Socio-economic and environmental impacts of Genetically Modified Organisms /Food, Feed and Processed Products

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GMO/FFPs is an acronym used to refer to Genetically Modified Organisms, Food, Feed and Processed Products. Some people name this as Genetically Engineered Organisms (GEO). Genetic modification or engineering merely means the process of transferring specific traits or genes from one organism into a different plant or animal in order to modify its genetic makeup. The resulting organism is called transgenic or a GMO (genetically modified organism). The GMO/FFPs include these organisms and the food, feed and processed products produced using the GMOs. These organisms have been modified in the laboratory to enhance desired traits such as increased resistance to herbicides or improved nutritional content.

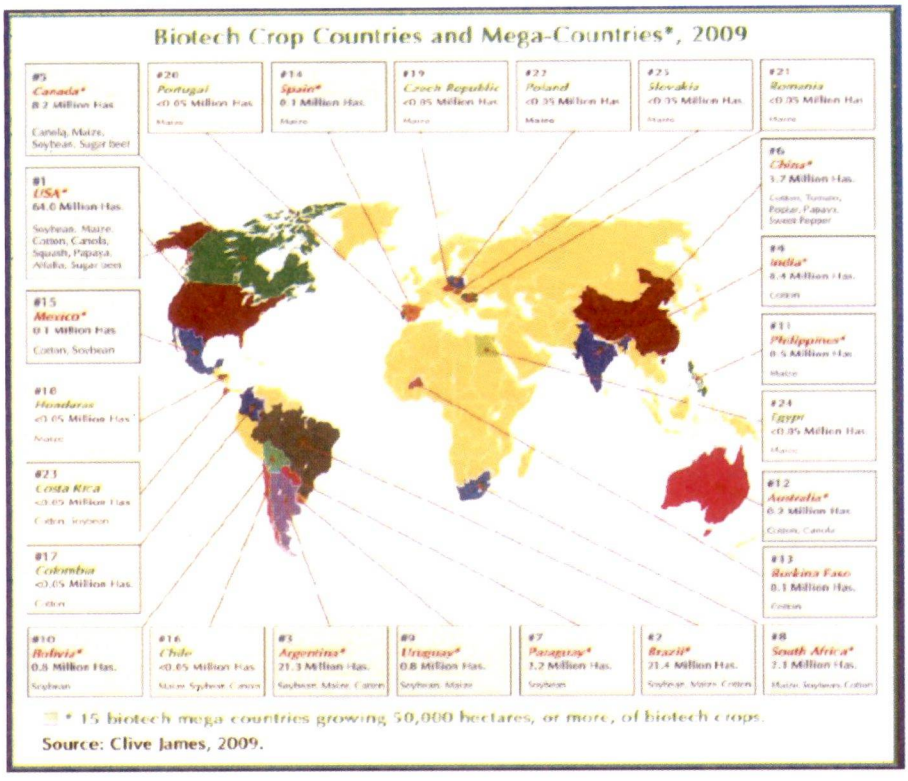
Genetic engineering is different from traditional cross breeding, where alleles can only be exchanged between closely-related species. With genetic engineering, genes from completely different species can be inserted into each other. Conventional plant breeding methods can be very time consuming and are often not very accurate. Genetic engineering, on the other hand, can create plants with the exact desired trait very rapidly and with great accuracy.

Genetic modifications have made a big splash in the news lately. European environmental organizations and public interest groups have been actively protesting against Genetically-modified foods (GM foods) for months, and recent controversial studies about the effects of GM corn pollen on monarch butterfly caterpillars have brought the issue of genetic engineering to the vanguard of the public consciousness in the U.S.

More than 200 million acres of farmland worldwide are now used to grow GM crops such as cotton, corn, soybeans and rice. The most common GM crops are soybeans, which represent 63% of all GM crops, Corn (19%), Transgenic Cotton (13%) and Canola or Rapeseed (5%). The majority of genetically modified crops grown today are engineered to be resistant to pesticides and/or herbicides so that they can withstand being sprayed with herbicide while the rest of the plants in the field die. Corn, papaya, cotton, canola, potato, rice, soybean, squash, sugar beet, tomato and alfalfa are some of the genetically modified crops.

There are more than 23 countries that grow genetically-engineered crops commercially, and of these, the U.S. produces the majority. In 2009, 68% of all GM crops were grown by U.S. farmers. In comparison, Argentina, Canada and China produced only 22%, 6% and 3%, respectively. In addition to the above four countries, there are nine other countries that are listed as biotech mega countries. They include Australia, Brazil, India, South Africa, Philippines, Spain, Paraguay, Bulgaria, Mexico and Uruguay.

Scientists have also worked on ways to genetically engineer farm animals. Transgenic cattle, sheep, goat, fish and swine have been produced by inserting different genes of interest such as human metallothionein-IIA gene.



