

## GMO Facts

<http://www.nongmoproject.org/gmo-facts/>

**What is a GMO?** A GMO, or genetically modified organism, is a plant, animal, microorganism or other organism whose genetic makeup has been modified using recombinant DNA methods (also called gene splicing), gene modification or transgenic technology. This relatively new science creates unstable combinations of plant, animal, bacterial and viral genes that do not occur in nature or through traditional crossbreeding methods. Visit the [What is GMO](#) page for more information and a list of high-risk crops.

**Are GMOs safe?** Most developed nations do not consider GMOs to be safe and have significant restrictions or outright bans on the production and sale of GMOs. The U.S. and Canadian governments, though, have approved GMOs based on studies conducted by the same corporations that created them and profit from their sale.

**Are GMOs labelled?** Sixty-four countries around the world, including Australia, Japan, and all of the countries in the European Union, require genetically modified foods to be labelled

1. While a 2015 ABC News survey found that 93% of Americans believe genetically modified foods should be labelled, GMOs are not required to be labelled in the U.S. and Canada
2. In the absence of mandatory labeling, the Non-GMO Project was created to give consumers the informed choice they deserve.

**Which foods might contain GMOs?** Most packaged foods contain ingredients derived from corn, soy, canola, and sugar beet — and the vast majority of those crops grown in North America are genetically modified

3. To see a list of high-risk crops, visit the [What is GMO](#) page.

**How do GMOs affect farmers?** Because GMOs are novel life forms, biotechnology companies have been able to obtain patents with which to restrict their use. As a result, the companies that make GMOs now have the power to sue farmers whose fields are contaminated with GMOs, even when it is the result of inevitable drift from neighboring fields

4. GMOs therefore pose a serious threat to farmer sovereignty and to the national food security of any country where they are grown, including the United States and Canada.

**What are the impacts of GMOs on the environment?** More than 80% of all GMOs grown worldwide are engineered for herbicide tolerance <sup>5</sup>. As a result, use of toxic herbicides like Roundup has increased 16 times since GMOs were introduced <sup>6</sup>. GM crops are also responsible for the emergence of herbicide resistant “super weeds” and “super bugs,” which can only be killed with more toxic poisons like 2,4-D (a major ingredient in Agent Orange) <sup>7,8</sup>. GMOs are a direct extension of chemical agriculture and are developed and sold by the world’s biggest chemical companies. The long-term impacts of GMOs are unknown, and once released into the environment, these novel organisms cannot be recalled.

- 1 “Center for Food Safety | Issues | GE Food Labeling | International Labeling Laws.”

*Center for Food Safety*. N.p., n.d. [Web](#).

- 2 Langer, Gary. “Poll: Skepticism of Genetically Modified Foods.” *ABC News*. ABC News

Network, 19 June 2015. [Web](#).

- 3 Fernandez-Cornejo, Jorge, and Seth James Wechsler. "USDA ERS – Adoption of Genetically Engineered Crops in the U.S.: Recent Trends in GE Adoption." *USDA ERS – Adoption of Genetically Engineered Crops in the U.S.: Recent Trends in GE Adoption*. United States Department of Agriculture, Economic Research Service, 09 July 2015. [Web](#).
- 4 Leader, Jessica. "Monsanto Wins Lawsuit Filed By U.S. Organic Farmers Worried About Seed Contamination." *The Huffington Post*. TheHuffingtonPost.com, 10 June 2013. [Web](#).
- 5 Duke, S.O., & Powles, S.B. (2009). "Glyphosate-resistant crops and weeds: Now and in the future." *AgBioForum*, 12(3&4), 346-357.
- 6 Kustin, Mary Ellen. "Glyphosate Is Spreading Like a Cancer Across the U.S." *EWG*. Environmental Working Group, 07 Apr. 2015. [Web](#).
- 7 Mortensen DA, Egan JF, Maxwell BD, Ryan MR, Smith RG. "Navigating a critical juncture for sustainable weed management." *BioScience*. 2012;62(1):75-84. "Newsroom." *Agent Orange: Background on Monsanto's Involvement*. N.p., n.d. [Web](#).

### High-Risk Crops & Inputs

One of the elements that sets the Non-GMO Project Standard apart from other non-GMO claims is the requirement to test high-risk ingredients for GMO contamination.

An ingredient can be classified as high risk if it is derived from, contains derivatives of, or is produced through a process involving organisms that are known to be genetically modified and commercially produced. The following inputs are considered high risk:

Classification	Ingredient
<b>Crops</b>	<u>Alfalfa, Canola, Corn, Cotton, Papaya, Soy, Sugar beet, Zucchini/</u>
<b>Animal Derivatives</b>	<u>Eggs, Gelatin, Hides and skin, Honey and other apiculture produc</u>
<b>Animal Production Inputs</b>	<u>rBGH, rBST, Semen, Vaccines, Veterinary medicines</u>
<b>Microbes and Microbial Products</b>	<u>Enzymes, including chymosin, Cultures and starters including yea</u>

To meet the Non-GMO Project Standard, an ingredient derived from a high-risk organism will need test results from the raw source material to prove that it is non-GMO. For example, in order to prove that soy lecithin meets the standard, the raw soy must be tested before it is processed into lecithin.

