Scientific evidence documenting the negative impacts of genetically modified (GM) foods on human and animal health and the environment

GM foods and crops were virtually excluded from the European Union in the 1990s by scientific objections and consumer concerns. But now they are once again being strongly promoted in Europe by the biotechnology industry, putting our health and environment at risk.

Scientists' warnings proven correct

When GM crops and foods were first introduced in the 1990s, scientists raised concerns that genetic modification was imprecise and unpredictable. They warned:

- GM could create foods that are toxic, allergenic and less nutritious than their non-GM counterparts
- GM crops could damage vulnerable wild plant and animal populations and harm biodiversity
- GM plants cannot be recalled, but as living organisms will multiply, passing any damaging traits from generation to generation
- GM crops could cause irreversible changes to our food supply, with serious effects on the environment and human and animal health.

All these concerns have since been proven correct. Nevertheless, the European Commission continues to approve GM crops for food and animal feed (more than 24 to date) and the GM industry continues to lobby to change GM regulations in its favour. As a result, European consumers are being exposed to the risks of genetically modified organisms (GMOs) without their knowledge or consent.

The scientific evidence

1. GM is not just another natural method of plant breeding

GM proponents have always claimed that GM is just an extension of natural plant breeding. This is false.

Natural reproduction or breeding can only occur between closely related forms of life (e.g. cats with cats, NOT cats with dogs; wheat with wheat, NOT wheat with tomatoes or fish). In this way, the genes that offspring inherit from parents, which carry information for all parts of the body, are passed down the generations in an orderly way.

GM is totally different. It is a laboratory technique that re-programmes the plant with completely new properties by inserting artificial gene units into its DNA blueprint (plan). These artificial gene units are created by joining fragments of DNA, usually derived from multiple organisms including viruses, bacteria, plants and animals. For example, the GM gene in the herbicide resistant soya beans grown since 1996 is pieced together from a plant virus, a soil bacterium and a petunia plant.

The GM transformation process of plants is crude, imprecise and causes widespread mutations resulting in major changes to the plant's DNA blueprint[1], unnaturally altering its functioning in unpredictable and potentially harmful ways[2]. As detailed below, adverse effects include poorer crop performance, toxic effects, allergic reactions, and damage to the environment.

2. GM foods have not been proven safe to eat

It is often claimed that people have been eating GM foods in the USA and elsewhere for ten years without ill effects and that this proves that the products are safe. But this claim is scientifically indefensible. GM foods are not labelled in the US and other nations where they are widely eaten and consumers are not monitored for health effects. Because of this, any health effects from a GM food would have to meet unusual conditions before they would be noticed. The health effects would have to:

- occur immediately after eating a food that was known to be GM (in spite of its not being labelled). This kind of response is called acute toxicity.
- cause symptoms that are completely different from common diseases. If GM foods caused a rise in common or slow-onset diseases like allergies or cancer, nobody would know what caused the rise.
- be dramatic and obvious to the naked eye. Nobody examines our body tissues with a microscope for harm after eating a GM food. But just this type of examination is needed to give early warning of problems such as pre-cancerous changes.

To detect more subtle effects on health, or effects that take time to show up (chronic effects), long-term controlled studies on larger populations are required. But no such studies have been done.

Under these conditions, moderate or slow-onset health effects of GM foods could take decades to become known, just as it took decades for the damaging effects of trans-fats (another type of artificial food) to be recognized. 'Slow poison' effects from trans-fats have caused millions of premature deaths across the world[3].

At present GM foods account for only a small part of the US diet (maize is less than 15% and soya bean products are less than 5%). This is another reason why any harmful effects of GM foods will be slow to surface and less obvious.

The biotech industry claims that GM foods are the "most tested" foods in history. But GM foods are not properly tested for human safety before they are released for sale[4, 5]. The only published study directly testing the safety of a GM food on humans found potential problems[6] but was never followed up.

> *"Ben Miflin, former director of the Institute of Arable Crops at Rothamsted, UK, and a proponent GM crops... argues that, under current monitoring conditions, any unanticipated health impact of such foods would need to be a 'monumental disaster' to be detectable[8]."*

Nevertheless, there are signs that all is not well with food in the USA. A report by the US Centers for Disease Control shows that food-related illnesses increased 2- to 10-fold in the years between 1994 (just before GM food was commercialised) and 1999[7]. Is there a link with GM food? No one knows, because studies on humans have not been done.

