Issues in GM Foods

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1. Introduction

GM foods developed through Genetic engineering have the potential to address the prevailing world hunger and malnutrition problems. At the same time, production of GM foods presents a number of challenges with regard to safety issues, regulations, labeling, and international policy and trade. The positive aspects and the promising potential of genetic engineering to address some of the global agricultural and food and nutrition problems are accompanied with possible risks and unintended harm to human and animal health as well as to the environment. The scientist's cautions that our enthusiasm about this powerful technology should not make us forget about the possibility of causing unintended harm to humans and the environment.

Consumers have been eating food products with GM ingredients for decades, yet many consumers are unaware of this. Many studies tried to ascertain consumers' views about GM foods and whether GM foods should be labelled or not. Some consumers say that they need to know whether their food contains GM ingredients, just as some want to know whether their food is natural or organic. Informing consumers on food ingredients has been the main motivation for labeling. Regulation of GM crops and GM foods proved to be a complex multidimensional issue that needs to be addressed carefully. It has been an issue of concern to the public, scientists, policy makers, as well as the food industry.

Governments around the globe have considered issues, regulation and labeling of GM foods, as an urgent priority and are working hard to set regulatory processes addressing GM foods. Different governments have taken different approaches based specifically on political, social, and economic conditions prevailing around the region or in the country. Differences in regulations among countries are clear and the most marked differences occur between the United States and Europe. In general, most governments have set "the protection of public health as affected by food consumption" as the first priority to be achieved through promoting and enforcing high standards of safety throughout the food chain. However, there are many issues have to be discussed for the better understanding of the GM foods.

2. Environmental and Food Safety

Environmental safety

Two main concerns about the effects of GM food plants on the environment are that the new plants will become pernicious weeds or that they will transfer their new genes to wild relatives or similar crops growing nearby with unforeseen effects. A great deal of research has been carried

out by ecologists to determine whether or not these worries are likely to be substantiated. This is one of the major reasons for carrying out field trails of GM crops.

Evidence from thousands of field trials suggests that the new plants will behave just like the varieties currently in cultivation. There is also evidence to suggest that the transfer genetic material from transgenic crops to their wild relatives or unmodified plants occurs, although the frequency of such transfer and its significance is still debated.

The ecologists involved in such work have emphasised the need for caution and the importance of case-by-case analysis (in other words, it is difficult to generalise about the impact of GM crops).

A further concern is whether plants with introduced genes that enable them to resist insect attack will quickly lead to the establishment of resistant populations of pests. Because of the intense selection pressure (favouring naturally-resistant individuals) that crops carrying, for example, Bt genes will exert, refugia of susceptible plants are usually grown alongside transgenic crops. Indeed, this has been a legal or voluntary requirement in the USA and Australia where transgenic, insect-resistant cotton has been grown. To date, there have been no confirmed cases of resistant populations developing, but it is generally accepted that without measures such as the limited use of a range of pesticides and the use of refugia, resistant pest populations will certainly develop. With this in mind, in January 1999, four major producers of Bt maize plants (Monsanto, Pioneer Hi-Bred, Novartis, and Mycogen-Dow AgroScience) proposed that 20% of farmland should be set aside for non-transgenic crops when Bt maize is grown.

Food safety

The current generation of genetically-modified organisms sometimes contains 'marker' genes. These are short, easily-detected sequences of DNA put there so that the researchers can tell which organisms have taken up the introduced genes. Among the questions that regulatory authorities have asked are whether the marker genes permit their recipient to make a new protein and if so, what levels of that protein (if any) would be expected in the food. Could that protein have any unwanted effects? Finally, is it at all likely that the marker gene could be transferred to other organisms such as microbes in the intestine of the consumer?

The Food Safety Unit of the World Health Organisation and a working party has looked specifically at the safety issues associated with marker genes in plants that are to be consumed as foods. The need for marker genes was accepted and the impracticality of removing these genes (at present) was recognised.

The marker genes in plant varieties approaching commercialisation are restricted to two markers that break down specific antibiotics and a few herbicide tolerance markers. The presence of marker genesper se (the DNA itself) in food was not thought to constitute a safety concern. There is DNA in abundance in almost all the food we eat, but no recorded evidence for the transfer of genes from plants to microorganisms in the gut or to any other living things (including humans).

However, the recent introduction and approval of maize with a bacterial marker conveying resistance to the antibiotic ampicillin has raised new fears, particularly in the European Union. Recent scientific advice has suggested that as a precaution, the use of antibiotic resistance

markers in commercial crops (rather than in contained research) should be phased out, and this is indeed happening.

