Status of Genetically modified (GM) crops in India

The Energy and Resources Institute

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What is Genetic Modification?

"Genetic modification" or "genetically modified" short for GM involves altering the genes of an organism, be it a plant, animal or microorganism. This can be done by altering an existing section of DNA, or inserting a gene from another organism. Genes carry the instructions for how we appear and what characteristics we have which are inherited by an organism. They are made up of DNA, the fundamental unit of heredity.

When a scientist performs genetic modification to a plant, they insert a foreign gene (called 'transgene') in the plant's own genes. This could be introduced from one plant to another plant, from a plant to an animal, or from a microorganism to a plant. For example, this might be a gene from a bacterium resistant to pesticide. Therefore, the genetically modified plant also is able to withstand pesticides due to the transgene (Food Standards Agency, 2012).

An organism that undergoes genetic engineering is considered to be a genetically modified organism (GMO). Bacteria and GM mice were the first GMOs generated in 1973 and 1974 respectively. In 1982, insulin-producing bacteria were the first to be commercialized and genetically modified food has been sold since 1994.

Altering genes

Apart from genetic modification, there are other ways to alter genes. Chemicals, radiation, spontaneous changes and traditional processing can also alter the characteristics of an organism without targeting a specific gene.

Spontaneous alteration most of the time have little-to-no effect on the genes and takes place naturally and is non-specific. It is not a reliable method if the intention

is to bring about changes in specific gene. It can lead to the development of both positive as well as negative characteristics.

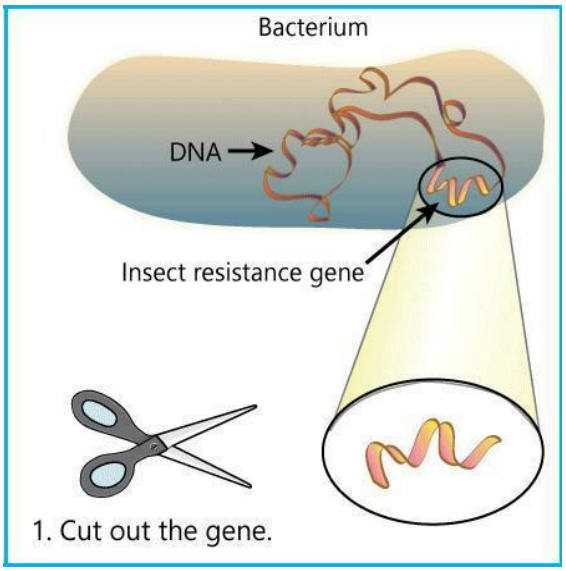
Radiation and chemicals are also used sometimes to bring about mutation in the genes i.e. to alter their characteristics.

How does genetic modification work?

The following is the process that occurs when a plant, for example, is modified by inserting a gene from another plant/organism known as **'heterologous cloning'**.

DNA Extraction

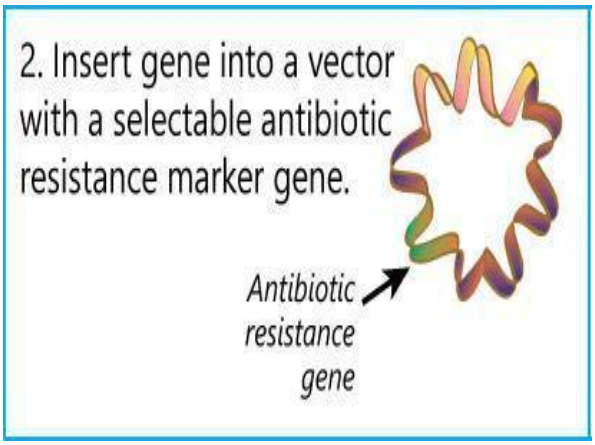
1) An organism carrying the desired trait is identified.
2) The specific gene responsible for the desired trait is located and cut out of the plant's DNA.



