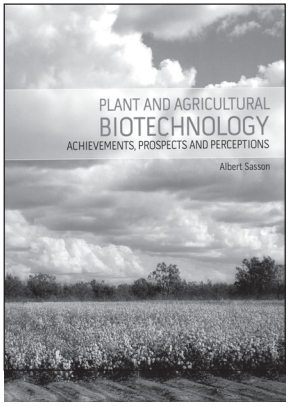
Book Review

Plant and Agricultural Biotechnology: Achievements, Prospects and Perceptions by Albert Sasson
COCyTE, N.L. (Ciencia Y Technología De Nuevo León, México) UNU/Institute of Advanced Studies and BioEuroLatina, Maxico. Pp.444, 2006.



Over the last few decades, there has been significant development of biotechnology through a very wide spectrum of human activities, from medicine and health care to agricultural and food production, and through biofuel production, environment protection, bioremediation and biomining. The present book mainly provides an overview of conventional agricultural biotechnology, genetically engineered crops extension, commercialization, benefits and prospects, innovations in advanced crop biotechnology along with the successful case studies of many developing countries. It also addresses the future of agricultural bio-industry in both technologically advanced and developing countries.

The book broadly consists of thirteen comprehensive sections or (chapters) though without any numbering followed by conclusions and prospects of agricultural biotechnology for the betterment of the human kind. The first chapter highlights the status of conventional agricultural biotechnology as the most widely adopted biotechnology in developing countries, where agriculture plays dominant role. Some of the interesting success stories of plant-tissue culture and clonal multiplication of crops in Malaysia, Cote d'Ivoire, Indonesia, Central Africa and Latin America, Thailand, Colombia and Ecuador have been presented. This technique is very effective even in rudimentary conditions and provides a regular source of income to the marginal framers. In Argentina, an autotrophic and hydroponic system (SAH) has been developed for the *in vitro* production of potato plantlets. However,

within a month's time from only 200 plantlets produced *in vitro*, 10,000 potato plantlets could be obtained. Similarly, for rapid expansion of cassava production, a technique was developed at the National Research Council Canada Plant Biotechnology Institute, that enabled the production of mosaic disease-free plants from *in vitro* cultured shoot apical meristems. Later, both these techniques have been successfully replicated to other countries as well for e.g. Bolivia, Chile, Colombia, Ecuador, Peru, Venezuela, Colombia, Africa and India.

For the commercial production of plantations banana was one of the first crops to be multiplied *in vitro*. Further, clonal multiplication of coffee, oil-palm and date-palm are the success story of conventional agricultural biotechnology.

After a brief explanation and definition of genetically engineered plants and crops in the second chapter, the extension of genetically engineered crops have been thoroughly discussed in third chapter of the present book. Around fifty crop species viz. maize, soybean, wheat, potato, tomato, papaya, melon, sugar-cane and cotton have been genetically transformed are insect resistant, disease and virus resistant. These crops are designed to tolerate climatic stresses such as cold, heat and drought. It has been also estimated that the net economic benefits to producers from transgenic crops are enormous. According to the global study by Australian economists on transgenic grains, oilseeds, fruit and vegetables, projected a global potential gain of US$ 210 billion by 2015. Further, it is estimated that application of biotechnology in rice would be more beneficial to many Asian countries to produce around 770 million tons of rice required to feed an additional 650 million rice consumers. Likewise, some commercial crops like maize, wheat, soybeans, banana, sugarcane and coffee are the best examples of the extension of genetically engineered plants.

The fourth chapter entitled *Innovation Prospects for Advanced Crop Biotechnology* discusses its status in developing countries viz. China, India, Brazil, Chile and Argentina as they are in constant pressure to increase their production as well as productivity. The developing countries are continuously facing challenges to protect environmental and biological diversity and subsequently diversify agro-products to meet the requirements of the consumers. It is suggested that, in this scenario, the advanced agricultural biotechnology can contribute to meet these challenges. The chapter also discusses in detail the different initiatives

under taken for the development of biotechnology in several developing countries viz. China, India, Brazil, Chile, Costa Rica and Argentina.

The future of agricultural bio-industry in both technologically advanced and developing countries has been analyzed in the next chapter. However, the two most challenging agricultural problems which developing countries face today are to provide sufficient food to billions of human beings, while preserving their biodiversity. The rapid increase in population and their demands for food have not been adequately taken care by the industries and services sector. It is therefore crucial to increase agricultural production through biotechnological research which has the potential to tackle the major problems of the developing world related to poverty, food, hunger, health and environment. The book identifies certain solutions to the challenges for agriculture and emphasized on agricultural R&D innovation to enhance productivity and improve natural resource management, increase household skills and know-how and lower food prices for consumers. The introduction of transgenic cotton and soybeans varieties in Africa and US are the illustrative example of the positive impact on trade of transgenic crops, apart from establishing commercial relationships between the exporting and the importing country. Farmers as well as the companies are benefiting from growing and selling transgenic crops like cotton, soybeans, oilseed rape and maize, primarily from the higher price of seeds. In India, ITC, an Indian conglomerate directing the farmers to use hybrid seeds, fertilizers and maintain wider space between plants to increase the soybean yields.

