



Genetically Modified Food

Debate Motion

This house proposes that Genetically Modified Foods (GMFs) are a significant benefit to human health.

Genetically Modified Foods

To constantly improve the yield or marketability of crops, farmers have selectively cross-bred species for years. Cross breeding aims to mix the benefits of one species of a crop with the benefits of another, and mixes half the genes from the two plants. Wanted and unwanted characteristics are mixed, therefore, and the results are unpredictable. Genetic engineering is a more scientifically advanced and predictable method.

Genetic engineering, (often referred to as biotechnology), involves introducing a single property from one species into another species, for example into an existing crop variety. Genetically modified foods (GMFs) are produced from genetically modified organisms that have had their genome altered by the introduction of one or a small number of genes. Genes carry the hereditary information encoded in DNA, which define the characteristics of animal and plant organisms. Potential GM crops are tested in laboratories and green houses for several generations for any obvious adverse effects of the genetic modification. GMFs have been available since the 1990s. Common genetically modified crops are soya, corn, canola and cotton (see also the data under Facts and Figures).

Genetic engineering vs. traditional crossbreeding (Source: Buu 2003)

Genetic engineering

Transfer of a single or small number of genes
Gene sequence known
Between or within species

Plant crossbreeding

Transfer of hundreds of genes
Genes are often not known
Within species

There are several incentives to produce GMFs:

- Improved yield, frost-, drought- and insect resistance, and herbicide tolerance.
- Improved nutrient value, taste, and appearance, and fewer allergens.
- Development of products with longer shelf-life for supermarket sales.
- Development of biofuels, degradable plastics, and medicines.
- Reduction of greenhouse gas emissions.

There are several ethical concerns related to GMFs, however, which we discuss below. First we describe the stakeholders and some key terms relevant to the GMF debate

Stakeholders

The ethical debate over GMFs involves many parties:

- Consumers, who benefit from improved nutrition value, non-allergenic foods and cheaper foods, etc.
- Farmers, who benefit financially from improved yields.
- Food distributors, such as supermarkets, who benefit financially from the longer shelf-life of products.
- Global and national governing bodies and national regulators, who are concerned with health, safety and the environment
- Less developed countries which benefit from higher crop yields and crops which can grow in normally barren soil.
- National Economies, which stand to gain if globally competitive in GMF research.
- Pharmaceutical and agri-biotechnology companies, who own GMF intellectual property rights.
- Scientists and researchers.
- The general population, everyone benefits from new medicine and reduction in greenhouse gases.

Key terms

A Genetically Modified Organism (GMO) has had its genome modified through genetic engineering.

A phenotype of an organism represents its actual physical properties, such as plant height, fruit size, colour, etc., ultimately defined by its genome

Biodiversity describes both the diversity of genes within a species and diversity among species in an ecosystem. Carbon sequestration refers to the permanent storage of carbon dioxide so that it is not released to the atmosphere, where it contributes to the greenhouse effect.

Key terms
(Continued)

Genes are the hereditary information encoded in DNA, which define a particular plant's or other organisms (i.e. a genotype's) characteristics.

Greenhouse gases are the gases which cause the 'greenhouse effect' or warming of the atmosphere, and include carbon dioxide (CO₂) and nitrous oxide (N₂O). Since the industrial revolution, the concentration of CO₂ in the atmosphere has increased by about 38% and N₂O by 16%. Two of the main sources of greenhouse gases due to human activity are burning of fossil fuels (coal, petrol etc.), leading to higher concentrations of CO₂, and agricultural activities including the use of fertilizers, which leads to higher concentrations of N₂O.

Ethical Questions

Food safety vs. Malnutrition

While industrialized countries don't have high risks of malnutrition, they can afford to ban GM foods. Elsewhere in the world, where people are suffering from hunger and malnutrition, the potential GM crops have to offer is welcomed. An example of a genetically modified product with potential to help address nutrition deficiencies is genetically modified 'golden rice'. This product can help to combat global vitamin A deficiency, which can lead to blindness and premature death (Buu 2003: see Fact and Figures below). Golden rice offers developing countries a crop they need to grow to best optimize their income, whilst also providing a solution to local nutrition deficiencies.

Regarding concerns over food safety, genetic modification is more precise than crossbreeding, and involves the transfer of less genetic material. From this tighter control, we might expect GMFs to be safer than traditionally cross-bred crops. GMF, however, brings a new development to evolution of biodiversity with the cross-species and even cross-kingdom (animal and plant) mix of genes. An example is the use of antifreeze proteins produced in some arctic fish being used to make crops resistant to frost. While this may increase biodiversity, it may also have (as yet) unknown consequences. However, non-GM agriculture can also have risks. For example, peanuts and kiwi fruit were not tested when first sold in the UK, but are now known to cause severe allergic reactions.

With GMF products already around for 20 years and half the global population living in countries which are already growing GMFs, which side of the fence you fall on with this issue depends on how cautious you feel about advances in biotechnology.

