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GENETIC ENGINEERING IS A DRIVING FORCE FOR MODERN AGRICULTURE

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Food insecurity and malnutrition are at the very moment among the most grievous matter of interest for human health, resulting in loss of innumerable lives in developing countries. To be strong and healthy, our regular diet chart must comprise bountiful high-quality foods with most of the essential nutrients, along with the nourishment that provides several health benefits beyond basic nutrition. Even sustaining the quantity of food per capita that we have access at present will be a mounting task in the distant future due to the continuing detrimental situation of arable lands and the prevalence of unfavourable environmental situations consisting drought, salinity, floods, diseases etc. In order to ensure food security for future generations, the world must produce 50% to 100% more food than today in spite of the predicted adverse environmental conditions. Notwithstanding, the traditional plant breeding programme alone can no longer maintain the ever-increasing global food requirements. Therefore, it is the high time to promote sustainable agricultural practices for boosting crop productivity along with the utmost preservation of available natural resources.

Agricultural biotechnology is being accepted as a powerful complement to conventional methods for meeting worldwide demand for quality food and with the help of modern plant biotechnological tools; nowadays we have access to massive gene pools that can be exploited to impart desirable traits in economically important crops. Subsequently, the introduction of genetic engineering involving the transfer of genes from different types of organisms into crops and livestock through hybridization, conjugation and transformation; conveyance of new genes from wild species into cultivated varieties of similar crops to attain desired traits or the substitution of diverse genes into agricultural species, possesses a more productive future and has long been regarded as an auspicious method to guarantee the continued productivity of agriculture and forestry (Beringer *et al.*, 1992) as well as maybe a means to utilize the undiscovered resources of biodiversity in the service of social and economic development. With deliberate design and a better apprehension of transgenic organisms, negligible ecological and social disturbances will appear with the development of genetically engineered organisms. Certain distinct property such as disease resistance, stress tolerance and improved nutritional qualities are quite advantageous to the farmers in view of a lot of time is spent on cultivation rather than considering outside interferences. Genetic engineering is expeditiously substituting the conventional plant breeding programs and has become the mainstay of agricultural crop improvement which might facilitate to circumvent the expensive and input-intensive crop production and also convert the traditional agricultural system into low input sustainable practices (Odum, 1989).

What Is Genetic Engineering?

The entire living community is consisted of cells and strings of DNA molecules retaining the instructions for making genes and forming an exceptional blueprint that determines the growth, development, looks and survival of an organism are present in those cells. Genetic engineering is defined as the straight forward administration of the genetic material/genome by means of manmade interventions to modify the hereditary characteristics of a cell or an organism that comprises the conveyance of definite traits/genes from one to another living cell, involving diversified species and the altered organism through genetic engineering is known as a genetically modified organism or GMO. The application of this widely accepted technology in the agricultural sector is quite different from the conventional cross-breeding methodologies, which have been utilized for a millennium. GMOs generally refer to the gene transfer among various live organisms by using a sequence of laboratory-based techniques for the purpose of duplicating genes; splicing DNA segments altogether as well as for insertion of genes into the cells and conjointly, these mechanisms are termed as recombinant DNA technology. Certain other terminologies are also customarily applied for the GMOs which include genetically engineered, bio-engineered, transgenic etc.

What are potential GM crops of the future?

Some potential applications of GM crop technology are:

- **Nutritional superiority**: The GM crops are highly nutritious enriched with protein, vitamins, minerals, healthy fatty acids and so on

- **Stress tolerance**: Those crops are very much tolerant to high and low temperatures, salinity, drought and other adverse conditions
- **Disease resistance**: Genetic Engineering imparts resistance power to the crops/plants to various dreadful diseases or insect pest
- **Biofuels**: The GM crops possessing modified cell constitution are highly efficacious for conversion to ethanol
- **Phytoremediation**: GM plants are also utilized for Phytoremediation by extracting and concentrating contaminants such as harmful heavy metals from the polluted places

Risks and benefits

Although genetic engineering can improve the control of insect pests, plant pathogens, and weeds, there are certain risks associated with it that are given as follows:

1. The gene for Bt toxin collected from the bacterium *Bacillus thuringiensis*, has been introduced into more than 50 crop species (Beegle and Yamamoto, 1992) and the plants expressing this gene demonstrate effective control of pests such as caterpillars and beetles, besides, the engineered Bt has been approved for use as a conventional insecticide.
2. Few viruses can also be genetically modified for imparting accelerated pathogenicity in order to control insect pests that have negligible persistence in the environment.
3. Employing genetic engineering to increase host plant resistance to pathogenic fungi is another promising goal. Some genes derived from plant RNA viruses confer virus resistance in transgenic crop plants.
4. Weeds possess a major problem in agriculture, and both herbicides and several non-chemical technologies are used to control them. The use of herbicide-resistant crops makes it possible to use the heavy doses of herbicides without damaging the crop. The crops are tolerant to herbicidal chemicals such as Glyphosate, Phosphinothricin, Sulfonylurea, Bromoxynil, and 2,4-D. However, actually, the use of herbicide-resistant crops is likely to increase herbicide use as well as production costs.

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5. It is likely to cause serious environmental hazards, and also the herbicide-resistant crops have been reported to be toxic to some non-target species like beneficial polyphagous predators in soil, such as spiders, predatory mites, carabid and coccinellid beetles, along with detritivores like earthworms and woodlice as well as to aquatic organisms, including fish.
6. These organisms bear alien genes circulating in wild relatives; some concern has been expressed about genetically engineered plants upsetting not only the agro-ecosystem but also other ecosystems.
7. The most serious risks of transgenic crops include simplifying crop systems and promoting genetic erosion, the potential transfer of genes from pesticide-resistant crops to wild vegetation, the generation of new virulent strains of viruses, insect resistance to Bt toxin and the destruction of natural relationships in the ecosystem.
8. If the release of transgenic crops continues, "superweeds" will eventually control the main population of wild and domestic plants, reducing biodiversity. The crops tolerant to diseases can also affect the ecosystem.
9. Although inserting a new gene into an existing genome can be regarded as increasing biodiversity, older plants might not be superior to newly introduced genetically modified organisms. If natural selection prefers transgenic plants, then the natural flora and fauna may be desperately lost.
10. Biotechnology is a key target for solving food production problems in developing countries. Resource-poor farmers are able to use biotechnology in genetic engineering to produce products of low cost and high efficiency against insects, weeds, and diseases. Because of the availability of the products extracted through the means of transferred genes in the market of underdeveloped or developing countries, world hunger and malnutrition can come to the proximity of an end due to less expensive and more adequacy of the crops.
11. Economic concerns are few to none in consideration of genetic engineering in agriculture. Since herbicide and insecticide-resistant crops reduce the number of herbicides, pesticides and other chemicals used, farmers will be spending less money on them that may create a greater profit for the farmer. Food production will be exceedingly amplified because GM food can be produced at a faster rate than normal harvests which determines that food industries can produce more superior quality food with sufficient quantity in the market places.

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Conclusions

The technical knowledge of genetic engineering holds a phenomenal commitment for improving agricultural productivity and keeping it environmentally or ecologically safe and sound with immanent advantages including higher productivity of crops and livestock, accelerated pest control and declined pesticide usage, reduced fertilizer application because of enhanced biological nitrogen fixation, and improved conservation of soil and water resources. GM strategies are being employed for having the potential to address various constraints regarding agriculture and society that include minimization of yield losses due to various stresses *viz.* biotic and abiotic and are being used extensively for value addition in food crops by enrichment with quality proteins, vitamins, iron, zinc, carotenoids, anthocyanins and many others in addition to the enhancement of shelf life of fruits and vegetables so as to reduce the post-harvest losses of perishable crops significantly. In essence, the release and regulation of genetically engineered organisms into the environment should be similar to the discharge and adjustment of exotic plant and animal species into an unfamiliar environment. Therefore, time and effort must be devoted to laboratory and field testing before releasing these types of organisms. Deprived of circumspection and appropriate regulation, ecological constraints feasibly emanate, and the anticipated advantages of genetic engineering technology are presumably to be imperilled. Consequently, it can be concluded that sustainable integration of conventional agricultural practices with modern biotechnology can enable the achievement of food security for present and future generations. Nevertheless, it is very much essential that the performance of a GM crop should be attentively scrutinized for numerous generations under field levels and gone through rigorous bio-safety assessments on a case-by-case basis, before being released for commercial cultivation. GM crops are going to be a mandatory part of our lives, and the enormous potential of biotechnology must be exploited to the benefit of humankind.

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