3. Studies show harmful effects of GM foods on animals

Farm animals have been raised on GM feed for many years. Does this mean that GM feed is safe for animals and humans? Certainly it means that ill effects may not show up immediately. But laboratory studies designed to assess longer-term and more subtle health effects of GM feed on animals do show harmful health effects.

Mouse and rat feeding studies:

- Rats fed GM tomatoes developed stomach ulcerations[9]
- Offspring of rats fed GM soya had 4 times the death rate of rats fed non-GM soya[10]
- Liver, pancreas and testes function was disturbed in mice fed GM soya[11, 12, 13]
- GM peas caused allergic reactions in mice[14]
- Rats fed GM oilseed rape developed enlarged livers, often a sign of toxicity[15]
- GM potatoes fed to rats caused excessive growth of the lining of the gut similar to a pre-cancerous condition[5, 16]
- Rats fed insecticide-producing GM maize grew more slowly, suffered problems with liver and kidney function, and showed higher levels of certain fats in their blood[17]
- Rats fed GM insecticide-producing maize over three generations suffered damage to liver and kidneys and showed alterations in blood biochemistry[18]
- Old and young mice fed with GM insecticide-producing maize showed a marked disturbance in immune system cell populations and in biochemical activity[19]
- Mice fed GM insecticide-producing maize over four generations showed a buildup of abnormal structural changes in various organs (liver, spleen, pancreas), major changes in the pattern of gene function in the gut, reflecting disturbances in the chemistry of this organ system (e.g. in cholesterol production, protein production and breakdown), and, most significantly, reduced fertility[20]
- Mice fed GM soya over their entire lifetime (24 months) showed more acute signs of ageing in their liver[21]
- Rabbits fed GM soya showed enzyme function disturbances in kidney and heart[22].

Feeding studies with farm animals:

There are very few studies of this type that have looked directly at the long-term effects on farm animals. However, even these have shown problems:

- GM DNA can survive processing and is detectable in the digestive tract of sheep. This raises the possibility that antibiotic resistance and Bt insecticide genes can move into gut bacteria[23], a process known as horizontal gene transfer. Horizontal gene transfer can lead to antibiotic resistant disease-causing bacteria ("superbugs") and may lead to Bt insecticide being produced in the gut with potentially harmful consequences. For years, regulators and the biotech industry claimed that horizontal gene transfer would not occur with GM DNA, but this research challenges this claim
- Sheep fed Bt insecticide-producing GM maize over three generations showed disturbances in the functioning of the digestive system of ewes and in the liver and pancreas of their lambs[24].

Do these animal feeding studies highlight potential health problems for people who eat GM foods?

Yes. Before food additives and new medicines can be tested on human subjects, they have to be tested on mice or rats. This is the scientifically established and generally accepted standard for safety testing. If toxic effects are found in these initial animal experiments, then the drug would most likely be disqualified for human use. Only if animal studies revealed no harmful effects would the drug be further tested on human volunteers.

If animal tests with a drug were to yield results similar to those seen in the GM feeding studies, the drug would most likely be disqualified for further development. But these GM crops were approved as safe for human consumption. Clearly, the government is using far less rigorous standards for GM crops than for new medicines.

Based on the existing evidence, approvals of GM products for human and animal consumption should be revoked and their status re-evaluated.

4. Stealth GMOs in animal feed

European Union (EU) regulations restrict cultivation of GM crops and insist that foods containing GM ingredients are labelled. But a huge loophole in the EU regulation means that milk, eggs, and meat from animals fed GM feed do not have to be labelled.

The biotechnology industry is exploiting this loophole to push millions of tons of GM crops into the EU food supply, unnoticed by consumers. This is despite the fact that plentiful supplies of GM-free animal feed are available.

Should consumers be worried? A growing body of evidence says that they should. Scientific studies have found that “stealth GMOs” in the form of animal feed can affect the health of animals. Humans who eat the milk, eggs, and meat of these animals may also be affected. No one knows, as the studies have not been done.

What’s wrong with GM animal feed?

