A STUDY ON CLIMATE VARIABILITY EFFECTS ON AGRICULTURE IN HARYANA

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INTRODUCTION:
The change in climate is a continuous and unequivocal process. The National Aeronautics and Space Administration, NASA (2014) describes climate change as the global phenomena of adding heat trapping gases to the earth’s atmosphere by burning of fossil fuels. It includes processes like increase in temperature or global warming, rise in sea level, loss of ice mass, extreme weather events etc. Climate change is one of the important problems faced by today’s world. Climate is the average atmospheric conditions prevailing in a particular area over a large period of time. Atmospheric conditions include elements like insolation, temperature, humidity, precipitation, air pressure winds etc. Climate change is therefore the process of long term changes in the atmosphere conditions or the weather phenomenon of a given area. According to Intergovernmental Panel on Climate Change, IPCC (2007) climate change refers to change in the state of climate that can be identified (by statistical tests) by changes in the mean and the variability of its properties and that persists for an extended period, typically decades or longer. United Nations Framework Convention on Climate Change. UNFCC (1992) defines climate change as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climatic vulnerability observed over comparable period of time.

The 5th Intergovernmental Panel on Climate Change, IPCC report (2014) states that the combined land and ocean temperature data shows an increase of 0.89°C over the period 1901-2012. The warmest 30 year period of the last 1400 years in the north hemisphere was 1983-2012.

CLIMATE VARIABILITY

The Intergovernmental Panel on Climate Change, IPCC (2013) defines Climate Variability as the variations in the mean state and other statistics such as standard deviation of the climate on all spatial and temporal scales beyond that of individual weather conditions. It can be explained as the fluctuation of climatic conditions around the average without causing the long-term average itself to change. The major causes of climate variability are the natural processes within the climate system and anthropogenic forces. It can be measured by observing the fluctuation in temperature, rainfall data and frequency of occurrence of extreme events. It may range from few months, seasons or years. The main impact of global warming is the increase in frequency of extreme weather events related to rainfall and temperature. (Karl et al., 2008). The last few decades experienced great variations in precipitation, particularly the south-west monsoon, sudden rise in temperature, change in radiation, extreme events such as cyclones etc.

CAUSES OF GLOBAL CLIMATE CHANGE

Before the industrial revolution, the natural factors like variation in solar energy, volcanic eruptions, natural change in greenhouse gas concentration etc were considered as the main causes of climate change. But in the present scenario natural factors are dominated by human activities. The main causes of climate change can be categorized into natural causes and anthropogenic causes as follows:

a) Role of Sun- The Sun is the source of energy for earth. The output of solar energy is not constant; it varies over time to time. The combined effect of sun spot activity, sun’s rotation and solar wind can be seen on the changes in the heat budget, the general circulation and the precipitation patterns on the earth.

b) The change in eccentricity of earth’s orbit- The tilt of earth’s angle varies slowly between 22.1° to 24.5° during a cycle of about 41,000 years. It affects the temperature distribution, seasons and general circulation. The ice age cycles of Milankovich are based on these orbital variations. The mean distance from the earth to the sun could vary with the change in eccentricity of the earth’s orbit which could affect the temperature on the earth.

c) Ocean currents - Almost 71% of earth’s surface is covered by ocean water. Oceans absorb two times more solar radiation as compared to the landsurface or the atmosphere. Important climatic phenomenon like El-Nino is the results of interaction of ocean and atmosphere. The concentration of carbon-dioxide in the atmosphere is also influenced by the oceans.

d) Volcanic eruptions – Volcanic eruptions scatter ash, sulphur dioxide and dust particles in the atmosphere. The effects of volcanic eruptions is felt in local climates deeply, though their global impact is undetectable. The scattered particles act as reflectors of sunlight.

e) Continental drift- The continental drift is responsible for the changes in physical features of landmass, their position and the movement of ocean currents and wind. Geophysicists explained the refined plate tectonic theory to support the crustal movements as the cause of climate change.

f) Anthropogenic causes-The human factors have major role in changing the climate of the earth. Human activities like burning of fossil fuels, industrial development, deforestation, construction work have greatly influenced the earth’s climate. Greenhouse gases and aerosols alter the incoming solar radiation and outgoing infrared radiation and affect the balance of heat budget of the earth. Human activities have a warming influence on the climate.
IMPACT OF CLIMATE VARIABILITY ON VULNERABILITY

