What are the Biotechnology applications in Agriculture?

Biotechnology has both GM and Non-GM applications in agriculture. It has made the plant breeding process more precise and quick. The non-GM applications involve tools like Marker Assisted Selection, Tissue Culture, Mutation breeding, etc. GM technology is being used in the world agriculture since 1996. It has applications like insect control, weed management, water use efficiency, nitrogen use efficiency, salinity tolerance etc. which help us to grow our crops with less pesticides and under difficult abiotic stress conditions. There are other applications like edible oil crops with modified fatty acid profile, maize with modified nutrition content for the animal feed industry, rice with beta carotene content, etc. which help in providing better quality food and feed for the humanity. GM technology can help in conserving soil and environment through reduced tilling and pesticide use. .

How can agriculture biotechnology address needs of a developing country?

Biotechnology applications in agriculture should be a part of the package of solutions to address the economic and social needs of a growing population. As per ISAAA (www.isaaa.org) brief 49 report more than 18 million farmers in 28 countries planted biotech crops in 181 million hectares in 2014, reflecting a 6.3 million or three to four percent increase in global biotech crop hectarage. Around the world global biotech crop plantings mark 19 years of continued growth, which justifies the continuous deployment of Genetic Modification (GM) to Indian Agriculture.

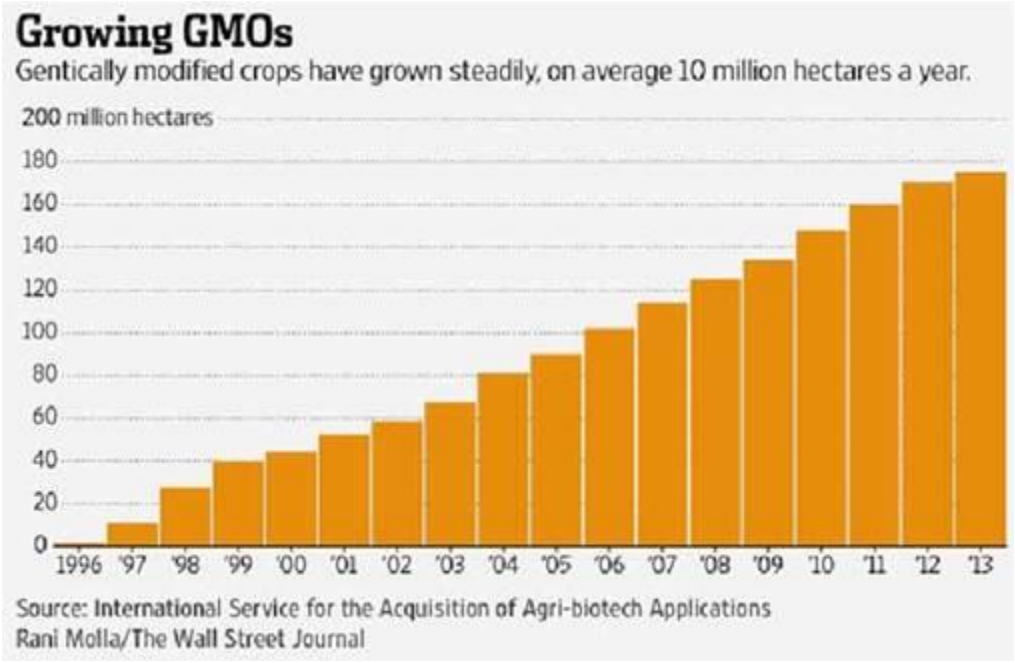
How can GM technology be useful for Indian farmers?

Crop losses due to climatic conditions, insects, pests, diseases and declining soil fertility, would also have to be factored in to apply genetic modification of crops. .In India, according to a recent study by ASSOCHAM (Associated Chambers of Commerce and Industry), crop losses due to pests and diseases amount to a whopping Rs. 50,000 crores (US$8.6 billion). GM technology can help Indian farmers in saving his crop from biotic stresses like insects and weeds, soil degradation with traits like Nitrogen Use Efficiency as well as abiotic stresses like water deficiency and salinity of the soil. With about 100m ha of rain fed agriculture in India the drought tolerant gene could make a big difference to the lives of the farmers.

Is Crop Biotechnology safe?

Biotechnology is safe, effective and widely used by more than 18 million farmers around the world
Biotechnology is a proven tool that has successfully improved crop productivity for growers around the world since 1995, resulting in an abundant and affordable food supply. Various studies have shown the safety of the technology to human beings, animals and the environment. Some of the leading Institutions like FAO have endorsed the safety. Europe has

analysed the results of over 130 research project conducted over a 25 year period involving more than 500 independent research groups and concluded that GMOs are not per se more risky than conventional plant breeding techniques.