Gene cloning

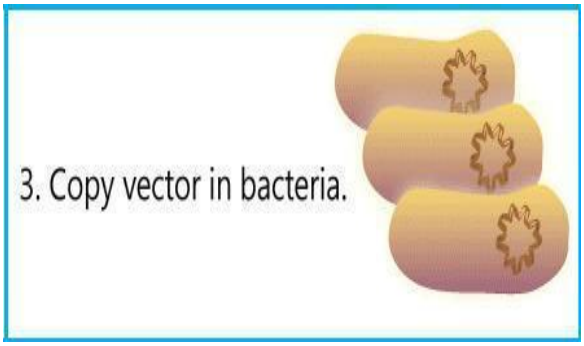
3) The gene needs to be attached to carrier to get the **'desired gene'** into the cells of the plant being modified. A bacterial piece of DNA called the **'plasmid'** is joined to the gene to act as a carrier.
4) To ensure that the gene works properly when it is put into the modified gene, a type of switch called a **'promoter'** is also combined with the gene and the

carrier. Often, the carrier package also includes a **'selectable marker gene'** to identify the **'transformants'**, i.e. the plant cells that have taken up the new gene against the non-transformants (Learn Genetics).

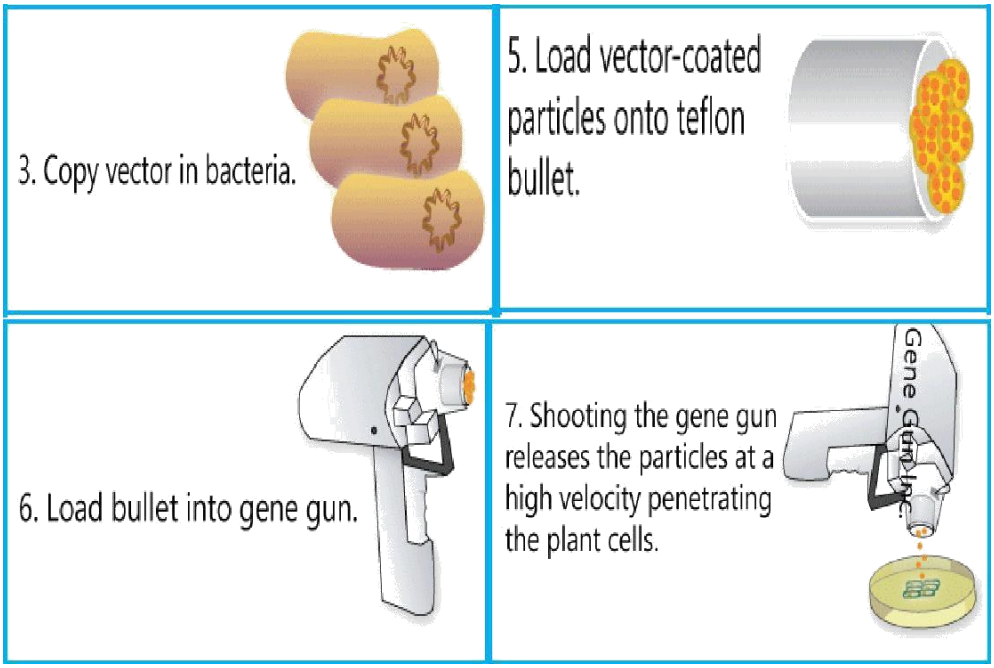


Transformation

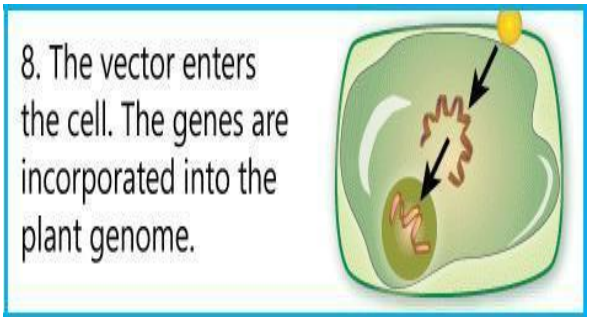
5) After transformants are picked, they've to be inserted into the bacterium/ a proper host that'll generate multiple copies of the gene package.



6) For modification of plants, the gene packages are transferred in either of two ways:
   - By attaching the gene packages to tiny particles of gold or tungsten and bombard them at high speed into the plant tissue. Gold or tungsten is preferred over others as they're chemically inert that is, they aren't reactive with their surroundings.

