

Not all science created equal: The genetically engineered crops story

There is tremendous controversy about genetically modified (GM) crops and derived food. Even the definition of what is a GM crop can differ depending upon with whom you talk. From a strictly scientific perspective all food has been manipulated at the genetic level by human activity; therefore all foods are genetically modified.

A more scientifically precise term for what goes by the popular term GMOs is genetically engineered (GE). This definition involves the use of recombinant DNA technology in the crop breeding process.

For thousands of year's entire plant genomes have been mixed to create new varieties of food crops. Starting in the twentieth century we began using ionizing radiation and chemicals to randomly change the DNA of food crops, a process known as mutagenesis. In all of these "traditional" breeding methods there is little knowledge of what changes have occurred to the DNA of our food crops. However, it is known that the extent of the DNA changes from traditional breeding are [far greater](#) than the precise, directed changes that are the result of genetic engineering. GE breeding technology is a refinement of the random uncontrolled DNA modification breeding procedures of the past.

This year marks the twentieth anniversary of commercialized genetically engineered (GE) crops and derived food. In 1987 the U.S. National Academy of Sciences stated [there were no new risks from plants that were created using recombinant DNA technology](#). Twenty-seven years later, a mountain of research continues to confirm this statement.

Twenty-first century society searches the web for quick access information. It's quick but not always accurate. The Internet is full of false information about GE food. Consumers and health care professionals face persistent bombardment with claims regarding GE crops and derived foods safety. Most people do not have the training or knowledge to distinguish misleading statements from the science in this emotionally charged debate. This document is designed to assist the reader to differentiate between the real science and the prolific non-credible science.

Myth 1: GE crops and food are not tested

All GE crops are extensively tested before they are permitted to be sold commercially. Three Federal agencies regulate all GE crops. The United States Department of Agriculture (USDA) regulates products that are known or suspected to be plant pests or become plant pests. The Environmental Protection Agency (EPA) regulates plants that produce pesticides and the Food and Drug Administration (FDA) regulates the safety of food derived from GE crops. Even though the present federal regulations declare FDA evaluations to be voluntary, every commercialized GE crops has undergone FDA evaluation. The legal and reputation consequences for not undergoing a careful FDA evaluation and then facing court challenges are so catastrophic that the system is considered de facto legal.

Although most of the testing is done by the companies that wish to market any given GE crop, the type of testing, the number of tests, the number of and type of animals used, the number and type of controls, the

composition of test diets, the duration of tests, etc are all determined by international agreed Organization for Economic Co-operation and Development (OECD) [standards](#) . The OECD has issued Consensus Documents that describe composition, nutrients, anti-nutrients and other compounds of biological relevance for each crop.

Every GE crop is compared to its isogenic (same genetic background except for transgene insertion) non-GE crop for compositional comparisons. [Comparisons](#) may include proximates (protein, fat, ash, carbohydrates, and moisture), fiber, minerals, amino acids, fatty acids, vitamins, anti-nutrients, endogenous allergens, and secondary metabolites.

Along with compositional comparisons, GE crops undergo toxicology, molecular, allergenic and nutritional comparisons. Exactly how these tests must be performed is detailed in the European Food Safety Authority 2011 document- Guidance for [risk assessment of food and feed from genetically modified plants](#).

Sometimes [animal feeding trials](#) are carried out to enhance the safety determination.

Many subchronic feeding studies in rodents have been conducted over the past 15 years on food and feed derived from GM plants developed so far...Results indicate that animals fed with feed derived from GM plants do not differ with respect to uptake of nutrients, health and performance, hatchability, milk yield, milk quality, etc., compared to animals fed with conventional comparable feed...Those studies which were well designed and followed internationally accepted protocols did not reveal indications of adverse effects.

If further testing is needed, that may include long term and multigenerational feeding studies. A [review](#) that looked at 12 long-term studies (of more than 90 days, up to 2 years in duration) and 12 multigenerational studies (from two to five generations) concluded GM plants are nutritionally equivalent to their non-GM counterparts and can be safely used in food and feed.

