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Genetically Modified Crops: An Essence

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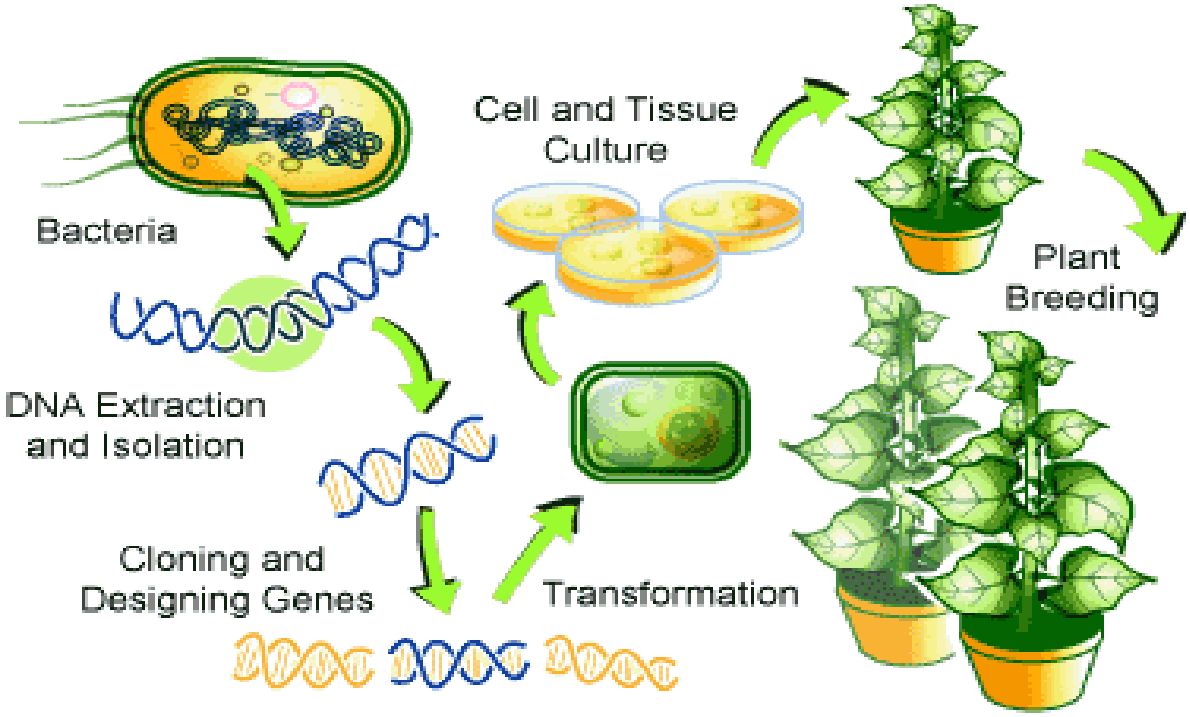
Introduction

World's population is increasing at alarming rate and consequently demand for food is increasing, while the cultivable land is limited to feed up the growing population. Modern biotechnological techniques including Recombinant DNA technology is coming up as a powerful tool to gear up the crop production in terms of both quality and quantity. The main aim behind the use of Genetic Engineering is to increase crop production, reduce chemical applications in food production, modify the nutritive value and increase the shelf life of the produce. But, there are many probable risks are associated with the applications of Genetic



Engineering.

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What are Genetically Modified Crop (GM crop/GMC)?

Those plants which are being used in agriculture and in which DNA has been modified with desirable changes by using genetic engineering technique, is called Genetically Modified Crops. While, genetic engineering refers to the process of removing, modifying or adding desirable genes by molecular techniques into the DNA strand of the recipient plant.

Some facts about GM Crops:-

- First genetic modified crop was an antibiotic resistant tobacco plant, developed in 1982.
- In 1994, First GM Crop which was permitted for sale was FlavrSavr Tomato, in USA.
- Bt. Cotton for bollworms resistant and GM maize for Glyphosate resistant was approved in 1995, which were developed by Monsanto.
- Golden Rice (Vit. A enriched rice) was developed by Ingo Portricus in 1999.

Overview of Some major Bt. Crops

(1)Bt. Cotton:-

The increased use of synthetic insecticides for control of insect-pest in cotton resulted into the development of resistant among major cotton pests against various insecticides. Through the development of insect resistance Bt. cotton by genetic engineering. The Bt. cotton was developed by cloning and transfer a gene from soil bacterium *Bacillus thuriginensis*, which is responsible for encoding the toxic protein for bollworms. In India, growing of Bt. Cotton at commercial scale, was permitted by Genetic Engineering Appraisal Committee (GEAC) in 2002, since then more than 95% of country's co

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Genetically modified brinjal is developed by the inserting a toxic crystal protein gene from soil bacterium *Bacillus thuriginensis* for lepidopteran insects intocultivatedspeciesofBrinjal. Bt.Brinjal particularly shows resistance against Brinjal fruitand shoot borer (*Leucinodesorbonalis*). Bt. Brinjal developed by the Maharashtra Seed company (Mahyco) in collaborationwith Monsanto. National research centerof plant biotechnology developed various

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Photo Source: Business-standard.com

gene. The Genetic Engineering Appraisal Committee (GEAC) approved Bt. Brinjal for commercial cultivation in, 2009 but later Government of India imposed a temporary ban on its commercial cultivation after the raised voices against Bt. Brinjal by Some scientists and activists. Mahyco's Bt. Brinjal is commercially grown in Bangladesh.

