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Dynamics of Crop Protection and Climate Change

Exploitation of Plant Genetic Resources for Crop Protection: On Climate Change Basis

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Climate change distracts the synchrony between temperature and photoperiod; insects and pathogens show individual patterns of response to temperature, carbon dioxide, and photoperiod which results in a loss of evolved phasing. This changes the relationship between plants and the environment. Rising temperature and atmospheric CO_2 are also indirectly affecting crops through their effects on pests and diseases. Climate change alters phases of life cycle and their rates of development for pests, pathogens, and associated antagonistic organisms. It may modify the mechanisms of host resistance and host-pathogen relationships. Impact of warming or drought on resistance of crops to specific diseases may be through the increased pathogenicity of organisms or by mutations induced by environmental stresses (Gregory *et al.* 2009). There is a need to improve an understanding of the implications and impacts of climate change on natural biodiversity. The focus could shift again soon to reflect the heightened attention to meet the needs of a growing population, projected to require a 70% increase in food production by 2050 (FAO 2010), particularly in the light of climate change and its impacts on agricultural production.

The challenge of climate change can be talked in two ways, i.e., mitigation and adaptation. "Mitigation" refers to measures to reduce emissions of greenhouse gases, such as adopting renewable energy; whereas "adaptation" involves actions that reduce the impact of the event without changing the likelihood that it will occur, such as relocating communities. Changes in climatic pattern will stimulate changes in the spatial distribution of agro-ecological zones, habitats, and distribution patterns of plant diseases and pests (Pathak *et al.* 2012). This can have significant impact on agriculture and food production. While ecological resilience is the ability of an ecosystem to persist despite disruption and change; biodiversity in all its components increases resilience to change environmental conditions and stresses. This depicts the role of biodiversity in supporting the continuity of ecological processes at smaller and larger scales. Richness of species and minimizing variations during change of climate with buffering capacity to crop species add increasingly to climate change adaptation. Thus, agro-biodiversity contributes to the adaptive and mitigating measures to resolve and protect the negative impacts of climate change (Kotschi 2006). Agro-biodiversity is the basis for human survival. However, due to global climate change in most arid and semi-arid regions, predominant losses have been underway.

Impact of Climate Change on Plant Genetic Resources

Yield Losses Due to Pests and Diseases

Current climate trends are already having negative effects on the agricultural sector, and with the predicted intensification of climate change, these are expected to get worse. Higher temperatures and lower precipitation are leading to lower crop productivity. More intense floods and other calamities are leading to dramatic crop losses. Droughts are also shortening growing seasons, and thus, reducing yields. Changes in temperature and precipitation profiles are shifting the range of many insects and creating conditions for the emergence of new combinations of pests and diseases that threaten productivity and crop yields.

Among various vegetables, tomato and cabbage are the most common and extensively grown all over the country. One of the major constraints identified in their production is the increasing incidence of insect pests, diseases, and nematodes, sometimes resulting in substantial yield losses (Datta 2013). Due to their tender and supple nature, and their cultivation under high moisture and input regimes, tomato and cabbage are more prone to pest attack, and at a conservative estimate, the losses are about 30-35%. Introduction of high yielding, short duration, off-seasonal hybrids/varieties have not only brought about changes in their pest scenario, but also resulted in availability of continuous and abundant food supply for the buildup, perpetuation, and multiplication of insect pests, diseases, and nematodes. Evidence indicates that biotic stress can cause a 28.2% yield loss of wheat, 37.4% loss of rice, 31.2% loss of maize, 40.3% loss of potatoes, 26.3% loss of soybeans, and 28.8% loss of cotton and annually about 42% of the crop productivity is lost owing to various abiotic stress factors (Oerke 2006).

Adaptation Measures to Overcome Yield Losses

The following are the measures which can be adapted in order to overcome the yield losses.

- Targeting of diverse plant genetic resources from different agro-climatic zones of world for introduction. The increased need for consolidating collections of crop wild relatives, newly adapted commercial species or varieties is due to the

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era of climate change, when new adapted genes are needed to allow species to cope with climate change (Lopez-Noriega *et al*. 2012). Despite the fact that many countries have signed up and adhered to various international conventions, treaties, and agreements for facilitating the exchange of germplasm, the second state of the world report on Plant Genetic Resources for Food and Agriculture (PGRFA) (FAO 2010) mentions that there are many constraints to the use of genetic resources, including the lack of human resources; the lack of fully effective linkages between curators, researchers, breeders, seed producers, and farmers; and the lack of comprehensive information systems and funding. An analysis of the global crop and regional conservation strategies developed by the Global Crop Diversity Trust (GCDT) also described the lack or low quality of accession level information, including passport, characterization, and evaluation data, as being the greatest constraint hindering the full use of conserved PGRs (Khoury *et al.* 2010). It is widely recognized that pests and diseases cause substantial yield losses in India due to narrow genetic bases of Indian germplasm (Kumar 2012). To minimize the crop losses higher yielding crop varieties and hybrids can be planted; crop yields can be increased by improving soil health; and crop loss can be reduced by improving crop protection.

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