

Impact of Climate Change on Water Resources Availability and Crop Productivity in Uttar Pradesh

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Abstract: Global food supply will depend on how well agriculture adapts to climate change. The apparent impacts of the global climate change in India include erratic monsoon, high intensity floods, increased frequency of draughts, decreasing crop yields among others. Rapid industrial development, urbanization and the increasing demand for irrigation water to feed the burgeoning population of India are already placing immense pressure on water resources. There is a direct link between the rise in global temperature and damage to eco-systems. About 130 million hectares (mha) land in India is undergoing different levels of degradation, namely water erosion (32.8 mha), wind erosion (10.8 mha), desertification (8.5 mha), waterlogging (8.5 mha). The arid and semi-arid regions of the country are more prone to desertification. Depletion of natural vegetation and cultivation on sand dunes and marginal lands accelerate soil erosion. Trends indicate that agricultural productivity will decline up to 25 percent which could be as much as 50 percent in rainfed agriculture. Small and marginal farmers with small land holdings will be more vulnerable to climate change. Climate change over last few decades has endangered food security. Impacts are diversified and need to be addressed through public-private partnerships among communities, local government and states. There are two fold approaches to mitigate the climate stress – firstly by reducing greenhouse gas emissions, the main culprits of climate change and secondly, by adopting measures to mitigate adverse impacts of climate change. Water harvesting and conservation both in agriculture and domestic sectors has to be a national priority. Use of drip and sprinkler irrigation systems, mulching and bed plantation, construction of small tanks and check-dams are some of the conventional measures for water conservation and harvesting. In Alwar region of Rajasthan for example, barren lands have been converted

into lush fields adopting these measures. Dried up rivers got rejuvenated by making 'Johads', - small earthen check dams.

Temperature and rainfall are the two major factors affecting crop-productivity in U.P. The main cropping pattern is rice-wheat based system in terms of area coverage, water consumption and farm income in both the sub-basins of Jaunpur and Immamganj Branch which falls in Tarai region. In both the sub-basins rain-fed pulse crops such as lentil and pigeon pea are grown on considerable area. Improvement in land drainage is a pre-requisite for achieving the crop diversification. Vertical drainage in the form of pumping groundwater is a cost effective measure to lower the high water table. Also, the aquifer has storage properties and can be operated as inter-seasonal and multi-annual water storage facilitating supply of water in periods of scarcity. Thus further development of groundwater is an important strategy to achieve crop diversification.

Introduction: Agriculture is one of the most vulnerable sector to the anticipated climate change. Despite the technological advances in the Green Revolution during 1967-68 onwards, weather and climate are the basic factors in determining the agricultural productivity. Agriculture in India is extremely diverse in the range of crops grown and livestock raised. The predicted change in climate as well as their associated impacts are all likely to effect substantially the potential of agriculture.

Climate change will increase productivity in certain crops and regions with reduced quality in short term but ultimately it will turn negative over the longer period .While climate change clearly effects agriculture, climate is also affected by agriculture, which contributes 13.5% of all human induced green house gas emissions globally.

Climate Change and Agriculture: Uttar Pradesh Scenario

Crop response in a changing climate reflect the interplay among three main factors:

- 1) Rising temperatures
- 2) Changing water resources
- 3) Increasing carbon dioxide concentration.

The spatial distribution of temperature change indicating a significant warming trend has been observed along the west coast, central India and interior peninsula and over north east India. However, cooling trend has been observed in north-west and some parts of southern India, but past 130 years records do not show any specific long term trend in the frequencies of large scale droughts or floods in summer monsoon season. Soil moisture is

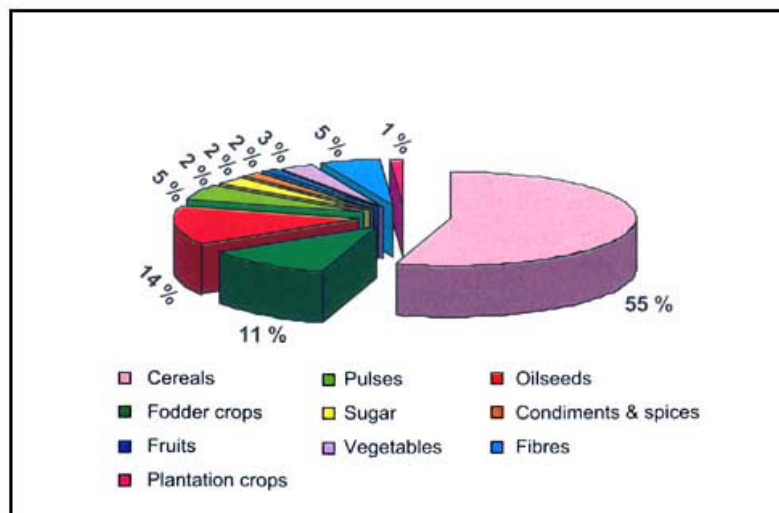
dependent of interaction of temperature increase and changing rainfall patterns. Evaporation and precipitation both are increased with rise in temperature. The resulting net effect on water availability would depend on dominating force. As per the IPCC reports of climate change at high latitudes and some wet tropical areas and decrease some dry regions at mid latitudes and in the dry tropics by the middle of 21st century (IPCC7b). Some drought prone regions may suffer more severely.