Safe to the environment?

Concerns for the environment are whether 'natural ecosystems' will be disrupted, whether biodiversity will be impacted in some way, and whether more resistant pests and weeds will develop. These are not concerns unique to genetic engineering, however. There has always been a risk with traditional crossbreeding that more resistant pests and weeds might develop. A further concern is that introducing a GM crop into the environment is irreversible, again also a risk with traditional crossbreeding. Integration of 'terminator technology', however, ensures that GM crops cannot reproduce naturally. Genes are manipulated to prevent any further cross-breeding that might occur naturally in the environment, which might then result in 'super weeds'. This risk is thus better controlled with GM crops than with traditional crossbreeding. However, lack of the potential to reproduce also means that poor farmers in developing countries using GM crops cannot retain seed for the next year. (Farmers in industrialized countries buy new seed each year already.)

Initial concerns over negative influences on biodiversity cannot be justified from a scientific viewpoint, because genetic engineering:

- allows genes from different species to be mixed, which offers the potential for greater biodiversity.
- is more efficient than traditional crossbreeding, because precise genes are targeted and transferred, whereas crossbreeding requires repeated trial and error.

A distinct advantage of GM crops appears to be the reduced fuel use from less frequent herbicide or insecticide applications and a reduction in energy use in soil cultivation. Fewer spray runs and reduced or 'no-till' farming systems reduce carbon dioxide emissions. Farmers have less need to control competing weeds, so that soil cultivation and seed-bed preparation are reduced. Tractor fuel for tillage is thus reduced, soil quality improved and level of soil erosion reduced. Also, more carbon remains in the soil (sequestration), which leads to lower greenhouse gas emissions (ISAAA 2009).

Economics

Several financial and economic factors play a role with GMFs: intellectual property ownership, who stands to gain financially, and potential exploitation of farmers in developing countries.

For example, the technology appears to be producer driven, with the goal of improved yield and return on investment for farmers. To date the benefits to the consumer in terms of improved taste or nutrients have been fulfilled to a much lesser extent, with genetically modified products usually being more expensive once they reach the supermarket shelves. As a mainly producer-driven technology, there may be a risk of large farming businesses cornering the market over small farmers, or for example, multinational companies promoting GM products and exploiting poor farmers in developing countries.

Ethical Questions (Continued)

Whether you are pro- or anti- GM Fs, new GMF products exist and one interesting question is who owns the intellectual property rights. How can we assure equal access to genetic resources, to share benefits on a global level? Should we be concerned about the growing influence of the chemical industry on seed markets, and how can we avoid a monopoly? For example, for golden rice, there were around 70 patents owned by some thirty-two companies and institutes. A complex series of events between inventors, developers and pharmaceutical companies resulted in the ownership of the intellectual property by a pharmaceutical company, with the proviso of free access to researchers and resource-poor farmers (IOT TD C 2001). The World Bank has calculated that the economic benefit to Asia from golden rice through increased agricultural productivity of healthier populations would amount to \$15 billion annually (Potrykus 2005).

The G8 members meeting in Hokkaido Japan in July 2008 produced a statement on biotech crops, which reads as follows, "accelerate research and development and increase access to new agricultural technologies to boost agriculture production; we will promote science-based risk analysis including on the contribution of seed varieties developed through biotechnology." This was the first time they had acknowledged their significance in food security. (Foundation for Biotechnology Awareness and Education 2008)

Facts and Figures

GM crop growth worldwide

- In the UK and Ireland, most people have probably eaten some GM food products as ingredients.
- Of the 2.6m tonnes of soya imported into the UK last year, nearly two-thirds was genetically modified (Royal Society UK 2009)
- No GM crops have been grown in the UK or Ireland, except for research.
- In 2008, the number of biotech countries planting biotech crops reached the historical milestone of 25 countries
- In 2008, accumulatively the second billionth acre (800 millionth hectare) of a biotech crop was planted – only 3 years after the first one-billionth acre of a biotech crop was planted in 2005.
- 40 countries, or even more, are expected to adopt biotech crops by 2015.
- The number of biotech crop farmers increased by 1.3 million in 2008, reaching 13.3 million globally.
- 90%, or 12.3 million were small and resource-poor farmers in developing countries. (ISAAA 2009)

Land area with GM crops grown by country (Source: James ISAAA 2008)

Country	Land area with GM F (Million hectares)	Crops
USA	62.5	Soya, corn, cotton, canola, squash, papaya and alfalfa
Argentina	21	Soya, corn, cotton
Brazil	15.8	Soya, corn, cotton
India	7.6	Cotton
Canada	7.6	Canola, corn, soya, sugarbeet
China	3.8	Cotton, tomato, poplar, petunia, papaya
Paraguay	2.7	Soya
South Africa	1.8	Corn, soya, cotton
Uruguay	0.7	Soya, corn
Bolivia	0.6	Soya
Philippines	0.4	Corn
Australia	0.2	Cotton, canola, carnation
Mexico	0.1	Cotton and soya
Spain	0.1	Corn
Chile	<0.1	Cotton
Columbia	<0.1	Corn
Honduras	<0.1	Rice
Burkina Faso	<0.1	Cotton
Czech Republic	<0.1	Corn
Romania	<0.1	Corn
Portugal	<0.1	Corn
Germany	<0.1	Corn
Poland	<0.1	Corn
Slovakia	<0.1	Corn
Egypt	<0.1	Corn

