterns of pest and diseases, lack of appropriate seeds and planting material and loss of livestock.

According to IFAD (2009) the number of poor and hungry people has been increasing and the world now faces a major economic downturn .Climate change, growing competition for land and prices volatility for food and impact on rural people in developing countries. In India, climate change will put additional stress on ecological and socioeconomic systems that are already facing tremendous pressures due to rapid urbanization, industrialization and economic development. With its huge and growing population, a 7500-km long densely populated and low-lying coastline and an economy that is closely tied to its natural resource base, India is considered to be especially vulnerable to the impacts of climate change. Within agriculture, it is the rainfed agriculture that will be most impacted by climate change. There are a number of studies which assessed the impact of climate change on Indian Agriculture and vulnerability of the small and medium rainfed farmers in different aspects. But the perceptions on the climate change and the factors which drive the farmers to adopt or to follow coping mechanisms have not been studied in detail. The aim of the study, therefore, is to assess the impact of climate change on the yield of rice, to identify the perception of farmers on climate change and to identify the coping mechanisms of farmers to mitigate the impact of climate change.

The study area selected to access the impact of climate change is Nalbari district of Assam, where the rain fed farmers are highly vulnerable to frequent floods, droughts and other climatic factors. The gross cropped area of the dristrict is about 99,860 ha. The District has a sub-tropical climate with semi-dry hot summer and cold winter. During summer, generally during the months from May to August, heavy rainfall occurs for which the district experiences flood. The District experiences annual (average) rainfall of 1500 mm and 80 per cent Relative Humidity (RH). Out of the total rainfall, 66.7 per cent is received during monsoon period (June-September). The pre-monsoon period (March-May) is characterized by unpredictable and erratic rainfall (26.1%) resulting in delayed sowing/planting of crops. The post monsoon period (October-November) is unpredictable with low rainfall. The primary activities found here is agricultural production and the common crops grown include paddy, mustard, linseed, lentil, pea, jute, Rabi vegetables, areca-nut *etc.*

METHODOLOGY

A study was conducted for 120 rice growers of Pub-Nalbari Block (Sariahtali and Chengnoi villages) and Barkhetri block(Adabari and Loharkatha villages). The farmers were interviewed to assess their perception towards climate change. Primary data were collected using appropriate questionnaire based on objective of the study. Focused group discussion (FGD) has been used for collection of base line data of the villages. Although the study focuses on Nalbari, it is held that the result generated from this study is relevant to many areas of the state as well as other states with a similar climate and socio-economic structures.

The information collected was to ascertain the present status of farming system, the traditional farming system practiced and its continuation, people's perception about climate change issues *etc.* The methodology adopted for achieving the stated objective was solely field based collection and collection of data. Both primary and secondary data were used in this study. The primary data include information sourced from administration of structured questionnaire to the rural farmers in the study area while the secondary data (Climatological and agricultural data for 12 years) was obtained from agricultural department. The clima-tological data examined here include rainfall (actual, normal rainfall and percent deviation) maximum and minimum temperature and relative humidity while the crops examined include paddy with area, production and productivity. The paddy yield was correlated with the climatic variables in order to establish a relationship. For the purpose of analysis rainfall, temperature, humidity was considered in the regression model as explanatory variables and yield as the dependent variable. For the purpose of present study, the following model has been used:

$$Y=f(X_1, X_2, X_3, X_4, X_5, X_6,)$$

Where,
Y= Winter rice yield (kg/ha)
X_1= Max temp =Maximum temperature (0C),
X_2=Min temp= Minimum temperature (0C),
X_3=RH =Relative humidity (%),
X_4=AR=Actual rainfall (mm),
X_5=NR=Normal rainfall (mm),
X_6=Dev R=Deviation rainfall, a dummy 0 is assigned for negative deviation and 1 for positive deviation.

Simple tabular analysis, percentage etc were used to analyze the perception, adaptation strategies of the respondents.