Biotech Crop Countries and Mega-Countries (2009)

Concerns over GMO/FFPs

Many concerns have been raised over the inadequate testing of the effects of genetic modification on humans and the environment. Genetic engineering is still an emerging field, and scientists do not know exactly what can result from putting the DNA of one species into another. The introduction of foreign DNA into an organism could trigger other DNA in the organism to mutate and change. In addition, researchers do not know if there are any long-term or unintended side effects from eating GM foods.

Opponents to genetic engineering state that GM foods must be proven safe before they are sold to the public because their safety has not yet been proven. Specific concerns over genetic engineering include allergic reactions, gene mutation, development of antibiotic resistance, loss of nutrition, gene pollution, formation of super weeds, etc.

Economic impacts of GMO/FFPs

The socio-economic reports provided by farmer's organizations and civil society organizations, most importantly from Spain, provide important insights to the practical impacts of this new technology on individuals and communities through eyes unclouded by the potential for scientific or financial advancement. The introduction of GMOs in dexterously balanced rural social and economic systems can have unanticipated and long-lasting consequences.

There is apparent evidence of direct negative economic impacts on farmers affected by GM contamination of their previously profitable productions, whether organic or conventional. Hence, farmers living in areas or regions where GMOs are cultivated are in jeopardy of considerable economic losses due to the loss of organic certification through contamination.

Bringing a GM food to market is a lengthy and costly process, and of course agri-biotech companies such as Monsanto wish to ensure a profitable return on their investment. Many new plant genetic engineering technologies and GM plants have been patented, and patent infringement is a big concern of agribusiness. Nonetheless consumer advocates are worried that patenting these new plant varieties will increase the price of seeds so high that small farmers and third world countries will not be able to afford, thus widening the gap between the wealthy and the poor.

Patent enforcement may also be difficult, as the contention of the farmers shows that they unwillingly grew Monsanto-engineered strains when their crops were cross-pollinated.
One way to combat possible patent infringement is to introduce a "suicide gene" into GM plants to produce "terminator seeds". These plants would be viable for only one growing season and would produce sterile seeds that do not germinate. Farmers would need to buy a fresh supply of seeds each year. However, this would be financially catastrophic for farmers in third world countries who cannot afford to buy seed each year because these farmers traditionally set aside a portion of their harvest to plant in the next growing season. This will affect the livelihood of farmers in the third world countries.

Impacts of GMO/FFPs on Society and Ethics

Some people and institutes perceive GMO/FFPs as an approach to help solve problems of hunger and environmental issues. Yet new social and moral principles and values about biotechnology may be different from traditional ethics. People now pay

more attention to food quality than to quantity. Therefore, people believe that new form of biotechnology although it can lead to high crop productivity is not necessarily an acceptable one.

GMOs are used by large companies to privatize seeds at the expense of the food sovereignty of people and rural communities throughout the world. The opponents of GMO utter that these companies' goal is to control people's access to food.

The other concern is patenting new varieties. The question is whether a life can be owned. The intellectual property right (IPR) is another concern in this aspect of technology. Biotheft and biopiracy are other ethical issues pertaining to this technology. Some take plants from other countries via unethical means and do some genetic modification to them and then patent it. Another moral issue is the transfer of genes from animals especially swine to plants and other animals. Jews and Muslims get affected by the genetic modifications of this sort. Moreover, an important social issue pertaining to the GMO/FFPs is whether the stuff is labeled as Genetically Modified.

Risks of GMO/FFPs to Environment and Biodiversity

GM crops can pose six kinds of potential risks to the environment and the biodiversity. First, plants engineered to express potentially toxic substances could present risks or unintended harm to other organisms (non-target organisms) such as butterflies, bees, moths, lady-bird beetle, lizards, frogs, soil organisms, etc. In 2000, the US media were abuzz with stories about a laboratory study published in *Nature* showing that pollen from Bt corn caused high mortality rates in monarch butterfly caterpillars. Monarch butterflies are widely admired for their splashy coloring, their long (about 3000 miles) migration and their spectacular habit of overwintering massed together in trees in a few isolated spots in Mexico. Monarch caterpillars consume milkweed plants, not corn, but the panic is that if pollen from Bt corn is blown by the wind onto milkweed plants in neighboring fields, the caterpillars could eat the pollen and perish. Although the *Nature* study was not conducted under natural field conditions, the results seemed to support this viewpoint. Unfortunately, Bt toxins kill many species of insect larvae indiscriminately; it is not possible to design a Bt toxin that would only kill crop damaging pests and remain harmless to all other insects. This study is being reexamined by the USDA, the US Environmental Protection Agency (EPA) and other nongovernment research groups, and preliminary data from new studies suggests that the original study may have been flawed. This topic is the subject of acrimonious debate, and both sides of the argument are defending their data robustly. At present, there is no accord about the results of these studies, and thus the potential risk to non-target organisms will need to be evaluated further.

