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Climate Change: Impact, Issues and Strategies

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Abstract

Agriculture production of India has been continuously rising; however, India still continues to have an alarming figure of undernourished population. Global climate change is widely viewed as one of the most significant challenges society is facing today. Combined with increased competition for land, water and labour from non-food sectors, climate change and associated increase in climatic variability will exacerbate seasonal/annual fluctuations in food yield. There are many options to mitigate the negative impacts of climate change, to minimize risks to agricultural systems. Options range from change in crop management, such as sowing time, stress resistance varieties, change in cropping systems and land use, to adjust to new climates. Government of India through its various schemes are also helping the country to adapt and mitigate the vagaries of climate. CRIDA with the help of NICRA and its climate related studies are identifying and demonstrating various climate resilient technologies to Indian farmers.

Key words: Climate change, NICRA, Adaptation Stress resistance, Resilience

Introduction

The world population is expected to increase by a further three billion by 2050 and 90% of the three billion will be from developing countries that rely on existing land, water, and ecology for food and well-being of human kind. The Intergovernmental Panel on Climate Change (IPCC) in its sixth assessment report (AR6) had warned that 1.5□ warming was likely to be achieved before 2040 itself. Climate change poses many challenges to growth and development in South Asia. The Indian agriculture production system faces the daunting task of feeding 17.5% of the global population with only 2.4% of land and 4% of water resources at its disposal. The global warming of 1.5°C and 2.0°C will be exceeded during the 21st century unless the predictions in the carbon dioxide and other GHG emissions occur in the coming years. The climate change is manifested in terms of rising temperature, more variable rainfall patterns, rise in sea level, increased frequency of extreme climatic events such as drought, floods, cyclones, heat wave, etc. Though climate change is a global phenomenon, the impacts are more inequitable in the sense that developing countries will be more affected. India, being a developing country, with a large population depending on agriculture will be more affected by climate change. Climate change affects agriculture directly through crop yields and indirectly by influencing water availability and changes in pest and pathogen incidence.

India is especially vulnerable to climate change due to its large population's reliance on agriculture, the excessive demand on its natural resources, and its comparatively ineffective coping mechanisms. The warming trend in India over the past 100 years has indicated an increase of 0.6°C, which is likely to impact many crops, negatively impacting food and livelihood security of millions of farmers. Reduced food grain yield, loss of vegetable and fruit harvests, fodder scarcity, shortage of drinking water for animals throughout the summer, forced animal migration, and severe losses in the poultry and fishing industries have all been reported, posing a threat to the rural poor's lives. As a result, increasing agricultural productivity is vital for maintaining food and nutritional security for all, particularly resource-poor, small, and marginal farmers who will be the most affected. Long-term climate change could have serious effects for the poor's livelihood security if adaptation is not planned. Other natural resource-based sectors are also important for the country's economic development. Field crops, horticulture, livestock, fisheries, and poultry are all strongly associated with various United Nations Sustainable Development Goals (SDGs), including zero hunger, nutrition, and climate action, among others.

Impact of Climate Change on Crop and Livestock Productivity

Studies on impacts of climate change on agricultural crop yields predicted that irrigated rice yields are likely to be reduced by 4% in 2020, 7% in 2050 and by 10% in 2080 scenarios. Studies conducted at the Indian Agricultural Research Institute and elsewhere indicated a yield loss up to ~9 per cent for wheat, ~12 per cent for irrigated rice, ~18 per cent for maize, ~12 per cent for mustard, and ~13 per cent for potato by 2040 under RCP 4.5 scenarios without adaptation as compared to the mean yield between 2000-2007 despite CO_2 fertilization effects (Naresh Kumar *et al*., 2020). On the other hand, rainfed rice yields in India are likely to decrease only marginally (<2.5%) in 2050 and 2080 scenarios. On an all India basis, yields of groundnut, soybean and cotton are projected to improve due to climate change. Similarly, chickpea yield is projected to improve (by 17-25%) in Haryana and central Madhya Pradesh but is projected to decrease by 7- 16 % in southern Andhra Pradesh in 2050 scenario. When late and very late sown wheat also were taken into consideration, the impacts are projected to be about 18% in 2020, 23% in 2050 and 25% in 2080 scenarios. *Kharif* groundnut yields are projected to increase by 4-7% in 2020 and 2050 scenarios where as in 2080 scenario the yield is likely to decline by 5%. However, a large spatial variability for magnitude of change in the productivity is projected. Climate change may likely to benefit potato in Punjab, Haryana and western and Central UP by 3.46 to 7.11% increase in production in 2030 scenario, but in West Bengal and southern plateau region, potato production may likely to decline by 4-16% by 2030. Climate change is projected to affect grain quality as well. Grain protein is projected to reduce by about 1.1 % in high CO_2 and low N input conditions in wheat (Asseng *et al*., 2018). In addition to protein, the concentration of minerals such as Zn and Fe is also likely to reduce in many crops.

Research work in CRIDA shows that high temperature and its interaction with elevated CO_2 (eCO_2) significantly affected physiological, biochemical, biomass and yield parameters of groundnut genotypes grown on Alfisols in Free Air Temperature Elevation (FATE) plots. There was significant variability between the selected groundnut genotypes for their performance including seed yield under eT and eT+eCO_2 conditions. The superior performance for seed yield of groundnut genotype K-9 at high temperature of >40°C, while responsiveness to elevated CO_2 even at high temperature were due to their ability to maintain better pod and seed number as well as improved test weight indicating their role under these conditions. The eCO_2 significantly improved the total biomass pod number and pod weight of the selected groundnut genotypes even at high temperature. Among the four groundnut genotypes, the better performance of K-9 under high temperature was attributed to its capacity to accumulate significantly higher concentrations of osmotic solutes especially proline and total soluble sugars, which led to better RWC and increased cell membrane stability. This indicated that the presence of eCO_2 ameliorated the negative impacts of elevated temperature of >40°C on this C3 leguminous oil seed crop.

Apart from Crop, the livestock sector is also projected to be significantly affected by climate change. Risks to plants and animals in home gardens in dry districts of West Bengal are becoming increasingly visible (Jana and Roy, 2020). The thermal stress affects the quantity and quality of milk, and reduces body weight of goats. It is estimated that this will reduce milk yield by 1.6 million tonnes in 2020 and >15 million tonnes in 2050 (NPCC report, 2012).

Adaptation strategies

Climate change is a long-term phenomenon and agriculture sector respond to evolving climate in different ways in terms of adaptation and coping mechanisms. Farmers have been adapting to climate variability and change over years though such an adaptation was not explicitly planned. Change of crop varieties, alteration of sowing dates, change of crop choice, investment in irrigation, etc. are some of the adaptation measures that we have adopted in response to climate variability and change. Insurance against weather induced risk is an important adaptation measure that helps farmers smoothen their income and consumption and enable them survive a risk. Contingent crop planning is another risk management component that aims at ensuring some income to the farmers in the event of any aberrations in the weather during the crop season. ICAR prepared district-wise contingency crop plans for all rural districts in India for coping with monsoon aberrations (www.agricoop. nic. in). For this to be effective, availability of seed of the appropriate crop and variety is a prerequisite.

National programmes for climate change adaptation

The National Mission of Sustainable Agriculture was launched in 2010 as part of the National Action Plan on Climate Change (NAPCC) to promote sensible resource

management. It was one of eight missions under the NAPCC. The *Pradhan Mantri Krishi Sinchayee Yojana* (PMKSY) was created in 2015 to solve water resource challenges and provide a long-term solution that promotes Per Drop More Crop by promoting micro/drip irrigation for optimal water conservation.

In collaboration with the Indian Council of Agricultural Research and state governments, the *Paramparagat Krishi VikasYojana* mission was implemented to extensively utilise adaption of climates mart practices and technology.

Green India Mission was started by the Government of India in 2014 under the auspices of the NAPCC with the primary goal of protecting, restoring, and increasing India's declining forest cover, thereby reducing the negative consequences of climate change. The launching of the Prime Minister's *Phasal Bhima Yojana* with its better provisions was rightly launched to address the issue of changing climate.

To maintain soil health, the Government of India has created the Soil Health Card scheme, which aims to analyze cluster soil samples and advise farmers on their land fertility condition. In addition, Neem Coated Urea was created to reduce the overuse of urea fertilizers, protecting soil health and providing plant nitrogen.

Programmes such as the National Project on Organic Farming and the National Agroforestry Policy were implemented in 2004 and 2014, respectively, to incentivize farmers with increased financial benefits and ecosystem conservation. These policies attempt to provide plant nutrients in the form of organic amendments, boost soil carbon stock, and protect soil from erosion.

National Initiative on Climate Resilient Agriculture (NICRA)

To meet the challenges of sustaining domestic food production in the face of changing climate and to generate information on adaptation and mitigation in agriculture, the Indian Council of Agricultural Research (ICAR) launched a flagship network project 'National Initiative on Climate Resilient Agriculture' (NICRA) during 2011, presently renamed as National Innovations in Climate Resilient Agriculture. NICRA is by far the largest farmer-participation outreach programme ever attempted in the subject of climate change adaptation anywhere on the planet. The research organization is in charge of programme planning, coordination, monitoring, and capacity building at the country level (ICAR-Central Research Institute for Dryland Agriculture). Krishi Vigyan Kendra (KVK; Farm Science Centre) under the Division of Agricultural Extension of the Indian Council of Agricultural Research (ICAR), All India Coordinated Research Project for Dryland Agriculture (AICRPDA) centres, and Transfer of Technology divisions of various ICAR Institutions across the country are responsible in implementing the project at village level through farmers' participatory approach. The major objectives of the project are: to enhance the resilience of Indian agriculture to climatic variability and climate change through strategic research on adaptation and mitigation; to validate and demonstrate climate resilient technologies on farmer's fields; to strengthen the capacity of scientists and other stakeholders in climate resilient agriculture and to draw policy guidelines for wider scale adoption of resilience-enhancing technologies and options. The project is being implemented through 3 major components viz. Strategic research through network and sponsored/ competitive grants mode, Technology demonstration & dissemination and Capacity building.

Technology demonstration component (TDC)

The TDC is a participatory programme of NICRA involving farmers to demonstrate site-specific technology interventions on farmers' fields for coping with climate variability in climatically vulnerable districts, to generate awareness and build capacity of farmers and other stakeholders on climate resilient agriculture and to evolve innovative institutional mechanisms at village level that enable the communities to respond to climate stresses in a continuous manner. The Krishi Vigyan Kendra (Farm Science Centres) located in the district is implementing the programme in 121 districts, the Centers of All India Coordinated Research Project on Dryland Agriculture (AICRPDA) implementing the programme in 23 districts and the ICAR Institutes involved in the implementing in 7 districts. Eleven Agricultural Technology Application Research Institutes (ATARIs) of ICAR are involved in coordinating the project in their respective zones. NRM interventions included site specific rainwater harvesting structures (RWH) in drought affected areas; recycling of harvested water through supplemental irrigation to alleviate moisture stress during midseason dry spells; improved drainage in flood-prone areas; conservation tillage; artificial groundwater recharge and water saving micro-irrigation methods were demonstrated.

Conclusion

Risks to food systems with ripple effects on income security of the agricultural sector and nutritional security of the population can originate from climatic factors. Though there are many adaptation strategies and technologies available the reach of these technologies to the people is limited. Indian researchers and policy makers should work hand in hand to address these issues and mitigate the negative impacts of climate change to feed the future population.

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