IOSR Journal Of Humanities And Social Science (IOSR-JHSS)
Volume 20, Issue 7, Ver. III (July 2015), PP 79-85
e-ISSN: 2279-0837, p-ISSN: 2279-0845.
www.iosrjournals.org

Impact of Climate Change on the Production of Rice and Potato in Paschim Medinipur District, West Bengal

Anirban Hatial and Dr. Manishree Mondal
Faculty, Department of Geography, Midnapore College, Midnapore, WB

I. Introduction:

Climate change is one of the most important global environmental challenges of the present century. Global warming has been in increasing trend since the 1980, although the earth's average surface temperature has increased by about 1.2 to 1.4^0F in the last 100 years (Mendelssohn, 2007). Climate change might be a major concern to human being since it affects so many economic sectors as well as different aspects of human life. Negative impacts of climate change on the agricultural sector will be especially dangerous since it is directly related to food security and human health.

Paschim Medinipur District of West Bengal is such a drought prone area where more than 80% people are dependent on agriculture. Around 60% of total agricultural lands are rainfed and it is highly vulnerable to climate change particularly in monsoon season. More than 80% of total farmers' in this district are small and marginal and thus, having less capacity to cope with climate change impacts on agriculture. At present, paddy as cereal crop in kharif season and potato as cash crop in Rabi season are the two most important staple foods in this region. In most agro-climatic regions, farmers have compelled to stop to cultivate such crops which are the best suitable for that regions. Climate change is projected to have serious implications for there crops because irrigation facilities are not available sufficiently although rice is rainfed crop but potato cultivation is fully dependent on irrigated water.

Our main concern is to assess the impact of climate change particularly the unevenness and variability of rainfall and fluctuating temperature on these two staple crops. We are also trying to analyse the perception of farmers about the impact of climate change, the adoption strategies adopted by them to cope with these climatic vagaries.

CONCEPT:
Before the impact analysis we must know about the climate change and the agricultural system of this district.

Climate Change:

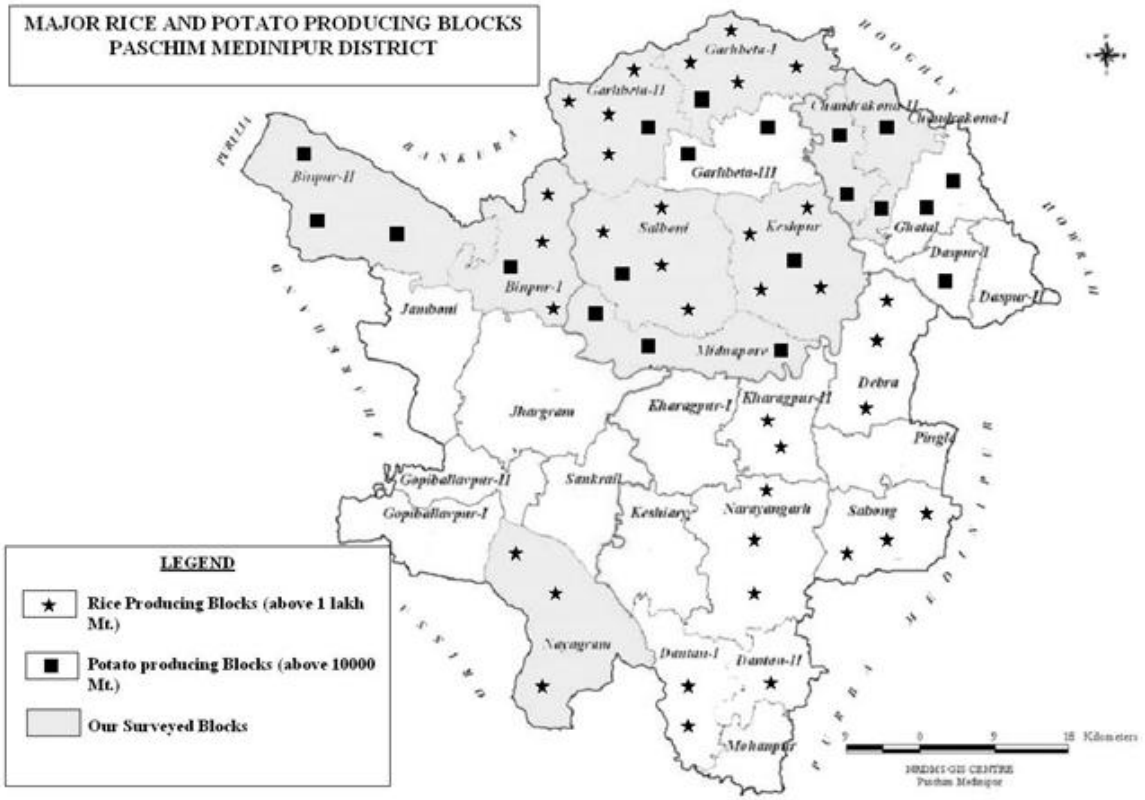
According to IPCC, "Climate change refers to a change in the state of the climate that can be identified by change in the mean or variability of its properties and that persists for extended periods, typically decades or longer". Climate change is evident from the observations of increase in global average air temperature, sea surface temperature, variability in precipitation, extreme weather events, widespread melting of snow and ice, storm surges and coastal flooding. The unprecedented change in the monsoon related rainfall is expected to have severe impact on the hydrological cycle of this area and thus, changing the pattern, frequency and intensity of extreme rainfall events (flood and drought).

