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PHASE-II: CAPACITY BUILDING PROJECT ON BIOSAFETY

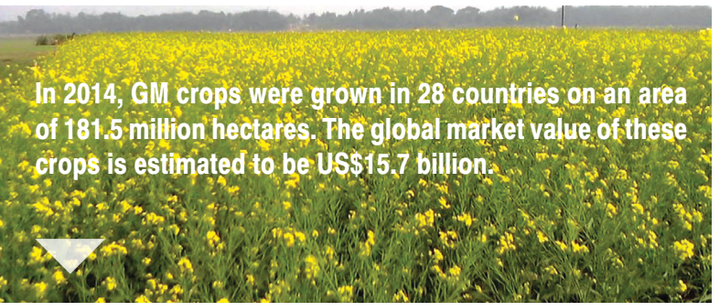
Genetically Modified Crops – An Overview

Introduction

A genetically modified organism (GMO) or living modified organism (LMO), hereinafter referred to as GMO, is any organism whose genetic material has been modified using laboratory-based transfer of genetic material from another organism.

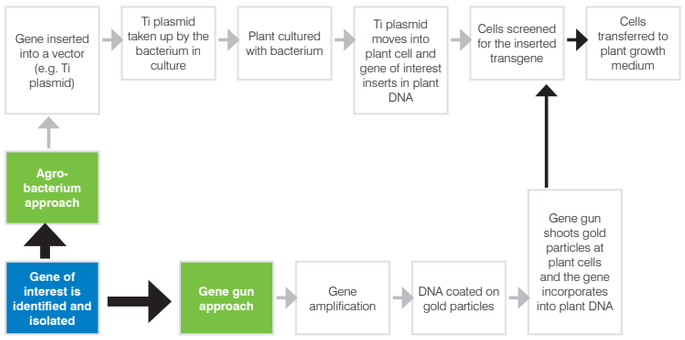
Genetic modification or genetic engineering technology has benefited us in many ways:

- Mass production of GM technology based human insulin, vaccines, growth hormones and other drugs has greatly facilitated the availability and access to life saving pharmaceuticals.
- World over, the use of animal based rennet for cheese production has been replaced to the extent of 80-90% by the enzyme chymosin produced by genetically modified microorganisms.



Developing GM crops

Development of GM crops starts with the identification of gene of interest and isolating it from the host organism. The gene is incorporated into the DNA of crop plant using laboratory based gene gun or agrobacterium approaches. The performance of the GM crop is tested under strict laboratory and field conditions.



The science behind crop Genetic modification

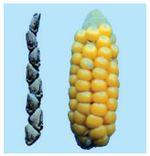
GM technology involves direct manipulation of DNA instead of using controlled pollination to alter the desired characteristics.

Genetic modification is one the approaches to crop improvement, all of which aim at adding desirable genes and removing undesirable ones to produce better varieties. Conventional crop improvement involves selection and cross breeding using control pollination of better types available naturally or produced through breeding.

Bt Cotton – A genetically modified crop

Cotton plants are often infested by bollworms which destroy the cotton buds and bolls thus rendering the crop useless. No cotton variety or a related crossable plant has a gene for resisting the pest. Hence, cross breeding is not the answer to the problem of cotton bollworm. Bt cotton developed through GM technology has provided the solution. Bt gene obtained from soil bacterium *Bacillus thuringiensis* has been inserted into cotton DNA making the modified plant resistant to bollworm.

Evolution of crop improvement



Teosinte to primitive maize

Modern maize

Insect resistant GM maize (top) non GM susceptible maize (bottom)

Prehistoric human selection and modification of wild plants to produce cultivated plants

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Modern breeding through scientific selection and cross pollination among related forms

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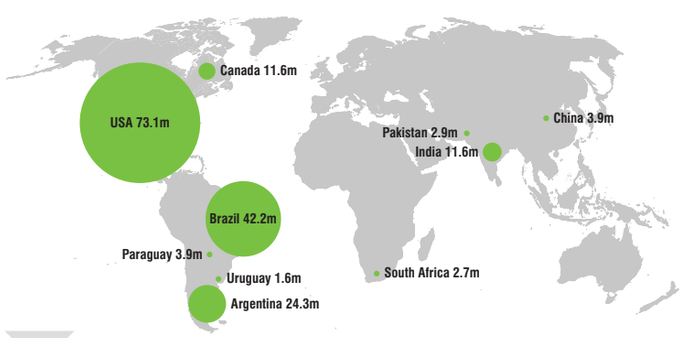
Genetic modification for transferring useful genes from other organisms to crop plants

Global GM crop cultivation

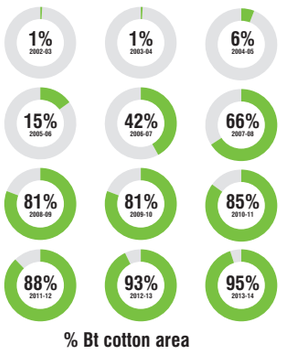
- USA, Brazil, Argentina, India and Canada are five top GM growing countries, together accounting for approx. 90% area of the GM cultivation.
- Soybean, maize, cotton and canola with herbicide tolerance and insect resistance are the major GM crops grown around the world.