Second, GM crops results in reduced effectiveness of pesticides and herbicides. Just as some populations of mosquitoes developed resistance to the now-banned pesticide DDT, many people are concerned that insects will become resistant to Bt or other crops that have been genetically modified to produce their own pesticides. GM crops might serve as conduits through which new genes (e.g. herbicide tolerant genes) move to wild plants or weeds resulting in the formation of "superweeds" which would then be herbicide tolerant.

Third, GM crops may initiate a perturbation that may have effects ripple through an ecosystem in ways that are difficult to predict. Introduced genes may cross over into non-GM crops planted next to GM crops. This also poses a risk of losing traditional varieties and endangered species. The possibility of interbreeding is shown by the defense of farmers against lawsuits filed by Monsanto. The company has filed patent infringement lawsuits against farmers who may have harvested GM crops. Monsanto claims that the farmers obtained Monsanto-licensed GM seeds from an unknown source and did not pay royalties to Monsanto. The farmers claim that their unmodified crops were cross-pollinated from someone else's GM crops planted a field or two away.

Fourth, crops engineered to protect from viral diseases could facilitate the creation of new, more virulent or more widely spread viruses. A research has shown that naturally occurring non-Hawaiian virus isolates, as well as laboratory-generated recombinant strains of Papaya Ring Spot Virus (PRSV), could overcome the CP (Coat Protein)-mediated resistance and cause disease in both varieties, though with varying degrees of severity. The results with the recombinant lab strains raise concerns that resistance-breaking strains could come up in a non-lab environment, that is, papaya plantations, through recombination of Hawaiian strains with engineered papaya expressing the CP gene.

Fifth, the GM crops might threaten centers of crop diversity. Genetic erosion by aggressive or

dominant GM crops leads to the loss of biodiversity, for instance loss of traditional rice varieties.
Finally, the engineered crops themselves could become weeds.

Human health impacts of GMO/FFPs

Over the past decade, food-safety experts have identified several potential problems that might crop up as a result of engineering food crops, including the possibilities of introducing new toxins or allergens into previously safe foods, increasing toxins to detrimental levels in foods that typically produce harmless amounts, or decreasing the nutritional value foods.
Among these potential impacts, scientists and regulators have been most worried about new allergens which sometimes may be life threatening, and indeed, two events within the last decade legitimate that concern. First, a paper published in the New England Journal of Medicine (NEJM) in 1996 confirmed predictions that genetic engineering could transfer an allergen from a known allergenic food to another. A few years earlier, scientists at Pioneer Hi-Bred seed company had successfully transferred a gene from Brazil nut into soybean to improve the grain crop's nutritional quality. Subsequent experiments showed that people allergic to Brazil nuts were similarly allergic to the transgenic soybean.

Second, in the late 1990s, reports that a Bt corn variety (StarLink) containing a potential allergen (The EPA had not approved StarLink corn for human consumption because of scientific concerns that the Bt toxin might cause allergic reactions in some consumers) had illegally entered the food supply set off a tidal wave of controversy that ultimately reduced corn exports, frightened the food industry, and created widespread uncertainties about the strength of the U.S.

There is a possibility that introducing a gene into a plant may create a new allergen or cause an allergic reaction in susceptible individuals. There is a growing concern that introducing foreign genes into food plants may have an unexpected and negative impact on human health. A recent article published in Lancet examined the effects of GM potatoes on the digestive tract in rats. This study claimed that there were significant differences in the intestines of rats fed with GM potatoes and rats fed with unmodified potatoes. Yet critics say that this paper is flawed and does not hold up to scientific scrutiny. Moreover, the gene introduced into the potatoes was a snowdrop flower lectin, a substance known to be toxic to mammals.

However, on the whole, with the exception of possible allergenicity, scientists believe that GM foods do not present a risk to human health.

Conclusion

How do we feed the nine billion people who are projected to inhabit the Earth by 2050? The issue is one of serious concerns as an increase in food production of up to 40% will be needed to cope with the growing population. In an article for the Philosophical Transactions of the Royal Society, Sir John Beddington, the UK Government's chief scientific adviser and professor of applied population biology at Imperial College London, lists the four main challenges for humanity in the twenty-first century as follows: to feed nine billion people in a sustainable way; to cope with increasing demands for clean water; to generate more energy; and to do all of this while mitigating and adapting to climate change. Science will play a crucial role in this endeavour, if the necessary investments are being made.

GM foods have the potential to solve many of the world's hunger and malnutrition problems, and to help protect and preserve the environment by increasing yield and reducing reliance upon chemical pesticides and herbicides. Yet there are many challenges ahead for governments and policy makers especially in the areas of safety testing, regulation, international policy and food labeling. Many people feel that genetic engineering is the inevitable wave of the future and that we cannot afford to ignore a technology that has such enormous potential benefits. However, we must proceed with caution to avoid causing unintended harm to human health and the environment as a result of our zest for this powerful technology. However, in Sri Lanka, now we have a National Biosafety Framework, under the Ministry of Environment the focal point, for regulation and risk management of GMO/FFPs.

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