Animal products such as milk, meat, eggs, and honey are considered high-risk inputs due the prevalence of GMOs in animal feed. As such, animal products are evaluated by looking at the feed and testing high-risk inputs in the feed. Cloned animals and their progeny are also considered GMOs under the standard.

<http://www.nongmoproject.org/gmo-facts/high-risk/>

### Corn

Corn, also called maize, is native to Mexico and has become one of the most widely grown crops in the world. There are 142 different events (types) of genetically modified corn, the most of any plant species. Almost 90% of the corn grown in the United States goes into animal feed and biofuels, while the remainder is processed down into various ingredients such as high-fructose corn syrup and corn starch, or used as the source material to make ingredients such as alcohol and citric acid.<sup>123</sup>

Herbicide Tolerant

Insect resistant

D

Newer varieties of genetically modified corn have developed for the following applications: drought stress tolerance, improved ethanol production, and increased lysine content.

**Cultivation** United States (92% of corn acreage in 2014)<sup>4</sup>

Canada (81% of corn acreage in 2014)<sup>5</sup>

Brazil Argentina

8 "USDA ERS – Corn." *USDA ERS – Corn*. United States Department of Agriculture Economic Research Service, n.d. [Web](#).

9 "U.S. Domestic Corn Use." *USDA Economic Research Service*, Nov. 2015. [Web](#)

- 10 "U.S. Domestic Corn Use Table." USDA Economic Research Service, n.d. [Web](#).
- 11 *Acreage*. Washington: U.S. Dept. of Agriculture, Statistical Reporting Service, Crop Reporting Board, 2015. 25. USDA, National Agricultural Statistics Service, June 2015. [Web](#).  
 Mchughen, Alan. "Where in the World Are GM Crops and Foods?" *GM Crops & Food* 4.3 (2013): 17. *GMO Inquiry 2015*. Canadian Biotechnology Action Network (CBAN), 30 Mar. 2015. [Web](#).

### Cotton

Cotton is the primary crop for producing textiles around the world. As such, it was targeted early on by biotech companies and there are now 56 events (types) of genetically modified cotton, the second most behind corn (maize)<sup>1</sup>. Though cotton fiber is not common in consumer packaged goods, cottonseed oil is becoming more so as prices drop.

Herbicide Tolerant

Insect resistant

Di

### Cultivation

United States (94% of cotton acreage in 2014)<sup>2</sup>

Brazil

Argentina

India

China

Paraguay

South Africa

Pakistan

Australia

Burkina Faso

Myanmar

Mexico

Columbia

Sudan

1. "GM Approval Database: Cotton." *GM Approval Database*. International Service for the Acquisition Of Agri-biotech Applications (ISAAA), n.d. [Web](#).

2. *Acreage*. Washington: U.S. Dept. of Agriculture, Statistical Reporting Service, Crop Reporting Board, 2015. 26. USDA, National Agricultural Statistics Service, June 2015. [Web](#).

<http://www.nongmoproject.org/high-risk/cotton/>

### Soy

Soybean, also called soya bean, is the number one genetically modified crop in the world, representing half of all worldwide biotech crop acreage with an 82% adoption rate among soy farmers<sup>12</sup>. Due to its high oil and protein content, soy is cultivated for a variety of food purposes. Besides being the foundation of soy sauce and tofu, soy oil is a common vegetable oil, soybean meal is a regular part of animal feed, and soy protein is added to breads and packaged goods.

Herbicide Tolerant

Insect resistant

Di

Some genetically modified varieties of soy have been altered specifically for oil production and produce three times as much oleic acid as conventional varieties<sup>3</sup>.

**Cultivation** United States (94% of soy acreage in 2014)<sup>4</sup> Canada (62% of soy acreage in 2014)<sup>5</sup>

Brazil Argentina Paraguay South Africa Uruguay Bolivia Mexico Chile Costa Rica

1. James, Clive. 2014. *Global Status of Commercialized Biotech/GM Crops: 2014*. ISAAA Brief No. 49. ISAAA: Ithaca, NY. 72. Print.

2. "Biotech Crop Annual Update: Soybean." (n.d.): n. pag. International Service for the Acquisition Of Agri-biotech Applications (ISAAA). [Web](#).

3. "Soybean." *Soybean*. International Service for the Acquisition Of Agri-biotech Applications (ISAAA), 2006. [Web](#).

