



## Book Review

### Genetically Modified Crops and Agricultural Development

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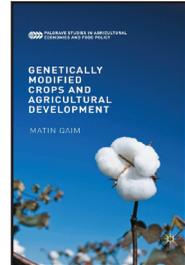
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Genetic modification in crops has the potential to address some of the biotic and abiotic challenges that reduces productivity and crop losses in agriculture. However, the ‘fear of the unknowns’, restricts the exploration of this technology in agriculture in many parts of this world. In this context, this interesting book by Matin Qaim presents a very scholarly debate on the relevance as well as the pros and cons of genetically modified (GM) crops for agricultural development. The book consists of eight chapters that include the introduction, core chapters and the conclusion.

The overall objective of the book is to contribute a rational discourse about GM crops by providing science based evidence on aspects of public concern on GM crops. The first chapter sets the tone for the rest of the book by emphatically stating the interconnected goals of agricultural development (production of sufficient food, improving the livelihoods of people involved in agriculture, and sustainable development of agriculture), issues in achieving the goals, possible solution via genetic engineering of crops and the limited public acceptance of the same. Intensification of agriculture in limited land results in environmental concerns, raising questions on sustainability. Hence, the focus has to be on use of improved technologies such as plant genetic engineering (PGE).

The second chapter on “Plant Breeding and Agricultural Development” takes the reader along the entire journey of plant breeding (PB) methods – beginning with collecting plants for food to present PGE.

The discussion on PB methods interestingly reveals that domestication of wild races for the purpose of cultivation meant that these crops would no longer grow in the wild. Thus, all forms of agriculture with any type of human intervention affect natural ecosystem and biodiversity and PGE is not the only aspect to be blamed. The depth of research on different PB methods presents a fascinating reading and informs the readers that the present rapeseed is the spontaneous cross between two species of the Brassica genus of cabbage and turnip that occurred about 2000 years ago. The author argues that as the wide crosses lead to the exchange of genes across boundaries, the resultant varieties are “transgenic”, though they are not considered so from the regulatory perspective. The introduction of the first maize hybrids and later the high yielding varieties (HYVs), during GR, though increased productivity, the economic and social impacts varied significantly between regions. Also, there were environmental concerns due to intense use of agro chemicals and reduction in varietal diversity. The continued demand for food exceeding the supply, invention of biofuels, and the need to restrict the agricultural loss due to pests and diseases resulted in the serious research on PGE leading to production of useful GMO traits. Thus, the third chapter on “Potentials and Risks of GM Crops” discusses these GMO traits. Among the input traits, while the herbicide tolerant and insect resistance varieties have already been commercialised, research is going on in the areas of: (1) nitrogen and phosphatic use efficiency (that will have a huge impact on the use of fertilizer by reducing the fertilizer use in areas where there is excess use and providing the required nutrients where fertilizer use is very less); (2) soil salinity (useful for highly irrigated lands and those areas which experience saline ingress); (3) aluminium toxicity; and (4) photo synthetic efficiency (will increase the yield) and are in various stages of research with promising initial results. Research is also going on in: (1) a few health characteristics or output traits, like quality; (2) industrial purposes like plant starch, bio fuel and cosmetic purposes; and (3) the pharmaceutical sector. In the pharmaceutical sector GM plants that produce monoclonal antibodies, hormones and other biopharmaceuticals are already developed but they have not been released for commercial use.

The fundamental difference between the PGE and conventional plant breeding (CPB) lies in the fact that PGE does not introduce a new plant but a new trait. Hence, the author stresses that PGE is not going to replace CPB;

PGE can help in conserving varietal diversity; and PGE will also be useful in transferring a particular trait like drought tolerance to varieties in different parts benefiting the farmers and in producing plants with desirable traits.

The author argues that while there could be risks associated with the plant transformation, trait or the gene that is introduced, but stresses that there are no risks associated with the plant transformation process. Hence, there can be concerns about the products but not the process. However, as it emerges practically, the anti-GM lobby is against both the process and the product, thus jeopardising the advancement in plant sciences itself.