Health risks and ethical problems posed by GM animal feed include:

- Milk and meat from GM-fed animals may be less wholesome. Laboratory studies show that GM feed can disturb animals’ body functions and make them sick (see Section 3).
- Anecdotal reports from some farmers suggest that animals fed GM crops can suffer ill effects. But these have not been followed up by detailed studies on farm animals.
- GM DNA in feed is taken up by the animal’s organs. Small amounts of GM DNA appear in the milk and meat that people eat[25, 26, 27]. The effects on the health of the animals and the people who eat them have not been researched.
- GM feed may create superbugs. GM feed can contain genes for antibiotic resistance that can be taken up by gut bacteria. These may then turn into superbugs — bacteria that cannot be controlled by antibiotics.
- The use of GM animal feed is hidden from consumers. As products are not labelled, consumers have no way of knowing that they are eating milk, eggs and meat from GM-fed animals and that they are probably eating GM material in those products.
- The use of GM feed raises animal welfare concerns because GM feed can harm the health of animals.

5. GM foods are not more nutritious but can be toxic or allergenic

There are no commercially available GM foods with improved nutritional value. Currently available GM foods are no better and in some cases are less nutritious than natural foods. Examples include:

- GM soya had 12—14% lower amounts of cancer-fighting isoflavones than non-GM soya[28]
- Oilseed rape engineered to have vitamin A in its oil had highly reduced vitamin E and altered oil-fat composition[29]
- Human volunteers fed a single GM soya bean meal showed that GM DNA can survive processing and is detectable in the digestive tract. There was evidence of horizontal gene transfer to gut bacteria[6, 30]. Horizontal gene transfer of antibiotic resistance and Bt insecticide genes from GM foods into gut bacteria is an extremely serious issue. This is because the modified gut bacteria could become resistant to antibiotics or become factories for Bt insecticide. While Bt in its natural form has been safely used for years as an insecticide in farming, Bt toxin genetically engineered into plant crops has been found to have potential ill health effects on laboratory animals[31, 32, 33]
- In the late 1980s, a food supplement produced using GM bacteria was toxic[34], initially killing 37 Americans and making more than 5,000 others seriously ill.

Several experimental GM food products (not commercialised) were found to be harmful:

- People allergic to Brazil nuts had allergic reactions to soya beans modified with a Brazil nut gene[35]
- The GM process itself can cause harmful effects. GM potatoes caused toxic reactions in multiple organ systems[5, 16]. GM peas caused a 2-fold allergic reaction — the GM protein was allergenic and stimulated an allergic reaction to other food components[14]. This raises the question of whether GM foods cause an increase in allergies to other substances.

6. GM foods are not the answer to the world food crisis

The root cause of hunger is not a lack of food, but a lack of access to food. The poor have no money to buy food and increasingly, no land on which to grow it. Hunger is fundamentally a social, political, and economic problem, which GM technology cannot address.

Recent reports from the World Bank and the United Nations Food and Agriculture Organisation have identified the biofuels boom as the main cause of the current food crisis[36, 37]. But GM crop producers and distributors continue to strongly promote the expansion of biofuels. This shows that their priority is to make a profit, not to feed the world.

> *“The climate crisis was used to boost biofuels, helping to create the food crisis; and now the food crisis is being used to revive the fortunes of the GM industry.”*
> Daniel Howden, Africa correspondent, “Hope for Africa lies in political reforms”, The Independent (London), 8 September 2008

GM companies focus on producing cash crops for animal feed and biofuels for affluent countries, not food for people.

GM crops contribute to the expansion of industrial agriculture and the decline of the small farmer around the world. This is a serious development as there is abundant evidence that small farms are more efficient than large ones, producing more crops per hectare of land[38, 39, 40, 41, 42].

7. GM crops do not increase yield potential

At best, GM crops have performed no better than their non-GM counterparts, with GM soya beans giving consistently lower yields for over a decade[43]. Controlled comparative field trials of GM/non-GM soya suggest that 50% of the drop in yield is due to the genetic disruptive effect of the GM transformation process[44]. Similarly, field tests of Bt insecticide-producing maize hybrids showed that they took longer to reach maturity and produced up to 12% lower yields than their non-GM counterpart[45].

