

Environmental and health impacts of GM crops - the science

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This briefing gives an overview of scientific evidence regarding the environmental and health risks of genetically modified crops.

Environmental impacts

Most genetically modified (GM) crops awaiting EU authorisation for cultivation are either herbicide-tolerant or pesticide-producing (or both). The environmental effects of these crops are increasingly well documented, often from experience in North and South America, where they are principally grown.

I. GM pesticide-producing crops kill specific pests, by secreting toxins known as Bt, which originate from a bacterium. Peer-reviewed scientific evidence is mounting that these GM crops are:

- **Toxic to harmless non-target species.** Long-term exposure to pollen from GM insect-resistant maize causes adverse effects on the behaviour¹ and survival² of the monarch butterfly, America's most famous butterfly. Few studies on European butterflies have been conducted, but those that have suggest they would suffer from pesticide-producing GM crops^{3,4,5,6}. These studies are all based on one type of toxin, Cry1Ab, present in GM maize varieties Bt11 and MON810. Much less is known about the toxicity of other types of Bt toxin (e.g. Cry1F, present in the GM maize 1507). Cry1F is highly likely to also be toxic to non-target organisms⁷, but requires separate study.
- **Toxic to beneficial insects.** GM Bt crops adversely affect⁸ beneficial insects important to controlling maize pests, such as green lacewings^{9, 10, 11, 12}. The toxin Cry1Ab has been shown to affect the learning performance of honeybees¹³. The environmental risk assessment under which current GM Bt crops have been assessed (in the EU and elsewhere) considers direct acute toxicity alone, and not effects on organisms higher up the food chain. But these effects can be important. The toxic effects to beneficial lacewings came through the prey they ate. The single-tier risk assessment has been widely criticised by scientists who call for a more holistic assessment^{14, 15, 16, 17}.
- **A threat to soil ecosystems.** Many Bt crops secrete their toxin from their roots into the soil¹⁸. Residues left in the field contain the active Bt toxin^{19, 20, 21, 22}. The long-term, cumulative effects of growing Bt maize are of concern.²³

EU risk assessments so far fail to foresee at least two other impacts of Bt maize:

- **Risk for aquatic life.** Leaves or grain from Bt maize can enter water courses^{24, 25, 26} where the toxin can accumulate in organisms²⁷ and possibly exert a toxic effect²⁸. This demonstrates the complexity of interactions in the natural environment and underlines the shortcomings of the current risk assessment.
- **Swapping one pest for another.** Several scientific studies show that new pests are filling the void left by the absence of rivals initially controlled by Bt crops^{29, 30, 31, 32}. Plant-insect interactions are complex, are hard to predict and are not adequately risk assessed.

II. GM herbicide tolerant (HT) crops are generally associated with one of two herbicides: glyphosate (the active ingredient of Monsanto's herbicide Roundup used with Roundup Ready GM crops, also sold by Monsanto), or glufosinate, used with Bayer's Liberty Link GM crops. Both herbicides raise concerns, but many recent environmental studies have focussed on glyphosate, which is associated with:

- **Toxic effects of herbicides on ecosystems.** Several new studies suggest that Roundup is far

less benign than previously thought³³. For example, it is toxic to aquatic organisms such as frog larvae³⁴ and there are concerns that it could affect plants essential for farmland birds³⁵. Wider impacts may exist. Glyphosate is associated with nutrient (nitrogen and manganese) deficiencies in GM Roundup Ready soya, thought to be induced by its effects on soil microorganisms³⁶.

- **Increased weed tolerance to herbicide.** Weed resistance to Roundup is now a serious problem in the US and South America³⁷ where Roundup Ready crops are grown on a large scale^{38, 39}. Increasing amounts of⁴⁰ glyphosate or additional herbicides⁴¹ are needed to control these 'superweeds', adding to the toxicity of food and the environment.

Independent researchers complain about the lack of seed material made available for tests on environmental effects⁴² and are seriously concerned because those finding adverse effects face persecution by the pro-GM industry.⁴³

A decade of research fails to acquit GM crops

Contrary to GM industry spin, the publication "A decade of EU-funded research"⁴⁴ prepared by the Directorate-General for Research of the European Commission, does not provide scientific evidence on the environmental safety of GM plants. The vast majority of research referred to under the chapter Environmental Impact of GMOs is mostly about the development of GM crops with plant protection traits and has very little to do with assessing the environmental impacts (for example on soil health or on butterflies and moths) of the pesticide-producing and herbicide-tolerant GM crops awaiting an EU authorisation. The few projects that do examine environmental safety raise concerns.

Effects on health

We simply do not know if GM crops are safe for human or animal consumption. This is reflected in the ongoing scientific controversy surrounding their safety assessment.

Independent scientific studies on the safety of GM crops for animals or humans are severely lacking^{45, 46, 47, 48} and there is a tendency for studies conducted by researchers with affiliations to the GM industry to give favourable results to GM crops.⁴⁹

GM crops do have the potential to cause allergenic reactions, more so than conventional crops^{50, 51}. In Australia, for example, GM peas were found to cause allergenic reactions in mice⁵². GM peas also made the mice more sensitive to other food allergies.

Since the introduction of GM Bt (Cry1Ab) crops, both applicant companies and the European Food Safety Authority (EFSA) have assumed that the Cry1Ab toxin degrades rapidly in the human digestive system and is safe for human consumption.⁵³ However, new studies show there is a lack of degradation in the human gut. This warrants further investigation as it may imply this toxin has a greater potential to cause allergenic reactions than first thought.⁵⁴

Another recent study found the Cry1Ab Bt toxin in the blood of pregnant women and their foetuses showing that it can cross the placental boundary. This raises health concerns, although the implications of this uptake and transference across the placenta are not yet known.⁵⁵

There are potential health risks associated with herbicides used with GM crop cultivation. Studies indicate Roundup may be toxic to mammals⁵⁶ and could interfere with hormones⁵⁷. Evidence on the toxicity of the herbicide glufosinate is so strong⁵⁸ that it will have to be phased out across Europe.⁵⁹

Almost all commercialised GM crops either produce or tolerate pesticides⁶⁰. While pesticides are tested for two years prior to European approval, the usual duration of safety tests for GM crops is just 28 days, with the longest tests at 90 days, including for pesticide-producing GM plants.

Genetic modification: an unpredictable and risky method

There are fundamental reasons why GM organisms should not be released into the environment. Genetic engineering inserts DNA sequences into a plant's genome in a crude fashion, often causing unintended deletions and rearrangements of the plant's DNA. Unexpected and unknown fragments of genetic material have been found in commercial GM crops such as RR soya and MON810. Inserted genes can affect the

complex regulation of the genome, which is still poorly understood. Thus, scientists are not able to predict exactly how inserted DNA will interact in the plant's genome. GM crops therefore have the potential to produce unintended novel proteins or altered plant proteins, raising concerns about their potential to cause allergies (most allergens are proteins). This makes GM crops prone to unexpected and unpredictable effects.

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