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Editorial

Green Biotechnology and Sustainable Agriculture to Cope with Rapid Climate Change

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Agriculture faces the serious threat of climate change. The uncertainty of weather patterns and extreme climatic events is increasing rapidly. Increasing temperatures, rising sea levels, saline water intrusion, floods, shifting precipitation, drought, cyclones, new pests and diseases are the major issues securing the desired food production. The planet's average temperature has increased by 0.8°C since 1850 and is estimated to be increased by 1.1-6.4°C by 2100 [1]. The increasing temperature is an indication of more frequent natural calamities in the upcoming days. The increased temperature also has multiple negative health impacts on plants and animals. Change in 1°C is anticipated to induce new diseases and may cause several plant and animal species to be extinct. The ecosystem balance would be under great threat. An increase in every centigrade may cause a loss of crop yield of 10% [2].

Altered precipitation patterns and frequent heat waves due to climate change alter the species' succession. Rapid climate change severely changes the natural and cultural ecosystems. Plants and animals need to acclimatize to survive with the shifting patterns. Adapting to the drastic changes is difficult, and it is predicted that more than 15% of species will be extinct in the near future due to climate change events [3]. Frequent droughts, floods, cyclones, and increased salinity in the soil also reduce food production and supplies throughout the world. The biological landscape of species is also shifting due to the effects of climate change. The crop yield in the lower latitude has declined, whereas increased in higher altitudes, the tropical species are shifting to the temperate region [4]. Species composition also changes as the temperature, precipitation, and salinity change. Alien species invasion due to climate change also alters the traits of species. The increased greenhouse gas contributes to the decrease in the nutritional quality of food. Plants will be attacked by various diseases that also impact animals as they feed on crops and are infected by the diseases. Moreover, monoculture increases the risk of attack by diseases and pests, influencing species extinction and genetic loss.

Agricultural production using traditional methods is slower than the growth rate of the world's population. Conventional agriculture faces problems like shortage of arable land, less water availability, scarcity of input materials, and genetic limitations of crops. In this situation, orthodox practices are not enough to manage sustainable production while increasing food security and reducing the adverse impacts of agriculture. So, this is the time to adopt green biotechnology for sustainable and environment-friendly agriculture. Agricultural biotechnology is one of the best coping methods for climate change challenges [5].

Biotechnology inclusion in agriculture is one of the best adaptation and mitigation techniques to cope with the changing environment. Green biotechnology combines sustainable agriculture and quality production practices by incorporating natural resources and biodiversity. It can produce vigorous crop plants with quality food and nutrition, which are economically beneficial and environment-friendly. It involves ecologically sound and sustainable approaches for new crop genotype development, biofertilizers and biopesticides production, and invitro and vegetative propagation for crop management with economic benefits.

The most common approaches are using bacteria for pest resistance plant development, microbe exploitation for abiotic stress tolerant and early ripen vigor plant production, genetic changes to generate pathogen tolerant and frost resist varieties, phytoremediation to avoid heavy metals, etc [6]. Genetic engineering modifies the crop genes to ensure higher yield without or with minimal use of pesticides, herbicides, and insecticides.

Green biotechnology can reduce greenhouse gases and mitigate climate change. Biotechnology can modify crops to tolerate fast and extreme climate changes. Pest and disease resistant, salinity tolerant, drought resistant, cold and heat tolerant crops can reduce the climate change impacts. It also reduces CO_2 emission, sequestrates carbon, and allows farmers to use environmentally friendly fertilizers. The herbicide tolerant biotech varieties need zero tillage, which reduces soil degradation and soil carbon loss. Moreover, insect and pest resistant varieties need fewer sprays and less fuel or energy for sprays. It is estimated that the reduction in sprays and plowing reduces 23.1 billion kg CO_2 emission and removes 10.2 million cars from the roads [7].

Rice is of primary importance as it provides food security to more than half the world's population. However, it is suffering from drought and salinity, which has reduced the production rate. By removing salinity susceptible genes, the tolerant verities can be grown in high saline soil without decreasing crop production, grain quality, and plant biomass. By reducing the stomatal densities, an improved variety of rice can be produced, which can tolerate high temperatures and drought without decreasing yield. By changing the flower related genes, it is also possible to produce early flowering plants that can grow well on longer days, cool temperatures, less fertile soil, and water deficit areas by shortening the lifetime of plants. Banana plants are always suffering from storms and intense wind. Storm impacts on banana production can be reduced by generating a dwarf variety by removing the genes responsible for the biosynthesis of gibberellins. Sometimes, a knock-in gene can produce the desired variety. In maize, drought tolerant variety can be produced by inserting a promoter gene. The proper gene introduction can produce high grain even if it is a water stress condition [8].

Like plants, gene editing is also effective in animals to mitigate the impacts of climate change. It is possible to breed cattle by replicating SLICK phenotype originally found in thermotolerant Senepol cattle. It lowers the temperature produced by biophysical activities and leads to sufficient milk production even during summer. Biotechnology also helpful to produce viral resistant chicken, Tuberculosis and Mastitis Resistance in Cattle, disease resistant pigs, viral resistant aquatic species [9].

As the climate changes and abiotic-biotic stresses increase gradually, this is the time to focus on adaptation and mitigation measures. We completely depend on agriculture, which is the most vulnerable area of climate change stressors. Thus, for producing food for the growing population, biotechnology is the best way to produce the maximum yield while acting as the climate change adaptation and mitigation factor.

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