A US Department of Agriculture report confirms the poor yield performance of GM crops, saying, “GE crops available for commercial use do not increase the yield potential of a variety. In fact, yield may even decrease.... Perhaps the biggest issue raised by these results is how to explain the rapid adoption of GE crops when farm financial impacts appear to be mixed or even negative[46]."

The failure of GM to increase yield potential was emphasised in 2008 by the United Nations International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) report[47]. This report on the future of farming, authored by 400 scientists and backed by 58 governments, concluded that GM is not likely to contribute significantly to increasing yield potential in the future.

8. GM crops will not counter the effects of climate change

Climate change brings sudden and extreme changes in weather. Our crop base needs to be flexible and diverse in order to adapt. GM technology offers just the opposite — a narrowing of crop diversity and an inflexible technology that requires years and millions in investment for each new variety.

GM companies have patented plant genes involved in tolerance to drought, heat, flooding, and salinity — but have not produced a single new crop with these properties. This is because these functions are highly complex and involve many different genes working together in a precise way. It is beyond existing GM technology to engineer crops with these sophisticated gene networks for improved tolerance traits.

Conventional natural cross-breeding, which works holistically, is much better adapted to achieving this aim, using the many varieties of virtually every common crop that tolerate drought, heat, flooding, and salinity (see section 11).

9. GM crops can harm the environment

Two kinds of GM crops dominate the marketplace:

- Crops that resist broad-spectrum (kill-all) herbicides such as Roundup — claimed to enable farmers to spray herbicide less frequently to kill weeds but without killing the crop
- Crops that produce the insecticide Bt toxin — claimed to reduce farmers' need for chemical insecticide sprays.

On this basis, GM proponents say GM crops will help the environment, but this claim does not stand up to analysis. On the contrary, growing GM crops has been found to harm the environment.

GM crops do not decrease herbicide use:

The most commonly grown herbicide-resistant GM crops are engineered to be resistant to Roundup. But the increasing use of Roundup has led to the appearance of numerous weeds resistant to this herbicide[48]. Roundup resistant weeds are now common and include pigweed[49], ryegrass[50], and marestail[51]. As a result, in the US, an initial drop in average herbicide use after GM crops were introduced has been followed by a large increase as farmers changed their farming practices and weeds developed resistance to herbicide[52, 53]. The appearance of resistant weeds has led to farmers being advised to use increasingly powerful mixtures of herbicides and not Roundup alone[54, 55].

A Canadian government study in 2001 showed that after just 4-5 years of commercial growing, herbicide-resistant GM oilseed rape ("canola") had cross-pollinated to create "superweeds" resistant to up to three different broad-spectrum herbicides. These superweeds have become a serious problem for farmers both within[56, 57] and outside their fields[58].

In addition, GM oilseed rape has also been found to cross-pollinate with and pass on its herbicide resistant genes to related wild plants, for example, charlock and wild radish/turnip. This raises the possibility that these too may become superweeds and difficult for farmers to control[59]. The industry's response has been to recommend use of higher amounts and complex mixtures of herbicides[54, 55] and to start developing crops resistant to additional or multiple herbicides.

"I stood side-by-side with a North Carolina [GM] grower looking at a field overrun with glyphosate-resistant weeds. He said that [glyphosate resistant] pigweed isn't his No. 1 problem; it's his No. 1, No. 2 and No. 3 problems. It was at the point where he was determining whether or not that property could be used for farming."
Chuck Foresman, manager of weed resistance strategies for Syngenta, Delta Farm Press, 30 May 2008[49]

Insecticide-producing crops tie farmers to a chemical treadmill:

Bt insecticide-producing GM crops have led to resistance in pests, resulting in rising chemical applications[60, 61, 62].

In China and India, Bt cotton was initially effective in suppressing the boll weevil. But secondary pests, especially mirids and mealy bugs, that are highly resistant to Bt toxin, soon took its place. The farmers suffered massive crop losses and had to apply costly pesticides, wiping out their profit margins[63, 64, 65, 66].

Growing GM crops harms wildlife:

Farm-scale trials sponsored by the UK government showed that the growing of herbicide-resistant GM crops (sugar beet, oilseed rape) can reduce wildlife populations[67, 68].

