Chapter 10

Social and Economic Issues – Genetically Modified Food

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1. Introduction

Food is one of the most important necessities for humans; we eat to live and at least most people are blesses with a meal a day, while some others can afford three or more. Independent of our culture and customs, dinning remains a vital aspect in different festivities across the world between and within families and friends. Furthermore, we want a healthy and nutritious meal but the question is "How safe is the food we are consuming?"

The improvement of plants and livestock for food production and the use of different conservation techniques have been in practice as long as humankind stopped migrating relying on agriculture for survival. With the quest to grow more and better food to meet the demand of our fast growing world population, genetic engineering of crops has become a new platform in addition to plant breeding.

Molecular genetics has been and is a very useful tool used to better understanding of genes underlying quantitative traits associated with increasing crop yields or improving food quality. The eagerness to increase crop products has resulted in the genetic manipulation of plants, which has raised much polemics ranging from political, ethical and social problems. Genetically modified food simply means that the original DNA (deoxyribonucleic acid) structure of plants has been altered or tempered with. Since the DNA is the finger print of every organism consequently, changes made within the genetic code could possible lead to alteration in the quality or characteristic of the plant in question.

Although, there has been steady increase in the total area under genetically modified (GM) crop cultivation, nevertheless, there has been a marked slowdown in the last few years. The most extensively cultivated GM crops include soybean, corn and cotton. Europe is known to grow less than 0.5% of the world's GM crops, primarily because of the very rigorous EU regulations imposed on GMO crops in Europe until 2003 and the refusal of European consumers to buy GM products.

Notwithstanding, the essential knowledge and understanding of cell function and heritability combined with genetic engineering offering new possibilities to transfer and or modify DNA between organisms has enabled governments in many countries, for the first time, to be able to provide adequate food supply to their growing population. These advancements have resulted in the development of efficient vaccines and pharmaceuticals, new food technologies and many other products improving the overall standard of life. This is also true of agriculture where genetic engineering of crops can complement traditional plant breeding to suit the needs of today's world. Most of these improvements can be grouped under the term "biotechnology", which aims to use organisms, cells and or part of cells in technical or industrial processes.

2. Regulations and why?

Because genetically modified foods have been one of the most controversial topics that have made news in the last years. Many European environmental organizations, NGOs and public interest groups have been actively protesting against GM foods for months. Beside, recent controversial studies about the effects of genetically-modified food have brought the issue of genetic engineering to the forefront of the public consciousness (Fonseca, Planchon, Renaut, Oliveira, & Batista, 2012; Losey, Rayor, & Carter, 1999; Nykiforuk, Shewmaker, Harry, Yurchenko, Zhang, Reed, et al., 2012). Generally in Europe, the idea of introducing GM food products in the market for human consumption and or as animal feed has not been welcome for health reasons (Maga & Murray, 2010). Although there are no clear research results suggesting the negative effects of GM food to human health, the distancing from GM foods is more or less preventive. Nevertheless, with the growing interest in the use of biofuels as one of the sources of alternative sources energy, genetic engineering then comes in to play for economic reasons.

As a reaction to the growing public concern on GM food and products, many governments across the world have taken different approaches to tackle this hot topic on GM foods. This has resulted in the creation of GMO regulations which are most often country or region specific. The European parliament and council for example have set up regulations regarding GM foods to protect human health and well-being of citizens, and European social and economic interests (McCabe & Butler, 1999). The EU regulations segregates between GM food and feed, it further gives specific instructions on how GM products should be labelled in terms of the amount of modifications involved.

EU GMO regulations suggest for example that it is appropriate to provide the combined level of adventitious or technically unavoidable presence of genetically modified materials in a food or feed or in one of its components is higher than the set threshold, such presence should be indicated in accordance with this regulation and that detailed provisions should be adopted for its implementation (Ramon, MacCabe, & Gil, 2004). The possibility of establishing lower thresholds, in particular for foods and feed containing or consisting of GMOs or in order to take into account advances in science and technology, should be provided for. In my opinion, the European GM food regulations are the most stringent in the world and it is not quite clear whether or not there is any room for GM products due to the complexity in understanding and implementation of the said regulations. Nonetheless, the EU GMO regulations could be summarized as it is meant to provide the basis for ensuring a high level of protection of human life and health, animal health and welfare, environment and consumer interests in relation to genetically modified food and feed, whilst ensuring the effective functioning of the internal market; lay down community procedures for the authorisation and supervision of genetically modified food and feed; and to lay down provisions for the labelling of genetically modified food and feed.