Food allergies are of special concern as consequences can be severe. An allergic reaction can develop against any type of food. Interestingly, GE crops are the only new food crops that are examined for potential allergenic properties. More than 2700 food products have been created through mutagenesis, creating thousands of unknown mutations and potential allergens, and not one has been tested. All GE proteins are compared to the [data bank of known allergenic](#) proteins. Developers do not use organisms that cause food allergies as source of genes. More importantly, there is no a priori reason to believe that GE crops are any more likely to contain allergens than crops bred by any other plant breeding method. GE proteins are also tested for digestibility.

Although the validity of these testing procedures have been challenged, there has never been an allergenic reaction documented to any commercial food derived from GE crops. Until newer validated tests for potential allergenic proteins are developed the present system of weight of evidence testing for potential allergenic in all GE crops will continue to be an important part of the evaluation process for all GE crops.

The Royal Society of Canada 2000 report on Food biotechnology stated:

“Notwithstanding the limits of current technology, a GM food which has undergone a thorough, scientifically valid evaluation process for allergenicity, with negative results, should be considered at low risk to provoke or induce allergic responses and could possibly be even safer than a non-GM novel or exotic food which has not been subjected to the same scrutiny”

The conclusion of this type of testing is clearly stated in the European Commission document –A Decade of EU-Funded GMO Research 2001-2010, and the WHO-Twenty Questions on GMO's;

The main conclusion to be drawn from the efforts of more than 130 research projects, covering a period of more than 25 years of research, and involving more than 500 independent research groups, is that biotechnology, and in particular GMOs, are not per se more risky than e.g. conventional plant breeding technologies.

The GM products that are currently on the international market have all passed risk assessments conducted by national authorities. These different assessments in general follow the same basic principles, including an assessment of environmental and human health risk. These assessments are thorough; they have not indicated any risk to human health.

Myth 2: GE Crops threaten the environment

If the world is to grow more food on the same amount of land, we must do it in a more sustainable manner. In this regard, the testing of GE crops for environmental considerations is just as extensive as that for food safety.²

In 2001 a report in Nature examined four different GE crops planted over 12 different locations. The GE crops were planted and then [left alone for 10](#) years. Not one of the GE crops survived. This is because all domesticated crops are designed to make food for humans, rarely if ever, do they out-compete wild plants.

The 2000 Royal Society of Canada report looked at pollen spread from GE crops and concluded:

Most engineered genes are likely to be ecologically neutral and some may carry fitness penalties to their carriers. In these cases the genes are likely to be lost from the population quite rapidly through genetic drift and/or natural selection.

GE crops have significant environmental benefits. Insect resistant GE crops have allowed farmers to reduce the amount of broad-spectrum insecticide use by hundreds of millions of pounds. Herbicide tolerant GE crops have helped farmers reduce top soil erosion and ground water contamination by switching to zero tillage and choosing herbicides with a [lower environmental impact](#).

Plowing soil has several negative environmental effects. Loose soil is subject to wind and water erosion. Decades of data demonstrate reduced or zero tillage farming used in collaboration with GE crops has

benefited the environment. The use of newer, low impact herbicides that do not persist, but rather break down into non-toxic compounds has also helps reduce the environmental impact of farming with GE crops.

The 2010 National Academy of Science report-Impact of GE Crops on [Farm Sustainability](#) in the United States stated:

In general, the committee finds that genetic-engineering technology has produced substantial net environmental and economic benefits to U.S. farmers compared with non-GE crops in conventional agriculture.

Myth 3: GE Crops do not Increase yields

A [review of global yield](#) data showed 154/168 studies of GE crops neutral or increased yields. Most striking was 101/107 studies in the developing world with neutral or increased yields. This explains why the [developing world farmers are adopting GE crops faster](#) than the developed world; they now grow over 50% of all GE crops on the planet.

Myth 4: GE Crops threaten organic agriculture

Organic certification is based on prescribed production methods, not on the quality of the end product. There is no threshold for GE content that would trigger decertification. Therefore trace amounts of GE do not threaten organic certification in North America. No organic farmer has ever lost certification for trace amounts of GE in their crop. Further, no non-GE farmer in the US has ever been sued for trace amounts of GE ending up in their field. [Organic and biotech crops](#) have co-existed and both forms of agriculture have prospered over the past 18 years.

