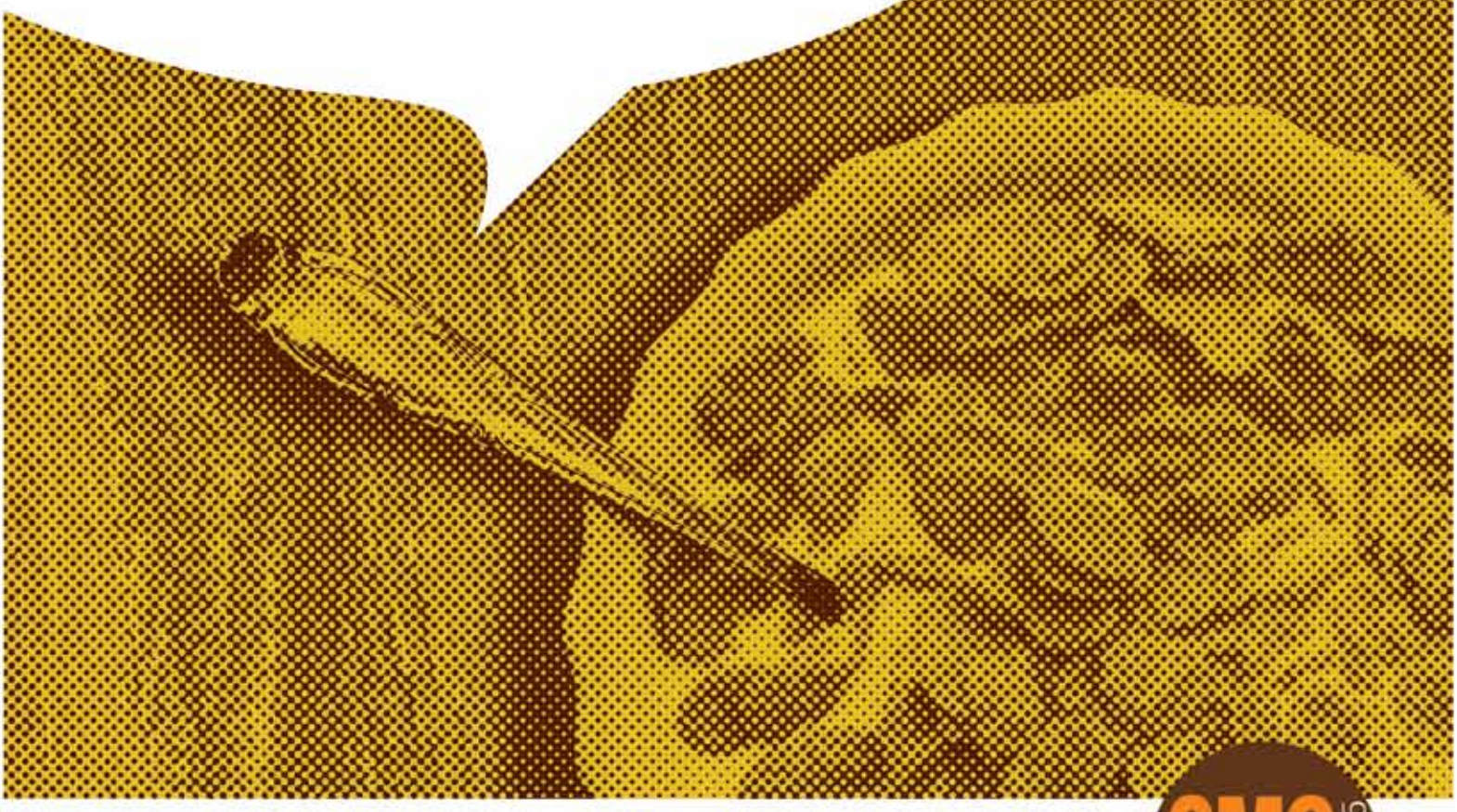
Report 3

Are GM foods better for consumers?



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Canadian Biotechnology Action Network

GMO Inquiry 2015

Report 3

Are GM crops better for consumers?

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For more details, please contact:

Canadian Biotechnology Action Network (CBAN)
Suite 206, 180 Metcalfe Street
Ottawa, Ontario, Canada, K2P 1P5

Phone: 613 241 2267 ext. 25 | Fax: 613 241 2506 | info@cban.ca | **www.cban.ca**

cban Canadian Biotechnology Action Network

Collaborative Campaigning for Food Sovereignty and Environmental Justice

The GMO Inquiry 2015 is a project of the Canadian Biotechnology Action Network (CBAN). CBAN is a campaign coalition of 17 organizations that researches, monitors and raises awareness about issues relating to genetic engineering in food and farming. CBAN members include farmer associations, environmental and social justice organizations, and regional coalitions of grassroots groups. CBAN is a project on the shared platform of Tides Canada.

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SUMMARY

This third CBAN report tackles the questions that Canadian consumers are still asking, twenty years after the government approved the first genetically modified organisms (GMOs) for human consumption.

GM foods have been allowed onto grocery store shelves in Canada (and the US) without labels, without meaningful public debate, without government testing, and without long-term animal feeding studies.

Although launched with many promises of benefits to consumers, two decades later **GM foods on the market are not cheaper, tastier, fresher, more nutritious, or more environmentally-friendly**. In fact, the use of GM crops has increased rather than decreased the use of synthetic herbicides, with broad environmental and health consequences that are not being evaluated.

There is no mandatory labelling of GM foods in Canada (or the US), despite twenty years of polling that shows an overwhelming majority of Canadians want GM foods labelled. The latest poll, commissioned by CBAN in 2015, confirms that 88% of Canadians want mandatory labelling. In Canada, the public call for labelling was particularly intense leading up to the 2001 defeat of the mandatory labeling bill C-287. This report examines industry efforts to ensure that this bill was defeated, and the investments made by the federal government to reassure Canadians that GM foods are safe.

Even after twenty years, the scientific literature on GM food safety is inconsistent and far from robust, **leaving more questions than answers**. Independent studies on human health questions are rare and long-term animal feeding tests are rarer still. The studies that do exist indicate that some genetic modification could result in toxic effects, allergic responses, or altered nutrition, and clearly point to a need for further research. Moreover, there is no monitoring of GM foods which means we do not know if the foods we have been eating for the past twenty years have had any health impacts.

Globally, **there is very little independent science on GM food safety questions**, partly because governments are content to rely on corporate science to assess the safety of new GM foods. Barriers to conducting independent science include funding and access to GM seeds for testing. The high stakes involved in commercializing new GM products have added to an environment that is hostile to critique, from the public and even from within the scientific community.

The potential risks from eating GM foods have not been fully investigated and there is no scientific basis to conclude that GM foods are safe.

Releasing GMOs into our food system and environment remains an ongoing experiment, still in need of testing and evaluation.

The potential risks from eating GM foods have not been fully investigated and there is no scientific basis to conclude that GM foods are safe.

A NOTE ON OUR APPROACH

This report provides a broad overview of the state of the science on GM food safety, including what we know, and do not know, from the scientific literature. It also provides some analysis of the most relevant ongoing safety questions. This analysis relies on twenty years of diverse experience and research housed inside the Canadian Biotechnology Action Network, as well as decades of work done in the scientific community and the global movement for food sovereignty.

