AgriCos e-Newsletter
ISSN: 2582-7049
www.agricosemagazine.com
Volume: 01 Issue: 01 May 2020 Article No: 04

Transgenic Crops - Perspectives and Prospects in India

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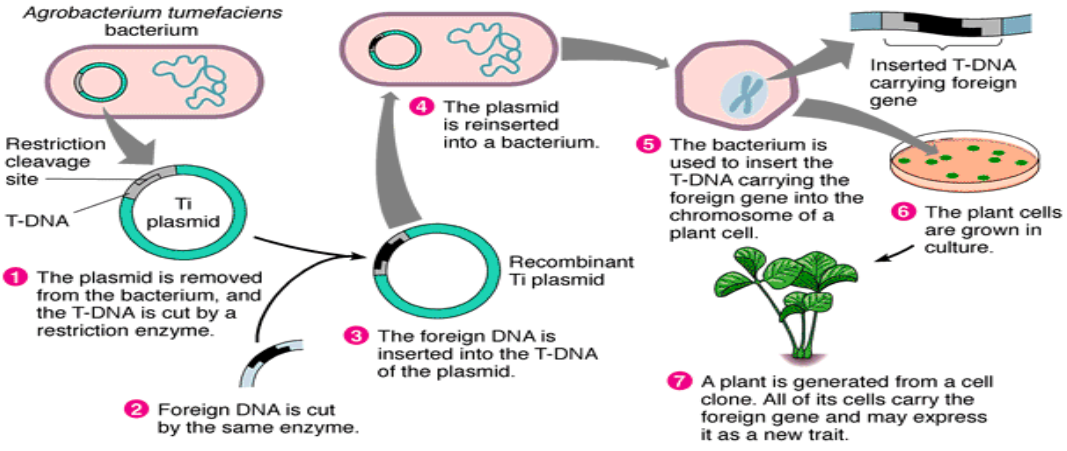
SUMMARY

Transgenic crops have the potential to solve world's hunger and malnutrition problems, and to help, protect and preserve the environment with the elevation of production and reducing reliance upon chemical pesticides and herbicides. Apart from these it add benefits such as higher nutritional value, herbicide tolerance, virus resistance, tolerance to various abiotic stresses, increase the shelf life of a fruit and thus, can account for a good market for farmers. Yet, there are many challenges ahead for governments, especially in the areas of safety testing, regulation, international policy and food labeling. The article delineates the adaptability and acceptability as well as advantages and challenges of GM crops related to the environmental and biosafety in India.

INTRODUCTION

"Biotechnology can contribute to meeting the challenges faced by poor farmers and developing countries."- United Nations Food and Agriculture Organization.

Dr. Norman E. Borlaug stated that *"Genomic modification of crops is not some kind of witchcraft; rather, it is the progressive harnessing of the forces of nature to the benefit of feeding the human race".* Agriculturists have improved agricultural production and productivity to support rapid growing population by introducing improved breeding techniques i.e. the genetic modification of crop plants. This is generally done by adding up one or more genes to a genome of selected plants using various gene manipulating methods. However, most of the GM crops by and large are developed using biolistic method (particle gun) or *Agrobacterium tumefaciens* mediated transformation method. The process of using Agrobacterium for genetic engineering is illustrated in the diagram below.



Achievements as Advantages:

The umpteen potential benefits of GM crops are providing resistances to crop pests. BT Tobacco, corn, rice and many other crops have been generated that express genes encoding for insecticidal proteins can help to eliminate the excess use of chemical pesticides. GM squash, papaya and potatoes have been developed to combat certain viral pathogens, such as cucumber mosaic virus (CMV) (Alam *et al.*, 2014). Thus it directly helps to increase crop yield by reducing chemical fertilizers and pesticides usage. GM Crops have been commercialized that are resistant to the herbicide glucosinate, Roundup, phosphinothricin and bromoxynil. Besides this transgenic crops can withstand unfavourable climatic conditions such as drought, extreme heat or cold, thereby enabling farmers to cultivate land that is poorly used. It also includes increased yield, reduced maturation time, increased nutritional value, e.g. increased protein content, and improved sensory attributes of food, e.g. flavor, texture, enhanced shelf life. Genetically modified Jatropha sp., has been modified for its traits improvement for better fuel product. Recently, Swiss-based Syngenta has get USDA approval to market genetically developed maize seed trademarked "Enogen" which covert its own starch into sugar to speed up process of ethanol conversion into biofuel. GM plants containing genes which produce bacterial enzymes responsible for bioremediation have been utilized to remove heavy metals like mercury, selenium and organic pollutants such as polychlorinated biphenyls (PCBs), RDX and TNT from soil. So far, 100 different GM strains are reported to be environmentally safe. Notable of them are soybean, corn, cotton, canola, potato, rice, papaya, cauliflower and chrysanthemum. Significantly a breakthrough has been achieved through genetic modification for delayed ripening in tomato, high oleic acid content in soybean, boll worm resistant cotton, fruit and shoot borer resistant in brinjal and modified flower colour and increased vase life in carnation.In medical science too, the Rhizobium rhizogenes mediated transformed hairy roots of medicinal plants are generating different biochemicals of medicinal importance.

Challenges Ahead

1. Promote rural economic development and self-esteem, decrease dependence on distribution systems, and lower the need for food aid.
2. Maintaining the Ecology and biodiversity after introducing this technology have been raised question for current cultivation systems. Gene transfer from the transgenic plant to related species as a result of hybridization that could lead to new pests. Harmful effects on non-target species with the expression, for example, of insecticide toxins that can kill beneficial as well as targeted insects.
3. The nervous apprehension of consumers on food quality and its safety has resulted reduction of interest to farmer which consequently damage the demand supply chain of commercial cultivation.
4. GM crop technology development policy is urgently needed and proper screening of human resource for risk assessment review, management and communication at all levels is required.
5. System for continual education and research resources for regulation is required and a sustainable long term communication system for promoting public understanding of science.