There is little doubt why the present controversies around GE crops and derived food are so prevalent with some of the public. There has been an explosion of publications that allege negative results for GE crops and derived foods. Because the average person, including politicians, is not trained in the science they are often fooled into believing the results of these publications. The vast majority of these non-credible science publications report on inappropriately conducted experiments or research. As a group they suffer from an assortment of inadequacies. Improper or lack of controls, too few test animals, improper design, inaccurate or incomplete quotes/citations, inappropriate statistics, data not supporting conclusions are all too common in non-credible reports. World food safety and world health authorities are not fooled. All of these GE-critical papers have been examined by experts and dismissed as non-credible.

The following table lists a few examples of the non-credible publications and expert opinions that explain why these publications were dismissed.

Global food safety, health and science expert response to key GE-critical publications:

Pusztai,1999	potatoes	Royal Society
Chapela , 2001	maize	EJB Disavowed
Ermakova, 2005	soy	Ask-force
Zenek , 2008	maize	Austrian retraction, 2008
Seralini , 2007	maize	EFSA
Dona, 2009	review	CRFSN
Vendomois , 2009	maize	EFSA
Seralini, 2012	maize/glyphosate	Health Canada paper retracted

In a similar vein, GMO critics have lately taken to publishing large (non-peer reviewed) tomes with hundreds of citations. Jeffrey Smith, founder of his one-man “Institute for Responsible Technology,” has no background in science or science journalism; he received a marketing degree from the cult Maharishi University. Smith has several such self-publications. *Genetic Roulette* is widely cited on the web as a credible source. But [Academics Review](#) demonstrates why it is not credible. Recently, another large publication claimed proof of dangers from GE crops and derived food. *GMO Myths and Truth* (Fagan is also associated with [Maharshi University](#)) is very similar to *Genetic Roulette* (often citing the same references). Many of the same Academics Review criticisms apply this publication as well.

The [American Association for the Advancement of Science](#) released this statement in 2012 about the safety of GE foods:

The World Health Organization, the American Medical Association, the U.S. National Academy of Sciences, the British Royal Society, and every other respected organization that has examined the evidence has come to the same conclusion: consuming foods containing ingredients derived from GM crops is no riskier than consuming the same foods containing ingredients from crop plants modified by conventional plant improvement techniques.

A 2013 Italian review looked at [1783 studies](#) and concluded the safety of GE crops and derived food. The European High Court of Justice [recently struck down the ban](#) on growing GE crops. Their reason was lack of evidence of harm to humans or the environment.

The European National Academies of Science 2013 report stated:

There is no validated evidence that GM crops have greater adverse impact on health and the environment than any other technology used in plant breeding... There is compelling evidence

that GM crops can contribute to sustainable development goals with benefits to farmers, consumers, the environment and the economy.

Health Canada statement encapsulated the [global scientific opinion](#):

The overwhelming body of scientific evidence continues to support the safety of genetically modified food and feed products in general...However, whenever new information concerning the safety of an authorized product arises, this new data is carefully reviewed.

Food has become an important topic in society; policy makers are being pressured by the anti-GMO lobby to create public policy that restricts or bans GE crops and derived food outright. Often these restrictive policies directly benefit the lobby organizations. It is very important that policy makers understand the GE crop technology and how it integrates into global food production systems.

It is estimated that 70 percent of the food in stores contains ingredients derived from GE crops. Learning the facts about GE technology from reputable sources will add an important element to the base of knowledge used to direct public policy. Organizations like the FDA, USDA, AMA, AAAS, NAS, WHO, EFSA, Health Canada are a good source for accurate information on GE crops and derived food.

The most asked question about food derived from GE crops has to be: Is it safe? After 20 years of commercial production of GE crops and after three trillion meals containing ingredients derived from these crops, there is not a single documented case of harm.

All foods carry some risk to some people but foods derived from GE crops have an impeccable history of safety. Although the Internet is full of claims to the contrary, global food safety authorities, health authorities, National Academies of Science and esteemed scientific bodies [all support](#) the continued safe use of GE technology.

The 2013 European National Academies of Science Advisory Council wrote:

There is abundant and accumulating evidence from extensive worldwide experience for benefit, and lack of evidence for environmental or human health risk associated with GM crop technology... It is vital that sustainable agricultural production and food security harnesses the potential of biotechnology in all its facets.

[Robert Wager](#) is a member of the Biology department at Vancouver Island University. He writes on genetically engineered crops and food. Follow him on Twitter @RobertWager1