This report is not a scientific literature review and avoids what the authors of the report *GMO Myths and Truths* call the "big list of studies" tactic of presenting a list of studies on GM food safety questions, often uneven in scope and results. Such lists are often misleading, and they are often incorrectly used to reach conclusions on food safety.

We are also mindful not to duplicate, in particular, the existing comprehensive work of *GMO Myths and Truths* (see below) that summarizes the potential risks of GM foods and surveys the scientific literature. CBAN recommends this resource for further details.

On questions of GM food safety, our report relies on studies and analyses from independent scientists and four sources in particular:

- *Elements of Precaution: Recommendations for the Regulation of Food Biotechnology*. The Royal Society of Canada's Expert Panel on the Future of Food Biotechnology, prepared by The Royal Society of Canada at the request of Health Canada, the Canadian Food Inspection Agency and Environment Canada. 2001. Available at www.rsc-src.ca
- *Genome Scrambling – Myth or Reality? Transformation-Induced Mutations in Transgenic Crop Plants* by Allison Wilson, PhD, Jonathan Latham, PhD and Ricarda Steinbrecher, PhD. 2004. Available at www.econexus.info
- *GMO Myths and Truths*, by John Fagan. PhD, Michael Antoniou, PhD, and Claire Robinson, published by Earth Open Source. 2014. Available at www.earthopensource.org
- *No scientific consensus on GMO safety*, published in Environmental Sciences Europe (27:4) by Angelika Hilbeck *et al.* 2015. See also www.ensser.org/media/0115/

CBAN makes common use of direct quotes in order to avoid incorrectly summarizing science or discussions over science, and to avoid misrepresenting the work of others; even the slightest change in terms can change the precise meaning intended by a researcher.

Also, necessarily, this report enters into some discussion about social issues and democracy. This report is not solely a "science-based"[A] analysis.

A The Canadian government calls its regulation of GMOs "science-based". This description excludes any consideration of socio-economic concerns. CBAN argues that non-science concerns, such as economic impacts, need to be incorporated into Canadian regulation.

GMO INQUIRY 2015

Twenty years ago, in 1995, the Canadian government approved the first genetically modified (GM, also called genetically engineered or GE) canola varieties, as well as the first GM soy, GM tomatoes (not currently on the market) and GM potatoes (not currently on the market). With these decisions, the government introduced genetically modified crops into our environment and food system for the first time.

After 20 years, however, we still have major unanswered questions and hear conflicting messages about the impacts and risks of GM crops and foods. Even while our questions persist, the Canadian government could soon approve new GM crops and even the first GM food animal, a GM salmon.

Canadian farmers and eaters want to know the true impacts of GM crops – on our environment, our food and farming systems, our economy, and on our health. We want to know about the food we're growing, eating and buying. And we want to know who truly benefits from GM crops and foods, and who pays their costs and bears the burden of their risks.

The Canadian government has not monitored or shared detailed information to answer these questions. However, research in Canada and from around the world, as well as the experiences of farmers in Canada and other countries, helps shed light on the problems with GM over the past two decades. It's time to bring all our research together and assess the evidence, so that we can decide whether GM crops have a place in the future of our food system.

This is the third in a series of six reports that are part of **GMO Inquiry 2015**. All reports are posted at **www.gmoinquiry.ca**.

- Where in the world are GM crops and foods? www.gmoinquiry.ca/where
- Are GM crops better for the environment? www.gmoinquiry.ca/environment
- Are GM foods better for consumers? www.gmoinquiry.ca/consumer
- Are GM crops better for farmers? *Coming soon*
- Are GM crops and foods well regulated? *Coming soon*
- Do we need GM crops to feed the world? *Coming soon*

Read and print the summary pamphlet for this report at GMOinquiry.ca/consumer

CONSUMER CONCERNS

CBAN's 2015 poll confirms that genetic modification in food and farming raises many concerns for the public including environmental, social and ethical issues. Through six reports, the *GMO Inquiry 2015* is addressing a range of important questions asked by the Canadian public. For the sake of this report, however, in answering the question *Are GM Foods Better for Consumers?* we have defined a set of questions that are most commonly identified as "consumer issues". These questions are based on those submitted by members of the public to the *GMO Inquiry 2015* via the website, and informed by twenty years of public debate in Canada.

The predominant questions CBAN received from a consumer perspective were about the safety of GM foods (both specific and general questions), the state of science on the question of safety, and the fate of GM food labelling. We also received many questions about how Canada regulates GM foods for safety, which we will address in detail in our upcoming report *Are GM Crops and Foods Well Regulated?* CBAN has already answered the question "What GM foods am I eating?" in the first report of the *GMO Inquiry 2015*, *Where in the World are GM Crops and Foods?*

The following is a sample of the questions sent by the public to the *GMO Inquiry 2015*:

HOW MUCH SCIENCE HAS BEEN DONE?

Have there been any independent studies on the short- and long-term health impacts of GMOs?

What is scientifically proven – with actual evidence from experimentation – about GMOs' negative effects on human health?

I would like to know of long-term, multigenerational studies that have been undertaken to prove that GMOs (and their pesticides – including the new products designed to be used with 2-4,D) are safe for human health.

What scientists in the world, and where, are doing independent research on the health and environmental effects of GMOs?

What evidence was used by the Canadian government to decide that GMOs are safe for human consumption?

What testing and/or analysis is done by the government to determine the impact and safety of GMOs? How long do they study, what information is gathered, how do they predict long term exposure?

WHAT ARE THE HEALTH EFFECTS OF GMOS?

What is a GMO and what is its impact on the body?

What are the health impacts of GMOs (both positive and negative), if any?

Just what are the full range of health risks that we face from GMOs and how do we protect ourselves from these risks?

What are the long-term health impacts of GM crops?

What are the health effects of GM food on children, pregnant moms, teens and elders?

What illnesses are GMO crops causing?

Do GMOs increase allergies?

Is there any link between GMO's and autoimmune diseases or cancer?

Food is making people sick in the developed western world, it was never like this 30 years ago: Can it be due to GMOs in our food?

How much pesticide residue is in the final product?

WHY DON'T WE HAVE GM FOOD LABELLING?

Why is it that in Europe GMOs are labelled and here in North America they are not?

Why is the Canadian government not willing to label GM food?

After 20 years, why in the world do we not have GMO labelling?

Why are large multinational corporations (ie: Monsanto) lobbying against GM food labeling?

INTRODUCTION

In 1995, Monsanto wrote that "Current research indicates that consumers are willing to try genetically engineered products as long as they: are safe to eat, taste good, don't harm the environment and don't cost more than existing products."[1] Twenty years later, how do GM foods measure up in the eyes of consumers? Are consumers willing to buy GM foods?

The question "Are GM Foods Better for Consumers?" is best left for consumers to answer themselves. However, without mandatory labelling, consumers do not have the tools to make a choice.

2015 Consumer Poll

The Ipsos Reid poll conducted for CBAN in August 2015 shows a high level of awareness and concern about genetically modified foods among Canadians:

- 71% of Canadians say they are aware of genetically modified foods.
- 88% of Canadians want mandatory labelling of GM foods.
- Six in ten (59%) Canadians oppose genetically modifying crops and animals to produce food, and one in three (34%) say they support it.
- 48% support a ban on all genetically modified food.