The author states that the regulatory system does not allow commercialisation of products which show allergic reactions during the trials like the case of Brazil nut or the case of the gene transfer from beans to peas. But at the same time, he points out that toxins and allergies from unknown substances could occur even in conventional breeding. The author also assures of the least likelihood of the transfer of the antibiotic resistance from crops to humans. On the other hand, there is positive health effect due to the insect resistant GMO that reduces the pesticide use for the farmers.

On the environmental risks, the author argues as the wild relatives of major field crops like maize, wheat or soybean are not found, the fear of gene escaping to the wild and affecting the wild races is unfounded. However, vertical gene transfer from GM to non-GM of the domesticated crops of the same specie could occur, which is not an environmental risk but an economic risk for those cultivating the non-GM crop. Such economic risks should be addressed by the biosafety measures. The author argues that resistance to GM crop is countered by the cultivation of the refuge crop or other host plants. For refuge effectiveness, the author suggests switching from refuge area requirements to a system of 'refuge in the bag' where the Bt seeds are mixed with certain proportion of non-Bt seeds, so that automatic refuge compliance takes place. (But it needs to be noted that in the Indian context, the refuge seeds were packed separately and placed in the same container of Bt seeds and farmers who were not adequately explained about the purpose of the non-Bt seeds, simply threw them away). The author admits that resistance to herbicides in weeds is a concern due to large scale use of glyphosate alone (which is less prone to leaching, more biodegradable and less toxic to human and animals) and due to monocultures.

Chapter 4 discusses the Adoption and Impacts of GM crops, predominantly drawing from author's own research. Despite the GMO potentials discussed, the available crop traits are limited. Analysing the studies that have researched on the performance of Bt crops, The author points out that the yield increases have been due to effective pest control than due to genetic yield potential. His analysis also highlights that 90 per cent of the studies were funded by public sector and not by companies as claimed by the anti-GMO lobby. Importantly, he mentions that there were no significant difference in the results of studies based on field trials and farm survey based studies. The author stresses on the fact that benefits of insect resistant crops like Bt maize, cotton and eggplant could vary depending on the pest infestation levels. Reduced pesticide use could lead to lower soil and water pollution and higher biodiversity. But despite the benefits, due to lack of consumer acceptance, the FlavrSavr tomato (with a gene to delay the ripening process which was the first product to be released among GM with output traits in the US), and Bt potato were not commercialised in the US. Similarly, Bt rice in China was not commercialised for the fear of losing the EU market. In both US and China, the virus resistant GM papaya variety has been successful, but replication in Thailand was thwarted by anti-GM groups effectively leading to moratorium on GM crops in Thailand.

The discussion on Bt cotton in India highlights the regional variation in benefits especially in the first season of technology due to the improper selection of hybrids (which was rectified in the subsequent approvals) and the farmers adoption behaviour. Widespread adoption of Bt cotton in India also suppressed the bollworm populations in general benefitting the non-Bt growers. The analysis of the panel data of Indian farmers shows improvement in the standard of living and food security, and on local economy due to employment and income generation. These findings emphasise the lack of direct link between farmer suicides and Bt adoption which is often raised by the anti-GM activists.

The fifth chapter discusses the "New and Future GM Crop Applications". The author argues the relatively narrow focus of GM applications has been due to complex gene structure, lower public acceptance and the complex politicised processes of biosafety and food safety regulations. The involvement of public sector and public-private partnerships in research on introducing quality traits in several food and vegetable crops that have

reached the field trial stage show the willingness on the part of the different governments about adopting the GM technology. Technologies (involving nitrogen use efficiency, water use efficiency, salt tolerant and insect resistant) donated by private sector to African countries are also mentioned.

Another useful area is the biofortified crops. The author argues that biofortified crops do not always involve genetic engineering. However, higher nutrient levels could be achieved with genetic engineering like the GM golden rice, the potential health benefits have been demonstrated in a few ex-ante studies. The author discusses the hurdles posed by the anti-GMO lobby in the development of the golden rice, but nevertheless it is slated to be released in the Philippines and Asia. Interestingly, farmers will be allowed to reproduce their own golden rice seeds. This dispenses the doubts on access to this useful trait.