Both the possibility of DNA transfer and the production of proteins from marker genes, and their possible effects, are considered on a case-by-case basis by the regulatory authorities in the USA and Europe.

3. Changes in farming structure and economic concerns

GM Food based biotechnology has the potential to affect world agriculture dramatically. Although great benefits may come, it has been suggested that there might also be accompanying disadvantages. Several of these disadvantages are no different to existing trends in world agriculture, such as the shift towards larger farms and more capital-intensive farming systems. This tends to favour, for example, wealthy farmers in the Northern hemisphere who can invest in new technologies rather than those in the impoverished South. In the developed world, there are concerns about over-production of food, although these worries are unlikely to be shared by those countries where the growth in population far outstrips the capacity of farmers to provide sufficient food. Biotechnology, alongside other changes and technologies offers a realistic prospect of long-term sustainable agriculture to farmers in the Third World. At least, this is the finding of several recent independent investigations into the topic.

Plant breeding methods have produced plants with greatly improved characteristics compared with the old cultivars. Biotechnology might encourage the production of a far wider variety of new crops, increasing biodiversity. Modern agriculture has been so successful in increasing the yield of food that farmers in the USA and Europe are paid to take land out of cultivation or to grow new crops, again increasing diversity. Because it has the potential to reduce waste, biotechnology may accelerate this trend.

The opposing argument is that plant breeding will increasingly fall into the hands of just a few companies, and that the plant varieties they offer to the farmer will be correspondingly reduced. This could make crops more susceptible to attack by pests and diseases, and lead to a reduction in the use of important old cultivars and their wild relatives.

Economic concerns

Bringing a GM food to market is a lengthy and costly process, and of course agri-biotech companies 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. Yet consumer advocates are 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.

Patent enforcement may also be difficult, as the contention of the farmers that they involuntarily grew engineered strains when their crops were cross-pollinated shows. One way to combat possible patent infringement is to introduce a "suicide gene" into GM plants. 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

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.

4. Human health and welfare

The safety assessment of GM foods generally focuses on:

(a) Direct health effects (toxicity),

(b) Potential to provoke allergic reaction (allergenicity);

(c) Specific components thought to have nutritional or toxic properties;

(d) The stability of the inserted gene;

(e) Nutritional effects associated with genetic modification; and

(f) Any unintended effects which could result from the gene insertion.

The majority of features in livestock are controlled by many genes, each with a small effect. Just which genes should be altered to improve animal productivity or health is therefore difficult to predict and the modification of animals by genetic engineering is still in its infancy. This area requires very careful consideration. Developments in livestock production that compromise animal welfare are increasingly unlikely to be accepted by regulatory authorities or the public. There are currently no products of animal biotechnology in food shops, nor do we know of any proposals to introduce them anywhere in the world. Several retailers in the UK already have specific policies regarding biotechnology and animal welfare.

Agriculture in Europe and North America already produces sufficient food for the indigenous population. Looking to the future, the real benefits from improved animal production might be seen in the Third World. For example, it may one day be possible to introduce disease resistance into otherwise vulnerable animals.

While theoretical discussions have covered a broad range of aspects, the three main issues debated are the potentials to provoke allergic reaction (allergenicity), gene transfer and outcrossing.

Allergenicity

As a matter of principle, the transfer of genes from commonly allergenic organisms to non-allergic organisms is discouraged unless it can be demonstrated that the protein product of the transferred gene is not allergenic. While foods developed using traditional breeding methods are not generally tested for allergenicity, protocols for the testing of GM foods have been evaluated by the Food and Agriculture Organization of the United Nations (FAO) and WHO. No allergic effects have been found relative to GM foods currently on the market.

Gene transfer

Gene transfer from GM foods to cells of the body or to bacteria in the gastrointestinal tract would cause concern if the transferred genetic material adversely affects human health. This

would be particularly relevant if antibiotic resistance genes, used as markers when creating GMOs, were to be transferred. Although the probability of transfer is low, the use of gene transfer technology that does not involve antibiotic resistance genes is encouraged.

Outcrossing

The migration of genes from GM plants into conventional crops or related species in the wild (referred to as "outcrossing"), as well as the mixing of crops derived from conventional seeds with GM crops, may have an indirect effect on food safety and food security. Cases have been reported where GM crops approved for animal feed or industrial use were detected at low levels in the products intended for human consumption. Several countries have adopted strategies to reduce mixing, including a clear separation of the fields within which GM crops and conventional crops are grown.