Agricultural System:

The key characteristics of the agricultural system of this area that could influence its vulnerability to climate change are; (i) the high level of subsistence type agriculture with very small holdings; (ii) majority of agricultural practices particularly in kharif season and rainfed; (iii) unevenness, seasonality and variability of rainfall mainly control the crop yield, (iv) maximum thrust on food cropping, not on cash cropping; (v) irrigation facility is not sufficient.

STUDY AREA:

Paschim Medinipur District (21^0 36'35"N – 22^0 57' 10" N to 86^0 33'50" E – 88^0 12' 40" E) is located in the extreme South Western part of West Bengal. The average attitude is 39 mt above m.s.l. The total geographical area is 928.53 ha. The area is served by the river Kangsabati, Silabati, Subarnarekha etc. and the soil mainly red lateritic and sandy loam type. The total population are 5943300 (2011) of which the no. of cultivators are 456650 (2011) and no. of agricultural labourers are 616181 (2011). The district headquarters is Medinipur (22^0 25'N and 87^0 19'E).



II. Methodology And Data Base:

The study is focused on the impact analysis of climate change particularly the change in temperature and rainfall on the yield of rice and potato. The related data were collected from Government published records and documents, climatic and agricultural departments and administrative offices.

For perception analysis of farmers, a multi-stage random sampling design was employed for the selection of the sample respondents across various economic, age and racial classes.

The total sample constitutes 300 respondents of 20 mouzas of 10 C.D. Blocks. The required information for the study was collected using pre tested structured questionnaire schedule. The collected data were tabulated and statistically analyzed to interpret the result. Descriptive statistics were used to assess farmer's perceptions.

III. Analyses And Results:

It is evident that physical impact of climate change are seen as, (i) increase in the average temperature by $2^0C - 4^0C$ (ii) changes in rainfall (both distribution and frequency) during pre-monsoon, monsoon and post-monsoon seasons, (iii) decrease in the no. of rainy days by more than 15 days, 9iv) an increase in the intensity of rain by 1-4 mm/day, (v) increase in the frequency and intensity of cyclonic and hail storms, (vi) improper onset of monsoon, (vii) increasing long dry spell etc.

Table: Distribution of mean seasonal temperature and rainfall.

Year	Season wise distribution of temp. ^0C			Season wise distribution of rainfall in mm		
	Pre-monsoon	Monsoon	Post-monsoon	Pre-monsoon	Monsoon	Post -monsoon
2000	27.5	29.13	22.75	75.75	279.50	11.25
2001	27.88	28.75	22.88	90.75	281.50	44.75
02	27.88	29.25	22.63	55.75	328.00	32.00
03	28.50	29.12	22.12	50.75	207.25	130.50 **
04	29.75 *t	31.25 *t	22.50	22.75 *r	275.00	43.50
05	28.5	29.88	22.50	56	254.50 *r	91.50
06	28.63	29.25	23.13	48.5	297.75	12.75
07	27.75	29.25	19.00	54.5	476.75 *rr	115.25 *rr
08	27.37	28.87	23.12	51.00	398.25	24.50
09	27.39	28.33	23.22	76.50	200.50 *r	20.75
2010	29.88 *t	32.50 *t	22.75	41.50 *r	192.75 *r	29.50
2011	28.5	31.13 *t	22.75	41.50 *r	192.75 *r	29.50

[Source: *Indian Meteorological Dept. - Alipore, Kolkata*].