4. *Acreage*. Washington: U.S. Dept. of Agriculture, Statistical Reporting Service, Crop Reporting

Board, 2015. 27. USDA, National Agricultural Statistics Service, June 2015. Web.

5. Mchughen, Alan. "Where in the World Are GM Crops and Foods?" *GM Crops & Food* 4.3 (2013):

18. *GMO Inquiry 2015*. Canadian Biotechnology Action Network (CBAN), 30 Mar. 2015. Web.

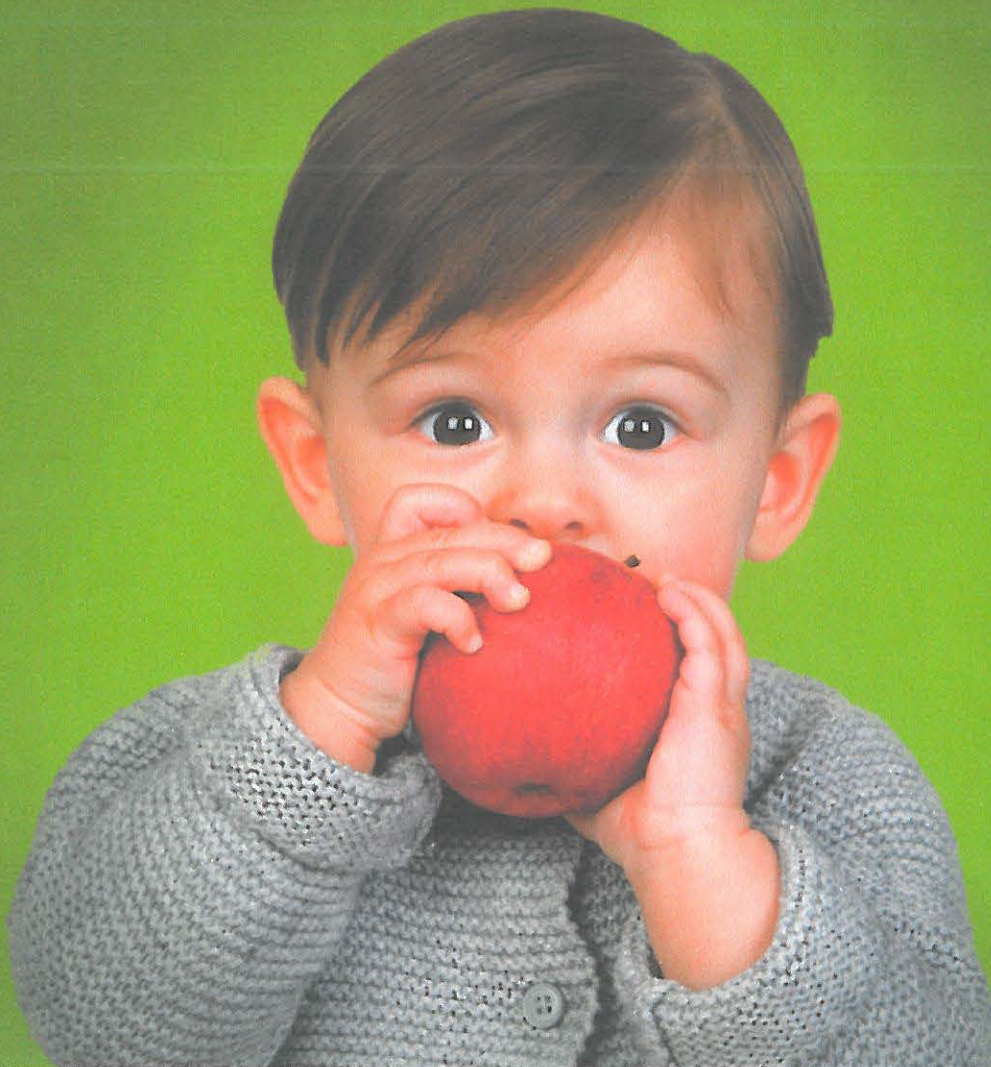
<http://www.nongmoproject.org/high-risk/soy/>

# GMO Myths and Truths

An evidence-based  
examination of the  
claims made for the  
safety and efficacy of  
genetically modified  
crops and foods