(3)GM Soybean:-

In 1996 the first genetically modified soybean was introduced in USA market by Monsanto. Firstly, manufacturer only wanted to develop GM Soybean only for minimize the cost of production. Later then, Monsanto developed genetically engineered Roundup Ready® Soybean resistant to Glyphosate along with cry1Ac protein coding gene. Roundup Ready® Soybean was developed by adding the

igure 3. Non-Bt eggplant Figure 4. Bt Eggplant

gene from *Agrobacterium tumefaciens*, promoter from CaMV and chloroplast transit peptide coding sequence from *Petunia hybrida*.

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(4) GM Maize/Corn:-

Genetically modified maize having specific agricultural desirable traits including insecticide and herbicide resistance, which developed by genetic engineering. In 1996, first GM corn having Bt. cry protein was approved against European Corn-Borer. Firstly Roundup Ready® Corn was commercialized by Monsanto. Later on bayer crop science developed Liberty Link® for Glufosinate and Pioneer hi-bred developed imidazolinonewith trade name Clearfield.

(5)Golden Rice:-

Rice is staple food of over the half the world's population, which is an effective crop to target Vitamins deficiencies. Golden rice is the genetically engineered rice which biosynthesize the beta carotien (precursor of the Vitamin A), in the edible portion of the rice. The journey towards development of the Golden rice had started in 1982, by Rockfellar Foundation.

Photo Source:

- In late 90's Ingo Potrycus *et. al.* developed the Golden Rice.
- In 2005, a researcher team of syngenta developed the Golden Rice 2, which produces 23 times more carotenoids than original golden rice.
- In 2015, Golden Rice has won the Patents for Humanity Awards in USA.

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(6)GM Canola:-

Photo Source: newhope.com

Normal canola is an oilseed crop developed by Canadian Scientists ("Canola" word indicates "Canada" and "Oil"). Since when canola plant was developed, scientists have developed various varieties for seed quality. In present time, most of the canola crops are genetically modified. First Genetically modified canola was developed for Glyphosate Tolerance named Roundup Ready® Canola by Monsanto. GM canola created by the combining two genes in canola genome, one gene from soil bacterium *Agrobacterium*, which encodes the EPSPS enzyme, responsible for high tolerance to glyphosate; another one gene from *Ochrobactrumanthropi* which encode the enzyme glyphosate oxidase (*GOX*). In 2003, Roundup Ready® canola was approved in Australia for commercial cultivation. However India does not allowed cultivation of GM canola in the country, but oil of GM canola is being imported every year in large quantity.

(7)GM Mustard: Dhara mustard hybrid-11 for herbicide tolerance.

(8) GM Tomato:-Delayed ripening and increased shelf life.

(9) GM Potato: Resistant against Collardo potato beetle and potato leafroll virus.

(10) GM Papaya: Ring spot disease resistance.

(11) GM Sugar-beet: Gylphosate resistant.

(12) GM Linseed: Tolerance against trisulfuron and metasulfuron.

(13) GM Alfalfa: Tolerance against glyphosate.

(14) GM Wheat: Tolerance against imidazolinone.

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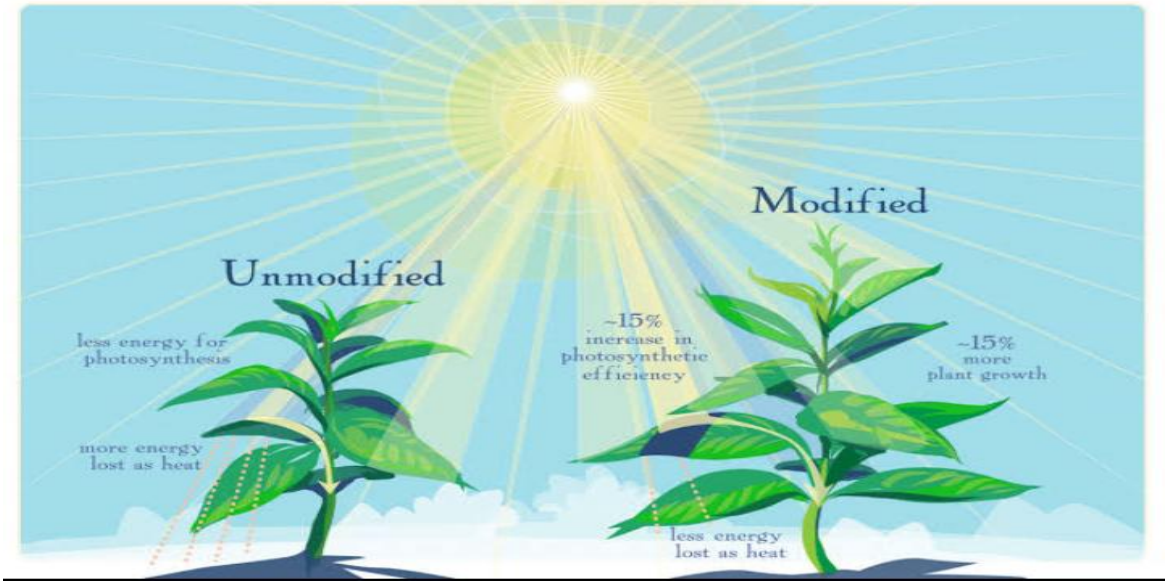
Possible benefits of GM crops