Overall economic impact and benefits of transgenic crops are analyzed in great detail in the chapter entitled 'Benefits *of Transgenic Crops.'* The chapter documented that in US due to extensive adoption of biotechnology derived varieties there are stances of higher yields, higher farm incomes and reduced pesticide use. For the benefit of the consumers, Japanese researchers have identified the ways to genetically modify the presence of enzyme (lacrymatory factor synthase) in onions that causes irritant effects to eyes. Monsanto and Cargill have formed a joint venture to modify the protein composition of soybeans and maize grown for animal feed. Weed management is an important incentive for farmers which can also contribute to higher yields. In the chapter, author also stressed that improvement in the nutritional quality of food is as important as to increase the higher productivity. Very rich examples of

bioengineering crops have been mentioned that are capable to reduce many micronutrient deficiencies.

The book also presents the potential hazards of genetically modified crops as well as the evaluation and management of risks associated with transgenic crop cultivation. In this chapter, author has beautifully explained in detail the journey of migration of monarch butterfly from US and Canada to Mexico and their exposure to the nature. However, it was stated that the biggest threat to the monarch's survival are man-made deforestation, development of highways and suburbs. The concept of 'bio-invasions' has been also considered as the major threat to biological diversity and the impoverishments of human communities. The incorporation of the precautionary principle in principle 15 of the Rio Declaration and in the preamble to the CBD as a basis for decision making and risk assessment with respect to the transboundary transfer of GMOs or living modified organisms (LMOs) have been analyzed in the next chapter that may have adverse effects on the conservation and sustainable use of biological diversity. The author throws light on the flaws in the precautionary principle as the principle itself provides no guidance on its application in situations where an action could lead to uncertain benefits and harms simultaneously. It has also been suggested in that case, prior to its application, there is need to formulate hierarchical criteria on how to rank various threats based upon their characteristics and the degree of certainty attached to them. Human mortality and threats to the environment can be associated with the public health criterion in this context. Apart from this, immediacy, uncertainty, expectation value, adaptation and irreversibility criterion have been put forth for consideration.

The author also cautioned about the risk assessment associated with genetic crop cultivation, as some degree of hazard is always associated with every technology. However, risk also comprises an outrage component which covers everything about risk apart from its possible effect on people. It is therefore important to be aware of the factors associated with the risk which are the contributing factors of an outrage. Findings of quite a few studies on the consumption of genetically modified food and its effects on human health and environment have been presented with a mixed picture. Biosafety regulations to deal with the health and environmental rDNA-derived products and in particular transgenic crops are a significant step in this direction. Though many international agencies like UNEP/GEF,

OECD, EC, FAO and ISNAR are actively involved in the harmonization of biosafety regulations in different regions. ICGEB Biosafety Unit was established to provide services relating to GMOs and their release into the environment, apart from information dissemination and the establishment of a biosafety clearing house, scientific training in risk assessment for the release of GMOs in the environment. Various policy measures and initiatives undertaken in both developing and developed countries with regard to the cultivation of transgenic crops and biosafety regulations have been discussed at length to present their holistic approach on the various issues involved in it.

The author raised a very important question in the chapter '*International Regulations and Trade Disputes,'* is the Cartagena protocol on biosafety a hindrance for advanced agricultural biotechnology? The role of Codex Alimentarius Commission (CODEX) has also been discussed which are responsible for adopting international standards for the trade of foodstuffs derived from transgenic organisms. It also adopts standards that may be used by its 162 participating governments to develop national regulations. It was stated that two WTO Agreements are relevant for CODEX standards, viz. the SPS Agreement applies to those national laws designed to protect life and health from risks arising from, among other things, additives, contaminants, toxins, diseases and pests. The other TBT Agreement applies to all national technical regulations and standards governing product characteristics, labeling and packaging. However, the focus on food safety in international trade and in trade agreements has made trade issue alike for many developing as well as developed countries. In addition to risk assessment involved in releasing transgenic crops in the environment, the concept of biovigilance has been put forth to keep a check on their patterns of behavior. Accordingly, all the plots cultivated with transgenic species should be mapped with respect to their characteristics.