John Fagan, PhD  
Michael Antoniou, PhD  
Claire Robinson, MPhil

2nd edition



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## Contents

GMO Myths and Truths .....	2
Disclaimer .....	3
Acknowledgements.....	3
Introduction .....	12
The critics .....	12
Questions and comments.....	13
The update.....	17
References .....	17
Summary .....	18
1. The genetic engineering technique .....	20
What is DNA? .....	20
Genetic engineering theory and practice .....	22
References .....	23
1.1 Myth: Genetic engineering is just an extension of natural breeding	
Truth: Genetic engineering is different from natural breeding and poses special risks ..	24
Myth at a glance .....	24
The steps of genetic modification .....	25
The GM transformation process is highly inefficient.....	28
How unnatural is genetic engineering and does it matter?.....	29
Contained and uncontained use of GM technology.....	29
Horizontal gene transfer – should we worry? .....	30
Muddying the waters with imprecise terms .....	31
GM attempts to override host plant gene regulatory mechanism.....	32
Conclusion.....	33
References .....	33
1.2 Myth: Genetic engineering is precise and the results are predictable	
Truth: Genetic engineering is crude and imprecise, and the results are unpredictable .....	34
Myth at a glance .....	34
The GM process is highly mutagenic.....	35
How GM selects for host gene mutational effects .....	37
Is GM technology becoming more precise?.....	38
Rapid Trait Development System: GM or not? .....	40
Conclusion.....	41
References .....	41
1.3 Myth: Genetic engineering of crops is no more risky than mutation breeding, which is	
widely accepted and not regulated	
Truth: Genetic engineering and mutation breeding are both risky and should be	
strictly regulated .....	43
Myth at a glance .....	43
What is mutation breeding?.....	43
Where did radiation-induced mutation breeding come from?.....	44
Is mutation breeding widely used? .....	45
Why isn't mutation breeding more widely used?.....	45
Why worry about mutations caused in genetic engineering? .....	46
Conclusion.....	50
References .....	50



1.4 Myth: Cisgenesis is a safe form of GM because no foreign genes are involved	
Truth: Cisgenesis shares many of the risks associated with transgenic genetic engineering.....	52
Myth at a glance .....	52
Experimental evidence that cisgenesis can be as unpredictable as transgenesis .....	54
Conclusion.....	54
References .....	55
2. Science and regulation .....	56
References .....	56
2.1 Myth: GM foods are strictly tested and regulated for safety	
Truth: GM foods are safety tested by the developer companies and regulation varies from non-existent to weak.....	57
Myth at a glance .....	57
How GMOs first entered world markets .....	59
The US regulatory process for GMOs.....	60
The US government is not impartial regarding GM crops and foods.....	61
FDA presumes that GMOs are “generally recognized as safe”.....	61
The sham of substantial equivalence .....	62
Different environmental conditions produce wide variations in protein expression.....	65
Herbicide residues in GM herbicide-tolerant crops mean they are not substantially equivalent to non-GM crops.....	65
Europe’s comparative safety assessment: Substantial equivalence by another name ..	66
What is the comparative assessment?.....	66
The right and wrong way to do a comparative assessment.....	67
GMOs would not pass an objective comparative safety assessment .....	67
The ILSI database.....	68
EFSA disregards advice of its own head of GMO risk assessment .....	69
EFSA weakens the comparative assessment by widening the range of comparators.....	69
Industry-backed lobbying to weaken the criteria for comparative assessment .....	70
Comparative assessment does not directly assess safety .....	72
Masking effects of a GM diet.....	72
Proof of equivalence not required in Europe until 2013 .....	74
Regulatory process is based on industry studies .....	74
GMO assessment turns its back on science.....	74
Grey literature and lack of transparency .....	74
Industry and the US government design the GMO regulatory process worldwide .....	76
Regulatory failures around the world .....	76
Conclusion.....	84
References .....	84
2.2 Myth: Independent studies confirm that GM foods and crops are safe	
Truth: Independent research on GM foods is difficult or impossible to carry out, but many studies that have been carried out find problems.....	89
Myth at a glance .....	89
Scientists protest .....	90
Is the problem of access to research materials solved?.....	90
Information that Johnson ignored or discounted .....	90
Another researcher finds problems accessing materials.....	92
Researchers who publish studies that find harm from GM crops are attacked .....	93
Conclusion.....	99
References .....	100

2.3 Myth: The Nicolia review compiles 1,700+ studies showing that GMOs are safe	
Truth: The review suffers from important omissions, fails to show GMOs are safe, and provides evidence of risk for some GMOs .....	102
Myth at a glance .....	102
Overview of problems with the Nicolia review .....	103
Historical background: The “big list of studies” tactic .....	120
Conclusion.....	120
References .....	121
3. Health hazards of GM foods .....	127
References .....	127
3.1 Myth: GM foods are safe to eat	
Truth: Studies show that GM foods can be toxic, allergenic, or have unintended nutritional changes .....	128
Myth at a glance .....	128
Unintended changes in composition .....	129
Toxic effects and signs of toxicity in laboratory and farm animal feeding studies with GMOs.....	129
Masking statistical significance through the concept of “biological relevance” .....	135
Misuse of “biological relevance” places public health at risk: Monsanto GM maize study .....	137
Masking statistical significance through the concept of “normal variation” .....	138
Limitation of many feeding studies on GM foods .....	139
Regulators do not require long-term tests on GMOs .....	140
Stacked-trait crops are less rigorously tested than single-trait crops .....	141
Antibiotic resistance genes could produce “superbugs” .....	142
What tests should GM crop developers do to ensure that they are safe to eat?.....	142
Conclusion.....	143
References .....	144
3.2 Myth: The Séralini (2012) study was bad science and no conclusions can be drawn from it	
Truth: The Séralini study is the most detailed and thorough study ever done on a GM food and its associated pesticide.....	147
Myth at a glance .....	147
Why this study? .....	147
The methodology .....	148
The findings in brief – and their implications .....	148
The findings in detail .....	149
Study “a bomb”.....	151
Campaign to discredit the study .....	152
Criticisms misrepresent the study .....	152
The “too few rats” criticism .....	153
The “wrong strain of rat” criticism .....	154
Support from scientists .....	154
The retraction .....	155
Scientists condemn retraction .....	156
Conclusion.....	157
References .....	158
3.3 Myth: Many long-term studies show GM is safe	
Truth: Few long-term studies have been carried out, but some show unexpected toxic effects .....	160