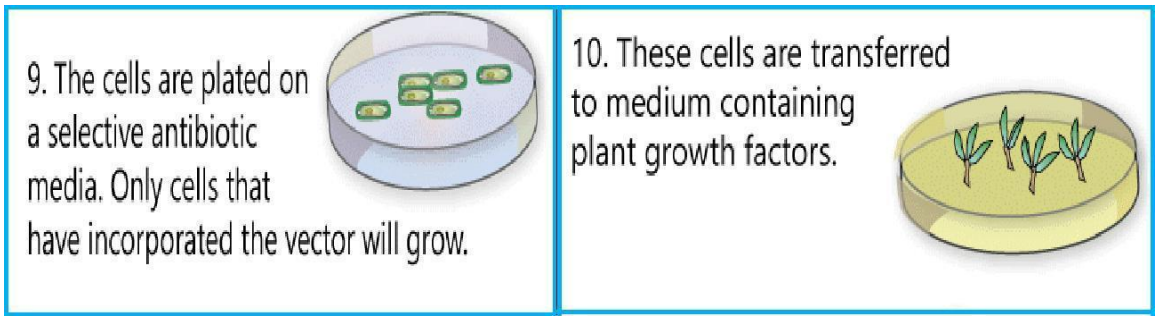


- Another way is by using *Agrobacterium tumefaciens*, a soil bacterium used to infect the plant tissue with the desired gene.



Selection

7) The plant tissue that has successfully taken up the genes is then grown into full size GM plants.



8) The GM plants are then monitored extensively to make sure that the genes inserted are working properly, as they should. This is done by growing the whole plants, allowing them to turn to seed, planting the seeds and growing the plant all over again. This is repeated for several times (Ag Biosafety, University of Nebraska).