N.B. $*^t$ = increasing temperature from normal.
$*^r$ = decreasing rainfall from normal.
$*^{rr}$ = flood situation.
** = increasingly rainfall in post monsoon period from normal.

Rice in kharif season and potato in Rabi season are the two most important staple crops in this region. We can say that the economy of this area depends on these two crops. All the climatic vagaries impose negative impact on the production of both rice (rainfed) and potato (irrigated water fed).

Table: Agricultural land use of the district (2012).

Agricultural land use	Area (000 ha)	Cropping intensity (%)
Net sown area	558.70	168
Area sown more than once	379.94	
Gross cropped area	938.64	

(Source*: Dept. of Agriculture, Govt. of West Bengal*).

Table: Irrigation (2012).

Irrigation status	Area (000 ha)	% to total geographical area (928.53 ha)
Net irrigated area	82.4	8.87
Gross irrigated area	428.12	46.11
Rainfed area	510.52	54.98

(Source: Dept. of Agriculture, Govt. of West Bengal).

Most of the areas of the district are largely dependent on rainfall for irrigation. Any change in rainfall pattern poses a serious threat to total agricultural system.

Table: Yield of rice and potato

Year	Rice				Remarks	Potato				Remarks
	Area (000 ha)	Production (000 tonnes)	Yield (Qnt./ha) (Dist. level)	Yield (Qnt./ha) (State level)		Area ('000 ha)	Production ('000 tonnes)	Yield (Qnt./ha) (Dist. Level)	Yield (Qnt./ha) (State level)	
2001-02	580.3	1441.1	24.83	24.12		47.1	1335.4	283.52	284.57	
02-03	642.1	1551.8	24.18	25.58		67.1	1841.8	274.49	282.51	
03-04	651.4	1508.2	23.15	25.23	Late onset of monsoon	61.1	1547.5	253.27	250.32	
04-05	655.3	1736.8	26.50	27.14		56.7	1268.7	223.76	225.14	
05-06	654.0	1629.6	24.92	25.94	Long dry spell	71.3	1519.6	213.13	215.24	Unpredicted rainfall
06-07	692.4	1798.8	25.98	25.93		79.4	843.7	106.26	123.84	Deep tog and more rainfall
07-08	650.2	1798.8	27.67	25.73		70.7	1874.4	265.12	247.04	
08-09	718.9	1856.7	25.83	25.33	Lesser rainfall	63.6	557.3	87.63	106.77	Out break of diseases
09-10	674.3	1756.5	26.05	25.47		62.7	2448.1	390.45	357.68	
10-11	616.7	1718.6	27.87	27.08		64.7	2482.4	383.68	328.31	

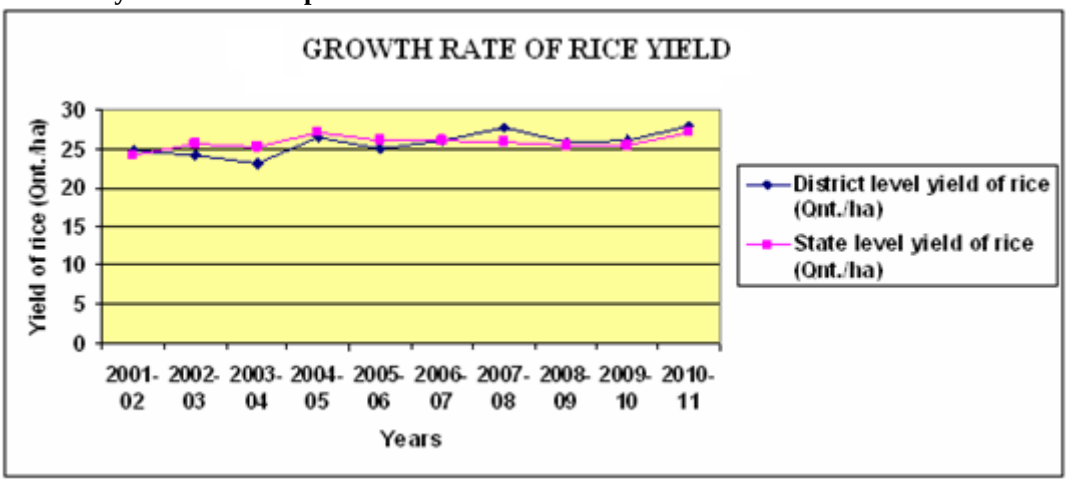
(Source: *Dept. of Agriculture, Govt. of West Bengal*).