Myth at a glance .....	160
The Séralini study.....	160
The Snell review.....	161
Russian long-term studies not followed up.....	163
Conclusion.....	164
References .....	165
3.4 Myth: EU research shows GM foods are safe	
Truth: EU research shows evidence of harm from GM foods .....	166
Myth at a glance .....	166
Poulsen and colleagues (2007) <sup>10</sup> .....	167
Schröder and colleagues (2007) <sup>11</sup> .....	167
Kroghsbo and colleagues (2008) <sup>8</sup> .....	168
Conclusion .....	168
References .....	169
3.5 Myth: Those who claim that GM foods are unsafe are being selective with the data, since many other studies show safety	
Truth: Studies that claim safety for GM crops are more likely to be industry-linked and therefore biased .....	170
Myth at a glance .....	170
Conclusion.....	171
References .....	171
3.6 Myth: GM foods are safe for human consumption	
Truth: The few studies that have been conducted on humans show problems .....	172
Myth at a glance .....	172
Conclusion.....	173
References .....	173
3.7 Myth: No one has ever been made ill by a GM food	
Truth: There is no scientific evidence to support this claim.....	174
Myth at a glance .....	174
Two outbreaks of illness linked to GM technology.....	175
Conclusion.....	178
References .....	178
3.8 Myth: GM Bt insecticidal crops only harm insects and are harmless to animals and people	
Truth: GM Bt insecticidal crops pose hazards to people and animals that eat them .....	180
Myth at a glance .....	180
Bt toxin in GM plants is not the same as natural Bt toxin .....	181
Bt toxin does not only affect insect pests .....	182
Bt toxin protein may not be broken down harmlessly in the digestive tract .....	183
How selective are the Bt toxins in GM crops? .....	183
Regulatory assessment of Bt crops flawed .....	184
Conclusion.....	184
References .....	185
3.9 Myth: GM foods are rigorously assessed for their ability to cause allergic reactions	
Truth: No thorough allergenicity assessment is conducted on GM foods .....	187
Myth at a glance .....	187
The EU system for assessing GM foods for allergenicity .....	188
Why the allergy assessment process is ineffective.....	188
Studies on GM foods confirm existing allergy assessments are inadequate .....	190
Conclusion.....	191
References .....	191

3.10 Myth: GM animal feed poses no risks to animal or human health	
Truth: GM feed affects the health of animals and may affect the humans who eat their products .....	193
Myth at a glance .....	193
Conclusion .....	195
References .....	195
3.11 Myth: Genetic engineering will deliver more nutritious crops	
Truth: No GM crop that is more nutritious than its non-GM counterpart has been commercialized and GM is not needed for good nutrition .....	197
Myth at a glance .....	197
GM golden rice: More hype than hope? .....	197
Human trials carried out before toxicological safety testing .....	198
Breaches of medical ethics and Chinese law .....	199
Solutions to vitamin A deficiency already available .....	199
Purple cancer-fighting tomato .....	200
“Biofortified” crops are not a solution to hunger .....	201
Non-GM biofortified crops are already available .....	201
Conclusion .....	202
References .....	202
4. Health hazards of Roundup and glyphosate .....	204
References .....	204
4.1 Myth: Roundup is a safe herbicide with low toxicity to animals and humans	
Truth: Roundup has never been tested or assessed for long-term safety for regulatory purposes but independent studies show it is highly toxic to animals and humans .....	205
Myth at a glance .....	205
Key studies showing toxic effects of glyphosate and Roundup .....	206
Reviews of health effects of Roundup spraying in South America .....	212
Roundup link with modern diseases suggested .....	213
Roundup linked to chronic kidney disease .....	213
Courts rule Roundup not safe – Brazil seeks to ban it .....	214
Arguments that Roundup replaces more toxic herbicides are false .....	214
Health risks of other herbicides used with GM crops .....	214
Conclusion .....	215
References .....	216
4.2 Myth: Strict regulations ensure we are only exposed to safe levels of Roundup	
Truth: So-called “safe” levels of Roundup may not be safe after all .....	219
Myth at a glance .....	219
How safe are “safe” levels? .....	220
In vitro versus in vivo studies .....	222
People and animals are widely exposed to glyphosate .....	223
People and animals are not protected by current regulations .....	225
Conclusion .....	226
References .....	226
5. GM crops – impacts on the farm and environment .....	229
References .....	229
5.1 Myth: GM crops increase yield potential	
Truth: GM crops do not increase yield potential – and in some cases decrease it .....	230
Myth at a glance .....	230
Failure to yield .....	232
Non-GM farming produces higher yields with less pesticide .....	232