RESULTS AND DISCUSSION

In order to study the impact of climate change on productivity, regression equations were estimated using log linear production function. Variables pertaining to actual rainfall, normal rainfall, temperature, humidity, crop area and yield pertains to year 2001-2012.Table 1 presents climatological data with rice yield.

Table 1: Climatological and rice yield data for 2001-2012. (Nalbari district)

Year	Yield (Kg/ha)	Actual Rainfall (mm)	Normal Rainfall (mm)	% Dep	Temperature		RH
					Max (^{0}C)	Min (^{0}C)	
2001	1130	2265.70	2208.80	2.58	32.75	19.80	69.99
2002	1150	1926.50	2168.05	-11.14	29.60	20.00	69.80
2003	1200	1890.60	1506.60	-11.13	28.70	20.30	68.10
2004	1260	2527.80	2037.10	10.37	28.70	20.20	70.80
2005	1190	2410.10	2880.80	-1.76	28.90	20.30	80.70
2006	1290	2385.70	2221.70	25.81	32.75	17.22	76.60
2007	1320	1518.70	1955.70	-15.45	34.52	17.32	76.90
2008	1616	2320.80	2520.80	15.43	37.30	17.24	77.70
2009	1757	1564.50	1836.40	-17.49	37.02	16.50	80.10
2010	1614	2404.00	1702.60	27.38	36.77	21.60	77.00
2011	1286	1512.00	2159.10	-35.82	37.25	19.00	79.00
2012	1306	2224.90	1921.30	-4.20	36.40	16.23	91.00
CV(%)	15.23	18.25	10.25	14.56	10.85	9.59	8.26

*Source-District Agricultural Office, Nalbari
Where,RH=Relative humidity (%),AR=Actual rainfall (mm),NR=Normal rainfall (mm), Dep=Departure(%),Max(0C)=Maximum temperature, Min (0C) =Minimum temperature

Table 1 revealed that there are variations in the yield (15.23 %) and other climatic factors such as actual rainfall (18.25), normal rainfall (10.25), per cent departure (14.56), maximum temperature (10.85), minimum temperature (9.59) and relative humidity (8.26). It is found that rice recorded the highest yield in the year 2009, decreased in 2010, increased again in 2012. The changes may be attributed to area, use of HYV seeds, other strategic inputs and climatic factors in the study area. According to Ayode (2004), rainfall is the most important climatic variable in agricultural production. It was reported that approximately 10000 bigha of land with paddy cultivation has been damaged across 21 villages in five revenue circles of Nalbari due to flood. (Gadanayak, 2012).

The result of the regression model in presented in Table 2. Model summary of regression analysis showed that R^2 for rice yield is 65 per cent (Table 2). This table reveals that the variable of maximum temperature, minimum temperature, relative humidity, actual rainfall, normal rainfall and deviation could explain 65 per cent of variation in rice yield . This implies that climate alone explained these percentages of variation observed in the crop yield in the study area. Other factors such as farm management techniques and edaphic factors (ecological influences properties of the soil brought about by its physical and chemical characteristics) could be responsible for the remaining percentages.

Table 2: Estimated Regression equation for rice productivity and climatic Variables in Nalbari district. (2001-2012)

Intercept	Coefficients	S.E	t-test
Intercept	6.84	4.57	1.49
X_1 (Max. temp)	0.78	0.96	0.80
X_2 (Min. temp)	0.18	0.61	0.29
X_3 (RH)	0.21	1.39	0.15
X_4 (AR)	0.17	0.62	0.26
X_5 (NR)	-0.67	0.49	-1.35
X_6 (Dev R)	-0.04	0.23	-0.15
R^2			65
R			81