Malnutrition and Food Allergies

- UNICEF estimated that one quarter of all children under 5 in the developing world were suffering from malnutrition in 2007.
- According to the Food and Agriculture Organization of the United Nations (FAO), more than 25,000 people die each day from malnutrition
- World food production must increase by 50 per cent by 2030 if it hopes to meet rising demand, according to the UN.

Facts and Figures (Continued)

- An estimated 250,000 to 500,000 vitamin A-deficient children become blind every year, half of them dying within 12 months of losing their sight (WHO 2009)
- Statistics in 2006 suggested that as many as 10% of the people in Ireland (375,000 people) would die prematurely as a result of inadequate nutritional content in diet (Halliday 2006).
- 1 out of every 4 patients admitted to hospital, mental units or care homes in the UK are suffering from malnutrition
- Few statistics are available for food allergies, but projecting from the 1% prevalence in the population in the US, prevalence for Ireland and the UK would be 39,695 and 602,707 sufferers respectively.

Environment

- The EU is second only to the US as one of the highest emitters of greenhouse gases based on figures from 2008.
- In Ireland, total greenhouse gas emissions in 2006 were 69.77 million tonnes CO₂ equivalent
- The EU is second only to the US as one of the highest emitters of greenhouse gases based on figures from 2008.
- The UK is expected to meet its target for greenhouse gas emissions agreed in the Kyoto Protocol on Climate Change. Ireland is one of three EU Member States with the highest per capita greenhouse emissions, and one of 7 Member States expected to miss Kyoto targets (European Environment Agency 2006).
- In 2007, the combined permanent and additional savings through soil carbon sequestration was equivalent to a saving of 14.2 billion kg of CO₂ or removing 6.3 million cars from the road (Brookes and Barfoot, 2009).
- The supply of fossil fuels (gas, coal and oil) is finite, i.e. one day they are likely to run out. Future GM crops will replace fossil fuels and recycle and sequester carbon. Biofuels could result in net savings of 65% in energy resource depletion.

Economics

- The global net economic benefit to GM farmers amounted to \$10.1 billion in 2007 and \$44.1 billion for the twelve year period 1996-2007.
- The cost farmers paid for accessing GM technology in 2007 was equal to 24% of the total technology gains.
- Production of soybeans, corn, cotton and canola on the areas planted to biotech crops, in 2007, were respectively +29.8%, +7.6%, +19.8% and +8.5% higher than levels would have otherwise been if GM technology had not been used by farmers (PG Economics 2009)

Legislation and Regulatory Authorities

There are two EU legislations covering GMFs in Europe

- Directive on the deliberate release into the environment of genetically modified organisms (2001/18). This legislation regulates the growing of GM crops.
- Regulation on genetically modified food and feed 1829/2003. This legislation regulates the use of food which has been made from or contains GM plants. For example, products with more than 0.9% GM ingredients must be labelled to communicate the content clearly to consumers.

At a European level, the regulatory authority is the European Food Safety Authority (EFSA). Applications are processed through cooperation between EU Member States and the EFSA. For example, if an application results in the cultivation of a GMO, the relevant Member State is asked to perform the environmental risk assessment.

At a national level, regulatory authorities in the UK and Ireland are the Food Safety Authority of Ireland, and the Food Standards Agency in the UK. The Food Safety Authority of Ireland (FSAI) routinely surveys the food supply in Ireland to ensure that only EU-authorized and appropriately labelled Genetically Modified (GM) food ingredients are placed on the market.

Religious influences

Some religions object to the intervention of mankind in an otherwise 'natural' process of evolution. Such practice is considered to be playing God, for example mixing plant and animal genes to create new species.

GMFs may also both cause and overcome difficulties with diet in different religions. For example, if religious beliefs prevent meat and dairy products from being eaten together, eating cheese is a problem, because milk is clotted using calf stomach enzymes. Using genetically engineered bacteria to clot the milk instead of the enzymes overcomes this problem. On the other hand, adding an animal gene to a plant so that the plant is no longer vegetarian causes a problem for religions restricted to a vegetarian diet.

Sources and Further Reading

For a collection of relevant news stories and references, visit the website of one of the DSI co-ordinating centres:

www.remedi.ie

<http://a.pcuccie>

www.bdi.ie

www.rcsi.ie

www.cit.ie

www.5online.co.uk

www.crossborder.ie

www.cranntcd.ie

www.clarity-centre.org

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