The issues of '*Traceability, Labelling and Transparency'* of products derived from GMOs, as well as the coexistence of the latter with conventional and organic agriculture has been thoroughly discussed in the next chapter. It states that traceability implies the monitoring of products through the whole chain of production and distribution and its potential effects on human health and the environment. In this context, labelling is the key factor that indicates the presence of transgenic organisms on the food labels. The French Agricultural Research Institute (INRA) and the University of Grenoble, from the

perspective of traceability, labelling and transparency proposed three options on the acceptance of transgenic organisms. Firstly, the complete phase out of production of GMOs, secondly the total submission in the scientific views and recognize these GMOs harmless and safe for human health and environment. And, lastly, they emphasized on the establishment of two separate production chains, one transgenic and the conventional one, for the consumers to decide on their own. The French researchers opted for the third option.

Though the issue of coexistence between the three types of agriculture based on conventional crops and intensive farming, organic farming and transgenic crops has been raised at the Council of European agriculture ministers in 2002. Organic farming which has a strong growth rate across the European Union's member countries might threatened by contamination by genetically engineered crops, when they are gradually adopted and grown. The chapter highlights that, later the European Commission considered that the modalities of coexistence between transgenic crops and conventional ones should be decided upon by the member states. For that, a three year programme called Sustainable Introduction of GMOs into European Agriculture (SIGMEA) was launched to create awareness about the co-existence.

The chapter also reveals the comprehensive measures undertaken by France to ensure crop existence in the case of maize. According to a research study, modelling and trials have shown that a minimum distance of hundred metres was necessary between a transgenic and a conventional agricultural plot in order to keep the level of transgenic material under 1 per cent in the conventional crop. Further, in case of two plots adjacent to each other, flowering in the plots should occur at a four-day interval. Though EC has adopted the pro-GMO attitude, whereas it seems that new members of the European Union are not more enthusiastic about GMOs than their predecessors, although countries like Hungary, Poland and Romania are found to be in favor of cultivating transgenic crops. On the other hand, researchers and experts also argue that GM crops can also bring benefits to small farmers and contribute to a more environment-friendly agriculture.

The issue of social acceptance of biotechnology derived products through the debate on patenting genetically engineered organisms has been examined in the chapter entitled '*Intellectual Property Protection: Impact on the Acceptance of Transgenic Crops.*' An overview of *sui generis* legislation in the shape of the Plant Varieties Protection and Farmer's

Right (PVFR) Act, 2001 was enacted by Indian Parliament to provide protection of new crop varieties has been mentioned. It has also been recognized that patenting and intellectual property protection are important ways to ensure a fair return to industry for its investments in R&D of new knowledge and technologies as they are vital ways to foster continued national innovation.

Besides, the issue of patents, it highlights that WIPO also addressed the issue of the growing gap between developing and developed countries with respect to intellectual property laws and its effect on access and rights to genetic resources. Further, it also aims to make an inventory of traditional knowledge in order to prevent its illegitimate appropriation by a third party. The concept of bioprospecting means the exploration of biological diversity for commercially valuable genetic and biochemical resources has been clarified. It also presents the 'access and benefit sharing' system that aims to promote scientific and technological breakthroughs from plant and animal sources while recognizing the contributions and rights of those who cultivate and preserve these resources. Furthermore, it provides a useful source of information regarding an Indian herbal medicine, Jeevani and the traditional knowledge of local Kani tribe. Jeevani is claimed to have anti-fatigue, anti-stress properties and other benefits. This case study shows that fair benefit sharing arrangements can play a key role in the enhancement of social and economic development among local communities.

Controversy related to the agricultural biotechnology from the different groups of stakeholders like consumer associations, organic farmers, environmentalists on the one hand opposed to the alterations of the foodstuffs and environment contamination. On the other hand, researchers, farmers, regulatory agencies and private industries are mainly concerned with the post harvest conditions and increase in yield and productivity and nutritional value. Apart from this, the debate on transgenic crops also deals with justice and democracy. Role of media coverage of biotechnology is a key factor in the social acceptance of these technologies through transparent information. It creates the general awareness about the potential benefits as well as the risks associated with their commercialization in the agricultural and food sectors. It was emphasized that there is a genuine need to bring science and society closer together to build a "knowledge democracy" in which the community is well informed about the technology and its application for the betterment of the humankind.

The final chapter summarizes the conclusions and prospects from the viewpoint of large consensus that research in developing countries should be linked to the problems and requirements of the local communities in their struggle against hunger, food security and undernutrition. The book rightly concluded with L. Fresco's remarks that "clearly the question is not what is technically possible, but where and how life sciences and biotechnology can contribute to meeting the challenges of sustainable agriculture and development in the 21st century."

On the whole the book gives an indepth account of achievements and prospects of agricultural biotechnology, highlighting different aspects of its benefits and risks with many examples from developing countries. The volume is loaded with comprehensive analysis of the wide range of agricultural techniques and its impact on both developed and developing countries. It is a great source of information for the students, scientists and researchers, civil societies and the stakeholders about the implications and prospects of agricultural biotechnology.

— Beena Pandey