5. Marketing, Labelling and Consumer choice

Marketing

Before it can be placed on the market, the Novel Foods Regulation demands that a novel food or ingredient: is safe for the consumer when eaten at the foreseeable levels of use; is not presented in such a way as to mislead the consumer; and does not differ from a food or ingredient that it replaces in such a way that its foreseeable consumption is nutritionally disadvantageous to the consumer.

Under the Regulation, when a company wishes to place a novel food or ingredient on the market, it must first apply to the responsible authority (e.g., the Food Standards Agency) in the country where the product is to be marketed for the first time.

Labelling

In short, the Novel Foods Regulation requires that labelling should be applied if: the GM food differs from the equivalent familiar food due to a change in composition or nutritional value; consumption of the GM food has health implications e.g., an allergen is present that is not present in the existing equivalent food; the GM food creates ethical considerations e.g., a food plant containing DNA of animal origin; the novel food is or contains a viable genetically-modified organism.

If the GM food is not substantially equivalent to an existing food, the labelling must indicate the properties of the food that have been altered and the method by which the new characteristic was obtained.

Where the inserted gene is the subject of health, ethical or religious concerns, the origin of the new material must be given.

The Labelling Regulation introduced additional labelling requirements specifically for GM soya and maize derivatives, which would not necessarily have been caught under the Novel Foods Regulation. It spells out the precise form of wording, type size, etc. to be used on food packaging. For labelling to be required, however, novel DNA and/or protein must be present in the food. If 1% or more of a product consists of GM-derived material labelling is mandatory. In

theory, modern methods allow even a single DNA molecule to be detected, so it is quite possible to detect GM material in fresh and processed foods. [In comparison, it is virtually impossible to differentiate between 'organic' and conventionally-produced foods, and the labelling requirements for them are also far less stringent -- up to 5% of the material in an 'organic' food may be from 'non-organic' sources.]

Individual food producers and retailers may implement their own voluntary labelling policies in addition to those required by law. For example, in the United Kingdom, both Sainsbury's and Safeway stores chose to label tomato purée from genetically-modified tomatoes, even though there was no statutory requirement for them to do so.

Most UK retailers and manufacturers have stated that they obtain all of their supplies from non-modified sources, particularly for their own-brand products over which they have the greatest control.

Additional regulations for the labelling of GM foods were introduced in the UK in March 1999. They extended the range of products in which labelling must be applied, including food in restaurants and from 'fast food' outlets.

Consumer choice

If the numerous surveys that have been undertaken in Western Europe are to be believed (and there is no reason to think that they are inaccurate), the vast majority of the population here does not wish to consume GM food.

The first GM product in Europe (the Zeneca tomato purée) presented no problem in this respect, as the cans were both clearly-labelled and always offered alongside a similar non-GM product. The problem arose when GM food ingredients that are traded as bulk commodities entered the market. First GM soya, then maize started to be grown in the USA and traded internationally. This presented UK retailers, who had planned carefully for the introduction of the tomato purée, with an unforeseen problem.

Initially, the amount of GM maize and soya grown was very small, forming just a fraction of the total US harvest. It was impossible, with GM and non-GM material being mixed after harvesting, to devise a statistical sampling regime that would reliably permit the detection of the GM material in bulk shipments. UK retailers therefore assumed that GM material would be present in any maize or soya obtained from the USA, and labelled their products accordingly. The major retailers prepared leaflets that were available to shoppers, explaining this decision and the reasons for it. This unavoidable decision fed right into the hands of anti-GM campaigners, who claimed that up to 65% of processed food sold in the UK was made with GM ingredients -- and the food packets in the shops seemed to bear this out. Consumers were being denied a choice. Newspaper articles and even entire books were devoted to lists of GM-containing and GM-free products, although they were often rather misleading.

As the proportion of GM soya and maize on the world market increased, food producers and retailers tried to obtain certified non-GM material. In August 1999, the UK firm Marks and Spencer estimated that the cost of obtaining crops that were segregated at source added 10-15% to the cost of the food sold in their shops.

It remains unclear whether those who oppose the commercial production of GM crops because of potential 'contamination' do so though a fundamental opposition to GM technology, or for well-founded concerns for the status of organic farming.

Conclusion: Nearly two and half decades have passed after the introduction of genetic modifications (GM) in food and new GM food are added in the existing list of foods. Who could imagine that there would come a day when the pig would be as “fat –free healthy food” as a fish or that the ice cream our children eat would contain a protein from the fish? Are GM safe to human health? Studies concerning their safety are still few when one considers the toxicity studies that must accompany the application of any novel drug for approval by the corresponding drug administration. GM foods have many challenges ahead for governments, especially in the areas of safety testing, regulation, international policy and food labeling.