Vulnerability of climate can be explained as the intensity of climate variation to which the system is exposed. The impact of climate change is uneven or varies from place to place because of the influence of various physical as well as human factors. It also depends on social, economical, political, and technological and development of environment of region. The developmental activities like industrialization, urbanization, deforestation, construction work have direct adverse impact on climate variation and increase the vulnerability. Vulnerability actually involves the exposure, the sensitivity and adaptability. Developing countries are more vulnerable to climate change than the developed nations. The developed nations are resourceful and have the capacity to manage the risk accordingly. The concept of vulnerability is helpful in planning the risk management strategies and reducing the impact of climate change and variability. Vulnerability is the base to decide the adaptation strategy to cope up with the influence of change of climate.

CLIMATE CHANGE AND INDIA

India is famous for its vast geographical and topographical features which strongly influenced its climate also. The tropic of Cancer passes through the middle of India. It has the features of both tropical and subtropical regions. The surface temperature has a rising trend of 0.6°C over the past hundred years. India has large proportion of population which is responsible for over exploitation of resources. Due to this over exploitation of resources, we are actually destroying the natural resources. The process of urbanization, industrialization and modernization are the main reason behind the alarming environmental problems and climate change. The increase in pollution has adverse impact on nature, climate, agriculture bio-diversity and human life. Air pollution and water pollution are the burning problems of the world as well as of India. Severe weather events like Uttarakhand floods-landslides (2013), Chennai flood (2015) and drought (2016) are the examples of disasters caused by change in climate. According to World Bank, there will be an increase of 2°C in the world’s average temperature in the next few decades. It is also going to influence the Indian monsoon mechanism which will directly affect the agriculture production and productivity of the country as India is agriculture based country and about 60% of the crop area depends on rain. The future impacts of climate change, identified by the Government of India’s National Communications in 2012 include:

1. Impact Assessment on Water Resources -Impacts of climate change and climate variability on the water resources are likely to affect irrigated agriculture, installed power capacity, environmental flows in the dry season and higher flows during the wet season, thereby causing severe droughts and flood problems in urban and rural areas. The per capita availability of water was 5177 m3/capita/year in 1951. This value is likely to reduce to below 1140 m3/year by 2050.

2. Impact Assessment on Forests -Forests are likely to be more vulnerable to climate change.

3. Impact Assessment on Indian Agriculture-The 1°C increase in mean temperature alone could lead to a decrease of 6 million tonnes of wheat production. This loss is likely to increase to 27.5 million tonnes in case of a 5°C increase in mean temperature.

4. Impact Assessment on Human Health Heat stresses, vector borne diseases, and water contamination are some of the main health impacts projected due to climate change. Warmer temperature, shifting rainfall patterns, and increasing humidity affect the transmission of diseases by vectors like mosquitoes.

5. Climate change and sea level rise - Sea level rise will modify the configuration of the Indian coastline and create a lot of environmental and societal problems.

6. Erratic monsoon with serious effects on rain-fed agriculture, peninsular rivers, water and power supply

7. Studies indicate that over 50% of India’s forests are likely to experience shift in forest types, adversely impacting associated biodiversity, regional climate dynamics as well as livelihoods based on forest products.

8. Vulnerability to extreme events would affect arid and semi-arid zones, of which nearly two-thirds are drought-prone.

CLIMATE VARIABILITY AND AGRICULTURE

Agriculture is a primary activity which directly depends on nature or climate of a specific area. The variety of crops requires different atmospheric conditions which include temperature, rainfall, sun light, humidity, wind conditions etc. Relevant climatic conditions are very much essential for quality and quantity production. The wide variety of climatic features provides large opportunities to Indian farmers to grow variety of crops. The Indian climate has dominant influence of south west monsoon which is responsible for majority of rainfall in the country. India receives about 80% of its rainfall in the month of June-September. Therefore Indian farmers have to plan their farming activities according to the prevailing climatic conditions. All important physiological processes such as photosynthesis, respiration, and grain formation require moisture. Therefore water is an essential requirement of agriculture sector. For India as a whole mean annual temperature shows a significant warming trend of 0.51 degrees Celsius per 100 years during the period 1901-2007 (Kothawale et al., 2010). Agriculture represents 35 percent of India’s GNP and
sustains the livelihoods of nearly 75 percent of the population (Kalra et al. 2003). This sector is also highly dependent on the South West monsoon (June-September), while 60 percent of the crop area under rain fed agriculture is in areas highly vulnerable to climate variability and change (National Communication on Climate Change, 2004).