Conclusion.....	233
References .....	234
5.2 Myth: GM crops decrease pesticide use	
Truth: GM crops increase pesticide use.....	235
Myth at a glance.....	235
North America .....	236
South America.....	236
Glyphosate-resistant superweeds.....	237
How are superweeds created? .....	238
The GM industry “solution” to superweeds: More herbicides.....	239
Conclusion.....	239
References .....	240
5.3 Myth: GM Bt crops reduce insecticide use	
Truth: GM Bt crops change the way in which insecticides are used.....	242
Myth at a glance.....	242
Reduction in chemical insecticides from Bt crops unspectacular .....	244
Pesticide use number crunching .....	244
Resistant pests are making GM Bt technology obsolete.....	244
Refuge recommendations ignored.....	245
Refuge concept breaking down .....	245
Bt crops are the opposite of integrated pest management.....	246
Bt crops harm natural enemies of pests .....	246
Secondary pests move in on GM Bt crops .....	246
GM Bt cotton farmers don’t always give up insecticides .....	247
Hidden chemical insecticides in GM Bt maize .....	248
Conclusion.....	249
References .....	249
5.4 Myth: GM Bt crops only affect target pests and their relatives	
Truth: GM Bt crops are not specific to pests but affect a range of organisms.....	251
Myth at a glance.....	251
GM Bt crops harm non-target and beneficial organisms.....	251
GM Bt crops negatively impact soil organisms .....	251
Bt crops harm aquatic organisms.....	252
Conclusion.....	252
References .....	252
5.5 Myth: GM has enabled the adoption of environmentally friendly no-till farming	
Truth: GM has had little impact on the adoption of no-till farming, and no-till with GM herbicide-tolerant crops is not environmentally friendly.....	254
Myth at a glance.....	254
Conclusion.....	256
References .....	256
5.6 Myth: Roundup is a benign herbicide that makes life easier for farmers	
Truth: Roundup causes soil and plant problems that negatively impact yield .....	257
Myth at a glance.....	257
Glyphosate causes or exacerbates plant diseases.....	257
Glyphosate makes nutrients unavailable to plants.....	258
Glyphosate impairs nitrogen fixation .....	258
Conclusion.....	259
References .....	259
5.7 Myth: GM crops help biodiversity	

Truth: The herbicides used with GM crops harm biodiversity.....	261
Myth at a glance.....	261
Conclusion.....	262
References .....	263
5.8 Myth: GM crops bring economic benefits to farmers	
Truth: Economic impacts of GM crops on farmers are mixed and depend on many factors .....	264
Myth at a glance.....	264
Importance of information that is independent of industry .....	266
Rising cost of GM seed and decreased seed choice .....	267
Conclusion.....	267
References .....	267
5.9 Myth: GM crops increase farmer choice	
Truth: GM-adopting countries have reduced farmer choice .....	269
Myth at a glance .....	269
Choice of seed decreases in GM-adopting country .....	270
Conclusion.....	270
References .....	270
5.10 Myth: GM crops can “coexist” with non-GM and organic crops	
Truth: Co-existence means widespread contamination of non-GM and organic crops ..	271
Myth at a glance .....	271
Who is liable for GM contamination?.....	272
GM contamination has had severe economic consequences .....	272
GM contamination: The learning process.....	273
Conclusion.....	274
References .....	274
5.11 Myth: Horizontal gene transfer from GM crops into bacteria or higher organisms is unlikely or of no consequence	
Truth: GM genes can escape into the environment by horizontal gene transfer with potentially serious consequences.....	276
Myth at a glance .....	276
DNA uptake by bacteria.....	277
DNA uptake during digestion of GM foods.....	278
Horizontal gene transfer by <i>Agrobacterium tumefaciens</i> .....	279
Gene transfer by viruses.....	281
Conclusion.....	282
References .....	282
5.12 Myth: GM will deliver climate-ready crops	
Truth: Conventional breeding outstrips GM in delivering climate-ready crops.....	284
Myth at a glance .....	284
Hollow promises vs. existing solutions.....	284
Genetics not the whole solution .....	286
Conclusion.....	286
References .....	286
5.13 Myth: GM will solve the nitrogen crisis	
Truth: GM has not delivered nitrogen-efficient crops and better solutions are available.....	288
Myth at a glance .....	288
Conclusion.....	290
References .....	290