It was found that none of the climatic variables had significant effect on rice yield in the district. However, both positive and negative relation between climatic variable and rice yield was found. Maximum temperature, minimum temperature, relative humidity and actual rainfall were found to impact positively rice yield and normal rainfall and deviated rainfall were found to impact rice yield negatively in Nalbari district. A positive relationship between rice yield and rainfall was reported by Ogbuene (2010). An increase in summer rain and maximum temperature was found to contribute positively to rice yield in Nepal (Joshi, *et al.,* 2011). Talukdar *et al.* (2009) reported that in chars of Assam, low precipitation in rabi season does not affect crops because of frequent low intensity rainfall, high relative humidity and contribution of dew during that period which substituted most of the requirements of rabi crops. However, in a study by Saseendran *et al.,* (2000) reported that rice yield was negatively related to maximum temperature. Wilson (1990), maintained that climatic factor of importance are precipitation and its mode of occurrence, humidity, temperature and wind (speed and direction), all of which directly affect evaporation and transpiration.

Perception of Climate Change on Agriculture

Socio-economic analysis

Looking at the farming activities, most farmers fell in 41-50 age group as indicated in Table 3 and this can be as the result of lack of interest in agricultural production from other age categories. It is found from literature that there is variation in age on adoption decision. According to Bekele & Darke L (2003) age had no influence on a farmer's decision to participate in climate change

adaptation activities. However, according to Bayard et al. (2007) age is positively related to some climate change adaptation measures. Most farmers in the village assumed that old age is associated with more experience and they expect older farmers to adapt to changes in climate while young farmers are expected to have longer planning horizon and thus to take long term adaptation measures. Education and employment are important factors influencing decision to adapt. Most of the farmers in the study have completed some secondary education (43.33 %) while only few farmers have graduate degree (20 percent) as seen in Table 3.The majority of farmers are marginal farmers with size of farm of less than 1 hactare (53.3 %) as seen in Table 3. It was further emphasized by Maddison (2007) that educated and experienced farmers are expected to have more knowledge and information about climate change and adaptation measures to use in response to climate challenges.

Table 3: Socio-economic characteristics of respondents

Age in years	**Frequency**	**Percentage**
21-30	8	6.66
31-40	28	23.33
41-50	76	63.33
Above 50	8	6.66
Total	120	100
Educational Status	**Frequency**	**Percentage**
Upto HSLC	44	36.66
Secondary (Upto HS)	52	43.33
Graduate	24	20
Total	120	100
Sizes of farm	**Frequency**	**Percentage**
Marginal (less than 1 ha)	60	50.00
Small (1-2 ha)	40	33.33
Semi Medium (2-4ha)	20	16.66
Total	120	100
Total Marginal area(ha)	9.46	31.54
Total small area (ha)	16.99	56.66
Total semi medium area (ha)	14.13	47.11

All most all farmers grew rice crop (100%), Rabi vegetables (83.33 %) and then mustard (53.33%)

Table 4: Major crop grown by the farmers

Crops	**No of farmers**	**Average Area (ha)**
Rice	120 (100 %)	1.06
Vegetables	100 (83.33%)	0.10
Mustard	64 (53.33%)	0.17

Figure within the parentheses indicate per cent to total farmer

Farmers in the study area were asked to discuss their perception about climate change and the results are presented in the Table 5. Most of the farmers were not able to express their perception on climate change directly but they expressed through the effects or the changes that occurred compared to the earlier years or based on their previous experiences.

Perception of climatic variability

From their discussion, most of them perceived climate change as severe incidence of drought (73.33%), increase in temperature (60%), occurrence of flood (36.66%) and delayed rainfall (26.66%). Some perceived it as unusual heavy rainfall (23.33%), Insect-pest damage and crop failure (16.66%) while very few just discover that the weather has changed from the way it was before. In the table 5, perceptions on the impact of climate change of the representatives are presented.