Similarly, the United States regulation process is confusing because there are three different government agencies that have jurisdiction over GM foods. The Food and Drug Administration (FDA) evaluate whether the plant is safe to eat; the U.S. Environmental Protection Agency (EPA) evaluates GM plants for environmental safety, and the United States Department of Agriculture (USDA) which evaluates whether the plant to be grown is safe (Pelletier, 2005; Strauss, 2006). The USDA has many internal divisions that share responsibility for assessing GM foods. Among these divisions are, the Animal Health and Plant Inspection Service (APHIS), which conducts field tests and issues permits to grow GM crops, the Agricultural Research Service which performs in-house GM food research, and the Cooperative State Research, Education and Extension Service which oversees the USDA risk assessment program (Whitman, 2000). This implies there is a combination of regulations from these three agencies to be followed in order to carry on with GM food. Nevertheless, it is estimated that up to 70% of processed food on US supermarkets shelves ranging from soda to soup, crackers to condiments contain genetically engineered ingredients. Currently, up to 85% of U.S. corn is genetically modified as are 91% of soybeans and 88% of cotton (cottonseed oil is often used in food products) (Whitman, 2000).

In many developing countries whereby due to seasonal changes, there are usually a season of plenty and that of starvation, GM food is less a problem because the goal is to feed the starving population. Although, some of them might have GMO regulations, when food aid is coming into their countries in the moment of disaster, their rules and regulations are not important at that moment. This is understandable because the ultimate goal is saving lives before thinking of any qualms.

Plants have always been able to developed mechanisms over the years to endured environmental stress (drought, predation and pollutions just to name a few) and consequently adapted to the changing environment by developing genes resistant to the different factors. This is supported by the fact that, historically it was assumed that changes in plants as a result of genetic modification in breeding are generally safe and not harmful. Nevertheless, this was eventually challenged with the arrival of rDNA (ribosomal deoxyribonucleic acid) technology in the early 1970s when Cohen and Boyer successfully linked two different pieces of DNA (McHughen & Smyth, 2008).

The scientific world did not acknowledged the positive potentials of genetic engineering to crop breeding but the risks associated with these techniques (Berg & et al., 1974; McHughen & Smyth, 2008).

Over the last century, agriculture in general and plant breeding in particular have enjoyed fast dynamic research, which have been speedy and valuable developments. Traditional forms of crop genetic improvements, such as selection and cross-pollination, remain the standard tools in the breeder's toolbox, but have been supplemented with a range of new and specialized innovations, such as mutation breeding using ionizing radiation or mutagenic chemicals, wide crosses across species requiring human interventions such as embryo rescue and transgenic, commonly called genetic modification.

3. GM food and human health

Food choice is influenced by a large number of factors, including social and cultural factors. One method for trying to understand the impact of these factors is through the study of attitudes. Research is described which utilizes social psychological attitude models of attitude-behaviour relationships, in particular the Theory of Planned Behaviour. This approach has shown good prediction of behaviour, but there are a number of possible extensions to this basic model which might improve its utility. One such extension is the inclusion of measures of moral concern, which have been found to be important both for the choice of genetically-modified foods and also for foods to be eaten by others.

It has been found to be difficult to effect dietary change, and there are a number of insights from social psychology which might address this difficulty. One is the phenomenon of optimistic bias, where individuals believe themselves to be at less risk from various hazards than the average person (Paparini & Romano-Spica, 2004).

This effect has been demonstrated for nutritional risks, and this might lead individuals to take less note of health education messages. Many children in the US and Europe have developed life-threatening allergies to peanuts and other foods. 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 (Brunner & Millstone, 1999).

Another concern is that individuals do not always have clear-cut attitudes, but rather can be ambivalent about food and about healthy eating. It is important, therefore, to have measures for this ambivalence, and an understanding of how it might impact on behaviour (Shepherd, 1999).

One measure of how far we have travelled down that road is that it hardly matters any more whether objections to GMO are based on alleged environmental risks of cultivating GM crops or alleged toxicological hazards of eating them. GMO like 'radioactivity' has become

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an odious, generic shibboleth. Given that millions of people throughout the world are already benefiting from pharmaceuticals made by GM organisms, this is bizarre (Dixon, 2003).

Among the next generation of genetically modified (GM) plants are those that are engineered to produce elevated levels of nutritional molecules such as vitamins, omega-3 fatty acids, and amino acids. Based upon the U.S. current regulatory scheme, the plants and their products may enter our food supply without any required safety testing. The potential risks of this type of GM plants are discussed in the context of human health, and it is argued that there should be very careful safety testing of plants designed to produce biologically active molecules before they are commercially grown and consumed. This will require a mandatory, scientifically rigorous review process (Schubert, 2008).

Nevertheless, advances in our understanding of molecular biology, biochemistry, and nutrition may in future allow further improvement of test methods that will over time render the safety assessment of foods even more effective and informative (Konig, Cockburn, Crevel, Debruyne, Grafstroem, Hammerling, et al., 2004).