But despite the benefits and evidences available elsewhere, adoption tends to be low including in Africa, due to low biotech capacities, strong export ties with EU and adoption of EU type biosafety law. The regulation aspects are discussed in detail in chapter 6. Author's dismay with the Cartagena Protocol (CP), as it singles out GMOs as a potential risk to genetic resources and policies related to GMOs should follow the precautionary principle, is evident in the discussion throughout the chapter. The United States, Canada, Australia, Argentina and a few other countries have not ratified the CP. Here, decisions regarding the GM crops are governed by the same laws that regulate conventional agricultural technologies. In the US, following the Codex Alimentarius of WHO and FAO, GM crops are examined with the existing equivalent crops and approvals are based on that. But in the EU, laws specific to GM crops and foods rely on the precautionary principle and being process based, they single out rules and standards regarding PGE. Implicitly, approvals to GM can be refused on grounds of uncertainty alone. The author describes the regulatory hurdles faced in the case of GM maize, despite the fact that the European Food Safety Authority, which gave positive assessment seven times on various assessment and reassessment done over a period of 10 years, approval for commercialisation was done given. This caused considerable delay and cost to the developer. Finally, when the European Commission (EC) gave the approval for commercialisation of GM maize, the parliament rejected citing the possible long-term effects on the non-target organisms. This is

very similar to the Indian case of Bt eggplant. The other hurdle is that even if a GMO has been approved by the European Commission, it can still be refused by the individual EU member countries. The author details the consequences in terms of cost implications for the developer, companies with GMO interest shifting their base to other GMO friendly countries impacting the technological development in the field of biotechnology and the foregone benefits. Complementing the regulation of GMOs, the EU also follows strictest mandatory labelling regime and zero threshold limits. Interestingly, the author informs that this labelling is not applicable to food derived from animals that were fed with GM crops.

Unlike the CP, WTO does not allow restrictions based on precautionary principle and hence it has repercussions in the international trade. Similarly the zero threshold limits implies cost for segregation of GMO and non-GMO crops and inadvertent mixtures could cost trade opportunities.

The author observes that the intellectual property protection accorded to plant varieties have increased the private sector participation in research and also consolidation of companies. He states that higher prices of patented varieties will have lower adoption, particularly where alternatives exist and in several countries GMOs do not enjoy IP protection due to the geographical scope of patents. Though the author recognises the concentration of crop genetic engineering in few hands in the private sector as a concern, he believes solution lies in sensible antitrust policies, reform in IPR laws, increase in public sector R&D and involvement.

The complex public debate which the author terms as the 'protest industry' and the lack of scientific strength in their argument is lucidly brought out in the seventh chapter. Several instances provided by the author clearly portray the darker side of the protest industry, where only biased anti-GM information based on flawed studies are circulated for public consumption. Even where the concerned journals have retracted such papers, the protest industry continues to base their propaganda on such information. The author notes with concern the growing influence of the anti-GM on policy making processes, causing frustrating delays in progressing with trials and staling commercialisation. The author also states that there are not adequate counter arguments from the concerned scientists and as he rightly observes, "with many ifs and buts messages are not particularly effective

in building social trust” (p.159). However, the shift in the stand of a few scientists in favour of GMOs, brings some ray of hope.

In conclusion, the author emphatically states that PGE should be incorporated in agricultural R&D. While suggesting that NGOs should not misinform, he also stresses the need for the international organisations to frequently communicate about GMOs proactively. He also suggests that the UN either cancels or substantially revises the Cartagena protocol to be based on recent scientific evidence, which in our opinion may be difficult to achieve.

While this book presents a very lucid account on the scientific view about the safety of GMOs and that GMOs are not riskier than conventional breeding methods, it does not discuss the diffusion challenges and the institutional mechanisms to ensure safe adoption of technologies at the farm level which will counter the anti-GM lobby. Also process intensive GMO traits will benefit the farmers more, if they are not dispensed just as a seed technology but as a combination of farm practices which needs to be stressed. On the whole this book, by providing balanced view on GMOs, helps the reader in engaging in ‘informed debate’ and should be read by all the stakeholders engaged in plant biotechnology.

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