Of Canadians who want GM foods labeled:

- 87% just want to know what is in the food they are eating,
- 55% are concerned about safety,
- 47% are concerned about government transparency in regulation,
- 46% are concerned about corporate control,
- 46% think GM is not natural,
- 45% have environmental concerns,
- 30% have ethical concerns,
- 58% are concerned that not enough research has been done on the long-term health and environmental impacts.

See cban.ca/2015poll

The biotechnology industry and federal government have been preoccupied with "consumer education" and "public perception" of GM foods for over 20 years. As Bob Ingratta of Monsanto Canada said at a government workshop on biotechnology in 1993, "Future availability [of food biotechnology] will require two things, regulatory approval and public acceptance and those are two key areas that we have been working on for many years and are trying to help develop."[2]

Despite the millions that have been spent by the government and industry to familiarize and reassure consumers (the federal government spent $13 million on biotech communications between 1997 and 2003 alone[3]), the Canadian public is still debating the merits of GM food, and is still demanding mandatory labelling.

Food safety is one of the serious and obvious questions raised by the use of genetic engineering in food and farming. The United Nations Codex Alimentarius Commission, which sets international food safety guidelines,[B] says that, "for many foods, the level of food safety generally accepted by the society reflects the history of their safe consumption by humans. It is recognized that in many cases the knowledge required to manage the risks associated with foods has been acquired in the course of their long history of use."[4] Genetically modified foods have, however, only been on the market for twenty years, yet consumers are asked to accept these new foods as safe.

Most governments recognize that "no blanket statement about the safety of all GMOs is possible and that they must be assessed on a 'case-by-case' basis."[5] This is also the case in Canada, where the government regulates each GM food separately. **Rather than asking "Are GM foods safe to eat?", the immediate, more precise and answerable question is, "Are the GM foods we're currently eating safe?"** The World Health Organization says that "GM foods currently available on the international market have passed safety assessments and are not likely to present risks for human health"[6] and Health Canada tells us that the GM foods sold in Canada are safe to eat.

After twenty years, however, how much do we know about genetically engineered foods? In 1999, four years after the first GM approvals, David Suzuki said, "We are performing a massive experiment. The results will only be known after millions of people have been exposed to (these foods) for decades… Any politician or scientist

What is Genetic Modification?

Genetic modification (GM) is the introduction of new traits to an organism by making changes directly to its genetic makeup, e.g. DNA, through intervention at the molecular level. It's also called genetic engineering or GE. With genetic engineering, scientists can change the traits of plants and animals by inserting DNA pieces, whole genes, or long stretches of DNA segments from many different organisms. These sequences can also be taken from the same species or be newly made up. Scientists can also delete or swap DNA sequences in organisms or introduce genetic material to silence genes.

Unlike conventional breeding and hybridization, genetic engineering is a laboratory technology that enables the direct transfer of genes between organisms in different species or kingdoms that would not breed in nature, and the introduction of new sequences that do not even exist in nature.

B The Codex Alimentarius Commission, or Codex, is the United Nations body administered jointly by two UN agencies, the Food and Agriculture Organization and the World Health Organization. Its role is to set global food safety standards and guidance. Codex is the reference point of the World Trade Organization on food safety matters which means that national measures based on Codex guidance cannot be challenged as barriers to trade or, alternatively, that national standards higher than those set by Codex may require justification. Codex guidelines such as the "Guideline for the conduct of food safety assessment of foods derived from recombinant-DNA plants" are the outcome of years of negotiation between participating national governments, with some involvement from non-governmental organizations and industry representatives.

who tells you these products are safe is either very stupid or lying." He said that the hazards of these foods are uncertain and "In view of our enormous ignorance, the premature application of biotechnology is downright dangerous."[7]

Dr. Suzuki also stated, "The experiments have simply not been done."[8] Have they been done now, fifteen years later? If introducing GM foods in Canada in 1995 was a "massive experiment", are the results now in?

Terms of Confusion

This report uses the terms genetic engineering (GE) and genetic modification (GM) interchangeably, to describe recombinant DNA (rDNA) technology (with a preference for "genetic engineering" when discussing the science).

The terms used to describe this technology have been subject to debate for decades and this had led to much public confusion. This long-standing argument over terms is largely due to an industry public relations strategy that sought to find descriptions that would reassure rather than alarm consumers, and avoid triggering new regulations. For example, the industry depicted rDNA technology in a continuum from beer making and farmer plant breeding[9] despite the radical departure of moving genes directly between unrelated species.

In 2000, the federal government pamphlet "Food Safety and You" (delivered to every house in Canada) referred to "biotechnology-derived foods" and said, "Some of these products are referred to as 'novel foods,' 'biotechnology-derived foods,' 'genetically modified foods' or 'genetically enhanced foods.'"[10]

GM is the term used in international agreements and in European regulation as well as in most other English-speaking countries. GE is the term used in US legislation. The Canadian government uses neither term in regulating the technology: the Canadian government regulates "Plants with Novel Traits" and "Novel Foods", which include products of genetic engineering but also products of conventional plant breeding.

The Canadian government's use of terms and definitions does not match common public use. Health Canada refers to genetically modified organisms (GMOs) as including those organisms "altered through any method, including conventional breeding" and defines an organism as genetically engineered "if it was genetically modified using techniques that permit the direct transfer or removal of genes in that organism. Such techniques are also called recombinant DNA or rDNA techniques."[11]

DO GM FOODS HAVE BENEFITS FOR CONSUMERS?

> One objective of agricultural biotechnology is to make our food and non-food products better, healthier, safe and cheaper in a way that is less of a burden on the environment.
>
> — Communications Committee of the Canada-Saskatchewan Agriculture Green Plant Agreement in collaboration with Ag-West Biotech Inc. (with funding from the Government of Saskatchewan and the Government of Canada) 1996, Agriculture Awareness Series[12]

> Biotechnology is the science of changing the genetic makeup of seeds that grow our food to add new benefits.
>
> — Monsanto, 1998 "Let the Harvest Begin"[13]

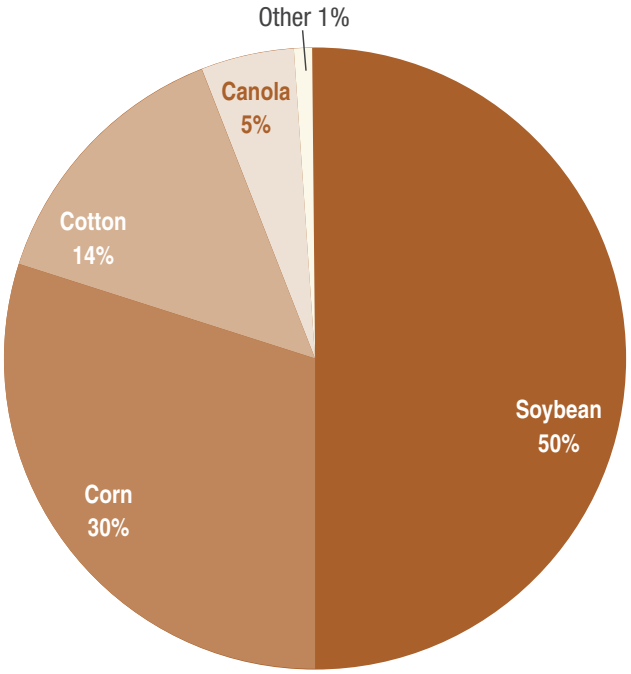
How does the current reality of GM foods measure up to the promises made to consumers over the past twenty years? In 1998, Monsanto advertised this vision for how genetic engineering would benefit consumers: "Imagine farm animals that produce leaner meat and more milk at less cost. Biotechnology offers new ways to improve the health and efficiency of farm animals...And, new ways to make food healthier for consumers."[14]

