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Review Article

GM Crops in India: Present Status-A Review

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Abstract

A large number of genetically modified (GM) crops, including both food and non-food crops carrying novel traits have been developed and released for commercial agriculture production. Soybean, maize, canola and cotton for the traits insect resistance and herbicide tolerance are the most crops under commercial cultivation worldwide. In addition, many other GM crops are under development and not yet released commercially. Food and Agriculture Organization (FAO) in its report, the State of Food Security and Nutrition within the World 2017, highlights the severity of food security and malnourishment problem in most of the Asian and developing countries. GM crops could be an option for nutrients. The increasing cultivation of genetically modified crops has raised a wide range of concerns with respect to food safety, environmental effects and socio-economic issues. Here, we discussed the present status of GM crops research, regulatory framework, and challenges involved transgenic plants acceptance in India.

Keywords: *GM crops, current status, tolerance, challenges in acceptance, regulatory actions*

Introduction

A genetically modified organism (GMO) is an organism or microorganism whose genetic material has been altered to include a strand of DNA from another organism. Modern recombinant DNA technology enables the pieces of DNA to unite together regardless of their origin. Since the 1980s, this technology has been widely used by the researchers for infinite purposes: to create new copies of genes or proteins, to know gene function, to study gene expression patterns, and to create models for studying human diseases. Currently the GM crops on the market have bacterial genes introduced into their genomes that encode for various beneficiary functions like pest or herbicide resistance, increase in productivity, drought resistance, flood resistance etc. As per theory, this should cut down on the amount of chemical pesticides that needs to be sprayed, but in practice that goal has not been realized as pests and weeds become resistant to the chemicals that are being used nowadays. In India, the most commonly found GM crops are rice, wheat, maize, cotton, sugarcane, potato, cauliflower etc.

Most scientists agree that GM foods are safe for human consumption. There is concern among scientists that the vocal resistance of certain individuals to GMOs is due insufficiency of understanding of the technology and as such there is prevalence of misinformation. Researchers have been altering the genome of the existing crops to produce more improved food through

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selective breeding and applying modern technology. GM crops are planted extensively for a touch over a decade. While no negative health consequences are detected (or are anticipated), the relative newness of GM crops requires that we still monitor for health impacts. At present, the ecological concerns that stem from the way GM crops are planted are a more pressing concern.

In the last 25 years, GM crop production has experienced over 100-fold increase (Brookes and Barfoot, 2013; Mathur *et al*., 2017). Globally, in other countries like Mexico, farmers are cultivating approximately 190 million hectares of biotech crops, which is approximately equivalent to the entire surface area of Mexico (ISAAA, 2020). Soybean (~50%), maize (~30%), cotton (~13%) and canola (~5%) make up the four primary cultivated crops (ISAAA, 2018, 2020).

In some states, public unease with GMOs has resulted in attempted legislation to require labeling of food products that contain GM ingredients development and commercialization of GM crops in India and helping in translating biotechnology research to reach to Indian farmers. Many private companies also invested enormously on research and development of transgenic crops. Now, without any doubt GMOs are an integral part of many agricultural based commodities in every corner of the world, adding billions of dollars per year to the global economy, and being major income source for developed and developing countries including India.

Current status in India

Genetically engineered cotton (popularly known as Bt cotton) for insect resistance has been released for commercial cultivation in India during 2002 by GEAC (Genetic Engineering Approval Committee), Government of India (GOI). and it has turn out to be a paradigm shift in Indian GM crop research, its deregulation and even for cotton industry in India. Cultivation and production of Bt cotton has grown exponentially since then and India has become second largest producer of cotton and leading exporter within the world (Choudhary and Gaur 2010). The GEAC cleared Bt brinjal for commercialization in October 2009 but following concerns raised by some farmers, anti-GM activists and scientists, the govt of India officially announced moratorium on 9 February 2010, and then Environment & Forest Minister Mr. Jairam Ramesh mentioned that there's no overriding urgency to introduce Bt brinjal in India and also reiterated that the govt had only imposed a moratorium on the discharge of transgenic brinjal hybrid, and not a permanent ban (MoEF 2010). Food grain production in India has increased to 241 million tonnes in 2010–2011 as compared to only 51 million tonnes in 1950 (Parwez 2013). India is largely an agricultural economy where almost 70 % of the working population is dependent on agricultural sector for employment and subsistence and the condition of farmers are very pathetic despite all these achievements. The story of Bt cotton producers are not so rosy as reported by several scientists and that too, if there is no clear evidence as yet that GM crops can actually increase yields then there's no urgent got to plow ahead for commercialization of GM crops in India and wish to develop new policy for ensuring food security in future without compromising the security of human and livestock health and jeopardising the vast biodiversity (Chaturvedi 2012). The process of development, its potential benefits and deregulation of Bt Brinjal in India is that the most debated issue till now. Recently, the GEAC (Genetic Engineering Appraisal Committee, since July 22, 2010) on July 18, 2014 has given approval

for limited experimental field trials of GM rice, brinjal, mustard, cotton and chickpea for the sole purpose of generating biosafety data (The Hindu 2014). The current Modi government may be a supporter of GM crops and former Environment Minister Mr Prakash Javadekar advocated his views and told to Reuters in February 2015 that "Field trials are already on because our mandate is to seek out out a scientific review, a scientific evaluation" (Reuters 2015). Recently, the GEAC recommended for commercial cultivation of GM mustard for clearance to Environment Minister (Indian Express 2017) but final judgment remains pending. Some GM crops entered into the regulatory system of India, precisely included in Table 1.