Table 5: Farmers perception on the impact of climate change

Variables	**Yes**	
	Frequency	**Percentage**
Drought	88	73.33
High temperature	72	60.00
Flood	44	36.66
Delayed rainfall	32	26.66
Unusual heavy rainfall	28	23.33
Insect-pest damage/crop failure	20	16.66

Reasons of changes in climatic variability

Majority agrees that human beings are the causes of changes in climatic variables due to increase in population, bush burning and cutting of trees i.e human or anthropogenic causes (70%) while others said it was because of natural cycle (13.33%) and 16.66 per cent said it was due to God's annoyance or God's 'Judgment' of our sin .Most of the farmers reported that the late monsoon rain causes a delay of planting paddy by 15 to 45 days almost every year. There is a shift of the onset of rain by more than a month in Kharif season (July-Sept) and about a month in Rabi Season (Nov- April).Besides this, rainfall is not sufficient, resulting in reduced yields and lower returns to the farmers. Mainly affected are the hybrids and so called high-yielding varieties which need a lot of water and require external inputs to produce well. The causes are presented in the table 6.

Table 6: Causes of changes in climatic variables

Causes	**Yes**		**No**	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Natural causes	16	13.33	104	86.66
*Anthropogenic causes	84	70.00	36	30.00
God's annoyance	20	16.66	100	83.33

(*Anthropogenic causes- changes in nature made by people)

Coping Mechanisms of Farmers to mitigate the impact of climate change

Farmers have always used their traditional knowledge to cope with the effect of climate change. They

learned from their ancestors to cope with the situations of their time as well as through technologies .The decisions are mainly taken by head of the family members and male persons only. In response to persistently unpredictable weather, more male respondents preferred migration in search of wage labour (43.33%) as a coping strategy, whereas more women preferred local wage labour to migration as a coping strategy. Some respondents adopted changing cropping pattern (46.67%) and some have changed variety of rice (*e.g.* Satyaranjan var., Basundhara var. *etc.*) instead of local variety (26.66%).

Table 7: Adaptation strategies of farmers to climatic changes

Strategies	Frequency
Change of cropping pattern	56 (46.67)
Change of variety of paddy	32 (26.66)
Shifting profession	52 (43.33)
Borrowing/financial support	60 (50.00)
Irrigation or technology	12 (10.00)
Selling livestock	44(36.66)
Migration to cities	4 (3.33)

Figures within parenthesis indicate per cent to the total respondents

CONCLUSION

The study revealed that changes in climatic variables as occurrence of flood, droughts have considerable impact on the yield of rice as rain fed crop. After analyzing the impacts of climatic variables on yield, it was found that both positive and negative relation existed between climatic variables and rice yield. In view of this, small and marginal rain fed farmers adopted coping mechanisms to thrive the effect of climate change. The farmers already reacted to the changes in the climatic changes both by adopting the coping mechanisms on positive side and negatively through shifting to other professions. Many of the farmers that participated in the study emphasized this during the interview: they want to adapt, but they cannot do it alone. It was widely suggested by participants that the government should enforce conservation policies, thus encouraging rainfall and environmental health. Farmers need adequate knowledge about the importance of climate change in order for these farmers to be able to adapt effectively. To accomplish these farmers should use different information sources like the media both printing and the electronic, research institutions such as the agricultural research council, agricultural extension services and civil societies like NGOs for the dissemination of the climate change, climate advisory information across various farmers in the province. Farmers should be encouraged and enabled to use crop diversification as adaptation coping strategy. The extreme weather patterns caused by climate variability and change have impacted the farming communities severely for the past several years. The majority of these farmers have limited adaptive capacity, finance and technology to respond towards climate change challenges. These farming communities must use the resources available to them to tackle climate variability and change. The women should be empowered to participate in debates, discussions and decision-making concerning agriculture. The KVK should aware the farmers to grow both flood and draught tolerant rice varieties depending on the situation. The study suggests that as the climate change is intensifying day by day it should be addressed through policy perspective to avoid yield loss and shifting professions by farmers.

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