The GM products on the market do not yet meet this promise. More importantly perhaps, the current reality reveals a mismatch between what Monsanto and other biotechnology companies have designed, and what Canadian consumers want, or are willing to accept. Monsanto's depiction of "more milk at less cost" is a reference to recombinant Bovine Growth Hormone, which was a veterinary drug designed to boost milk production in dairy cows. This was the first GM product that Monsanto asked the US and Canadian governments to approve, but it was rejected by both consumers and farmers as unnecessary and potentially dangerous.[15] Ultimately, Health Canada denied approval based on animal-health grounds, after ten years of public protest and controversy.

In 2000, in answer to the question "Are biotech foods really more nutritious than conventional foods?" the Council for Biotechnology Information, a public relations arm of Monsanto, Dow Chemical, DuPont and other biotechnology companies, relied on **future promises**: "Now and in the near future biotechnology products provide potential food quality improvements. Some biotech foods may help to prevent heart disease and cancer by delivering more of vitamin C and E. Research is under way on "golden rice," which would combat vitamin A deficiency in developing nations by delivering more beta-carotene. Other biotech foods, like a potato that absorbs less oil, may help to prevent heart disease by cutting back on fatty acids. Biotechnology could improve nutrition in other ways, such as producing allergy-free peanuts and rice. Researchers are even working on a banana that could deliver vaccines against hepatitis B and other deadly diseases."[16]

Many experiments to develop GM foods with new healthy characteristics have been reported in the media over the years but most of them have remained experiments in the lab. Except for the newly approved GM potato and apple, all of the GM crops on the market around the world are genetically modified with traits to simplify and improve weed and pest management. In fact, the four GM crops grown in Canada – corn, canola, soy and white sugar beet – are all modified with one or both of two traits: herbicide resistance and insect tolerance. *See the GMO Inquiry report "Where in the World Are GM Crops and Foods?" for details.*

Figure 1: GM crops as percent of total GM area



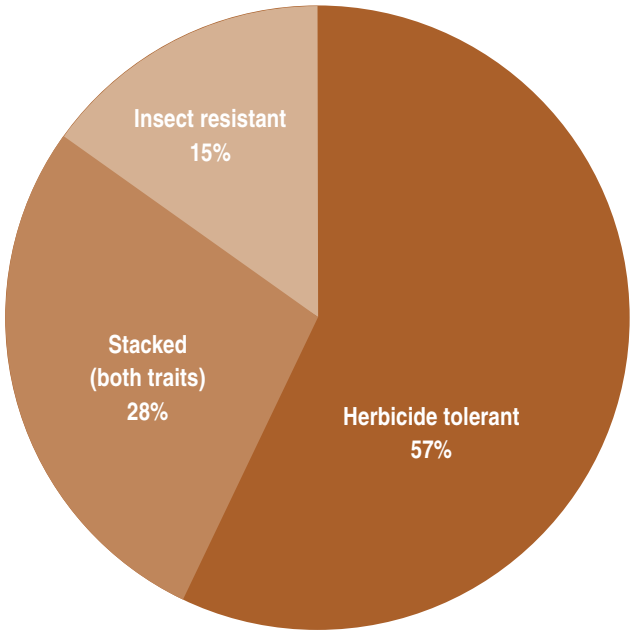
MAJOR GM CROPS

1. Soybean
2. Corn
3. Cotton
4. Canola

MINOR GM CROPS

5. Alfalfa
6. Sugar Beet
7. Papaya
8. Squash
9. Eggplant

Figure 2: GM traits as percent of total GM area



MAJOR GM TRAITS

- Herbicide tolerance
- Insect resistance

MINOR GM TRAITS

- Virus resistance
- Drought tolerance

See the GMO Inquiry report "Where in the World Are GM Crops and Foods?" for details.

Despite the industry's poor track record in delivering direct, or even indirect, benefits to consumers, Health Canada still projects optimism about **future GM products**. In 2015, in answer to the question "What are the potential benefits of the application of genetic modification to foods?", Health Canada's website states, "Benefits resulting from such changes may include longer lasting and better tasting fruits and vegetables, crops which require less use of pesticides, improved nutrient content in certain foods, etc. In general, food production could be more efficient or more inexpensive and may contribute to enhancing the global food supply."[17] These wide-ranging benefits are all *speculative* except for the failed promise of using fewer pesticides. CBAN has calculated that herbicide sales have increased by 130% over the timespan of GM crop adoption in Canada.[18]

For the first time in twenty years, new GM foods with potential consumer benefits (as opposed to the two major traits of herbicide tolerance and insect resistance) have been approved in Canada and the US, and could soon be on the market.

Table 1: GM Foods in Canada

GM CROPS GROWN IN CANADA

CROP	TRAIT	WHERE ON THE SHELVES
1. Corn	Insect resistant Herbicide tolerant	Corn flakes • Corn chips • Cornstarch • Corn syrup • Corn oil and other corn ingredients in processed foods • Sweeteners like glucose and fructose • Eggs, milk and meat* • Some sweet corn
2. Canola	Herbicide tolerant	Canola oil • Eggs, milk and meat*
3. Soy	Herbicide tolerant	Soy oil • Soy protein • Soy lecithin • Tofu • Soy beverages • Soy puddings • Eggs, milk and meat*
4. Sugar beet	Herbicide tolerant	Sugar

GM FOODS IMPORTED TO CANADA

FOOD	GROWN	WHERE ON THE SHELVES
5. Cottonseed oil	U.S.	Cottonseed oil • Vegetable oil in processed foods such as potato chips
6. Papaya	U.S. (Hawaii)	Papaya in fruit juices and other processed foods
7. Squash	U.S.	Some zucchini • Yellow crookneck and straightneck squash
8. Milk products (Bovine Growth Hormone)	U.S.	Milk solids and powder • Frozen desserts with dairy • Imported mixed drinks with milk ingredients

CERTIFIED ORGANIC FARMERS DO NOT PLANT GM SEEDS OR FEED ANIMALS GM GRAINS

*GM soy, canola and/or corn are commonly fed to livestock.

cban.ca/gmfoods for updates

These wide-ranging benefits are all ***speculative*** except for the failed promise of using fewer pesticides. CBAN has calculated that herbicide sales have increased by 130% over the timespan of GM crop adoption in Canada

The following sections list GM foods and their promised consumer benefits. Some of these crops could be approved soon, and others have already been approved. **Most of these GM foods are not on the market**: a few are on the market, some may soon make it to market, and others have totally disappeared.

TASTIER?

