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Climate Change and Its Impact on Agriculture

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Global climate change refers to long term fluctuation in temperature and weather patterns. The term "weather" refers to the short-term (daily) changes in temperature, wind, and/or precipitation of a region. 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. Climate change is likely to directly impact food production across the globe. Climate change and variability are concerns of human being. The recurrent droughts and floods threaten seriously the livelihood of billions of people who depend on land for most of their needs. The global economy is adversely being influenced very frequently due to extreme events such as droughts and floods, cold and heat waves, forest fires, landslips etc. The natural calamities like earthquakes, tsunamis and volcanic eruptions, though not related to weather disasters, may change chemical composition of the atmosphere. It will, in turn, lead to weather related disasters. 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 temperatures, changes in precipitation, and higher atmospheric CO2 concentrations. There are three ways in which the Greenhouse Effect may be important for agriculture. First, increased atmospheric CO2 concentrations can have a direct effect on the growth rate of crop plants and weeds. Secondly, CO2-induced changes of climate may alter levels of temperature, rainfall and sunshine that can influence plant and animal productivity. Finally, rises in sea level may lead to loss of farmland by inundation and increasing salinity of groundwater in coastal areas. The greenhouse effect is a natural process that plays a major part in shaping the earth's climate. However, the increased level of greenhouse gases (GHGs) (carbon dioxide (CO2), water vapor (H2O), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6) etc) due to anthropogenic activities has contributed to an overall increase of the earth's temperature, leading to a global warming. The global warming is nothing but heating of surface atmosphere due to emission of greenhouse gases, thereby increasing global atmospheric temperature over a long period of time. Such changes in surface air temperature and consequent adverse impact on rainfall over a long period of time are known as climate change. If these parameters show year-to-year variations or cyclic trends, it is known as climate variability.

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 pre- monsoon changes will primarily affect the wheat crop (>0.5oC increase in time slice 2010-2039; IPCC 2007). In the states of Jharkhand, Odisha and Chhattisgarh 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 CO2 to 550 ppm increases yields of rice, wheat, legumes and oilseeds by 10-20%. A 1oC 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 2100 due 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. A temperature rise by 0.5oC in winter temperature is projected to reduce rain fed wheat yield by 0.45 tonnes per hectare in India. Possibly some improvement in yields of chickpea, rabi maize, sorghum and millets; and coconut in west coast. Less loss in potato, mustard and vegetables in north-western India due to reduced frost damage. Increased droughts and floods are likely to increase production variability

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 1oC temperature throughout the growing period. Rice production is slated to decrease by almost a tonne/hectare if the temperature goes up by 2 o C. In Rajasthan, a 2oC rise in temperature was estimated to reduce production of Pearl Millet by 10-15%. If maximum and minimum temperature rises by 3oC and 3.5oC respectively, then Soyabean yields in M.P will decline by 5% compared to 1998. Agriculture will be worst affected in the coastal regions of Gujarat and Maharashtra, as fertile areas are vulnerable to inundation and salinisation.

India's Approach towards Climate change: Mitigation strategies and preparedness: To meet the challenges of sustaining domestic food production in the face of changing climate, The Indian council of agricultural research (ICAR) under ministry of agriculture and farmers welfare, has launched a flagship network project aims to study the impact of climate change on agriculture including crops, livestock ,horticulture and fisheries and to develop and promote climate resilient technologies in agriculture which will address vulnerable areas of the country and the output of the projects will help the districts and regions prone to climatic hazards. ICAR has developed resilient varieties in different crops tolerant to climatic stresses to improve the food grain production in the face of changing climate. Out of 2122, 1752 varieties are climatic stress resilient. Based on vulnerability assessment, climate resilient technologies are being demonstrated on farmer's fields covering 446 villages. Agromet advisories are reaching the farmers through m-Kisan portal, whatsapp groups and SMS services etc. To deal with climate change, the government of India is implementing a National action plan on climate change which aims to evolve and implement strategies to make Indian agriculture more resilient to the changing climate and to sustain increase in production. Per drop more crop schemes are being implemented to increase the irrigation area. Similarly, the Rainfed Area Development (RAD) scheme is being implemented to promote sustainable integrated farming systems. With the help of technological interventions GOI is preparing effectively to increase the crop produce and decrease the crop loss.

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 flood 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.

Food insecurity could be an indicator for assessing vulnerability to extreme events and slow-onset changes. This impact of global warming has significant consequences for agricultural production and trade of developing countries as well as an increased risk of hunger. The number of people suffering from chronic hunger has increased from under 800 million in 1996 to over 1 billion recently. United Nations population data and projections (UN 2009) show the global population reaching 9.1 billion by 2050, an increase of 32 per cent from 2010. The world's population is expected to grow by 2.2 billion in the next 40 years to 2050, and a significant part of the additional population will be in countries that have difficulties feeding themselves. Preliminary estimates for the period up to 2080 suggest a decline of some 15–30 per cent of agricultural productivity in the most climate-change-exposed developing country regions – Africa and South Asia.

Climate change – mitigation and adaptation in agriculture

1. Assist farmers in coping with current climatic risks by providing value-added weather 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. An Early warning system should be put in place to monitor changes in pest and disease outbreaks. The overall pest control strategy should be based on integrated pest management because it takes care of multiple pests in a given climatic scenario.
3. Participatory and formal plant breeding to develop climate-resilient crop varieties that can tolerate higher temperatures, drought and salinity.
4. Developing short-duration crop varieties that can mature before the peak heat phase set in.
5. Selecting genotype in crops that have a higher per day yield potential to counter yield loss from heat-induced reduction in growing periods.
6. Efficient water use such as frequent but shallow irrigation, drip and sprinkler irrigation for high value crops, irrigation at critical stages.
7. Efficient fertilizer use such as optimum fertilizer dose, split application of nitrogenous and potassium fertilizers, deep placement, use of neem, karanja products and other such nitrification inhibitors, liming of acid soils, use of micronutrients such as zinc and boron, use of sulphur in oilseed crops, integrated nutrient management.
8. Seasonal weather forecasts could be used as a supportive measure to optimize planting and irrigation patterns.
9. Provide greater coverage of weather linked agriculture- insurance.
10. Intensify the food production system by improving the technology and input delivery system.
11. Develop a long-term land use plan for ensuring food security and climatic resilience.
12. National grid grain storages at the household/ community level to the district level must be established to ensure local food security and stabilize prices.
13. Provide incentives to farmers for resource conservation and efficiency by providing credit to the farmers for transition to adaptation technologies.
14. Provide technical, institutional and financial support for establishment of community banks of food, forage and seed.
15. Provide more funds to strengthen research for enhancing adaptation and mitigation capacity of agriculture.