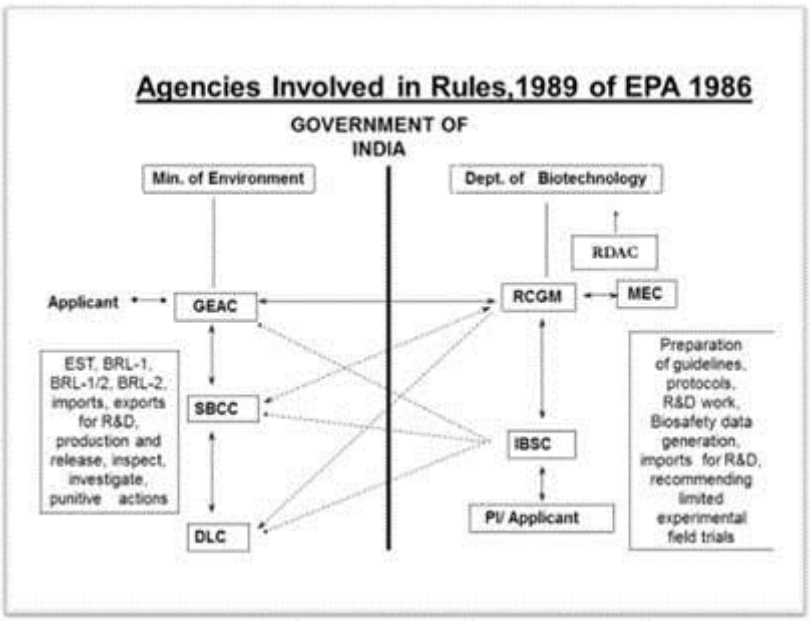


Does GM crop development need extensive research?

Research in GM crops involves developing the gene/construct which gets transferred into the seeds of a crop (Known as an Event).Developing a particular GM crop is expensive and takes 10-15 years of rigorous testing in labs, green houses, conducting cattle feed studies and open trials in actual field conditions across various parts of the country since India has a multi-agro climatic zone to test the bio-efficacy and bio-safety of the crop prior to commercialization.

Many global corporations, medium sized biotech companies and public institutions conduct this research in many parts of the world. Obtaining regulatory approval sometimes involves getting clearances from some of the countries who import food (example: Japan). Due to continuous increase in regulatory requirements the cost of obtaining global regulatory approval for a single event has gone beyond 100M$ (Rs.600cr).

Pictorial representation of Regulatory process for evaluation Biotech cropsin India



How strong is the Indian biosafety protocols and tests, do they conform to international standards?

India has a robust, multi-tiered regulatory system for evaluating biotech crops and very stringent rules and regulations governing the use of plant biotechnology. The regulatory authorities have developed guidelines and protocols for evaluating the biosafety, toxicity, allergenicity, food and feed safety, and large-scale use of biotech crops. As per the procedure there are three committees. Namely the Institutional Bio-safety Committee (IBSC), which reviews the facilities (laboratory, green houses & net houses) and the ability to undertake research like recombinant DNA research work, project objectives and capabilities of scientists and adherence of bio-safety guidelines. RCGM (Review Committee on Genetic Modification) under the Ministry of Science and Technology reviews Bio-safety data generated. GEAC (Genetic Engineering Appraisal Committee) under the Ministry of Environment & Forests carries out extensive assessment of the biosafety and environmental safety of the technology before approving open field trials to develop the product line for further commercial cultivation. These committees comprise of renowned scientists, experts and policy makers from multiple Ministries including the Ministry of Health. Recommendations of IBSC are important and necessary for getting any approvals from RCGM or GEAC.

After being satisfied that the introduced trait is safe, RCGM recommends conducting contained field trials. At this stage the safety of the product is fairly established. Minimum of three years of BRL trials are required for approval of an event by GEAC. These trials are limited to no more than one acre per trial site location with a cumulative of 20 acres. During field trials along with agronomy data that is generated, effect on soil and environment, effect on non-target organisms, beneficial organisms &

other organisms are generated and submitted to the regulatory bodies before the GM crop is approved for cultivation.