GM crops can't solve all problems

Genetic engineering has had ramifications on many fruits and vegetables including soybean, cotton, Canola, tomato, potato, papaya, flux, squash, sugarbeet for many years. Even

a few years back all these had great importance at least to the farmers. But most of these crops are not grown today including the Flavr Savr tomato, despite approval for release. Unfortunately, genetic engineering does not solve all problems. All human activities are not completely free of risk, and socio-economic decisions are needed to establish an acceptable level of risk. For example the evolution of resistance in insects and weeds is a concern when using transgenic crops, but no more than conventional cropping systems. In most of the cases the field performances of GM crops are not at par with that of claim. Sometimes cultivation is not cost effective and not eco-friendly. Still to date the large-scale use of the GM crops has been the subject of controversy even in the United States and European Union. However, many public and private agencies are working around the clock and globe to provide themselves and consumers with more information about the benefits and drawbacks of genetically engineered crops.

Risk assessment studies are integral part in the production and placing to the market a transgenic variety. Different countries have adopted different approaches in biosafety assessment. International harmonization of biosafety standards is an important challenge as we face the international trade of transgenic plant products. The most important reason is growing public concern about food safety and environment pollution. Regarding sustainable agriculture it may be mentioned here that over the past decade, agricultural biotechnology has played a role in improving plant productivity and crop quality, increasing farmers' income, and supporting stewardship of the land, while contributing to a safe food supply. Transgenic crops have been cultivated for more than 10 years, and consumed by billions of people, without one single documented health problem. This is a remarkable food safety record, which is consistent with safety, conclusions drawn from pre-market scrutiny and testing of Transgenic crops and foods (Tsaftaris, A. 1996)

Genetically modified plants commonly contain one antibiotic resistance gene to allow confirmation that the gene for the desired trait is present. These genes work by producing proteins to protect plant cells from the specific antibiotic. These proteins have been shown to be easily broken down within seconds of being ingested and do not have any allergenic or toxic effects on human or animal life. Moreover, transfer of this gene from plant cell back to bacteria has not been shown to occur in nature. Still scientists have identified new marker genes to avoid this controversy.

Scenario of GM Foods

A report by the International Service for the Acquisition of Agri-biotech Applications (ISAAA) named, 'Global Status of Commercialized Biotech/GM Crops: 2016', stated that GM Crop cultivation has touched a new peak showcasing 110-fold increase in adoption rate of GM/biotech crops globally from 1.7 million hectares in 1996 to 185.1 million hectares in 2016. The most planted GM crops in 2016 were soybean, maize, cotton and canola.

Adoption of GM crops in India has gained a rapid pace. It is on fifth position with an area of 10.8 million hectares cultivation. United State of America rank first as the producer of GM crops with an area of 72.9 million hectares under GM crops in 2016. Brazil ranks second in area planted biotech crops with 49.1 million hectare but has highest year over year adoption growth in 2016 with 4.9 million hectares followed by USA with its share of 2 million hectares. For the first time in India since 2002, a drop in the area under Bt cotton by 0.8 million hectare has been recorded from 11.6 million hectares in 2015 to 10.8 million hectares, due to low global cotton price. But 2016 has been a turning point in Indian scenario of

biotechnologically intervened crops. India's biosafety regulations have been streamlined with revised guidelines on the monitoring of confined field trials of biotech crops. Commercial release of GM mustard is underway where this mustard expressing the Barnase-Bar- Barstar genes is under review after completing the process of public comment on the biosafety dossier. It is seeking permission for the environmental release of transgenic mustard hybrid DMH- 11 and its parental line expressing Barnase-Bar- Barstar genes. These have been developed by the Centre for Genetic Manipulation of Crop Plants (CGMCP) of the University of Delhi. For past 20 years, mustard production and yield have remained stagnant and it is hoped that introduction of GM mustard would revive this crop. Alongwith mustard, India has received approval of field trials of insect resistant (IR) chickpea and IR pigeon pea developed by ICAR-Indian Institute of Pulses Research. India retained the title as the number one cotton producing country in the world with cotton production surpassing 35 million bales despite the slowed down global cotton market. The 11 major states growing IR cotton in 2016 include Maharashtra, Gujarat, Andhra Pradesh, Telangana, Madhya Pradesh, Punjab, Haryana, Rajasthan, Karnataka, Tamil Nadu and Odisha.

CONCLUSION

Plant biotechnology is an extension of traditional plant breeding with one component difference. After the gene has been transferred, the newly modified plant exhibits specific modifications rather than the extensive changes that occur with traditional breeding. That's why we should not be much anxious about the safety of biotech foods. Besides, without certified as "substantial equivalence" no biotech food is being commercialized. For the cultivation of transgenic crops, farmers are dependent on private industries for seeds, but at the same time they are increasingly less dependent on industry for agrochemicals. Furthermore, much of the worldwide research on transgenic crops is being done not only by private industry but also by ministries of agriculture, research institutes, and university laboratories. The world expects from modern agriculture both an increase in quality produce and decrease in its environmental footprint. Transgenic crops already have achieved these needs and will continue to offer much more, as long as mankind is willing to apply technology to meet social needs. Finally, it is noteworthy to mention that transgenic crops should be assessed as a complement and not competent with the conventional crops.

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