5.14 Myth: GM crops reduce energy use	
Truth: GM crops are energy-hungry .....	291
Myth at a glance .....	291
Peak oil and gas mean GM crops are unsustainable.....	293
Conclusion.....	293
References .....	294
6. Feeding the world.....	295
References .....	296
6.1 Myth: GM crops are needed to feed the world's growing population	
Truth: GM crops are irrelevant to feeding the world.....	297
Myth at a glance .....	297
GM crops for Africa: Catalogue of failure .....	298
Conclusion.....	301
References .....	301
6.2 Myth: GM crops are vital to achieve food security	
Truth: Agroecological farming is the key to food security .....	303
Myth at a glance .....	303
Dramatic yield increases from sustainable agriculture.....	304
Small farms are more efficient .....	305
Sustainable agriculture can reduce poverty.....	305
Who owns food?.....	306
Conclusion.....	307
References .....	308
6.3 Myth: Anti-GMO activists in wealthy countries are keeping people in poor countries hungry by denying them GM crops	
Truth: The 2008 food crisis was not caused by a lack of GM crops but by the rush to biofuels.....	310
Myth at a glance .....	310
Biofuels couple food prices to petrochemical fuel prices .....	312
Food speculation and hunger .....	312
Currently available GM crops do not address hunger.....	312
Conclusion.....	312
References .....	313
6.4 Myth: GM is needed to provide the crops that will enable us to survive the challenges ahead .....	314
Truth: Non-GM breeding methods are more effective at creating crops with useful traits .....	314
The GM successes that never were .....	316
Non-GM breeding successes show no need for GM .....	318
GM "solution" to pest problem that's already solved by agroecology .....	319
Conventional breeding outstrips GM in delivering desirable traits.....	321
GM is no quicker than conventional breeding – but it is more expensive.....	321
Conclusion .....	323
References .....	323
Conclusion .....	327
Why has GM failed to deliver on its promises? .....	327
Why do farmers plant GM crops? .....	328
Time to move on .....	328
References .....	329
About the authors .....	330

# Introduction

We began work on *GMO Myths and Truths* in 2010, prompted by frequent claims that the case against genetically modifying our food supply had no science behind it. As we had followed the scientific debate and evidence on genetically modified (GM) crops and foods since the early 1990s, we knew that this was untrue.

Another driving factor was the inflated claims that were being made for GM crops. The public was being told that they would make agriculture more sustainable, provide higher yields to feed the world's growing population, reduce pesticide use, help meet the challenges of climate change, provide more nutritious foods, and make farming easier and more profitable.

We knew that these claims were at best questionable and at worst false. GM had not provided a single crop that had sustainably delivered these benefits. On the contrary, a considerable and growing body of scientific evidence pointed not only to potential hazards but also to actual harm from GMOs (genetically modified organisms) to animal and human health and the environment. But this evidence was not reaching the public, campaigners, policy-makers, or even the majority of scientists.

We decided to produce a document explaining the evidence in simple language. Initially we planned a short 10-page document. But it grew – and grew. We finally published the first edition of *GMO Myths and Truths* as a free download on the Earth Open Source website in June 2012, with more than 120 pages and over 600 references, 280 of them to peer-reviewed papers.

Unexpectedly for such a dry, technical publication, *GMO Myths and Truths* appeared to hit a nerve. Its publication coincided with a big push for GMO labelling in the United States and campaigners in many states made good use of it. Requests for press interviews flooded in from North America. Well-wishers mailed thousands of copies to the US for those campaigning for GMO food labelling to use and send to their Congressmen and women. Within weeks, *GMO Myths and Truths* had been translated into Mandarin and published on a Chinese blog. Spanish speakers translated parts for dissemination in South America. In India, where citizens and farmers were smarting from a series of scandals and disasters involving GM Bt cotton, a publishing company asked for our permission to print a few thousand copies under their imprint. They sold them as cheaply as they could manage, given that their target readership was poor villagers and farmers. We were invited to speak in countries all over the world by citizen, government, and industry organizations.

## The critics

Not everyone appreciated *GMO Myths and Truths*. GMO lobbyists launched attacks against it in online forums. These people are online 24/7, defending GMOs. They criticize *GMO Myths and Truths* every time someone cites it in an article, blog, or online post. While we may be able to manage a couple of comments in response before we have to do our work or otherwise live our lives, the GMO lobbyists seem to have nothing else to do than defend



## Conclusion

The introduction of GM crops and foods represents an unprecedented development in the history of agriculture. Never before has the nature of the food supply and the manner in which crops are grown been so fundamentally altered in such a short period of time. This change will affect the lives of all people on earth for many years to come.