Many state governments do not allow GM crop trials: Post the moratorium on the commercialization of bt-brinjal in 2010, the MOEF had suggested in June 2011 that a **NOC should be obtained by applicants from the state agricultural department to conduct the GM field trials in the respective state agricultural universities**, even after the RCGM & GEAC, the highest regulatory authority in the country, provides a go ahead. Ironically when applicants visits the state agricultural department for an NOC they rest aside the applications since there is no designated official who has been trained to deal with the subject even though GEAC & RCGM the highest regulatory authority has given approvals. Now when the question arises that state government does not want GM crops- **have they been equipped to say "NO to GM trials"**? While saying no to commercialization in 2010, few state governments depended on the non-science based myths created by activists through negative media reports instead of attempting to study the scientific and economic benefits the technology would provide to Indian farmers.

How is the safety of the GM Crop established?

Safety of the GM crop to humans is established by acute feeding studies of pure protein; sub-chronic feeding studies of the plant materials, compositional analysis; allergenicity tests and animal feeding studies. Only after, data from all these studies indicated that the product is safe, it would be approved for commercial cultivation. Hence GM crops approved so far are safe to humans, animals and environment.

At the final stage, Genetic Engineering Approval (Appraisal) Committee reviews the entire information on the trait and takes a decision. In RCGM & GEAC scientific experts deliberate on the efficacy and validity of the data to take appropriate decisions. India has adequate safeguards in bio-safety and food safety already built into the existing system. Only after thorough testing at different stages with great care and regulatory oversight, GM crops are authorized for commercial cultivation.

Are there any food crops approved for cultivation across the globe?

Some of the several food crops approved and being cultivated across the globe are cotton, corn, soybean, canola, sugar beet, potato, and alfalfa.

Conventional farming practises alone will enhance productivity instead of GM technology. No single approach like conventional crop improvement alone will double crop production by 2050. Blending traditional plant breeding techniques with GM techniques would improve

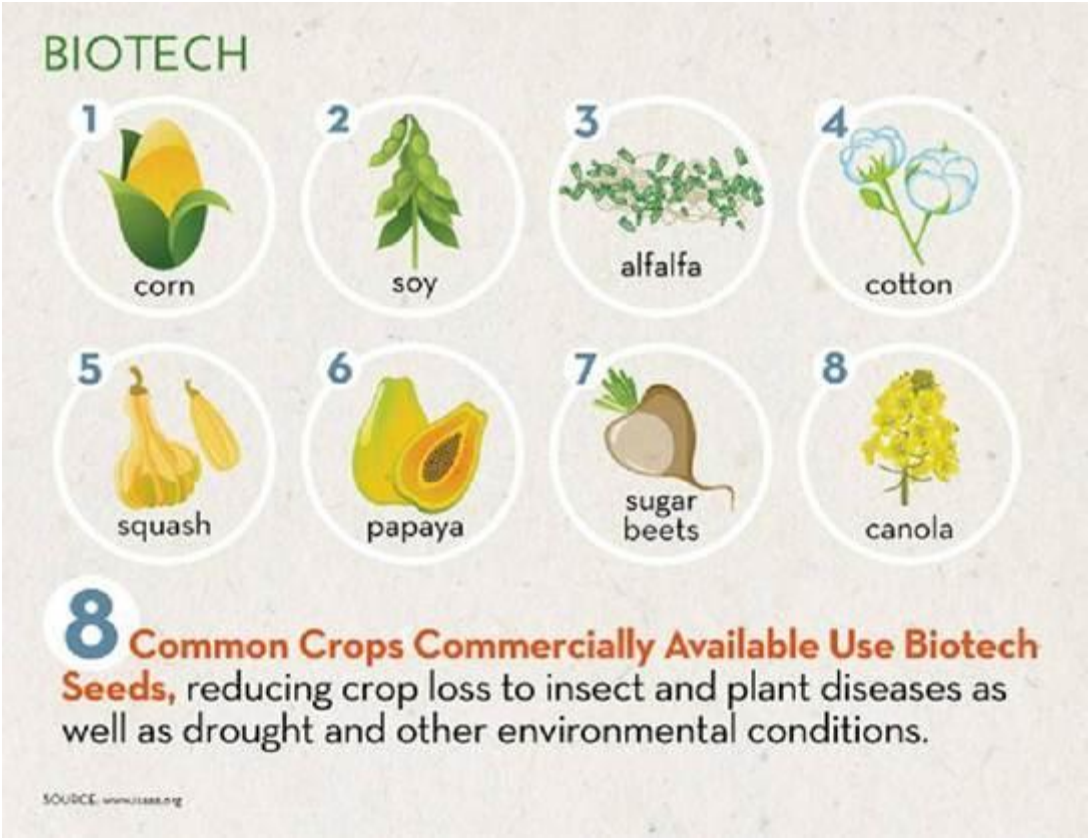
crop yields where traditional agricultural practices may not have solutions or would take too long to arrive for farm benefits

Farmers are capable of addressing agricultural hazards like pests, insects with existing farming practices

Crop losses due to climatic conditions, insects, pests, diseases and declining soil fertility, would also have to be factored in to apply genetic modification of crops. There are many technological traits available in the GM space which could be of great use to Indian farmers in the coming years.