TABLE 1. Some important GM crops entered into regulatory system in India

Sl.No.	Name of Crop	Gene	Name of gene	Released by	Status
1.	Cotton	Insect Resistance	MON531/*cry1Ac*	Monsanto	Approved
2.	Cotton	Insect Resistance	cry1F gene, *cry1Ac gene*	ICAR-CICR, Nagpur	Event selection trials
3.	Cotton	Herbicide Tolerance	*cp4epsps gene*	Mahyco	Confined field trials
4.	Brinjal	Insect Resistance	cry1Fa1, cry2Aa, stacked cry1Fa1 and cry2Aa	Global Transgenes	Event selection trials
5.	Brinjal	Insect Resistance	ANK-19 event/Cry1Fa1 gene	Ankur Seeds	BRL-I trials
6.	Brinjal	Insect Resistance	Cry1Fa1 gene	Rasi Seeds	Event selection trials
7.	Maize	Insect Resistance	MON89034	Monsanto	BRL-I trials
8.	Maize	Herbicide Tolerance	NK603	Monsanto	BRL-II trials
9.	Maize	Herbicide Tolerance	cp4epsps	Metahelix	Confined field trials
10.	Groundnut	Drought Tolerance	*rd29A gene (DREB1A)*	ICRISAT, Hyderabad	Confined field trials
11.	Rice	Salt Tolerant	*OSnhx1 gene*	Mahyco	Event selection trials
12.	Rice	Water use efficiency	*ipt gene*	Mahyco	Event selection trials
13.	Cauliflower	Insect Resistance	Event CFE4	Sungro Seeds	Confined field trials
14.	Wheat	Salt Tolerant	*OSnhx1 gene*	Mahyco	Event selection trials
15.	Potato	Fungal Resistance	*RB gene*	CPRI, Shimla	Event selection trials

Advantages

1. It improves production and raise farmer's income. Indian farmers are still practicing traditional process of seeding and cultivation, which required scientific moves for raising their production. Hence, it's one among the moves to reinforce the farm production.

2. It reduces the utilization of pesticide and insecticide during farming which may be great moves towards the betterment of the quality of food supply.

3. It can feed a rapidly increasing population because it shows dramatically increased yields.

4. It can produce more in small area of land.

5. India introduced Bt cotton seeds in 2002. It has greatly reduced the utilization of toxic pesticides. Bt cotton produces a standard soil

bacterium, Bacillus Thuringiensis (Bt). It is a natural pest repelling bacteria that's toxic to several worms and pests which will harm the crop but isn't hazardous to humans. Bt is widely sprayed on crops by organic farmers as a pesticide. As a results of the adoption of Bt cotton, India has become the most important cotton producer in the world.

Disadvantages

1. The assembly of genes imposes high risks to the disruption of ecosystem and biodiversity as it influences the natural process of gene flow and hence the natural selection.
2. It increases the worth of cultivation and more inclined towards marketization of farming.
3. The transgenic crops endanger not only farmers but also the trade, and thus the environment also. 4. It's biologically altered. Hence, biotech foods may pose an individual's health risk. 5. The excessive production of genetically modified foods are going to be rendered ineffective over time. The pests might eventually develop resistance towards them.

Success of GM crops depends on the key points

The future of genetically modified crops in India will depend on those varieties which can address the country's three pressing needs of improving farm efficiency, sustainability and food security as said by Niti Aayog Member Ramesh Chand in his report. Futhermore, he added that we must come out with varieties that have significant gains. It means in terms of yields or reduction in use of pesticides, among others, Chand said at a book release event. He released a book titled "Socio Economic Impact Assessment of GM Crops: Global Implications Based on Case-Studies from India". The nation has currently in need of improving farm efficiency, sustainable farm production and food security. Chand said any GM variety which can address these three areas would have more acceptability. (https://www.bloombergquint.com/pti/future-of-gm-crops-in-india-will-depend-on-significant-gains-in-3-key-areas-ramesh-chand).

Conclusion

The wide advantages of transgenic crops for a society to unravel food security or nutrition security issues are well established. Many added benefits like higher nutritional value, herbicide tolerance, virus resistance, tolerance to varied abiotic stresses, increase the time period of a fruit and thus, can account for a good market for farmers. There is an urgent need for India to hold on its GM crop research program to sustain its food and nutrition security targets. Debate on GM crops about safe or unsafe will never end although there's hardly any substantial scientific evidence against safety of GM foods. Surprisingly, few public sector intuitions also showed their concerns for GM foods. Intuitions funded by GOI should follow same broad policies of Indian Government and must show their strength with the govt to fight poverty and malnutrition. This valid point has appreciates the opposite views of the members of Technical Expert Committee appointed by the Supreme Court of India for Safety and Guidelines for GM crop research. Although, this is often a incontrovertible fact that India doesn't have basic infrastructure and stringent guidelines for GM crop research and risk assessment but taking in to account India's urgent need, we cannot halt this program. Ideally, India must continue on its research on GM crop and its deregulation along side building basic infrastructure facilities and preparing stringent biosafety and marketing guidelines. Although portals like GEAC, IGMORIS (Indian GMO Research Information System), Biosafety financial institution do

their role for assessing biosafety and their regulation of GM crops but there's an urgent got to build one window system and online portal for assessment, control, regulations and approval of GM crops. It should become mandatory for agro based companies and public sector institutions to register themselves with this portal whenever they develop any event for transgenic development and starting their field trials before submitting for approval.

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