Advances in agriculture are to be welcomed if they can contribute to a more sustainable, secure and fair production system and help solve the problem of world hunger and malnutrition. GM crops and foods have been consistently promoted as a way to produce higher yields with less inputs, reduce pesticide use, make farming easier and more profitable, produce more nutritious foods, and meet the challenges of climate change.

But the evidence that has emerged since their introduction in 1996 paints a very different picture. Scientific research and real-world farming experience shows that GM crops have not delivered on the promises above. They have not increased yields or sustainably reduced toxic chemical inputs. They have presented farmers with the new challenges of controlling herbicide-resistant superweeds and Bt toxin-resistant super-pests. GM crops are no less dependent on artificial fertilizers than any other chemically grown crop. They are not as safe to eat as conventionally bred crop varieties. They provide no solution to the major challenges of our time: climate change, the energy crisis, and world hunger.

## Why has GM failed to deliver on its promises?

The GM approach treats genes as isolated units of information with predictable outcomes. But this approach is flawed. Gene organization within the DNA of any organism is not random and gene function is a complex, interconnected, and coordinated network, consisting of layer upon layer of molecular systems.

GM is based on an outdated understanding of genetics and is destined to fail. It is beyond the ability of GM to deliver anything but the simplest of properties such as single-gene herbicide tolerance. GM is simply not up to the task of delivering safe, productive, and resilient food production systems.

Our modern understanding of genetics tells us that we need to take a holistic “systems biology” approach in crop development that preserves gene organization and regulation, rather than disrupting it, as GM does. The way to safely and effectively generate crops with complex desirable properties such as higher yield, drought tolerance, and disease resistance is through natural breeding, augmented where useful by marker assisted selection.

Given the fundamental technical and conceptual flaws of the GM approach to crop and food development, we should not be surprised to find that it has failed to deliver on any of its promises and has delivered foods that are not safe to eat.

## Why do farmers plant GM crops?

The GMO lobby's trump card in responding to these arguments is to ask: If GMOs are as unimpressive and problematic as we suggest, why do so many farmers in so many countries plant them?

The simple answer is that while some farmers do plant GM crops, the vast majority do not. Non-GM farming is by far the dominant model. Industry figures from 2013 show that 18 million farmers grow GM crops in 27 countries worldwide: that's less than 1% of the farming population. Around 92% of all GMOs are grown in just six countries, and these countries mainly grow just four GM crops: soy, maize, oilseed rape (canola) and cotton. Eighty-eight percent of arable land across the globe remains GM-free.<sup>1</sup>

What is more, in 2014, industry figures revealed that GM crop planting had fallen in industrialized countries for the first time since the technology was commercialized in 1996. Clive James, head of the industry group ISAAA, admitted that the industry now sees the developing world as the target for GMO industry expansion.<sup>2</sup>

As the evidence and case studies presented in this report make clear, it is irresponsible to use farmers in the developing world as guinea pigs for experimental GM crops that the majority of people do not want to eat.

## Time to move on

For two decades, GM proponents have dominated the political and media discussion on food and agriculture. Many of our agricultural research institutes and universities accept GMO industry funding and obligingly pursue a narrow GM-focused agenda, at the expense of proven effective agroecological solutions that focus on improving soil quality and maintaining crop diversity and health. Pro-GMO propaganda has even made its way into school and college curricula.

Yet the public, the vast majority of whom do not want to eat GM foods, is unconvinced. It has become common for pro-GMO lobbyists to try to shut down resistance to GM food and agriculture by saying that the debate is over, that science has shown that GMOs are safe and beneficial, and that it is time to move on and accept them.

We agree with only one aspect of this argument. It is indeed time to move on, but in the opposite direction to the one promoted by the GMO proponents. The scientific evidence presented in this report shows that the hypothetical benefits of GM crops and foods are not worth the known risks.

It is time to face up to what the evidence tells us about GMOs and stop pretending that GMOs can do anything that non-GM agriculture and good farming can't do far better, at a fraction of the cost, and without the restrictions attached to patent ownership. In fact, patents represent the single area in which GM crops and foods outstrip non-GM. If it ever becomes as easy to patent a non-GM crop as it is to patent a GM crop, it is likely that GM

## About the authors

John Fagan, PhD was an early voice in the scientific debate on genetically engineered food. Today, as a director at Earth Open Source, Dr Fagan conducts research on biosafety and sustainable agriculture and works to advance environmental sustainability and social responsibility in the food system. Dr Fagan's expertise is sought by industry, government and the scientific community, and he has given hundreds of lectures around the world in the last two decades. Dr Fagan pioneered genetic testing methods for GMOs, and founded, built, and later sold a leading company in this field, Global ID Group. Earlier, he researched molecular mechanisms of carcinogenesis at the US National Institutes of Health and in academia. He earned a PhD in biochemistry, molecular biology, and cell biology from Cornell University.

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