There is a need to identify crops and traits beneficial for India, existing varieties will benefit farmers:

The government and the industry should work together to identify high priority crops useful for India and provide necessary policy support in these areas, to deliver the best value to the farmer. Identifying the genetic trait and deploying the correct technology to fight drought, salinity, low irrigation facilities, water resistant, high pesticide usage and fertiliser subsidy would improve agricultural productivity. This is all what it takes to place the genetic modification of crops.

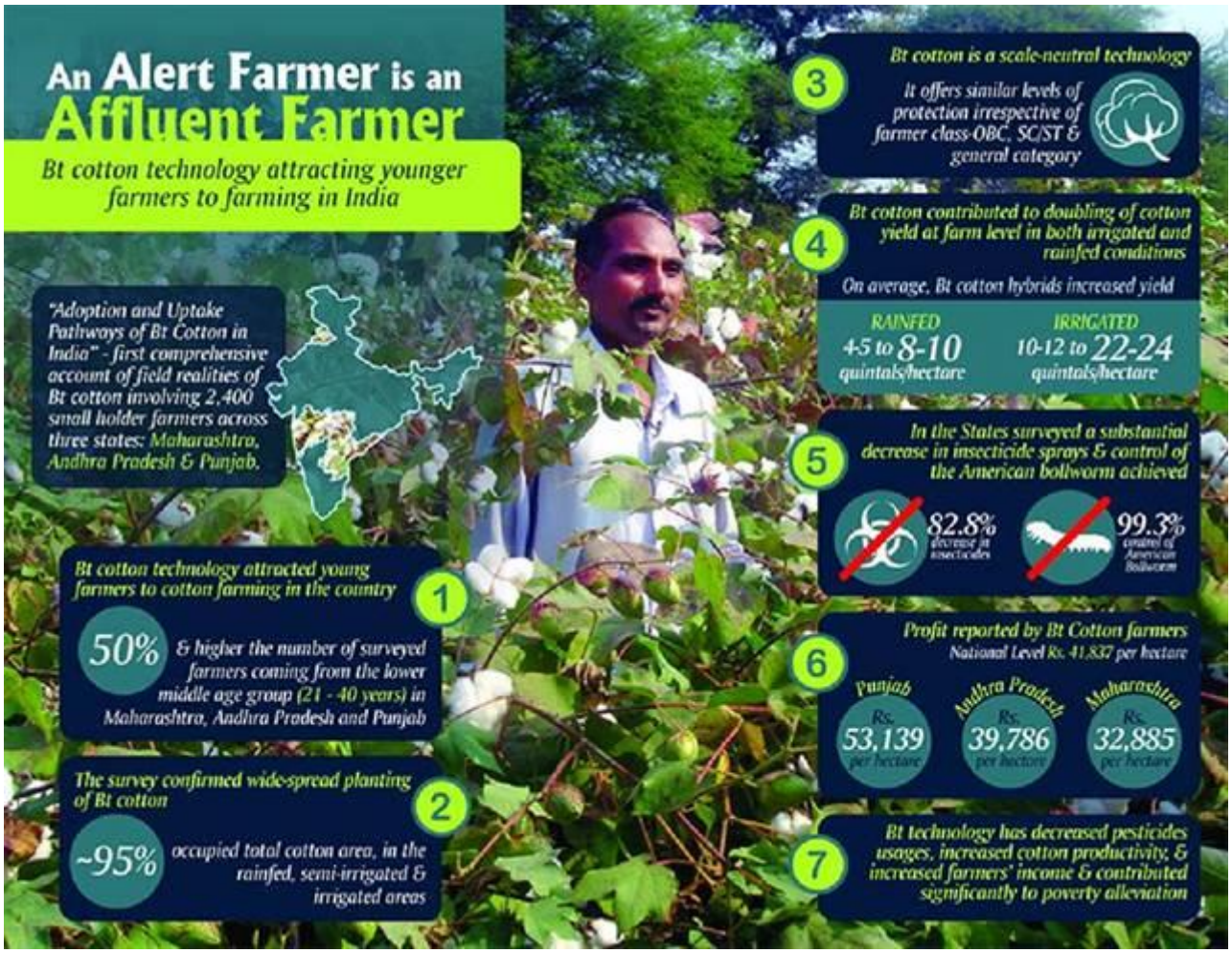


Can seeds with biotech traits increase food production?

