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INDEX

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Climate Change and its Impact on Agriculture

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Abstrat - Global climate change is a change in the long-term weather patterns that characterize the regions of the world. The term "wheather" refers to the short-term (daily) changes in temperature, wind, and/or precipitation of a region (Merritts *et al.* 1998). In the long run, the climatic change could affect agriculture in several ways such as quantity and quality of crops in terms of productivity, growth rates, photosynthesis and transpiration rates, moisture availability etc.

Index Terms - Climate change, Greenhouse Effect, Greenhouse gases (GHGs), Global Warming Potential (GWP), Inter governmental Panel on Climate Change (IPCC), parts per million (ppm).

I . INTRODUCTION :

Climate change is any significant long-term change in the expected patterns of average weather of region (or the whole Earth) over a significant period of time. It is about non-normal variations to the climate, and the effects of these variations on other parts of the Earth. These changes may take tens, hundreds or perhaps millions of year. But increased in anthropogenic activities such as industrialization, urbanization, deforestation, agriculture, change in land use pattern etc. leads to emission of green house gases due to which the rate of climate change is much faster. Climate change scenarios include higher temperature, changes in precipitation, and higher atmospheric CO_2 concentrations. There are three wasys in which the Greenhouse Effect may be important for agriculture.First, increased atmospheric CO_2 concentrations can have a direct effect on the growth rate of crop plants and weeds. Secondly, CO_2- induced changes of climate may alter levels of temperature, rainfall and sunshine that can influence plant and animal productivity. Finally, rises in a sea level may lead to loss of farmland by inundation and increasing salinity of ground water in coastal areas.

The greenhouse effect is a natural process that plays a major part in shaping the earth's climate. It produces the relatively warm and hospitable environment near the earth's surface where humans and other life-forms have been able to develop and prosper. However, the increased level of greenhouse gases (GHGs) (carbon dioxide (CO_2), water vapor (H_2O), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), and sulfur hexafluoride

(SF_6) etc) due to anthropogenic activities has contributed to an overall increase of the earth's temperature, leading to a global warming.

II. INDIAN SCENARIO OF CLIMATE CHANGE

The warming may be more pronounced in the northern parts of India. The extremes in maximum and minimum temperatures are expected to increase under changing climate, few places are expected to get more rain while some may remain dry. Leaving Punjab and Rajasthan in the North West and Tamil Nadu in the South, which show a slight decrease on an average a 20 per cent rise in all India summer monsoon rainfall over all states are expected. Number of rainy days may come down (e.g. MP) but the intensity is expected to rise at most of the parts of India (e.g. North East). Gross per capita water availability in India will decline from 1820 m^3/ yr in 2001 to as low as 1140 m^3/yr in 2050.

Corals in Indian Ocean will be soon exposed to summer temperatures that will exceed the thermal thresholds observed over the last 20 years. Annual bleaching of corals will become almost a certainty from 2050. Currently the districts of Jagatsinghpur and Kendrapara in Odisha; Nellore and Nagapattinam in Tamilnadu; and Janagadh and Porabandar district in Gujrat are the most vulnerable to impacts of increased intensity and frequency of cyclones in India (NATCOM, 2004).

III. CROP RESPONSES TO EXPECTETD CLIMATE CHANGE FACTORS :

Climate change scenarios include higher temperatures, changes in precipitation, and higher atomospheric CO_2 concentrations which may affect on yield (both quality and quanitity), growth rates, photosynthesis and transpiration rates, moisture availability, through changes of water use (irrigation) and agricultural inputs such as herbicides, insecticides and fertilizers etc. Environmental effects such as frequency and intensity of soil drainage (leading to nitrogen leaching), soil erosion, land availability, reduction of crop diversity may also affect agricultural productivity.

Predicted effects of climate change on agriculture over the next 50 years)

Climatic element	Expected changes by 2050's	Confidence in prediction	Effects on agriculture
CO_2	Increase from 360 ppm to 450-600 ppm (2005 levels now at 379 ppm)	Very high	Good for crops: increased photosynthesis; reduced water use
Sea level rise	Rise by 10-15 cm Increased in south and offset in north by natural subsitence/rebound	Very high	Loss of land, coastal erosion, flooding salinisation of groundwater.
Temperature	Rise by 1-2°C. Winters warming more	High	Faster, shorter, earlier growing sesons,

	than summers. Increased frequency of heat waves		range moving north and to higher altitudes, heat stress risk, increased evapotranspiration
Precipitation	Seasonal changes by ≠ 10%	Low	Impacts on drought risk' soil workability, water logging irrigation supply, transpiration
Storminess	Increased wing speeds, especially in north. More intense rainfall events.	Very low	Lodging, soil erosion, reduced infiltration of rainfall
Variability	Increases across most climatic variables. Predictions uncertain	Very Low	Changing risk of damaging evernts (hea waves, front, droughts floods) which effect crops and timing of farm operations

Source : Climate change and Agriculture, MAFF (2000)

Warming will caccelerate many microbial processe in the soil-floodwater system, with consequences for the C and N cycle.Crop residue decomposition patterns may change. Increased soil temperature may also lead to an increase in autotrophic CO_2 losses from the soil caused by root respiration, root exudates, and fine-root turnover. Climate change impacts will also impact on rice production through rising sea level rise. Most studies project decreased yields in non-irrigated wheat and in rice, and a loss in farm-level net revenue between 9% and 25% for a temperature increase of 2-3.5°C. Aggarwal and Mall (2002) observed that a 2 °C increase resulted in a 15-17% decrease in grain yield of rice and wheat. Fungal and bacterial pathogens are also likely to increase in severity in areas where precipitation increases. Under warmer and more humid conditions cereals would be more prone to outbreaks of pest and diseases thereby reducing yield.