"FLAVR SAVR" TOMATO:

The first GM food approved in Canada and the US was the "Flavr Savr" tomato from the company Calgene, which was later bought by Monsanto. It was genetically modified to soften at a slower rate, so that the tomato could stay ripening on the vine longer before being picked for transport "resulting in more flavour."[19] (Tomatoes are generally picked unripe so they can survive transport to grocery stores and have a longer shelf-life). The GM tomato was launched in the US in 1994 and approved in Canada in 1995, but was taken off the market by Monsanto in 1997 due to financial problems.[20] Despite the disappearance of the "Flavr Savr", the industry was still using it as an example to advertise the consumer benefits of genetic modification three years later. A 2000 information kit circulated in Canada from the Council for Biotechnology Information (funded by Monsanto and other biotech companies) said, "Biotechnology is producing food that tastes better and stay fresh longer. Our new type of tomato ripens slowly, keeping it fresh for longer periods of time."[21]

STATUS **DISAPPEARED.**

Not on the market anywhere in the world. A small amount was on the market briefly in 1995/6 in the US and Canada only. There are no GM tomatoes currently on the market anywhere in the world.

MORE NUTRITIOUS?

VITAMIN-A ENHANCED "GOLDEN RICE":

A prominent example of a promised nutritionally enhanced GM food is rice that has been genetically modified to produce beta-carotene, which the body can convert into vitamin A. However, this product is still being tested and "it has not yet been determined whether daily consumption of Golden Rice does improve the vitamin A status of people who are vitamin A deficient."[22] Even if the GM rice can be proven to be both safe and effective, vitamin A can only be absorbed by the body when consumed along with fat, and children and adults suffering from malnutrition often do not have access to fat in their diets. In the meantime, there are many other solutions to vitamin-A deficiency being implemented. *For details and a broader discussion, see CBAN's report* www.cban.ca/GoldenRiceFactsheet

STATUS **NOT READY.**

No application for approval has been submitted to any government. It is still in field trials. (The first multi-location field-testing of the "most advanced versions" of Golden Rice began in 2012).[23]

HEALTHIER SOYBEAN OIL:

Two GM high-oleic soybeans have been developed by Dupont Pioneer and Monsanto, to produce cooking oils with less saturated fats and no trans fats. Monsanto says, "For consumers interested in heart health, Monsanto has developed a soybean that offers a better-health combination of higher monounsaturated fats, lower saturated fats, zero trans fats and improved stability."[24]

STATUS **APPROVED. NOT YET ON THE MARKET.**

Approved in Canada and the US but not yet on the market; pending approval in export markets.[25]

PURPLE TOMATO:

A tomato has been genetically modified with genes from a snapdragon plant, to contain high levels of anthocyanins and antioxidants normally found in fruits such as blueberries and blackberries (the flesh of the tomato is purple).[26] The media has reported various claims of health benefits that are disputed, including references to fighting cancer and the role of antioxidants in preventing disease.[27]

STATUS **NOT READY.**

Not approved anywhere in the world. In greenhouse tests in Canada.[28]

HEALTHIER?

POTATO WITH LESS BRUISING AND REDUCED ASPARAGINE:

A GM potato from the company Simplot, called "Innate", reduces the potential production of acrylamide, a suspected carcinogen, when the potato is fried. The GM potato also resists bruising. Simplot says, "Innate potatoes have fewer black spots from bruising, stay whiter longer when cut or peeled, and have lower levels of naturally-occurring asparagine, resulting in less acrylamide when cooked at high temperatures."[29]

STATUS **NOT APPROVED IN CANADA YET. ON THE MARKET IN THE US.**

The potato was approved in the US in 2015 and a small amount of fresh GM potatoes is reportedly on the market in the US,[30] from 400 acres harvested in 2014[31] and a few thousand acres in 2015[32]. Simplot says the GM potato is destined for potato chips and to be bought as fresh potatoes.[33] It is not yet approved in Canada and Health Canada will not disclose if it is currently evaluating the GM potato.[34] (A GM insect-resistant potato from Monsanto was approved in Canada in 1995. It was test-marketed but was taken off the market by Monsanto in 2001 due to consumer opposition.[35])

FEWER PESTICIDES?

GM HERBICIDE-TOLERANT CROPS:

GM herbicide-tolerant crops have increased rather than decreased the use of synthetic herbicides in farming. In 2000, the government-funded booklet *A Growing Appetite for Information* (see page 37) promised: "With the help of biotechnology, plants have been developed that tolerate these herbicides. This allows farmers to spray less often and use fewer chemicals."[36] However, CBAN's earlier *GMO Inquiry 2015* report "Are GM Crops Better for the Environment?" found that herbicide sales in Canada increased by 130% between 1994 and 2011.[37]

STATUS **ON THE MARKET. BROKEN PROMISE.**

Almost all of the four GM crops grown in Canada – corn, canola, sugarbeet and soy – are genetically modified to be herbicide-tolerant, and most are glyphosate-tolerant.[38] New GM herbicide-tolerant corn and soy, modified to be tolerant to the herbicides 2,4-D and dicamba, have been approved in Canada and the US and may soon be widely planted.

GM INSECT-RESISTANT CORN:

GM corn is modified to be insect-resistant through the use of genes from the bacteria *Bacillus thuringiensis* (Bt). (There are also varieties of Bt cotton grown in other countries.). Bt plants are toxic to certain pests and are designed to replace the use of certain insecticides. However, Bt crops have not consistently reduced insectide use, and a number of insects have developed resistance to the Bt toxin, reversing any benefits the crops may have offered.[39] Industry claimed that consumers would benefit from corn grown with fewer pesticides and less insect damage.[40]

STATUS **ON THE MARKET. UNDETERMINED BENEFIT.**

While over 80% of the grain corn grown in Canada is GM, only a very small, unknown amount of GM sweet corn is on the market.[42]

GM crops have increased the use of synthetic herbicides in food production. See the GMO Inquiry report "Are GM Crops Better for the Environment?" for details.

MORE CONVENIENT?

GM NON-BROWNING APPLE:

The Canadian government approved a GM non-browning apple in 2015. The company that developed the apple says that the suppression of browning means that the GM apples "have more eye appeal: no yucky browning"[43] and will therefore lead to more consumption of apples, particularly by "offering children the increased convenience and eye-appeal of apple slices rather than the whole fruit."[44]

STATUS **APPROVED IN THE US AND CANADA. NOT YET ON THE MARKET.**

According to the company, the GM apples could enter the market in late 2017.[45]

CHEAPER?

GM CROPS:

The Grocery Manufacturers Association of America says "GM technology helps keep the price of staple crops lower by as much as 15% to 30%".[46] However they provide no data to support this claim.[47] In fact, the price of food has not decreased,[48] and the vast majority of GM corn, canola and soy is used for livestock feed, processed food ingredients and biofuel production.

ARE GM FOODS SAFE TO EAT?