Seeds with biotech traits can protect crops from the weeds, insects and

diseases that reduce crop yields and farmer income, increase farmers' productivity on existing farmland, without putting fragile or forested lands into food production.

What are the GM crops approved for commercial cultivation in India?



In India an example of insect resistant trait developed by GM technology is the commercial production of bt cotton. Currently more than 600 Bt cotton hybrids are approved from more than 30 seed companies containing Bt technology from five different sources. Since its commercial introduction in 2002, the acreage under cotton has gone up from 9 million hectares to around 12 million hectares while the cotton production has gone up from 13 million bales to 34 million bales, thus an increase of 165 per cent. India's cotton yield which was 200 kg per ha in 2000, rose to 362 kg per ha in 2005-06 and 510 kg per ha in 2010. From being an importer of cotton in 2002, today India is the second largest exporter of cotton. 60 lakh cotton farmers of India would not use a technology if it has not delivered results.

Does India consume GM foods now?

India has been importing GM oils of Canola and Soybean since 2007. Bt Cotton seed oil is being consumed in India since 2002.

Moratorium on bt brinjal in 2010, was due to inadequate bio-safety tests conducted & data generated.

For bt brinjal more than 25 independent biosafety studies were performed, six years of field testing completed with at least 60 field trials conducted to establish efficacy and economic benefit to farmers. Yet GEAC was reluctant to approve commercialization citing the need for more tests, yet the tests have not been defined till date.

Has bt brinjal been approved for commercial cultivation in any other country? Bangladesh through the NCB (the Bangladeshi equivalent of the Genetic Engineering Appraisal Committee) approved commercial planting of four Bt brinjal varieties developed by the Bangladesh Agricultural Research Institute (BARI), incorporating Mahyco's proprietary gene construct technology in Oct 30, 2013, becoming the first country in the world to do so. Following this, 20 farmers planted Bt brinjal seedlings on over two hectares of land in four brinjal growing regions of Gazipur, Jamalpur, Pabna/Ishurdi and Rangpur in the spring of 2014, and there has been no reports of any ill effects so far, mentioned the International Service for the Acquisition of Agri-biotech Applications (ISAAA) in its latest status report.

India has enough food stock to address food security goals and increasing population. Although our current situation in rice and wheat is comfortable, the country is going to face serious shortage of pulses and oilseeds in the next 10-15 years when India's population is expected to reach 1.5 billion by 2030. With increasing population and climate change , additional food would has to be produced on existing agricultural land or marginal soils to remain a nation with food and nutrition security.

GM crop technology will destroy biodiversity

The variety of biological and genetic diversity is progressively reduced in the commercial arena because of the process of selection and breeding. It has nothing to do with the use of Genetic Modification (GM) technology. The biodiversity in the farm fields is not destroyed in this process of crop improvement or the deployment of Genetic Modification technology (GM), genetic diversity is rather preserved in the gene banks of various Governments see banks and Institutes and is utilized fully to develop new varieties. Such diverse genetic background is available to plant breeders to be used in their breeding programs to improve the plant varieties, hence it is not lost.

How will GM research help? We have a serious shortage of farm

labour. Humongous amount of water is required for cultivating transplanted paddy, just to use water as a weed management mechanism, will shortly become a luxury that we cannot afford. We need to find different ways of cultivating paddy, utilizing new technologies to control weeds. We can the water to grow other crops.

India public sector has no role in GM Research & Development, only MNCs are involved in research. The Government of India spends thousands of crores of rupees every year including ongoing work in public institutions on GM technology. Overall trait development through genetic modification is at various stages of research in public institutions, out of the total regulatory pipeline of about 9 crops and more than 50 events, more than 50% are from public institutions. If we want to encourage Indian public sector in this field, as is done in China, we should provide them with the right support to deregulate their products and bring them into the market.

The government in its biotech policy declaration has banned GM crop technology in India. In its written biotech policy of the Government of India, drafted by a Committee headed by Dr MS Swaminathan ten years ago clearly supports the use of GM technology in all crops including food crops. The only exception made was Basmati Rice. There was no other ban on the use of this technology in the policy document.