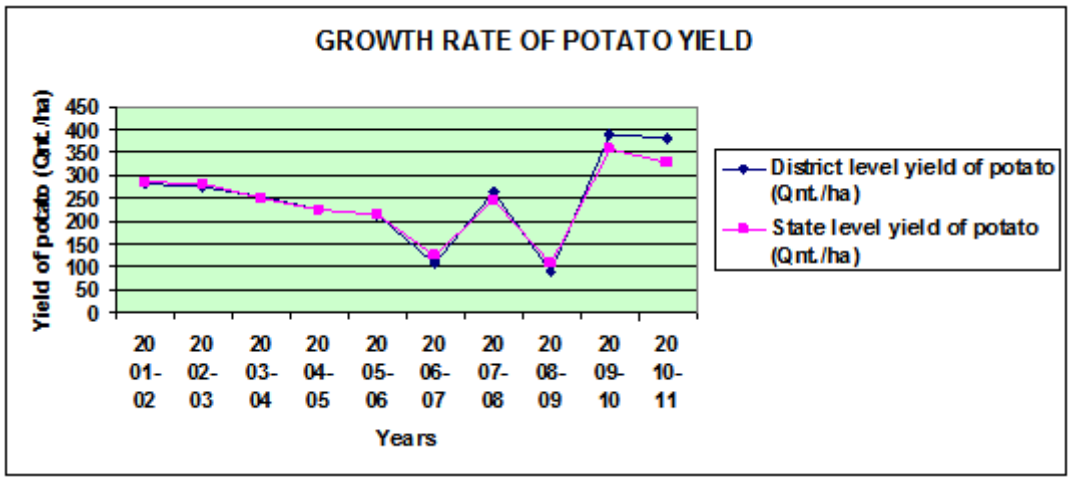
The cultivation of rice and potato is adversely affected not only by an increase and decrease in all overall amounts of rainfall but also by shifts in the timing of rainfall. For instance, the yield of rice is sufficient in the year of 2004-05, 2007-08, 2010-11 due to the right timing and distribution of rainfall. On the other hand the rice yield is poor in the year of 2003-04, 2005-06, and 2008-09 because of improper onset of monsoon, long dry spell, and intense rainfall in 2-3 days or flooding. The cultivation of potato in Rabi season also hampers due to the unpredicted rainfall (2005-06), hail (2006-07), out break of diseases (2008-09) etc. Even the amount of moisture and temperature in the soil will be affected by changes in factors such as precipitation, run off and evaporation.

The multivariate regression analyses between changes in temperature, rainfall and yield of rice and potato show the positive relation in case of positive changes and negative relation in case of negative changes (+1 in the case of temp. and yield of rice, +0.82 in the case of rainfall ; - 0.48 in case of rainfall and potato etc.).

Besides other agricultural technologies it is evident that supply response of food production is greatly influenced by the irrigation facilities. It is however, true that now with over 54.98% of rainfed areas under rainfall is still one of the most important factors determining average yield. Due to the vagaries in rainfall in 2008-09 1856.7 thousand tonnes of rice production, nearly 515.42 thousand tonnes were produced in the areas without irrigation.