Contribution of Agriculture in Mitigating Climate Change

There are various ways with which we can set limits to our GHG emission. We must aim to adopt the technology and knowledge which reduce the emission of GHG especially in the agricultural sector. This process is called Mitigation to Climate Change. Experts say modern industrial agriculture is causing problems and traditional agriculture maybe a possible solution. However, both are so interconnected with each other that it is difficult to isolate traditional and modern ways of food production. Let us see the sustainable ways of agriculture through which we could mitigate climate change.

1. Cultivation of Rice
2. Organic Agriculture
3. Development of Resource Conserving Technologies
4. Multiple-cropping or Inter-cropping
5. Turning Vegetarian
6. Agro-forestry
7. Carbon Sequestration
8. Localization of food
9. Livestock Management
10. Soil Management
11. Afforestation and promotion to wetlands

FIGURE 1
Crop groups by cropped area



Rainfall pattern and annual number of wet days over GGB

In Ghaghra-Gomti Basin, decadal pattern of annual rainfall and number of wet days were studied from 1901-2007. Study reflected that decadal rainfall was below normal during the decades 1901-1910, 1981-1990,1991-2000 and 2001-2007. The detailed annual analysis indicated that the Ghaghra-Gomti Basin has been experiencing below normal rainfall consistently since 1987 with exception of year1990, when it was +4.56% above normal rainfall . In the study it was found that the pattern of temporal variation of number. of wet days in basin was almost the same as that of quantity of rainfall. Above study over Ghaghra-Gomti basin indicates that there has been marked decrease in rainfall pattern since 1987 onwards.

The river of Ghaghra Gomti basin are perennial in nature. The river do not follow the same pattern through out the year, even do not remain at a high stage over the monsoon season. It is only spell of sever rains may be several hours or few day that generates large run off in the catchments. The rivers of the basin namely Gomti and Sai have minimum flow during most part of the year.

Figure 1 Percent Deviation of Annual Rainfall with Mean (1981-2007)

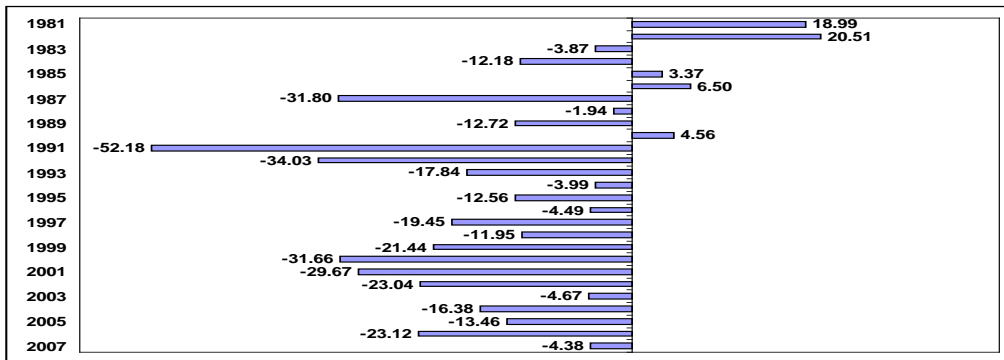
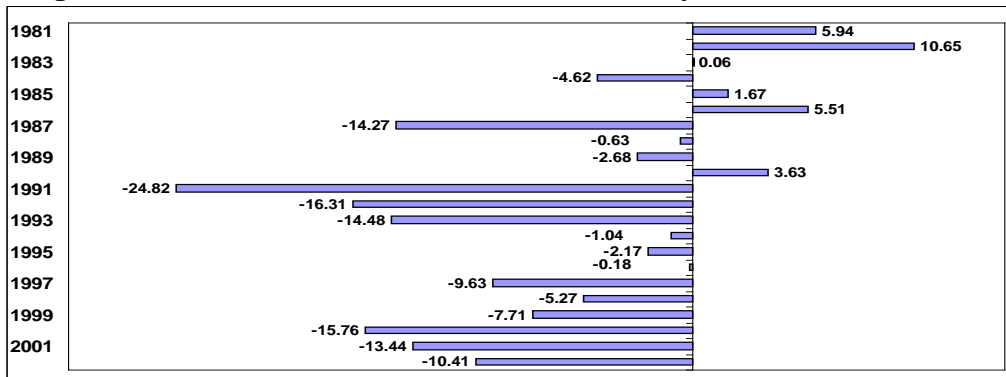
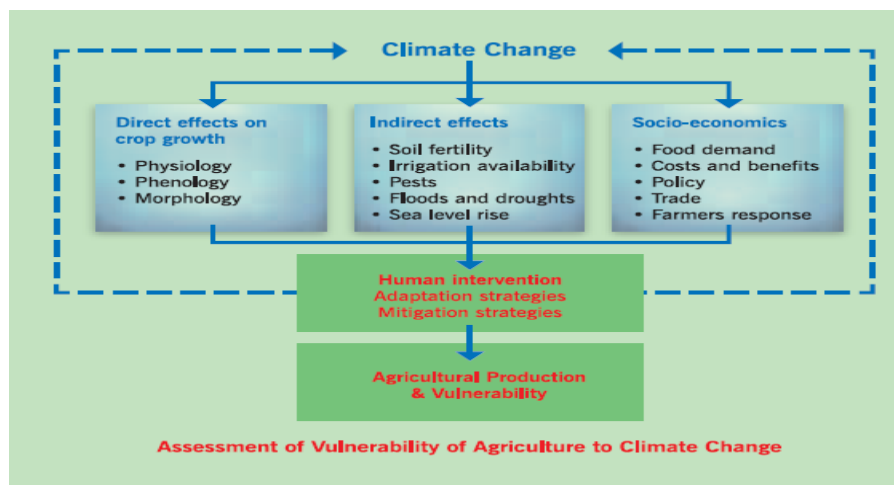