4. GM food and environment

Genetic modification and "biosafety" are concepts that have not been well understood by, or accessible to, the non-geneticists working in the fields of conservation science, law, administration and management, and in the scientific, legal, administrative and management aspects of sustainable use.

Genetically modified (GM) plants represent a potential benefit for environmentally friendly agriculture and human health. Although, poor knowledge is available on the potential hazards posed by unintended modifications occurring during genetic manipulation processes, the increasing amount of reports on ecological risks and benefits of GM plants stresses the need for experimental works aimed at evaluating the impact of GM crops on the natural and agro-ecosystems. One of the major environmental risks associated with GM crops include their potential impact on non-target soil microorganisms which plays a fundamental role in crop residues degradation and in biogeochemical cycles (Giovannetti, Sbrana, & Turrini, 2005).

Transformed corn plants with genetic material from the bacterium *Bacillus thuringiensis* (*Bt*) have been reported to represent a risk because most hybrids express the Bt toxin in pollen which could be further deposited on other plants near such corn fields causing non-target organisms that consume these plants (Yu & Shepard, 1998). It is thought that genetically modified plants could be harmful to the environment by depleting soil microorganism which are very important for soil fertility and or influence the micro-environments of other organisms (Giovannetti, Sbrana, & Turrini, 2005). The cultivation of GM seeds and plants could be detrimental to the environment (Losey, Rayor, & Carter, 1999).

The biodiversity debate is at the forefront of the larger question of how humanity can, in an integrated, congruent way, address human livelihoods, while at the same time fulfilling its international mandates to conserve and sustainably use the environment. In a world focused on issues such as poverty and food security, as well as species loss and ecosystem destruction, these questions are among the most important and the most difficult on the planet.

5. GM food and economic issues

Bringing a GM food to market is a lengthy and costly process, and of course agro-biotechnological companies wish to ensure a profitable return on their investment. Thus many new plant genetic engineering technologies and GM plants have been patented, and patent infringement is a big concern of agribusiness.

Although, genetically modified (GM) plants represent a potential benefit for environmentally friendly agriculture and human health, poor knowledge is available on the potential hazards posed by unintended modifications occurring during genetic manipulation. The major economic fears are the risk of patent enforcement which may oblige farmers to depend on giant engineering companies such as Monsanto for strains when their crops are cross pollinated. Consumer advocates are equally worried that patenting these new plant varieties will raise the price of seeds so high that small farmers and third world countries will not be able to afford seeds for GM crops, thus widening the gap between the wealthy and the poor. It is hoped that in a humanitarian gesture, more companies and non-profits will follow the lead of the Rockefeller Foundation and offer their products at reduced costs to impoverished nations.

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, consequently will have to be dependent on the few agric-biotech companies with patent rights. However, this would be financially disastrous for farmers in third world countries who cannot afford to buy seed each year and traditionally set aside a portion of their harvest to plant in the next growing season.

6. Social and cultural aspects on GM foods

With the emergence of transgenic technologies, new ways to improve the agronomic performance of crops for food, feed, and processing applications have been devised. In addition, ability to express foreign genes using transgenic technologies has opened up options for producing large quantities of commercially important industrial or pharmaceutical products in plants. Despite this high adoption rates and future promises, there is a multitude of concerns about the impact of genetically modified (GM) crops on the environment (Paparini & Romano-Spica, 2004). Potential contamination of the environment and food chains has prompted detailed consideration of how such crops and the molecules that they produce can be effectively isolated and contained. One of the reasonable steps after creating a transgenic plant is to evaluate its potential benefits and risks to the environment and these should be compared to those generated by traditional agricultural practices (Poppy, 2004). The precautionary approach in risk management of GM plants may make it necessary to monitor significant wild and weed populations that might be affected by transgene escape. Effective risk assessment and monitoring mechanisms are the basic prerequisites of any legal framework to adequately address the risks and watch out for new risks. Several agencies in different countries monitor the release of GM organisms or frame guidelines for the appropriate application of recombinant organisms in agro-industries so as to assure the safe use of recombinant organisms and to achieve sound overall development. We feel that it is important to establish an internationally harmonized framework for the safe handling of recombinant DNA organisms within a few years (Singh, Ghai, Paul, & Jain, 2006).

7. Conclusion

Genetically-modified 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, especially in the areas of safety testing, regulation, international policy and food labelling. 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 enthusiasm for this powerful technology.

In this connection, we find many claims about genetically modified organisms (GMOs) – that they can be a basis for increasing food production, without the need to convert more land to cultivation, for example. These claims, however, are countered by the claims that GMOs may have a variety of impacts on people and animals, and especially on ecosystems and lands not under cultivation, and concerns about whether and how the benefits of GMOs are actually experienced in developing countries.