Growth rate of yield of rice and potato:





Farmers' Perception About The Impact Of Climate Change On Rice And Potato Production:

The farmer's perception on the climate change was assessed using open ended as well as closed and perceptive as well as conceptual type questions. Most of the farmers did not know the concept of climate change as such directly but they expressed through the effects or changes of different climatic phenomena that occurred compared to the earlier years or based on their elder's experiences. The perceptions of the farmers are organized and tabulated in the following:

Impact factors	Perception in %			
	Small farmers	Medium farmers	Large farmers	Total farmers
Reduction in yield	84.27	79.58	65.13	76.33
Reduction in net income	89.26	81.63	62.15	77.68
Pest and disease out break	75.34	72.67	69.25	72.42
Seasonal variation in rainfall	98.26	92.56	96.25	95.69
Crop failure	96.25	94.26	74.56	88.36
Shifting of seasons	74.56	76.68	72.48	74.57
Change in other climatic phenomena such as deep fog, hail, cyclones etc.	96.25	92.45	95.36	94.69
No idea	2.56	3.26	13.56	6.46

Table: Farmer's perception on the impact of climate change

The results of the above table reveal that the farmers of all categories are suffered by the impact of climate change but the worst impact imposes on the small and medium farmers because of their dependence on

climatic phenomena particularly on rainfall hazards. Large farmers can cope with the changing pattern to some extent due to their capacity to avail agricultural technologies and better economy.

Table: Farmer's perception of climate.

Climatic events	Perception of farmer's (%)		
	Increased	Decreased	No Change
Temperature	96.17	0	3.83
Rainfall	16.25	73.50	10.25
Occurrences of drought	61.00	5.00	34
Late onset of monsoon	85.00	0	15
Early withdrawal of monsoon	76.00	0	24
Long dry spell	86.00	0	14
Uneven distribution of rainfall	98.00	0	2
Unpredictable rainfall	84.00	6.00	10
Other climatic hazards	83.00	0	17

The result indicates that most of farmers perceived that the distribution of the temperature had significantly increased. By contrast almost all said that the rainfall level had continuously decreased. The majority of respondent believed the uneven distribution and unpredictable behavior of climatic phenomena.

Table: Reasons for reduction in yield and net revenue.

Impact factors	Perception of total farmers (%)
1. Change in seasonal pattern of temperature	56
2. Change in seasonal pattern of rainfall distribution	92
3. Soil erosion and fertility	12
4. Out break of pests and diseases	78
5. Other climatic hazards, such as fog, hail, cyclones etc.	62
6. No idea	8

The respondent farmers are highly concerned about the reduction of yield and net income because crop yield sustains their lives. The seasonal increase in temperature and seasonal variation of rainfall, and other climatic hazards such as deep fog, hail and cyclones etc. mainly are responsible for low yield rate. They mostly perceived that the out break of pests and diseases occurred due to these climatic changes. It is clear that most of the farmers are very much conscious about the lowering yield rate and the reduction of their annual income.

Thus, we can say that the impact of climate change on agricultural production are considered into main three ways, such as –

(i) direct effects on rainfed yields through changes in temperature and rainfall;
(ii) indirect effect on irrigated yields from changes in temperature and in water available for irrigation ; and
(iii) Autonomous adjustments to area and yield due to the use of agricultural technology, price effects and changes in trade system.

The direct and indirect effects of climate change on agriculture play out through the economic systems, altering prices, production productivity, food demand and ultimately human well-being.

ADAPTIVE MEASURES AND STRATEGIES:

It is now urgent need to recognize the climatic change and variability issues holistically through various adaptive measures particularly what the farmers want. Proper use of latest improvements in agricultural technologies and right time weather forecasting system can enhance the agricultural productive and meet the future challenges of climate change in this region.

FARMER'S PERCEPTION ON ADAPTIVE MEASURES:

Various adaptation strategies used by the farmers in response to challenge climatic changes.