Figure 2 Percent Deviation of Annual No. of Wet Days with Mean (1981-2002)



The Sai river, has gone in the worst position in view of flow; where one can travel across the river bed. All the irrigation schemes on this river almost have been closed, which effected the irrigation and ultimately crop yields. Other rivers of GGB have flow because they receive water from their sources and base flow but in reduced quantum. This is the direct impact of decrease in rainfall pattern, as after 1987, the decreased rainfall resulted as the lowering ground water level and flow less condition of rivers. Unavailability of surface water has forced the farmers to use ground-water for irrigation purpose which ultimately adversely affected the ground water as lowering of that. Increased agricultural productivity will be required to feed the increasing population. Climate change can have detrimental impact on plants and this will be increase in steady manner. For the food security, agriculture enterprise have coped with change in climate through management and in crop or animal selection. However, in future scenarios, the projected climate changes are likely to increasingly challenge the food security of India and need to efficient strategies



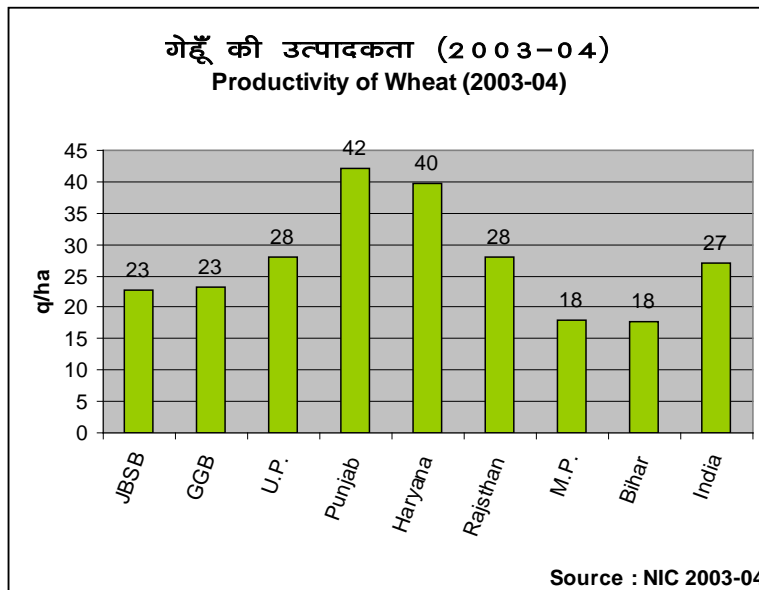
Water

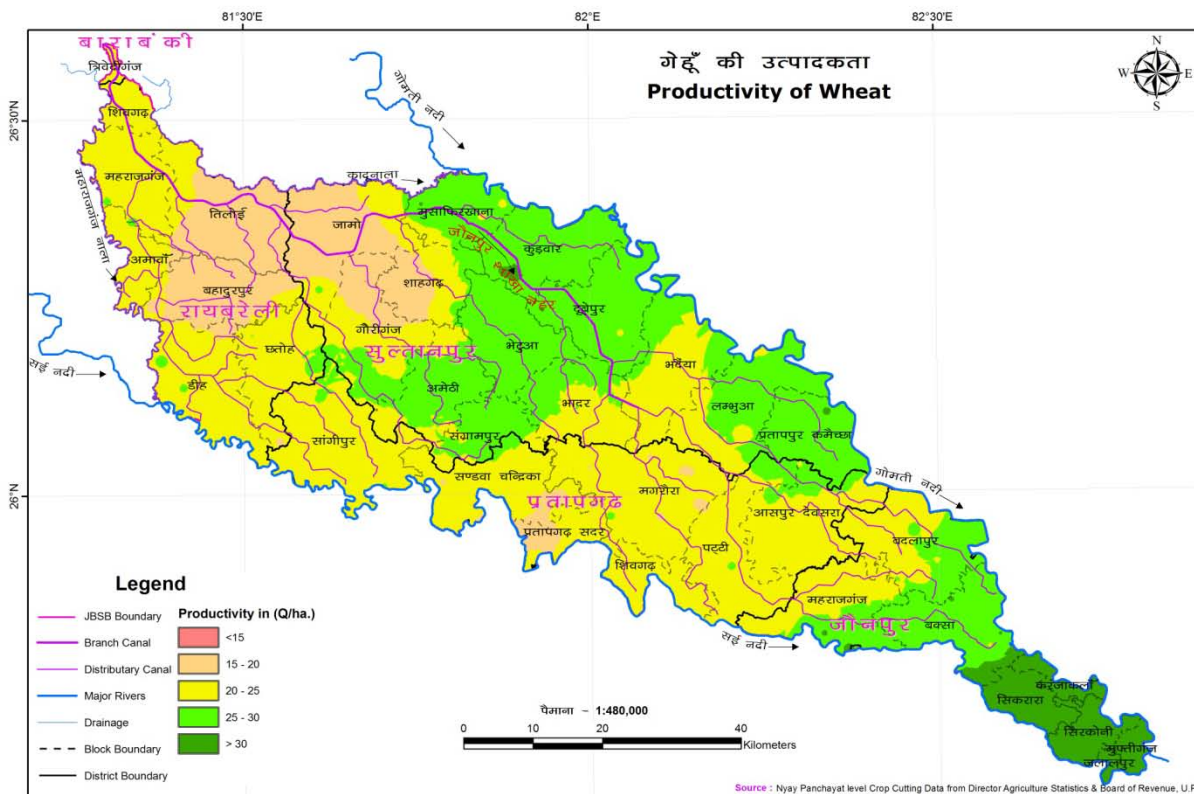
One of the most pronounced effects of climate change is the increase in heavy rainfall with more intensity. As it is projected that number of wet days will decrease and

monsoon rain will increase. A combination of increase in rainfall intensity and reduction of number of wet days suggest the possibility of increasing severity of floods.

On consequence of field flooding during the growing season production is reduced due to low oxygen level in soil, susceptibility of roots for diseases, affected nutrients supply etc. Amount of moisture in soil will be affected by change in rainfall, runoff and evaporation. Drought frequency is also projected specially in tropical region. In high temperature water requirement of plants will be increased as a resultant in drought.

