

GM crops: The socio-economic impacts

M.A. Malboobi

National Institute of Genetic Engineering and Biotechnology, P.O. Box 14155-6343, Tehran, Islamic Republic of Iran.
E-mail: malboobi@nigeb.ac.ir

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Abstract

World population has already exceeded 6.5 billion, out of which about 850 million (13 percent) are undernourished. With the current growth rate, the world community faces even a greater challenge of hunger and food security as the estimated the population will catch 9 billion by the year 2050 with doubled needs for food. At the same time, preservation of biodiversity, stopping deforestation and reduced environmental footprint caused by agricultural practice are the main concerns towards sustainable agriculture. The progressive adoption of genetically modified organisms (GMOs) including GM crops and trees can make a decisive contribution to improve harvest and alleviate hunger and poverty. In addition to the environmental benefits, the introduced GMOs can improve water use efficiency and reduce the need for fossil based fuels and pesticide application and reduce thousands of tons of emissions of green house gases. In this respect, several social issues are still of concern. On one hand, many beneficial advantages of GMOs have encouraged a wide spectrum of large or small farmers to cultivate transgenic plants which is translated to food security and job opportunities. On the other hand, while ideological debates have hindered, or even ceased, technology provisions in developing and underdeveloped countries, GMO seed and food productions are monopolized by a quite small number of transnational companies. For instance, seeds that were previously available at low or no cost, mainly through public institutes, international entities or seed exchange among farmers, would be offered at higher prices due to exclusive right of producers and additional cost of patent royalties. Cartagena protocol is going to regulate the relationship among countries aiming at preservation of world biodiversity. Although the developing countries outnumbered developed nations that cultivate transgenic plants in recent years, current statistic shows that around 84 percent of GMO crops are cultivated by only four countries, USA, Brazil, Argentina and Canada. Scientist and scholars, particularly in Islamic states, as well as decision makers are the major responsible bodies that must take roles for the current and future situations. Despite the fact that most of scientists or scholars are not in navigation positions, however, they can discuss socio-economic issues and raise public awareness in order to harmonize their efforts towards proper utilization of biotech products in their society and towards a reliable point for food security and safety.

Key words: genetically modified crop and socio-economic

Introduction

Socio-economic (SE) and cultural considerations related to the use and release of genetically modified organisms (GMOs) have received more

attention in recent years as challenges based on possible health and environmental risk are being faded out by massive experimental data as well as 15 years of consuming hundreds of tons of

commercialized products containing GMOs and/or derived from GMOs with no verifiable negative report on human health. Now, new trends of old disputes are rationalized by claiming that showing SE impacts of any new technology take several years by when it has already become widespread and, in most cases, become deeply institutionalized. Therefore, it is argued that “even when the technology is withdrawn or people totally discontinue adopting the technology, its SE impacts may persist and leave a permanent imprint in society” (Dano, 2007).

SE concerns in Biotechnology takes into account a broad spectrum of aspects about the actual and potential consequences of biotechnology, such as impacts on farmers’ incomes and welfare, cultural practices, community well-being, traditional crops and varieties, domestic science and technology, rural employment, trade and competition, the role of transnational corporations, indigenous peoples’ rights, food security, ethics and religion, consumer benefits, and ideas about agriculture, technology and society (Garforth/WRI, 2004).

In this paper, I have attempted to bring up some possible SE aspects of GM crops and their extensions in the human livelihood. Of course, this issue highly depends on differences among societies with respect to cultures, religion, social behavior and economies as well as approaches to food security and/or food safety.

Facts and realities

At present time, around 7000 species are cultivated as crops and trees by human being. However, only 30 percent of these species constitute 90 percent of food. Green revolution in 60’s doubled the food production with the use of high-yield varieties, chemical fertilizers and pesticide and mechanizations. Despite this breakthrough, the number of undernourished people remained over 800 millions, reaching 900 millions in 2008 (Fig. 1). According to 2007 statistic, 835 million (98.6 percent) of the total of 847 millions world undernourished population lived in the developing countries (Table 1).

Based on an estimation given in the latest FAO report (2010), the food production must be doubled by the year 2050 to meet the needs of an expected world population of 9.2 billion. Besides, genetic uniformity, massive loss of topsoil, soil and water pollution by agrochemicals, and deforestation are the main problems to be pointed out as a result of mass cultivations such that it is well accepted that our current agricultural practices need to become more sustainable. Therefore, it is necessary to adopt new agricultural technologies to feed over 900 million undernourished people while facing the above challenges.