Argentina — GM-led environmental and social disaster:

In Argentina, the massive conversion of agriculture to GM soya production has had disastrous effects on rural social and economic structures. It has damaged food security and caused a range of environmental problems, including the spread of herbicide-resistant weeds, soil depletion, and increased pests and diseases[69, 70].

GM crops harm non-target insects and organisms:

Bt insecticide-producing GM crops harm non-target insect populations, including butterflies[71, 72, 73] and beneficial pest predators[74]. Bt insecticide released from GM crops can be toxic to water life[75] and soil organisms[76].

10. GM and non-GM crops cannot co-exist in European agriculture

The biotech industry argues that European farmers should be able to choose to plant GM crops if they wish. It says GM and non-GM crops can peacefully "co-exist". But the idea of choice is a myth. Experience in North America has shown that "coexistence" of GM and non-GM crops rapidly results in widespread contamination of non-GM crops. Contamination occurs through cross-pollination, spread of GM seed by farm machinery, and inadvertent mixing during storage. The entry of GM crops into a country removes all choice — everyone is gradually forced to grow GM crops or to have their non-GM crop contaminated.

Here are a few examples:

- GM rice grown for only one year in field trials was found to have widely contaminated the US rice supply and seed stocks[77]. Contaminated rice was found as far away as Africa, Europe, and Central America
- In Canada, contamination from GM oilseed rape has made it virtually impossible to cultivate organic, non-GM oilseed rape[78]
- US courts reversed the approval of GM alfalfa because it threatened the existence of non-GM alfalfa through cross-pollination[79]
- Organic maize production in Spain has dropped significantly as the acreage of GM maize production has increased, because of cross-pollination problems[80]
- In 2007 alone, there were 39 new instances of GM contamination in 23 countries, and 216 incidents have been reported since 2005[81].

11. There are better alternatives to GM

Many authoritative sources, including the IAASTD report on the future of agriculture[47], have concluded that GM crops have little to offer global agriculture and the challenges of poverty, hunger and climate change, because better alternatives are available. These go by many names, including integrated pest management (IPM), organic, sustainable, low-input, non-chemical pest management (NPM) and agroecological farming, but extend beyond the boundaries of any particular category. Projects employing these sustainable strategies in the developing world have produced dramatic increases in yields and food security[82, 83, 84, 85, 86, 87].

Strategies employed include:

- Sustainable, low-input, energy-saving practices that conserve and build soil, conserve water, and enhance natural pest resistance and resilience in crops
- Innovative farming methods that minimise or eliminate costly chemical pesticides and fertilizers
- Use of thousands of traditional varieties of each major food crop, which are naturally adapted to stresses such as drought, heat, harsh weather conditions, flooding, salinity, poor soil, and pests and diseases[88]
- Use of existing crops and their wild relatives in traditional breeding programmes to develop varieties with useful traits
- Programmes that enable farmers to cooperatively preserve and improve traditional seeds
- Use of beneficial and holistic aspects of modern biotechnology, such as Marker Assisted Selection (MAS), which uses the latest genetic knowledge to speed up traditional breeding[89]. Unlike GM technology, MAS can safely produce new varieties of crops with valuable, genetically complex properties such as enhanced nutrition, taste, yield potential, resistance to pests and diseases, and tolerance to drought, heat, salinity, and flooding[90].

Conclusion

From the beginning, industry and governments around the world have overstated the benefits of GM crops. They claimed that GM crops would:

- benefit the environment by reducing use of herbicides and insecticides
- help farmers
- solve the food crisis
- feed the hungry by increasing crop yields
- produce more nutritious food.

Above all, they claimed that they were safe to eat and for the environment.

But an accumulating body of scientific evidence and on-the-ground experience with GM crops over the last ten years shows that this technology has failed to live up to any of these promises. On the contrary, GM crops have been scientifically proven to increase chemical inputs over the long term. They have been shown to deliver yields that are no better, and in some cases worse, than conventional varieties.

Most seriously, GM crops have been shown to pose risks to human and animal health and to cause social and environmental problems. With the availability of proven, energy-efficient and safe ways of meeting the current and future food needs of the world, GM crops are a waste of resources and a risk that is not worth taking.

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