3.1 IMPACT OF CLIMATE CHANGE ON INDIA'S AGRICULTURE :

India's agriculture is more dependent on monsoon from the ancient periods. Any change in monsoon trend drastically affects agriculture. Even the increasing temperature is affecting the Indian agriculture. In the Indo-Gangetic Plain, these premonsoon changes will primarily affect the wheat crop (>0.5°C increase in time slice 2010-2039; IPCC 2007). In the states of Jharkhand,Odisha and Chattisgarh alone, rice production losses during severe droughts (about one year in five) average about 40% of total production, with an estimated value of $800 million (Pandey, 2007).

Increase in CO_2 to 550 ppm increases yields of rice, wheat, legumes and oilseeds by 10-20%. A 1°C increase in temperature may reduce yields of wheat, soybean, mustard, groundnut, and potato by 3-7%. Much higher losses at higher temperatures. Productivity of most crops to decrease only marginally by 2020 but by 10-40% by 2100due to increases in temperature, rainfall variability, and decreases in irrigation water. The major impacts of climate change will be on rain fed or un-irrigated crops, which is cultivated in nearly 60 % of cropland.

Recent studies done at the Indian Agricultural Research Institute indicate the possibility of loss of 4 - 5 million tons in wheat production in future with every rise of 1°C temperature throught the growing period. Rice production is slated to decrease by almost a tone/hectare if the temperature goes up by 2°C. In Rajasthan, a 2°C rise in temperature was estimated to reduce production of Pearl Millet by 10-15%. If maximum and minimum temperature rises by 3°C and 3.5°C respectively, then Soyabean yields in M.P. will decline by5% compared to 1998. Agriculture will be worst affected in the coastal regions of Gujrat and Maharashtra, as fertile areas are vulnerable to inundation and salinisation.

IV. AGRICULTURAL PRODUCTIVITY AND FOOD SECURITY :

Food security is both directly and indirectly linked with climate change. Any alteration in the climatic parameters such as temperature and humidity which govern crop growth will have a direct impact on quantity of food produced. Indirect linkage pertains to catastrophic events such as food and drought which are projected to multiply as a consequence of climate change leading to huge crop loss and leaving large patches of arable land unfit for cultivation and hence threatening food security. The net impact of food security will depend on the exposure to global environmental change and the capacity to cope with and recover from global environmental change. On a global level, increasingly unpredictable weather patterns will lead to fall in agricultural production and higher food prices, leading to food insecurity.

Even the IPCC, scarcely alarmist, says 0.5°C rise in winter temperature would reduce wheat yield by 0.45 tons per hectare in India. Rice and wheat have a total share in total food grain production in India. Any change in rice and wheat yields may have a significant impact on food security of the country. And this when Indian agriculture has already pushed into crisis, and 2.56 lakh farmers have committed suicide since 1995.

V. CLIMATE CHANGE - MITIGATION AND ADAPTATION IN AGRICULTURE:

(1) Assist farmers in coping with current climatic risks by providing value-added wheather services to farmers. Farmers can adapt to climate changes to some degree by shifting planting

dates, choosing varieties with different growth duration, or changing crop rotations. (2) Participatory and formal plant breeding to develop climate-resilient crop varieties that can tolerate higher temperature, drought and salinity. (3) Developing short duration crop varieties that can mature before the peak heat phase set in. 4. Selecting genotype in crops that have a higher per day yield potential to counter yield loss from heat induced reduction in growing periods. (5) Provide greater coverage of whether linked agriculture-insurance. (6) Intensify the food production system by improving the technology and input delivery system. (7) Provide incentives to farmers for resource conservation and efficiency by providing credit to the farmers for transition of adaptation technologies.

VI. CONCLUSION :

Climate change, the outcome of the "Global Warming" has now started showing its impacts worldwide. Climate is the primary determinant of agricultural productivity which directly impact on food production across the globe. Agriculture sector is the most sensitive sector to the climate changes because the climate of a region/country determines the nature and characteristics of vegetation and crops. Increase in the mean seasonal temperature can reduce the duration of many crops and hence reduce final yield. Food production systems are extremely sensitive to climate changes like changes in temperature and precipitation, which may lead to outbreaks of pests and diseases thereby reducing harvest ultimately affecting the food security of the country. The net impact of food security will depend on the exposure to global environmental change and the capacity to cope with and recover from global environmental change.

Coping with the impact of climate change on agriculture will require careful management of resources like soil, water and biodiversity. To cope with the impact of climate change on agriculture and food production, India will need to act at the global, regional, national and local levels.

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