> After twelve years of reviewing the safety of novel foods, Health Canada is not aware of any published scientific evidence demonstrating that novel foods are any less safe than traditional foods.
>
> — Health Canada [49]

> Based on available evidence and inadequacy of the tests required by regulators, at present no GM crop and food can be categorically stated as safe to consume, especially on a long-term, life-long basis.
>
> — Michael Antoniou, 2013 [50]

THERE IS NO SCIENTIFIC CONSENSUS

In 2013, a group of 93 scientists, academics and researchers wrote a statement of "no scientific consensus" in response to claims "by GM seed developers and some scientists, commentators, and journalists that there is a 'scientific consensus' on GMO safety and that the debate on this topic is 'over'."[51] The statement (endorsed by over 300 researchers as of January 2015) was later published in a peer-reviewed journal (Hilbeck *et al.*, 2015) with the conclusion, "**the scarcity and contradictory nature of the scientific evidence published to date prevents conclusive claims of safety, or of lack of safety, of GMOs. Claims of consensus on the safety of GMOs are not supported by an objective analysis of the refereed literature.**"[52]

The statement argues that claiming that there is consensus on GM safety is "misleading and misrepresents the currently available scientific evidence and the broad diversity of opinion among scientists on this issue." Further, it argues that such a claim "encourages a climate of complacency that could lead to a lack of regulatory and scientific rigour and appropriate caution, potentially endangering the health of humans, animals, and the environment."[53]

What would scientific consensus on the safety of genetically modified food look like? Scientific consensus is understood as the collective judgment, position, and opinion of the community of scientists in a particular field of study; it implies general agreement, though not necessarily unanimity.[54] Supporters of GM technology have recently introduced an erroneous comparison between the scientific consensus in climate science and the state of the scientific debate over GM food safety.[55] This comparison is incorrect. However, contrasting the consensus in climate science with the disparate science on GM food safety exposes just how much science still needs to be done on GMOs.

According to NASA, at least 97% of actively publishing climate scientists agree that climate-warming trends over the past century are very likely due to human activities.[56] In contrast, on GM, as Hilbeck *et al.* say, there is a "diversity of opinion over GMOs in the scientific community" and "often contradictory or inconclusive findings of studies on GMO safety."[57] More importantly perhaps, the volume and rigour of study in climate science dwarfs the uneven investigations into GM food safety. The peer-reviewed literature on GM food safety questions mostly consists of short-term studies and is inconsistent in the GM crops studied, kinds of tests performed, the purpose and duration of tests, and test animals used.

In contrast to the wealth of climate science, the scientific literature on GM food safety questions was characterised (in 2000 and again in 2006) as "many opinions but very few data."[58] In his 2003 review of animal tests on GM foods, scientist Arpad Pusztai (who had conducted the first independent test, published in 1999) lamented the limited number of studies and the poor quality of the science. He stated, "there is absolutely nothing known about the potential hazards (if any) for human health" and also said, "We need more science, not less."[59] Though there has been more testing since 2006,[60] the scientific literature remains inadequate and has left many questions unexamined (see the following section on experimental testing for a more detailed discussion). Moreover, the majority of the science behind government approvals is generated by companies and is not in the public scientific literature (in Canada data submissions for regulatory safety assessments are classified as "Confidential Business Information"). As Hilbeck *et al.* summarize in 2015, "**In reality, many unanswered questions remain and in some cases there is serious cause for concern**."[61]

"No one has died"

Consumer concerns over the safety of GM foods are commonly met with the response that no one has died from eating GM food.[62] The World Health Organization articulates this as, "no effects on human health have been shown as a result of the consumption of such foods by the general population in the countries where they have been approved."[63] However, **there is no scientific basis for making such a statement**. There have been no studies on human populations to determine if there have been adverse health effects from eating GM foods and, without tracing or labelling of GM foods, such studies are not even possible.[64]

Additionally, the assertion that "no one has died" from eating GM foods is an inappropriate response to questions of safety, not only because it is unfounded, but also because it trivializes the need for public health protection. In particular, it is in opposition to the precautionary principle that advises taking action to *avoid risk*. As stated by Conrad Brunk, co-chair of the 2001 Royal Society of Canada's Expert Panel on the Future of Food Biotechnology, "**When it comes to human and environmental safety, there should be clear evidence of the absence of risks; the mere absence of evidence is not enough**."[65] The precautionary principle has also been summarized in these terms: "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically,"[66] along with the argument that it is the proponent of the activity, rather than the public, that should bear the burden of proof.

INHERENT RISKS OF THE PROCESS OF GENETIC ENGINEERING

The process of genetic engineering can create unintended and unpredictable changes in organisms that may have implications for health and safety. General statements of GM food safety assume that no unintended effects will be triggered and/or, if they occur, regulatory agencies across the world will be able to identify them, that they will take them seriously, and that they will take action to deny product approval until further tests can reliably show there are no negative impacts. **To state that GM foods in general are safe is to assume that the process of moving genes around will have no impacts beyond the planned changes to the organism. It is therefore a statement of ideology rather than one established in scientific fact**.

The debate over GM food safety can largely be described as a fundamental difference of opinion over the risks inherent in the process of genetic engineering (as well as over our ability to discover any resultant hazards and determine their possible health implications). **Health Canada, for example, states, "genetic modification does not introduce unique risks"**.[67] However, this statement is at odds with the concerns shared by many scientists that unintended consequences could arise, not only from the inserted transgene, but also from the process of gene insertion itself. The first independent animal feeding study on a GM food was conducted by Arpad Pusztai (1999) and it was also the first study to indicate adverse impacts could result from the process of genetic engineering itself.[68] **The fact that genetic engineering can result in organisms that successfully express new intended traits does not itself permit a conclusion that this is the only change that we can expect**.

Genetic engineering allows scientists to change plants or animals at the molecular level by inserting genes from other organisms – or, more recently, by directly editing the genomes of organisms and even making genes from scratch. With genetic engineering, scientists choose a desirable trait and then isolate the gene(s) associated with that trait, to insert them into the new target organism. Any inserted transgene is actually a whole assembly of various DNA pieces that are commonly sourced from a range of different species. These gene packages or "gene cassettes" also include DNA segments with various regulatory functions, such as a promoter (often from a virus) to make sure the gene will be active in the target organism. (*See the EcoNexus briefing What is Genetic Engineering? cban.ca/whatsGEbriefing*). Before genetic engineering, traditional methods of selecting and breeding the best specimens were used to attain desired traits. Creating new traits was also later done in the lab through the use of gamma rays, X-rays and chemicals to induce mutations (a process called mutagenesis).