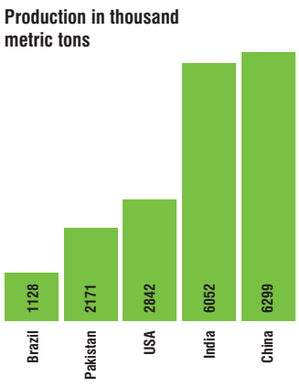
Source: ISAAA 2014

GM cotton in India

Indian farmers started cultivating Bt cotton in 2002-03. By 2014 the area had expanded to 11.6 million hectares and nearly 96 percent of the cotton area was covered by Bt cotton. India became the fourth largest cultivator of GM crops by acreage and second largest producer of cotton.



Source: ISAAA 2014

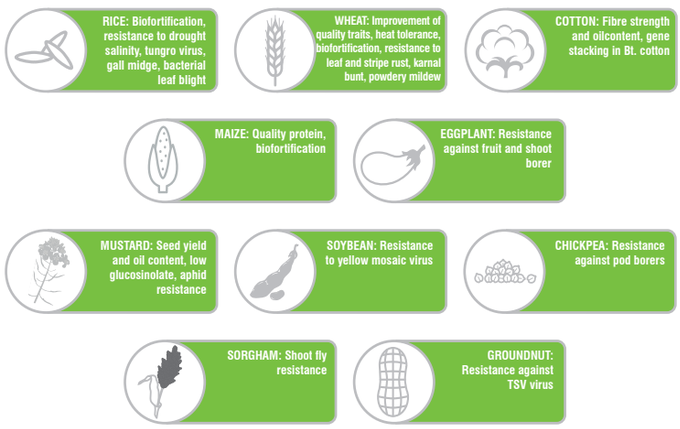


Source: FAOSTAT for Cotton production 2013

Statutory bodies on GM crop regulation

- Recombinant DNA Advisory Committee (RDAC): Monitors the developments in biotechnology at national and international levels.
- Institutional Biosafety Committee (IBSC): Approves low-risk experiments and ensures adherence to prescribed safety guidelines. Recommends high-risk experiments to Review Committee on Genetic Manipulation (RCGM) for approval.
- Review Committee on Genetic Manipulation (RCGM): Reviews all ongoing projects involving high-risk and controlled field experiments. Approves applications for generating research information on GM plants.
- Genetic Engineering Appraisal Committee (GEAC): Approves activities involving large-scale use of GMOs in research and production.
- State Biotechnology Coordination Committee (SBCC): Reviews the safety and control measures in various institutions handling GMOs. Acts as State level nodal agency to assess the damage, if any, due to release of GMOs and to take on-site control measures.
- District Level Committee (DLC): Inspects, investigates and reports to the SBCC or the GEAC about compliance or non-compliance of regulatory guidelines. Acts as nodal agency at District level to assess the damage, if any, due to release of GMOs and to take on site control measures.

GM crops R&D in India



Other considerations

- GM trade
  - Acceptability of GM food and feed in international market
  - Access and Intellectual Property
  - Domination of world food production by a few GM producing companies
- Socio-economic considerations
  - Potential benefits to the consumers and farmers
  - Socio-economic considerations arising from the impact on the conservation and sustainable use of biodiversity

Regulating GM crops

Development, cultivation and transboundary movement of GM crops is regulated so as to ensure the safety of animal health, human health and biodiversity. In India, such regulations are provided in the Rules for Manufacture, Use, Import, Export and Storage of Hazardous Microorganisms (HM) Genetically Engineered Organisms or Cells, 1989 under the Environment Protection Act (1986). The rules cover:

- All activities involving research and development of products containing GMOs including transgenic crops, pharma products, industrial products, food and foodstuffs.
- Field and clinical trials
- Deliberate or unintentional release
- Import, export and manufacture

Way forward

- Focussed GM research agenda vis-a-vis agriculture development priorities
- Capacity building on GM research, development and regulation
- Increasing public awareness with reliable evidence based information on GM crops and products
- Science based and consistent regulatory policy
- Simplified modules for risk assessment and management

Information to be generated for regulatory approval

- Description of the plant, its biology and genetic modification
- Expression of new protein
- Compositional analysis of key components
- Assessment of possible allergenicity and toxicity
- Inheritance of genetically modified trait over generations
- Data on reproductive biology, survival and ecological impact of GM plant as compared to non-GM plant

"We cannot turn back the clock on agriculture and only use methods that were developed to feed a much smaller population. It took some 10,000 years to expand food production to the current level of about 5 billion tons per year. By 2025, we will have to nearly double current production again. This increase cannot be accomplished unless farmers across the world have access to current high-yielding crop production methods as well as new biotechnological breakthroughs that can increase the yields, dependability, and nutritional quality of our basic food crops. We need to bring common sense into the debate on agricultural science and technology and the sooner the better!"

Norman E. Borlaug, Nobel Laureate, 1970