Progressive utilization of GM crops

Following the green revolution, two major methods of genetic modifications were persuaded for improvement of desired traits in crop plants for years: a) Collection of mutants introduced by radiation or active chemical materials; and, b) continued conventional plant breeding approach. However, the gained increase in the yield was very little and there was no success in improving some desired traits due to the limited gene pool. Therefore, there has been a great acceptance for GM crops produced through transfer of beneficial genes without gross differences with their corresponding traditional counterpart such as the parental plants. Having commercialized GM crops in six countries that cultivated 2.5 million hectare in 1996, progressive adoption reached 25 countries with 137 million hectare in the year 2009 (James, 2010). As such, about 55-fold increase in cultivated lands within 14 years made it one of the fastest adopted crop technology in the recent history. The new technology has granted significant economic, environmental, health and social benefits to both small and large farmers in developing and industrial countries. Such that in the 15th year of GM crop commercialization, we witnessed increases in both the number of countries and farmers planting biotech crops globally plus adoption of stacked traits in newly produced biotech crop. It is noteworthy that the

generated GM food products are consumed by almost all countries at present time.

SE concerns about GMOs at international arena

In parallel to intensifying effort on implementation of Genetic Engineering in Biological researches, biosafety concerns have been subject of controversial discussions among researchers as well as policy makers during the last two decade. Such discussions coincide with the world negotiations on Biosafety issues during 1992 Earth Summit at Rio de Janeiro as a part of a comprehensive strategy for "sustainable development". These together made ground for development of Cartagena Protocol. Many countries was committed to the creation and maintenance of tools necessary for supervising, management and controlling risks associated with the use or release of living modified organisms (LMOs) with respect to human health and the environment. Since then, efforts for preparation of Biosafety Law have been exhaustively followed by almost all nations. The general

assumption has been that such law must regulate all domestic technology developments as well as transboundary movements involving LMOs so that it complements Cartagena Protocol for nation-wide needs. Owing to the strong lobby by activists particularly in the African countries, Cartagena Protocol has acknowledged that SE considerations for LMO may also be taken into account during decision making for accepting a particular LMO. Based on Article 26 of Cartagena Protocol, "the parties may take into account, consistent with their international obligations, SE considerations arising from the impact of LMOs on the conservation and sustainable use of biological diversity, especially with regard to the value of biological diversity to indigenous and local communities. The parties are encouraged to cooperate on research and information exchange on any SE impacts of LMOs, especially on indigenous and local communities". Nevertheless, the pertinent decisions are all at recommendation or forum levels aiming at development of guidance documents to assist the parties in dealing with SE considerations.

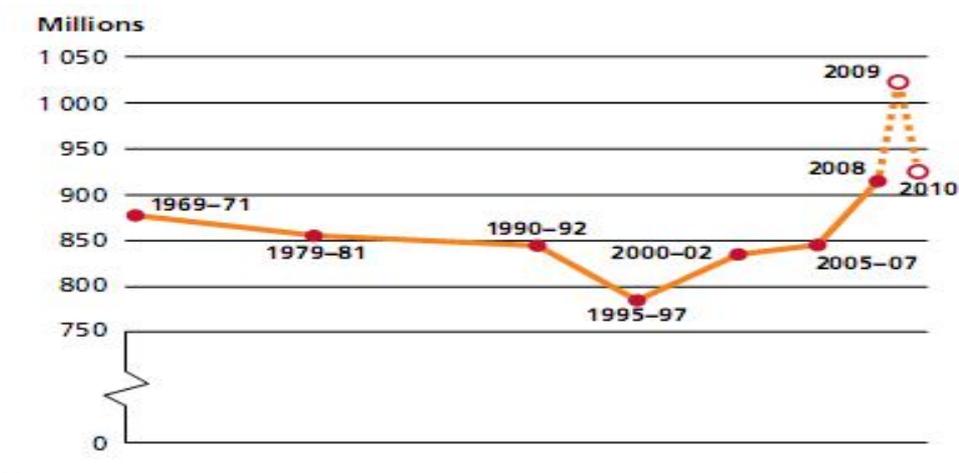


Figure 1. Number of undernourished people in the world since 1969. Figures for years 2009 and 2010 are estimations (Source: FAO, 2010).