Genetic engineering is unique because it gives scientists access to genes that may never have been available to traditional breeders. Many of these genes and the proteins associated with them have never been part of our human diet, or not in this form or context. The technology enables the direct transfer of genes between organisms in different species or even kingdoms that would not breed in nature. It also enables the introduction of new genetic sequences that do not exist in nature. As described by authors of *GMO Myths and Truths*, however, "The fact that the GM transformation process is unnatural and artificial does not automatically make it undesirable or dangerous. It is the consequences of the procedure, combined with the current lack of systematic assessment of potential risks, that give cause for concern."[69]

The uncertainties created by the process of genetic engineering are enhanced by the complexity of organisms and our limited understanding of this complexity. While the complexity that influences the processes within organisms is increasingly being recognized and identified, it is still not fully understood or defined. As the Royal Society of Canada's Expert Panel on the Future of Food Biotechnology described: "While our understanding of the intricacies of genetic interaction networks is still only poorly developed, it is clear that living cells are exquisitely tuned to both their internal and external environments. Perturbations in either will typically induce a spectrum of changes in gene expression, protein synthesis and metabolic patterns, all designed

to enhance the organism's ability to survive and thrive. Mutations in single genes have long been known usually to produce multiple effects (pleiotropic effects) within the mutated organism."[70]

In 2001, the Human Genome Project discovered that humans had far fewer genes than expected and, according to the paradigms and gene models of that time, there were not enough genes to explain the complexity of our inherited traits and the number of our proteins. Following this outcome, biologist Barry Commoner derided the "central dogma" of "one gene-one trait" that was the general framework of the science up to that point.[71] In 1995, Agriculture Canada had described that genes are "the basic unit of heredity and each gene is responsible for a particular characteristic."[72] While this explanation is the foundation of genetic engineering, it no longer accounts for our current, still incomplete, understanding of genetics. It is now understood, for example, that a single gene can influence, or be responsible for two or more seemingly unrelated traits (pleiotropy); equally, it can take multiple genes to trigger or create one single trait (polygeny).

The authors of *GMO Myths and Truths* provide a summary description of this complexity, that also poses major challenges for risk assessment: "Manipulating one or two genes does not just produce one or two desired traits. Instead, just a single change at the level of the DNA can give rise to multiple changes within the organism… genes do not act as isolated units but interact with one another and are regulated by a highly complex, multi-layered network of genetic and epigenetic processes (epigenetic effects are inheritable changes in gene expression or cells caused by mechanisms other than changes in the underlying DNA sequence)."[73] They conclude that, "**Because of these diverse interactions, and because even the simplest organism is extremely complex, it is impossible to predict the impacts of even a single GM gene on the organism**."[74] Ultimately, genetic engineering is used to transform plants despite our inability to predict all of the impacts of the process and our incomplete knowledge of how all the genetic material in organisms work.

Genetic engineering has been, and still is commonly described as a precise technology. Certainly it is described as more precise than traditional breeding, including by Health Canada. Health Canada (2015) says "The techniques of genetic modification permit scientists to transfer the genetic material responsible for these traits from one species to another in a faster and more precise fashion."[75] **While isolating and moving specific genetic material suggests precision, the process of genetic engineering is not precise and is, ultimately, also highly mutagenic**.

The GM foods on the market are the product of one of two gene delivery systems. New genetic material is transferred to target organisms either by infecting them with a bacterium that carries the transgene (*Agrobacterium*-mediated transformation) or by the use of a "gene gun" (particle bombardment). These techniques insert genetic material at random sites in the genome (a site of insertion cannot be precisely chosen or predicted) and this process itself can lead to unexpected changes, including altered expression of untargeted genes. As discussed in the report *Genome Scrambling* by Wilson *et al.* (2004), "In theory, plant transformation could result in exact insertion of a single transgene without further genomic disruption. In practice, this rarely, if ever, occurs."[76]

The transformation process itself induces mutations at the site of insertion and at random locations in the genome (Wilson *et al.* 2006).[77] Although mutations are not necessarily dangerous, their consequences can be extreme. Such mutations occur as unpredictable changes, with possible consequences for human health. "When mutations occur in functional DNA sequences they can result in loss of gene activity, altered gene function and altered gene expression, and may impact on proteins involved in complex gene regulation systems and biochemical pathways."[78] While mutations with observable (phenotypic) consequences can be subsequently bred out of GM plants (through multiple back crossing), other unexpected traits may remain.[79]

Wilson *et al.* (2004) observe, "Transgene insertion, by its very nature, disrupts the sequences into which it inserts. It is usually accompanied by additional rearrangement, duplication or deletion of plant genomic DNA and by insertion of superfluous DNA..."[80] Arpad Pusztai also said, "**When you are inserting the transgene construct, you are changing the whole genome. Anything can happen**."[81]

Unintended and unpredicted changes in GM crop plants can remain undetected for years. For example, in 2003, an independent study found that the structure of the transgene in Monsanto's GM corn MON810 differed from the description provided to regulators by the company.[82] The authors say their discovery suggests a genomic rearrangement involving the transgene insertion site. More recently, in 2013, European regulators discovered a "hidden" gene present in many commercialized GM crops - a substantial segment of the multifunctional Gene VI from Cauliflower Mosaic Virus.[83] Because it had not been identified, this gene was not examined as part of product risk assessments.[84]

Wilson *et al.* (2004) conclude: "As long as plant transformation [genetic engineering of plants] continues to be mutagenic, and while the genomic location of transgene insertion is not able to be controlled, we feel that it is unacceptable and inaccurate for transgenic plant breeders to claim that either plant transformation or its products are precise, predictable or innately safe."[85]

New technologies such as genome editing, in which DNA can be cut and changed at pre-destined locations (sometimes called "precision genome editing"[86]), are now being developed and tested. These technologies are often claimed to eliminate some of the risk factors generated by earlier techniques of genetic engineering. However, such claims remain unproven and these "New Breeding Technologies" could equally result in off-target (unintended) effects.[87] There are no GM foods yet on the market that have been developed using these technologies.

THE NEED FOR INDEPENDENT SCIENCE

Health Canada's assessments of GM food safety rely entirely on industry-generated science, except in the few cases where relevant studies already exist in the public literature. This reliance on information generated and owned by companies also means that the science behind Canada's GM food approvals is largely not in the public realm. This equally means that the science is not published, peer-reviewed science, and is therefore not actually part of the global scientific literature, available to the scientific community for comment and use. **Without peer review, the quality of the data assessed by Health Canada regulators cannot be verified**. The 2001 Royal Society of Canada's Expert Panel concluded that without access to the science behind GM food approvals, "there is no objective way for the public or independent scientists to evaluate fully the scientific rigor of these assessments."[88] The Panel was clear that, "Peer review and independent corroboration of research findings are axioms of the scientific method, and part of the very meaning of the objectivity and neutrality of science."[89]

Health Canada's assessments of GM food safety rely almost entirely on industry-generated science

Independence from industry in the production of science and in risk assessments is also important because **industry-funded studies tend to produce results that are more favourable to company products**. This trend of funding bias has been widely observed, for example in research on the health risks of nicotine[90] and in clinical drug trials.[91] In relation to GM foods, a 2011 review found that studies where authors had professional links to the biotech industry were strongly associated with conclusions of GM food safety and nutritional value.[92]

Independent animal feeding studies on GM food safety questions are rare.[93] There are a number of significant obstacles to conducting independent trials, including funding. The two-year study conducted by Gilles-Éric Séralini's team (2012/2014), for instance, cost 3.2-million Euro,[94] and the follow-up study commissioned by the European Commission is budgeted at 3.77-million Euro.[95] In 2007, the cost of 90-day animal studies was estimated at between $300,000 – $845,000 USD.[96]

Obtaining the actual test material (the GM material and the control isogenic lines from which the GM strains are derived) is also difficult, or even impossible, because the GM product is patent-protected. The companies that stand to profit from the commercialization of GM crops own the germplasm and the new genetic sequences, and can require researchers to sign contracts to get access to seeds. These contracts may require researchers to provide results before publication and get company permission to publish.[97] Scientists Judy Carman and Gilles-Eric Séralini both documented their difficulties accessing test grain.[98] In 2009, 26 corn entomologists wrote (anonymously) to the US government to complain about industry control over access to GM seeds for research.[99]