Table: Major adaptation strategies to mitigate the impact of climate change

	Adaptations	Farmer's perception (%)			
		Small farmers	Medium farmers	Large farmers	Total farmers
1	Integrated / mixed farming system	94.35	75.27	61.19	76.94
2	Use of short duration crop varieties	45.23	46.68	33.59	41.83
3	Change in cropping pattern	62.57	44.23	28.11	44.97
4	Change in time of farm operation	74.02	65.81	55.73	65.19
5	Soil conservation techniques	35.32	46.27	55.29	45.63
6	Crop rotation	83.42	71.57	65.19	75.39
7	Inter cropping	81.22	73.42	63.56	72.73
8	Increase the use of organic manners	47.13	45.67	16.23	36.34
9	Use of stress tolerant seeds	10.56	20.32	30.45	20.44
10	Use of water conservation techniques	70.21	61.35	55.53	62.36
11	Shifting of other occupations	85.58	76.29	25.63	62.50
12	Borrowing	86.74	59.45	10.41	52.20
13	Insurance	12.32	15.52	35.39	21.08
14	Reduce expenditure of consumer goods	65.35	51.21	5.29	40.62

The results reveal that an integrated farming system was considered to be one of the most important adaptations to cope with the climatic vagaries. Changing the timing of sowing, planting, harvesting; to take advantages of the changing duration of growing season and associated heat and moisture level was another options. Farmers have developed a wide range of management practices such as intercropping, crop rotation, rainwater harvesting etc. But even now the agricultural insurance is not so popular among farmers most probably due to their unconsciousness.

IV. Recommendations:

In order to reduce the adverse impacts of climate change on agriculture, few adaptive actions need to be taken at various levels. These strategies will have to be based on sustainable land use practices which are better suited for the local climatic variability.

1. Care management of resources like soil, water etc. taking up all possible measures to increase water resources and reserves at all levels taking the advantages of local relief.
2. Focus should be given on the stress tolerant local varieties of seeds.
3. Changes in the cropping pattern and cropping sequence if necessary. Focus to given on sustainable agriculture techniques like mixed cropping, intercropping etc.
4. Change in the land use pattern considering relief and soil depth and water availability of the area.
5. Close monitoring of weather elements and their impact on standing crops to bring the situation under control.
6. An early warning system should be put in place to monitor changes in pest and disease profiles and predict new pest and disease out breaks.
7. The agriculture credit and insurance system must be made more comprehensive and responsible to the needs of small farmers particularly.
8. Substitute employment opportunities outside the agricultural sector such as fishing, poultry farming can improve the economy of the farmers.
9. Awareness among the farmers about the nature and extent of weather changes is very essential.
10. Transportation, distribution and market integration to provide the infrastructure to supply food during crop failures.

V. Conclusion:

This research clearly reveals that the climatic variations have significant impact on the production of both rainfed as well as irrigated crops. The small and medium farmers are most affected due to the poverty and lesser ability to cope with the climatic changes. Agriculture is still the main source of income and provides a fundamental contribution to welfare and socio-economic development of this region. Thus, climate change can be viewed as one of the most critical environmental problems to confront us as it is most immediately linked to human well-being, development and economic growth.

References:

[1]. Agarwal, P.K. (2008), "Global climatic change and Indian agriculture, impacts and mitigation", **International Journal at Agricultural Science,** 78 (10).
[2]. Dinar, A.R, R.Mendelson, J.Parikh, A.Sanghi, K.Kumar, J.Mckinsay and S.Lonerger (1998), "Measuring the impact of climate change on Indian agriculture" – **Technical Report, the World Bank,** Washington D.C. USA.
[3]. IPCC (2007), "Climate change 2007: Impacts, Adaptations and vulneratrility", Summary for Policy Makers, Contributions of Working Group" to the **Fourth Assets must Report of the IPCC.**
[4]. MC Michael, A.J., R.E. Woodruff et al (2000), "Climate change and human health: present and future risks", **Lancet** 367 (9513).
[5]. Mishra, S. (2008), "Dakshin Bonger Paschim anchaler Samasya -o- Samadhan" **SAAR SAMACHAR**, Vol. 46, No.-1.
[6]. Shukla, P.R., S.K. Sharma and Venkata P.Ramana (2002), **"Climate change and India – issues, concerns and opportunities**" Tata McGraw – Hill, New Delhi.

ABOUT AUTHORS:

[1]. DR. MANISHREE MONDAL – Reader, Dept. of Geography, Midnapore College, West Bengal.
[2]. SRI ANIRBAN HATIAL – Permanent Part time Lecturer, Dept. of Geography, Midnapore College, West Bengal.