Table 1. The distribution of undernourished people per population in the developing and developed countries (Source: FAO, 2010).

	Total population (2007)	Number of undernourished people	Undernourished per population (percent)
World	6559.3	847.5	12.9
Developed countries	1275.6	12.3	0.96
Developing countries	5283.7	835.2	15.8

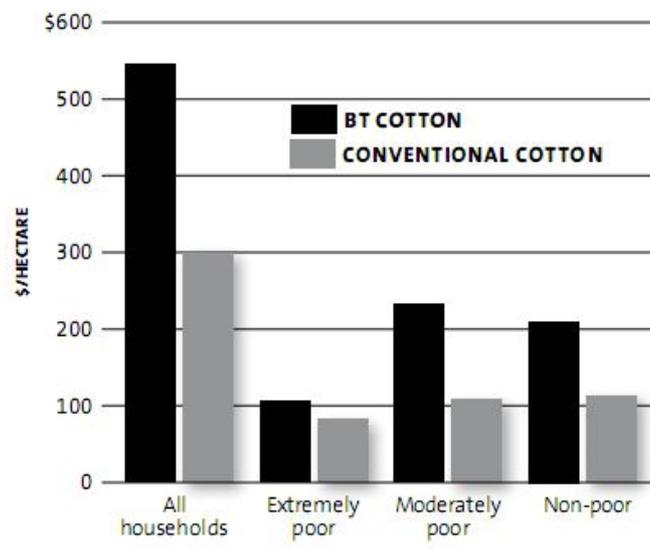


Figure 2. Comparing the net income of farmers cultivated Bt or conventional cotton. The increased incomes of the extremely poor, poor and non-poor farmers are also shown (Source: Rao and Dev, 2009).

GMOs are acceptable or not?

To be clear about what is argued by some social activists against GMOs as “contaminants” to the environment, it is a matter of what we compare them with. For instance, insect resistant GM crops expressing Cry proteins, known as Bt proteins, must be compared with the traditional method of insecticide-based pest control measures and the amounts of pesticides added to the soil, water and food products. One might claim that the fixed amounts of used chemical toxic compounds remain constant or even reduced by decomposition whereas transgenes are propagated

thoroughly. While we should not neglect the fact that the use of chemical toxin induces a strong selection force for or against certain genotypes of the target organism and non-target organisms, including microbial flora.

In fact, the improved products of biotechnology, GM crops in particular, are going to provide solutions for the food security versus food safety dilemma. This is because both increased yield and quality of the harvested products could be engineered deliberately. In this respect, several direct and indirect benefits of biotech crops as listed below:

1. Improving the nutritional quality of foods, e.g. golden rice containing pro-vitamin A;
2. Reducing the presence of toxic compound, e.g. cassava with less cyanide;
3. Reducing allergens in certain foods, e.g. groundnuts.
4. Reduced pesticide use., e.g. Bt crops;
5. Lower occurrence of mycotoxins (produced through fungal infections);
6. Increased availability of affordable food;
7. Reduced needed fossil fuels to disperse pesticides and so on;
8. Decreased emissions of green-house gases;
9. Reduced the accumulation of toxic compounds in soil and water.

Economic concerns

GMOs- GM crops in particular- have formed a major trend in a bio-based economy in the last decade and the coming years. Collectively, GM crops contributed US\$60 billion during the period 1996-2009 due to substantial yield gains and reduction in production costs. Only in 2009, 29.6 million tons of GMO foods were produced by 14 million farmers. This is translated to added value of \$9.2 billion globally, out of which \$4.7 billion is the share of developing countries (James, 2010).

As a detailed case, the impacts of Bt corn on corn borer suppression was studied in a long term course (Hutchison et al, 2010). *Ostrinia nubilalis* insect readily disperses among farms at a distance of at least 800 m and colonizes over 200 host plants throughout their lifetime. There have been surges of the insect every 4 to 6 years as recorded since 1962. However, there was no such notable rise since the use of Bt corn during the period of 1996 to 2010. In addition, there has been at least 50 percent reduction in consumption of insecticides.

As a result, US\$4.3 billion of direct benefits plus \$1.7 billion of indirect benefits were gained in 2009 because of *O. nubilalis* population suppression in 18.7 million hectare of corns in USA.