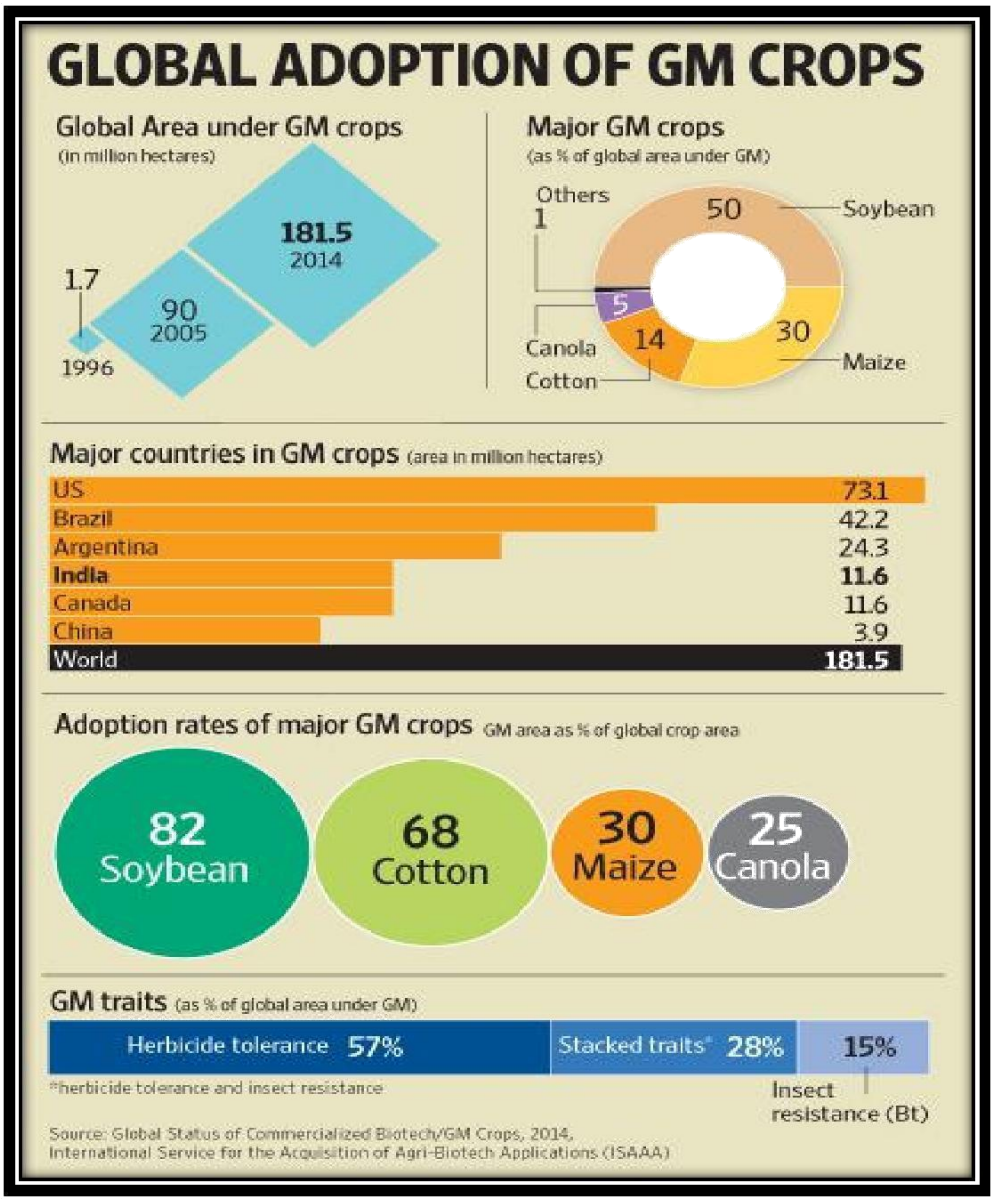
GM Crops in India

The topic on GM crops is a convoluted one. Currently, India has the world's fourth largest GM crop acreage surpassing China's 3.0 million hectares (mh), while equaling that of Canada's 11.6 mh, according to the International Service for the Acquisition of Agri-Biotech Applications (ISAAA) mostly on the basis of GM Cotton, the only genetically modified crop allowed in the country.

In 2014, farmers in India planted a total 11.6 mh under transgenics, leaving the first three spots for Argentina (24.3 mh), Brazil (42.2 mh) and the US (73.1 mh). Significantly, the entire 11.57 mh GM crop area in India last year consisted of Bt cotton, most of which (about 96%) is now covered by Bt hybrids.

While Bt cotton wholly dominates India's GM crop acreage –much of it based on the US life sciences giant Monsanto's proprietary "Bollgard" technology, this is not the case with major countries.

For example, Brazil's 42.2 mh included 29.1 mh, 12.5 mh and 0.6 mh under soyabean, maize and cotton respectively. And, US's 73.1 mh GM crop area included 34.5 mh, 32.3 mh and 4.3 mh under maize, soyabean and cotton respectively. China has most of its 3.9 mh GM planted area under Bt cotton. But the commercial cultivation of seven other crops –papaya, rice, maize, petunia, tomato and sweet pepper has been allowed by the government (The Indian Express, February 2, 2015).



Source: Global Status of Commercialized Biotech/GM Crops, 2014,

International Service for the Acquisition of Agri-Biotech Applications (ISAAA)

GM Mustard –In or Out?

India hasn't seen any new entrant in the sector of GM based crop varieties after Bt Cotton and a fleeting appearance of Bt Brinjal. Many GM varieties are believed to be under different stages of development, but yet to mark a formal release. GM Mustard is the new GM crop in the block that is doing the rounds of constant

speculation and has been cleared by the Genetic Engineering Approval Committee (GEAC), the biotech regulator in India under the Ministry of environment and forests with no such biosafety or public health concerns.

India spends roughly around $12 billion annually on vegetable oil imports. GM mustard has been considered by agri-experts as a solution for the country's edible oil deficit because it has yields upto 30% higher than the normal varieties. The variety –named as Dhara Mustard Hybrid-11 or DMH-11 which has been developed by a team of scientists from Delhi University led by former Vice-

Chancellor, Deepak Pental by genetically modifying mustard variety "Varuna" and crossed it with an Eastern European line.

Bt cotton that was modified to produce an insecticide that could kill any invading pest, that's not the case with GM mustard wherein modification has been effected to simplify the breeding process. It uses a system of genes from soil bacterium that makes mustard –a self-pollinating plant, to better adapt it to hybridization than the current Indian gene pool.

Therefore, the current status of yet another GM crop hinges on public perception and not on scientific reports (Agriculture Today, 2016).

Field trials for 21 GM food crops, including GM vegetables and cereals have been approved by the government though commercial cultivation of GM food has not been permitted by any State government in India till now (Vidya Venkat, 2016).

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