In the both situations tolerant crops /varieties are required to avoid the detrimental effects. Another projection which indicated to increase the monsoon rainfall needs to increase the area under crops like rice. Rainfall is likely to be reduced in winters, need to grow the less water required crop eg. pulses, oilseeds etc.





Livestock are very sensitive to heat. Warming would cause a decline in livestock yield. Temperature and humidity causes stress and discomfort in animals and reduce the ability to produce milk, gain weight & reproduce, require longer period for meat operations, decrease in conception rate. Warming also cause disease and suitability to pathogens. To maintain the productivity of animals would require modified facilities to reduce stress and proper under standing of diseases to protect them.

MITIGATION/ ADAPTATION STRATEGIES: WAY FORWARD

Climate change over last few decades has endangered food security in India. Impacts are diversified and need to be addressed through public-private partnerships among communities, local government and states. There are two fold approaches to mitigate the climate stress – firstly by reducing greenhouse gas emissions, the main culprits of climate change and secondly, by adopting measures to mitigate adverse impacts of climate change. Water harvesting and conservation both in agriculture and domestic sectors has to be a national priority. Use of drip and sprinkler irrigation systems, mulching and bed plantation, construction of small tanks and check-dams are some of the conventional measures for water conservation and harvesting. In Alwar region of Rajasthan for example, barren lands have been converted into lush fields adopting these measures. Dried up rivers got rejuvenated by making ‘Johads’, - small earthen check dams.

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