**CLIMATE VARIABILITY IN HARYANA**

Haryana came into existence as an independent state on 1st November 1966 on linguistic and cultural basis. Earlier it was the part of the former state of Eastern Punjab. It is situated on the northern part of India and surrounds Delhi on three sides. The river Yamuna flows on the eastern side of the state, Punjab and Himachal Pradesh are situated on its northern borders and Rajasthan shares its boundary on west and south. It has 22 districts and shares its capital Chandigarh with Punjab. Haryana is an agriculture based state where almost 85% of its land is under cultivation. The climate of Haryana is arid and semi arid. It is hot insummers and mild in winters. Major crops grown in Haryana are wheat, rice, sugarcane, cotton, Bajra, pulses etc. According to the vision document of the Haryana government, the state is experiencing an increasing trend of about 1°C to 1.2°C in maximum and minimum temperature in the past decades. The meanannual rainfall shows decreasing aspects of 3% in the mid century and increasing trend of 17% by the end of the century. Haryana shows high variation and poor distribution of rainfall during the monsoon season, it is major cause of crop failure and poor crop productivity during kharif season under dryland conditions (Singh et al, 2006) The changing pattern of Haryana climate thus, calls for reviewing the agricultural strategies and research priorities for sustainable and climate resilient agriculture.

Rewari was carved out of Gurgaon by the Government of Haryana on 1 November 1989. About 83.79% of its land is used for agriculture. Rewari is deficient in rainfall and has to depend on manual irrigation. The crops grown in Rewari can be classified into Kharif crops (Bajra, Jowar, Cotton etc) which are grown in the summer between June to October and Rabi crops (Wheat, Mustard, Gram etc) which are grown in winter between November to April/May.

**ADAPTATION STRATEGY FOR CLIMATE VARIABILITY**

The Intergovernmental Panel on Climate Change, IPCC (2007) defined Adaptationas “The result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return, maintain, or achieve a desired state.”

It is the process which prevents or reduces the adverse effects of a system by adopting certain changes. The impact of climate change is predicted to be more intense in future, so adaptation is the utmost need for today’s world. It includes reducing the adverse or negative impact of climate change by implementing preventive methods. The fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC 2007) also accepts the mitigation strategies are not enough to save the earth from the ill effects of climate change. Policies to adapt the climate change are urgently needed for the world. Sustainable development is the most powerful weapon to defend against climate change impacts and reducing the vulnerability. Capacity building and can play an important role in this regard. Exposure to extreme events cannot be cope up without reducing vulnerability. Integrated adaptive measures could manage the risks of the climate change.

Some of the significant measures which can be adopted to minimize the impact of climate change on agriculture are:

- Management of salinity of soil
- Development of alternative irrigation methods
- Crop insurance facilities
- Shifting of growing crop season according to change in season
- Adopting new technologies and management programs to improve crop yield
- Selection of appropriate crops as per climatic conditions

**OBJECTIVES OF THE STUDY**

1. To understand the changing climatic scenario of Haryana with reference to Rewari district by analyzing the temperature and rainfall data from 1986 to 2017.
2. To study the impact of climate variability on selected Rabi crops in Rewari district.
3. To study the impact of climate variability on selected Kharif crops in Rewaridistrict.
4. To evaluate the Indian government policies, plans, programs and adaptation strategies (with special reference to Haryana) for reducing the influence of climate variability on agriculture.

**SIGNIFICANCE**

1. My rural agriculture background of Rewari district where most of the people are still engaged in agricultural activities.
2. Despite being an agricultural dominant area, no related study has been carried out in Rewari district.
3. Analyses of plans and programs run by the government related to climatic variability in Rewari district have not been done.
4. As I am familiar with the area, it will be easy for me to gather the information required for the study more conveniently and accurately.
BIBLIOGRAPHY: