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Climate Resilient Agriculture: Future Scope

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Climate Resilient Agriculture can be defined as 'agriculture that reduces poverty and hunger in the face of climate change, improving the resources it depends on for future generations.' (Christian Aid, Time for Climate Justice 2015). Climate Resilient Agriculture wants to transform the current systems, and has a wider perspective than increased production only. It supports food production systems at local, regional and global level that are socially, economically and environmentally sustainable. Climate Smart Agriculture is defined as "an approach that guides actions needed to transform and reorient agricultural systems to effectively support development and ensure food security in a changing climate". It aims to tackle three main objectives: sustainably increasing agricultural productivity and incomes; adapting and building resilience to climate change; and reducing and/or removing greenhouse gas emissions, where possible (FAO website, 2016). Main criticism on the concept of Climate Smart Agriculture is that it also includes large-scale, high external input food production, without properly accounting for social and environmental aspects, such as inclusion of small-scale producers and an ecosystem management focus.

CRA means the incorporation of adaptation, mitigation and other practices in agriculture which increases the capacity of the system to respond to various climate related disturbances by resisting damage and recovering quickly. Such perturbations and disturbances can include events such as drought, flooding, heat/cold wave, erratic rainfall pattern, long dry spells, insect or pest population explosions and other perceived threats caused by changing climate. In short it is the ability of the system to bounce back. Climate resilient agriculture includes an in-built property in the system for the recognition of a threat that needs to be responded to, and also the degree of effectiveness of the response. CRA will essentially involve judicious and improved management of natural resources *viz*., land, water, soil and genetic resources through adoption of best bet practices.

IMPACT OF CLIMATE CHANGE ON INDIAN AGRICULTURE

Climate change impacts agriculture both directly and indirectly. The type and magnitude of impact will vary depending on the degree of change in climate, geographical region and type of production system. Assessment of impact of climate change is carried out through controlled experimentation and simulation modelling. Experimental results obtained are extrapolated on regional basis in relation to the projected climate change under different scenarios. Climate change impacts on agriculture are being witnessed all over the world, but countries like India are more vulnerable in view of the huge popular on dependent on agriculture, excessive pressure on natural resources and poor coping mechanisms. The warming trend in India over the past 100 years has indicated on increase of 0.60°C. The projected impacts are likely to further aggravate field fluctuations of many crops thus impacting food security. There are already evidences of negative impacts on yield of wheat and paddy in parts of India due to increased temperature, water stress and reduction in

number of rainy days. Significant negative impacts have been projected with medium-term (2010-2039) climate change, e.g. Yield reduction by 4.5 to 9%, depending on the magnitude and distribution of warming. Since agriculture makes up roughly 15% of India's GDP, a 4.5 to 9.0% negative impact on production implies cost of climate change to be roughly at 1.5% of GDP per year. Enhancing agricultural productivity, therefore, is critical for ensuring food and nutritional security for all, particularly the resource poor small and marginal farmers who would be affected most. In the absence of planned adaption, the consequences of long- term climate change could be severe on the livelihood security of the poor.

Effects on agricultural crops: The major effect on crop is due to shortening of crop duration which is related to the thermal environment. Increase in temperature will hasten crop maturity. In annual crops, the shortening of crop duration may vary from 2-3 weeks, thus, adversely impacting productivity. Another direct effect in crops such as rice, wheat, sunflower etc., is on reproduction, pollination and fertilization processes, which are highly sensitive to temperature. The indirect influences operate through changes in water availability due to inadequate or excess rainfall and effect of increase in temperatures on pest and disease incidence. Modelling studies have indicated that changing climate will decrease yields in major crops like wheat, rice and maize.

Effect on Horticulture: Climate change may increase production of potatoes in some states like Punjab, Haryana and Uttar Pradesh by 3% to 7% in 2030 scenario, but in the rest of India, particularly West Bengal and Southern Plateau region, the production may decline by 4-16%. It is primarily attributed to the rise in mean minimum temperature during tuber development stages which affects potato yield. Adaptation to climate change can increase the yields by 13-19% in different scenarios, thereby increasing the overall production by about 20%. Potato and vegetables mature early, and heavy crop losses will be noted when crops are exposed to abnormal increases in temperature (heat wave). Grapes and its value-added products have also been affected by variable climate. The grape yields are expected to be reduced with the likelihood of change in the incidence and pattern of attack of insect-pests like mealy bug, thrips and mites. Similarly, the disease incidence pattern is also likely to be affected with a change in climate. This is evidenced by decrease in productivity during recent years from > 25 t/ha to 8 t/ha during 2009–10 and 12 t/ha in 2010–11 due to unseasonal rains which led to a serious infection of downy mildew. Cashew nut, an important export-oriented horticultural crop is also likely to be affected by changing climate thereby affecting the export revenues. Climate change would pose problem for cashew cultivation since cashew is grown in ecologically sensitive regions such as coastal belts, hilly areas, and areas with high rainfall and humidity. The flowering, fruiting, insect-pest incidence, yield and quality of cashew nut and kernels are more vulnerable to climate variability. Unseasonal rains and heavy dew during flowering and fruiting periods are the major factors which adversely affect the yield and quality of cashew nut. Cloudy conditions, high relative humidity and heavy dew are favourable for outbreak of insect-pests and diseases. Drought conditions also drastically reduce cashew production. Oil palm is grown as an irrigated crop in India. It is likely to be more vulnerable to climate change due to excessive dependence on ground water with poor adaptation mechanisms. The water requirement is estimated to increase by 10% for every 1°C rise in temperature. Under such situations, when oil palm yield decreases, small and marginal palm growers would be affected the most.

Effect on Livestock: Climate changes could impact the economic viability and livestock production. Changes in crop biomass availability and quality affect animal production through changes in feed supplies. Dairy cattle will be affected by climate change more adversely than others. The maintenance energy needed may increase by 20-30% under heat stress. Heat stress induced by climate change is also reported to decrease reproductive performance in dairy cows. The main effects include decreased length and intensity of oestrus

period, fertility rate, growth, size and development of ovarian follicles; increased risk of early embryonic deaths, and decreased foetal growth and calf size. Environmental conditions induced by climate change directly affect mechanisms and rates of heat gain or loss by all animals. Since ingestion of feed is directly associated to heat production, any alteration in voluntary feed intake will change the amount of heat produced by the animal. Other intensive livestock production systems such as poultry and piggery are also susceptible to heat stress. Some responses include reduced feed intake, laying performance (chickens), fertility levels, decreased activity and in the worst cases, increased mortality. Heat stress has strong influence on livestock performance. The estimated annual loss at present due to heat stress is estimated at about 2 million tonnes, i.e. nearly 2% of the total milk production in the country. Time to attain puberty of crossbred cows and buffaloes will increase by 1-2 weeks due to their higher sensitivity to temperature than indigenous cattle. Increase in temperature and humidity is likely to cause an increase in incidence of animal diseases (bacterial, protozoan and viral) that are spread by insects and vectors.

Effect on Fisheries: Climate change is also likely to have impacts on aquaculture. Positive effects are manifested as longer growing seasons, lower natural winter mortality and faster growth rates in higher latitudes. New opportunities for brackish water aquaculture arise (as in Andaman & Nicobar Islands) where agriculture may become non-viable due to saltwater intrusion. The abundance and species diversity of riverine fishes are predicted to be particularly sensitive to climatic disturbances, since lower dry season water levels may reduce the number of individuals able to spawn successfully. A 1–3°C temperature rise relative to the last decade would result in the bleaching and possible death of most of the world's coral reefs (IPCC, 2007). If small-sized, low-value fish species with rapid turnover of generations are able to cope up with changing climate, they may replace large-sized high-value species. Such distributional changes would lead to novel mixes of organisms in a region and result in considerable changes in ecosystem structure and function. The sensitivity of small-scale fisheries to climate change threat is very high while adaptive capacity is low.

Village level interventions towards climate resilient agriculture

1. **Building resilience in soil:** Soil health is the key property that determines the resilience of crop production under changing climate. A number of interventions are made to build soil carbon, control soil loss due to erosion and enhance water holding capacity of soils, all of which build resilience in soil. Mandatory soil testing is done in all villages to ensure balanced use of chemical fertilizers. Improved methods of fertilizer application, matching with crop requirement to reduce nitrous oxide emission.
2. **Adapted cultivars and cropping systems:** Farmers in the villages traditionally grow local varieties of different crops resulting in poor crop productivity due to heat, droughts or floods. Hence, improved, early duration drought, heat and flood tolerant varieties are introduced for achieving optimum yields despite climatic stresses. This varietal shift was carefully promoted by encouraging village level seed production and linking farmers decision-making to weather based agro advisories and contingency planning.
3. **Rainwater harvesting and recycling:** Rainwater harvesting and recycling through farm ponds, restoration of old rainwater harvesting structures in dryland/rainfed areas, percolation ponds for recharging of open wells, bore wells and injection wells for recharging ground water are taken up for enhancing farm level water storage.
4. **Water saving technologies:** Since climate variability manifests in terms of deficit or excess water, major emphasis was laid on introduction of water saving technologies like direct seeded rice, zero tillage and other resource conservation practices, which also reduce GHG emissions besides saving of water.

5. **Farm machinery (custom hiring) centres:** Community managed custom hiring centres are setup in each village to access farm machinery for timely sowing/planting. This is an important intervention to deal with variable climate like delay in monsoon, inadequate rains needing replanting of crops.
6. **Crop contingency plans:** To cope with climate variability, ICAR/CRIDA has developed district level contingency plans for more than 400 rural districts in country. Operationalization of these plans during aberrant monsoon years through the district/ block level extension staff helps farmers cope with climate variability.
7. **Livestock and fishery interventions:** Use of community lands for fodder production during droughts/floods, improved fodder/feed storage methods, feed supplements, micronutrient use to enhance adaptation to heat stress, preventive vaccination, improved shelters for reducing heat/cold stress in livestock, management of fish ponds/tanks during water scarcity and excess water are some key interventions in livestock/fishery sector.
8. **Weather based agro advisories:** Automatic weather stations at KVK experimental farms and mini-weather observatories in project villages are established to record real time weather parameters such as rainfall, temperature and wind speed etc. both to issue customized agro advisories and improve weather literacy among farmers.
9. **Institutional interventions:** nstitutional interventions either by strengthening the existing ones or initiating new ones relating to seed bank, fodder bank, commodity groups, custom hiring centre, collective marketing, introduction of weather index based insurance and climate literacy through a village level weather station are introduced to ensure effective adoption of all other interventions and promote community ownership of the entire programme.
10. **Village Climate Risk Management Committee (VCRMC):** A village committee representing all categories of farmers including women and the land less is formed with the approval of Gram Sabha to take all decisions regarding interventions, promote farmers participation and convergence with ongoing Government schemes relevant to climate change adaptation. VCRMC participates in all discussions leading to finalizing interventions, selection of target farmers and area, and liaison with gram panchayat and local elected representatives and maintain all financial transactions under the project.

Conclusion

Climate change has a direct effect on agriculture affecting the most vulnerable segment of small and marginal farmers of India. Enhancing the resilience of Indian agriculture to cope with climatic variability and climate change is boon for the livelihood security of millions of small and marginal farmers in the country. Climate-resilient agriculture (CRA) achieve long-term higher productivity and farm incomes under different climate variabilities through improved crop and livestock management. It is a way for farmers to cope with the climate change, but despite the superficial benefits, rates of adoption by smallholder farmers are highly variable, if government and other responsible organizations step forward to encourage the practice of CRA then it is easier to reduce the effect of climate change.

References

1. Nanjappan, B. (2018). Adoption of Climate Resilient Agricultural Technologies by Farmers. Journal of Agricultural Extension Management Vol. XIX No. (1)
2. IPCC. (2007). Climate Change 2007: Synthesis Report: Contribution of Working Groups I, II and III. Fourth Assessment report of the Intergovernmental Panel on Climate Change. Core Writing Team, Pachauri R K and Reisinger A, IPCC, Geneva, 2008: pp 45-78
3. NAAS 2013. Climate Resilient Agriculture in India. Policy Paper No. 65, National Academy of Agricultural Sciences, New Delhi: 20 p.

4. Udit Debangshi(2021) Climate Resilient Agriculture an Approach to Reduce the Ill-Effect of Climate Change. International Journal of Recent Advances in Multidisciplinary Topics.
5. AICRPDA. Annual Reports 1971-2001. All INDIA Co-ordinated Research Project for Dry land Agriculture (AICRPDA), Central Research Institute for Dry land Agriculture (CRIDA), Hyderabad, India. pp. 6357. 2003.
6. Aggarwal, P. K. "Global Climate Change and Indian Agriculture: Case studies from the Indian Council of Agricultural Research Network Project." ICAR, New Delhi. pp. 148. 2009.