In another case study, Rao and Dev (2009) showed that the averaged cotton yields increased from 183 to 270 kg per hectare between 1996 to 2002 (before Bt-cotton adoption) to 306 to 470 kg per hectare between 2003 to 2008 (after Bt cotton adoption) in India. Considering both the reduced pesticide cost and elevated yield benefit, the average net income of cotton farmers (cumulative Bt and conventional cottons) increased three times. The interesting point was that both poor and non-poor farmers were benefited from Bt cotton adoption, although the extremely poor had lower earnings (Fig. 2).

Job analysis

The majority of farmers (over 11 millions) growing biotech crops are small-holder, poor farmers, mostly residing in developing countries (James, 2010). While the higher earning directly leads to job creation, however, GM crops affect the occupation level, particularly in developing countries where resistance against technology adoption is prominent. There are some obvious examples of GM crops challenging jobs in developing world. Growing rapeseed plants engineered to produce lauric acid (used in soaps and cosmetics) threaten 30 percent of jobs in Philippines. New types of sweeteners, such as thaumatin, a protein derived from an African plant, which is 3000 times as sweet as sucrose, jeopardizes sugar beet and sugar cane cultivating farmers and sugar producing industries. It was even more alarming from a job point of view when a US Biotech company claimed it could produce thaumatin protein using recombinant DNA and fermentation technologies. These extreme examples evidently show that the developing countries can not step aside and watch the waves of technologies sinking the scared people. As

these countries accommodate the most of needy people, they are highly affected.

In developing countries, the problem must be considered from several points of views:

1. Historically, a strong resistance against new technologies is being imposed by state bodies that govern these nations.
2. These countries are mostly dependent on technologies transferred from developed countries which increase the cost of seeds, at least for the patent royalties.
3. By nature, GM crops are introduced by private sectors that are not strong enough in developing countries to compete with giant transnational companies.
4. Developed varieties via classic breeding were available through governmental and international agencies at nil prices while GM seeds are developed by private transnational companies.
5. The inability of developing countries to compete in the international market might threaten the job opportunities even within their own market. At present time, the lower costs of imported food products have already out-competed several domestic agricultural products. It would be harder for exportation. With stringent sanitary measures imposed internationally on exchanged food products, the better quality of GMO products in compare to conventional crops containing pesticides is alarming for competitive export market.

According to the recent statistics, around 84 percent of GMO crops are cultivated by only four countries, USA, Brazil, Argentina and Canada. Those developing countries (e.g. Brazil, India, China and Argentina) that were pioneer to explore GM crops benefitted remarkably (James, 2010). For example, cultivation of transgenic soybean

has produced around one million jobs in Argentina from 1996 to 2005 which is about 36 percent of total created jobs during this period (Trigo and Cap, 2006).

Cost aspects

Seventy five percent of all poor people in the world are small farmers residing in developing countries. Despite the increased rice and corn production, Green Revolution imposed income inequality and wealth distribution in the rural areas in the past (Conway, 2003). It made poor farmers to become heavily dependent on the elite people who had better control over the new tools and technologies.

At present time, GM crops need lesser inputs (except for seeds, see below) and produce higher yield. Therefore, the products are sold at lower price making them affordable for larger markets. This is the good scenario for the big farmers while the small ones are affected differently. Companies that develop GMO products are determined to recover their investments on research and development through the intellectual property rights (IPR) system and marketing schemes. As a result, GM seeds are generally sold at a higher price to all farmers, no matter rich or poor. This is not in harmony with the traditional practice of farmers in saving, reusing, sharing, exchanging and selling farm-saved seeds. It must be noted that the traditional seed saving practices of farmers are widely regarded as the foundation of the immense genetic diversity in agriculture. Thus, any developments that limit this practice, such as the stringent application of the IPR on seeds, potentially threaten the preservation of crop biodiversity.

Indeed, the issue of IPR has received extensive attention and has been the subject of intense debates. The impacts of IPRs on public access to knowledge and technological innovations are far-reaching, especially in developing and underdeveloped countries. In addition, proprietary controls over useful technologies severely limit

the access of the poor, under-developed or sanctioned countries, making undesired SE gaps among human communities.

Another important issue is that GM crops produced for the developed countries may not fulfill the needs in other regions as the situation is different in many developing countries. In the former the expense and availability of labor are major production costs, while in the latter labors are abundant and often cheap. Therefore, GM crops like herbicide-resistant ones might be beneficial in the developed countries while it adds up the cost of GM seeds plus herbicide compounds for farmers in the other regions. Therefore, every country must be seriously involved in developing their own GM crops or be very selective to choose among them considering regional SE aspects.