Furthermore, some of the questions we need to answer to better understand GMOs include;

- **a.** Are the current scope and objectives of the GMO legislation in line with the needs of society, and especially the biotechnology operators and consumers?
- **b.** Are the procedures associated with the legislative framework fit for purpose, in definition and in implementation?
- **c.** Are the procedures for the risk assessment of GMOs and their implementation up to date, are efficient, time limited and transparent known?
- **d.** In design and implementation are provisions governing risk management of GMO marketing up to date, efficient transparent and in line with the general objectives of our legislation?
- **e.** And is the communication of risk concerning the release of GMOs into the environment and the manner in which it has been implemented known?

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References

[1] Berg, P., & et al. (1974). Potential biohazards of recombinant DNA molecules. *Science, 185*(4148), 303.

[2] Brunner, E., & Millstone, E. (1999). Health risks of genetically modified foods. *Lancet, 354*(9172), 71.

[3] Dixon, B. (2003). Genes in food--why the furore? *Biochemical Society transactions, 31*(2), 299-306.

[4] Fonseca, C., Planchon, S., Renaut, J., Oliveira, M. M., & Batista, R. (2012). Characterization of maize allergens - MON810 vs. its non-transgenic counterpart. *Journal of proteomics, 75*(7), 2027-2037.

[5] Giovannetti, M., Sbrana, C., & Turrini, A. (2005). The impact of genetically modified crops on soil microbial communities. *Rivista di biologia, 98*(3), 393-417.

[6] Konig, A., Cockburn, A., Crevel, R. W., Debruyne, E., Grafstroem, R., Hammerling, U., Kimber, I., Knudsen, I., Kuiper, H. A., Peijnenburg, A. A., Penninks, A. H., Poulsen, M., Schauzu, M., & Wal, J. M. (2004). Assessment of the safety of foods derived from genetically modified (GM) crops. *Food and chemical toxicology : an international journal published for the British Industrial Biological Research Association, 42*(7), 1047-1088.

[7] Losey, J. E., Rayor, L. S., & Carter, M. E. (1999). Transgenic pollen harms monarch larvae. *Nature, 399*(6733), 214.

[8] Maga, E. A., & Murray, J. D. (2010). Welfare applications of genetically engineered animals for use in agriculture. *Journal of animal science, 88*(4), 1588-1591.

[9] McCabe, H., & Butler, D. (1999). European Union tightens GMO regulations. Genetically modified organisms. *Nature, 400*(6739), 7.

[10] McHughen, A., & Smyth, S. (2008). US regulatory system for genetically modified [genetically modified organism (GMO), rDNA or transgenic] crop cultivars. *Plant biotechnology journal, 6*(1), 2-12.

[11] Nykiforuk, C. L., Shewmaker, C., Harry, I., Yurchenko, O. P., Zhang, M., Reed, C., Oinam, G. S., Zaplachinski, S., Fidantsef, A., Boothe, J. G., & Moloney, M. M. (2012). High level accumulation of gamma linolenic acid (C18:3Delta6.9,12 cis) in transgenic safflower (Carthamus tinctorius) seeds. *Transgenic research, 21*(2), 367-381.

[12] Paparini, A., & Romano-Spica, V. (2004). Public health issues related with the consumption of food obtained from genetically modified organisms. *Biotechnology annual review, 10*, 85-122.

[13] Pelletier, D. L. (2005). Science, law, and politics in the Food and Drug Administration's genetically engineered foods policy: FDA's 1992 policy statement. *Nutrition reviews, 63*(5), 171-181.

[14] Poppy, G. M. (2004). Geneflow from GM plants--towards a more quantitative risk assessment. *Trends in biotechnology, 22*(9), 436-438.

[15] Ramon, D., MacCabe, A., & Gil, J. V. (2004). Questions linger over European GM food regulations. *Nature biotechnology, 22*(2), 149.

[16] Schubert, D. R. (2008). The problem with nutritionally enhanced plants. *Journal of medicinal food, 11*(4), 601-605.

[17] Shepherd, R. (1999). Social determinants of food choice. *The Proceedings of the Nutrition Society, 58*(4), 807-812.

[18] Singh, O. V., Ghai, S., Paul, D., & Jain, R. K. (2006). Genetically modified crops: success, safety assessment, and public concern. *Applied microbiology and biotechnology, 71*(5), 598-607.

[19] Strauss, D. M. (2006). The international regulation of genetically modified organisms: importing caution into the U.S. food supply. *Food and drug law journal, 61*(2), 167-196.

[20] Whitman, D. B. (2000). Genetically Modified Foods: Harmful or Helpful? *CSA Discovery Guides*.

[21] Yu, D. W., & Shepard, G. H., Jr. (1998). Is beauty in the eye of the beholder? *Nature, 396*(6709), 321-322.