- Development of tastier and nutrition rich crop. (Vit.A enriched Golden Rice)
- Development of Insect resistant crops. (Bt. Crops)
- Development of higher starch potatoes.
- Development of Disease resistant crops. (Plum against Viral disease)
- Development of legumes crop with increased efficiency of nitrogen fixation.
- Increase the food security for rapidly increasing population.
- Development of crops against many abiotic stresses.
- Development of fertilizer use efficient crops.
- Helps to increasing the supply of food with longer shelf life. (Flavrsavr).
- Reduces the application of pesticides which helps farmers in reducing the cost of production.
- Reduced use of pesticides results in better environment and also maintains agro-ecological balance.
- Production of biofuels by genetically modified crops.
- Development of such plants which extract contaminants from polluted sites. (Phytoremediation)



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Probable risks associated with GM crops

- Bt. Crops is totally ineffective against other major pests. (e.g. White fly)
- Dominance of few companies in world's food and seed production industry.
- Risks are also associated with the breaking all the barriers of evolution and mixing genes artificially within intergeneric or interspecific hybrids.
- Seeds of non-GM crops may be mixed with GM crops due to lacking a particular labelling for produce of GM crops.
- GM crops are biologically altered, so it may have human health risk.
- GM crops may cause allergic reactions to human by genetic modification due to mixing the non-indigenous protein into human body.

Photo Source:allianceforscience.cornell.edu

- Cross pollination may cause a big problem among GM and non-GM crops.
- Releasing pollens from the GM crops, may fertilize the wild relatives surrounding them, through insects or wind which could have dramatic impact on ecosystem. There is yet long term research need to be conducted to gauge this impact.
- Scientists believed that the herbicide tolerant gene can transfer by cross pollination into a wild relatives from a GM crop will create them super weeds, which will become impossible to kill.
- Genetically modified crops may lead to creation and spread of new diseases, by even a little negligence in the application of genetic engineering.
- New diseases can be used as a biological weapon by a country on their enemy countries. (Biological Warfare)

Current Status of GM crops in Global and Indian scenario

Globally, area under GM crops has increased upto 1917 lakh hactares in 2018, which was 17 lakh hactares in 1996. USA is the largest producer of GM crops having about 39% of global GM crops area. Indonesia planted GM Sugarcane fir the first time in 2018. During cropping year 2018-19, Indian farmers had planted Bt. Cotton on 11.6 million hactares.

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According to Directorate of Economics and Statistics, Bt. Cotton has covered upto 94% of the total cotton growing area in India. On the other hand, approval for Bt. Brinjal and GM mustard (DMH-11) is still under process. Environment Ministry of India has put a moratorium on the commercial cultivation of Bt. Brinjal in 2010. Even a research paper which was co-authored by leading agriculture scientist Dr. MS Swaminathan, which describe Bt. Cotton as "failure".

Future of GM crops

Genetic engineering or Transgenic technology is a powerful tool, which helped a lot in higher crop production and increasing farmer's income by reducing use of pesticides and other costs. But, concerns raising for its safety to the environment and human health and adverse effect on non-target pests or organisms, which would result into evolution of resistant weeds and insects. Such implications on GM crops have contributes into the lesser acceptance in many countries. There are new alternatives of transgenic technology such as *cisgenesis*, *intragenesis* and genome editing techniques are being used to develop improved crop plants. It is hoped that improved crop plants using genome editing technique would be similar to conventionally bred plants and will get faster regulatory approvals which leads to their widespread adoption for cultivation.

Conclusion

Considering the rapidly increasing population, shrinking cultivable land and rapid pace of climate change, there is a need to develop the high yielding varieties, which would be highly nutritious and tolerant to various biotic and abiotic stresses. Genetically modified crops have the potential to solve the problem of world hunger and malnutrition. Thus genetic engineering can reduce the environmental risks associated with conventional agriculture, but will also introduce the new challenges that must be addressed. The world must proceed for new technologies with caution to avoid unintended harm to human health and environment, to acquire sustainable development and future for our upcoming generations.

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