Environmental and biodiversity aspects

Conserving biodiversity has been a great concern as experienced during Green Revolution. Superiority of the seeds directs farmers toward mono-cropping leading to genetic uniformity and loss of endogenous germplasm, no matter if crops are produced through conventional breeding or genetic engineering. According to a FAO report in 1996, genetic erosion has already occurred in 154 countries where the replacements of local varieties were the main cause in over 80 of them. The proposed solution for this problem is to have as many as varieties carrying transgenes through conventional breeding.

As mentioned above, reduced chemical toxin usage is important to keep the distribution of non-target organism safe as deliberately engineered GM crops have specific parasite targeted. In addition, the higher yield of GM crops means saving millions of hectare of natural forests and ranches away from being cultivated.

Social conflicts

Throughout the history, technological and scientific innovations have greatly impacted SE

relations within and among communities directly and indirectly. The introduction of mechanized farming during the Green Revolution increased the inequity between small-scale and large-scale farm communities is a known example of indirect impact of new technologies (Conway, 2003)

As an example of current direct conflicts, for unknown reasons, organic certification standards generally do not allow GMO contents. Agricultural products containing even small traces of GMOs do not merit the organic label. In countries where GMOs are already legally commercialized, organic agriculture certification may be in trouble. This has been controversial issue in the US and Canada where some organic farmers have filed legal suits demanding damages (Nature Biotechnology, 2002). Such a situation is expected to be much more complicated in most developing countries where landholdings are much smaller and distances between farms are much shorter. This problem necessitates establishment of regional policies to pave the way.

Freedom of choice

Freedom of choice is applicable to all food and agricultural products in general. However, as certification for labeling include several additional expenses such as isolation in field, separation in storage and shipping as well as the cost of analysis, the extra costs must be born by the end consumer. As a result, the needs for labeling become highly controversial in the case of GMOs. A declared meaningful label, instead of a certified one, may be more acceptable for all societies while a product with higher price would be primarily intended for markets that can afford them. Otherwise, GMOs could be channeled to markets with less capacity to pay or where such labeling is not legally required.

Cultural and religious concerns

Culture, ethics and religion are the major concerns in defining the way technologies are introduced and disseminated in any given society, particularly in countries where religion remains a strong

societal force. For instance, in Islamic states debates on if GMO products are halal or haram sets their acceptability among Muslims. Such concerns must be deliberately resolved by dialogues among scholar and scientists considering culture, ethics, religion and social behavior in their society. Otherwise, false statement may obscure the reality and true verdicts.

Bodies involved in biotechnology implementation

When it comes to SE concerns of biotechnology products, not only scientists and scholars, but also national policy and decision makers are taken responsible. However, a disturbing fact is that even the scientists who moved forward biotechnology, are not in navigation position of the route they are taking. To this, we may add exogenous influences, particularly by transnational companies, many of which have invested billions of dollars influencing the type and extend of research projects in universities and research institutes worldwide. With respect to profit-seeking nature of private companies, this contradicts with socialist approach of the developing countries suffering from lower public awareness. Adopting appropriate legislation and policies could regulate the social behavior of stakeholders in this respect.

Scientists who develop and introduce technology into any society need to bear the moral and ethical responsibility for the impacts that their innovation may have on society. They are also required to ensure social acceptance and public awareness when GMOs are introduced in any given societal context.

Conclusions

Modern biotechnology can make decisive contributions to sustainable development in several ways to alleviate poverty and hunger, to improve the food security, to reduce environmental damages and to preserve

endogenous genetic resources. Neglecting GMOs may lead to social crises due to higher food cost, job losses, higher farming expenditure, lower productivity, food insecurity, economical and thus political dependency polluted environment. Developing countries, including Islamic states, need to speed up the adoption of this technology more progressively while observing and managing social, religious and cultural concerns. These could be done through the following recommendations:

- 1) To define national goals and strategies,
- 2) To form proper structure for sharing resources,
- 3) To build up capacity by educating and training of required personnel,
- 4) To smooth scientific collaborations,
- 5) To provide legislative and governmental support,
- 6) To raise public awareness,
- 7) To address sharia concerns consciously.
- 8) To allow transparency and public access to information

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