

Genetically modified crops

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Introduction

Genetically modified crops (GM crops) are plants used in agriculture, the DNA of which has been modified using genetic engineering methods. Plant genomes can be engineered by physical methods or by use of *Agrobacterium* for the delivery of sequences hosted in T-DNA binary vectors. In most cases, the aim is to introduce a new trait to the plant which does not occur naturally in the species. Examples in food crops include resistance to certain pests, diseases, environmental conditions, reduction of spoilage, resistance to chemical treatments (e.g. resistance to a herbicide), or improving the nutrient profile of the crop. Examples in non-food crops include production of pharmaceutical agents, biofuels, and other industrially useful goods, as well as for bioremediation.

Advantages of Genetically Modified Crops

- The benefits experienced by the developed world by usage of GM crops are:
 - Higher crop yields
 - Reduced farm costs
 - Increased farm profit
 - Safer environment
 - More nutritious food
- The features of first generation crops such as insect resistance and herbicide tolerance have proven their ability to lower farm-level production costs.
- The features of second-generation GM crops include increased nutritional and/or industrial traits. These crops have more direct benefits to consumers.
- Examples of commercialized second generation crops include
 - Non-browning apples
 - Non-bruising and low acrylamide potatoes
 - Maize varieties with low phytic acid and increased essential amino acids

- Healthier oils from soybean and canola
- Other GM crops in the research and/or regulatory pipeline include:
- Rice enriched with iron, vitamin A and E, and lysine
- Potatoes with higher starch content, and inulin
- Insect resistant eggplant
- Edible vaccines in maize, banana, and potatoes
- Allergen-free nuts

Major GM Crops

1. Bt Cotton

- Bt cotton is insect-resistant cotton variety.
- Strains of the bacterium *Bacillus thuringiensis* produce different Bt toxins.
- Bt toxins are insecticidal to the larvae of moths, bollworms, etc. but are harmless to other forms of life.
- In 2002, a joint venture between Monsanto and Mahyco introduced Bt cotton to India.

Advantages

- Increases yield of cotton due to effective control of three types of bollworms.
- Reduction in insecticide use in the cultivation of Bt cotton in which bollworms are major pests.
- Potential reduction in the cost of cultivation (depending on seed cost versus insecticide costs).

Problems with Bt Cotton

- High cost of Bt cotton seeds as compared to non Bt cotton seeds.
- Ineffective against sucking pests like whitefly.
- Whitefly attack has become rampant in Punjab, Haryana and elsewhere.
- The costs of Bt seed and insecticide increase the risk of farmer bankruptcy in low-yield rain-fed settings.

2. Bt Brinjal

- Brinjal is India's second most consumed vegetable after potatoes.
- Bt brinjal is created by inserting a crystal protein gene from the soil bacterium *Bacillus thuringiensis*.
- The Bt brinjal has been developed to give resistance to the Brinjal Fruit and Shoot Borer (FSB).

- Mahyco has developed the Bt brinjal variety.
- Insecticide requirement for Bt brinjal is far less than its non-Bt counterpart for the control of FSB.
- The Genetic Engineering Appraisal Committee (GEAC) cleared Bt brinjal for commercialization in 2009.
- Following concerns raised by some scientists and anti-GMO activists, the GOI has imposed a moratorium on its commercial use (not a permanent ban).
- Mahyco's Bt brinjal is commercially grown in Bangladesh.

3. Golden rice

- Golden rice is a variety of rice (*Oryza sativa*) produced to biosynthesize beta-carotene, a precursor of Vitamin A, in the edible parts of rice.
- It is mostly consumed in areas with a shortage of dietary vitamin A.

Issues Surrounding GMO

Safety

- The adverse impacts of genetically modified food are not evident immediately.
- Potential human health impact: allergens, transfer of antibiotic resistance markers, unknown effects.
- Potential environmental impact: unintended transfer of transgenes through crosspollination, unknown effects on other organisms (e.g., soil microbes) and loss of flora and fauna biodiversity.
- Criticism against Anti-GM lobby: Instead of evaluating the risks, costs and benefits of hybrids on a case-by-case basis, they propose a blanket ban on genetic modification.

Access and intellectual property

- Domination of world food production by a few companies.
- Increasing dependence on industrialized nations by developing countries.
- Biopiracy — foreign exploitation of natural resources.

Ethics

- Violation of natural organisms' intrinsic values.
- Tampering with nature by mixing genes among species.
- Objections to transferring animal genes in plants and vice versa.

Labelling

- Not mandatory in some countries (e.g. United States).
- Mixing GM crops with non-GM confounds labelling attempts.

Research

- The objectivity and authenticity of scientific research and publication.

Effectiveness

- The ineffectiveness of BT cotton against whitefly attack in Punjab and Haryana has raised more questions.

Issues with banning GM crops

- The ban on GM crops is also promoting an illegal market to flourish in India.
- Bangladesh is reaping the benefits of Bt Brinjal while its cultivation is banned in India.

GMO have already entered the food chain

- Cotton seed oil extracted from Bt cotton plants is being consumed in Gujarat and Maharashtra.
- Soybean oil is extracted from imported seeds, which are produced from GM crops abroad.

Illegal cultivation (Farmer's rights vs. Government Regulation)

- A farmers' group in Maharashtra, marked its protest against the government ban on genetically modified (GM) crops by planting Bt brinjal and HT cotton.
- There is a grave danger of illegal genetically modified brinjal cultivation proliferating.