Conducting studies on such high-stakes questions can also expose researchers to hostile reactions on a global media stage. As the authors of *GMO Myths and Truths* summarize, "scientists who have published provocative results about GM crops have been vilified beyond any scientific justification."[100] In response to the public critiques of Gilles-Éric Séralini and his team, a group of scientists wrote an open letter arguing, "Séralini and colleagues are just the latest in a series of researchers whose findings have triggered orchestrated campaigns of harassment."[101] In fact, they refer to "systematic suppression of independent scientists working in the public interest". The scientists discuss this suppression as part of "fundamental challenges faced by science in a world increasingly dominated by corporate influence," challenges that they say are rarely discussed in scientific venues.[102]

The fact that government regulators around the world rely on data generated by corporations is a major reason why there is so little independent science on GM food safety questions – it is not required. Eight years ago, in 2007, scientists Terje Traavik and Jack Heinemann asked, "Will another 20 years pass before societies realise the urgent need for public funding of genuinely independent risk- and hazard-related research? The time for such investment is now, so that a new scientific culture with working hypotheses rooted in the Precautionary Principle can discover other, possibly even more important, questions of safety."[103] Such investments in public research have not yet been made, with notable exceptions such as the European Commission's funding to provide some follow-up to Séralini's study.[104]

There is a lot at stake in the investigation of GM food safety. The power of profit-seeking companies is one factor that is making it difficult for independent scientists to do their work. **The commercial pressures behind getting GM products to market are undeniably influencing how science is being done, and how much.**

The "Séralini Affair"

The global controversy over Gilles-Éric Séralini's long-term study on GM corn, and the herbicide Roundup, is the most visible recent dispute over an independent GM food safety study and serves as a warning to other independent scientists. (See pages 25-26 for information on this study.)

The results published in 2012 described harmful effects from the GM corn, both with and without the herbicide Roundup, on lab rats.[105] Much of the critical response was immediately hostile and even "vehement".[106] Dismissals of the study's methodology and disparagement of Séralini's reputation were fuelled and sustained by a coordinated response[107] including a campaign for retraction.[108] Ultimately, the article was retracted by the journal in 2013 – and then republished in another journal in 2014.[109]

GMWatch called the retraction of the Séralini study "illicit, unscientific, and unethical" and in violation of the guidelines for retractions set out by the Committee on Publication Ethics.[110] The guidelines set the grounds on which a journal should retract a paper: clear evidence that the findings are unreliable due to misconduct (e.g. data fabrication) or honest error, plagiarism or redundant publication, or unethical research. None of these were at play in the stated reason (inconclusive results[111]) for retracting Séralini's study.[112] Whatever the challenges to the study's methodology, retraction was not a justified response.

Retraction removes a study from the scientific literature such that it cannot be referenced and used in future scientific examination; the work cannot be explicitly investigated and built upon by other scientists. Séralini and his team ultimately called this move censorship and said, "Censorship of research into health risks undermines the value and the credibility of science."[113]

For their part, in 2012, Health Canada and the Canadian Food Inspection Agency responded to the Séralini *et al.* study in broad strokes: "The methodology used was inadequately described, the full data set was not presented, and the data that was reported was not presented in a transparent manner. Furthermore, the statistical methods used by the authors to analyse the data were judged to be inappropriate. These limitations make the validity of the study results difficult to determine."[114] Health Canada had approved the GM corn tested by Séralini's team (NK603) in 2001 without reference to any data from animal feeding trials, four years before Monsanto published its own 90-day trial.[115]

The serious implications of this one study largely explain the wave of heated response, the global media attention and the public responses from regulatory agencies around the world. As the authors of *GMO Myths and Truths* describe, "An objective analysis of Séralini's study would conclude that long-term chronic toxicity and carcinogenicity studies are needed on all GM foods and complete commercial pesticide formulations before they are commercialized."[116] Such an analysis would put all past and future approvals of GM foods in jeopardy.

Specific criticisms of the study's methodology have been variously answered, including by Séralini's team,[117] in the publication GMO Myths and Truths, *and via the website www.gmoSeralini.org. For a detailed documentation of the arguments back and forth, see the list of resources posted at* ***www.cban.ca/Seralinireponse***

THE LACK OF EXPERIMENTAL TESTING FOR SAFETY

We commonly hear that "foods derived from GM crops have undergone more testing than any other food in history."[118] This includes, for example, the statement from company Okanagan Specialty Fruits that their newly approved GM non-browning apples are "likely the most tested apples in existence."[119] These are technically correct but meaningless statements. Until foods came from the lab, they were not tested in the lab. Moreover, such testing of GM foods is actually warranted. As it happens, GM foods have not been extensively and consistently tested, and the quality and rigour of this testing is in dispute.

It has been twenty years since the Canadian government approved the first GM crops and foods, and **there are only a few long-term animal feeding tests that correspond with any of the GM foods currently on the market**.[120] Four recent long-term studies were conducted by independent scientists, **years after the GM products were approved by Health Canada**. The first is Séralini *et al.*'s long-term test on Monsanto's GM corn NK603, initially published in 2012,[121] a full 10 years after Health Canada's approval (the 2012 study was retracted and then republished in 2014[122]).[123] The second is the first-ever long-term toxicology study on mixed GM corn and soy from Judy Carman *et al.*, published in 2013.[124] (Both these studies are discussed in the following pages.) There are only two other long-term studies that that investigate the effects of a GM glyphosate-tolerant crop along with its herbicide - both were conducted in 2008 (Malatesta *et al.* and Sakamoto *et al.*). The specific GM soy tested by Malatesta *et al.* was approved by Health Canada in 1995.[125] **There is a lack of long-term testing supporting the release of GM foods onto the market in Canada…but does this matter?**

Hilbeck *et al.* (2015) state, "Rigorous studies investigating the safety of GM crops and foods would normally involve, [among other things], animal feeding studies in which one group of animals is fed GM food and another group is fed an equivalent non-GM diet."[126] Michael Antoniou maintains that the increasing body of evidence showing disruptive effects of genetic engineering and signs of toxicity in animal feeding studies "demand that toxicity be confirmed or refuted in life-long animal feeding studies."[127]

However, it is not universally agreed that animal feeding tests are necessary to determine the safety of GM foods.[128] For example, **Health Canada does not require any animal feeding studies on GM food.** Without this requirement, it appears that very few animal feeding trials have been provided to Health Canada for GM food safety assessments.[C] For example, there were no animal feeding trials conducted to investigate possible risks from the recently approved GM non-browning apple[129] and Health Canada's summary Decision Document on the GM corn NK603 does not indicate the use of data from any animal feeding trials[130] (CBAN has asked Health Canada to confirm but the department will not provide information beyond what is stated in the Decision Document[131]). In responding to the Séralini *et al.* 2012 paper, the French Agency for Food, Environmental and Occupational Health & Safety (ANSES) set up an emergency expert assessment group which remarked on the "controversy in the scientific community" over "whether current assessment methods can detect potential long-term effects and the plausibility of these effects."[132] They further stated that this debate is likely to continue, "given that there are so few studies documenting these effects."

Until 2013 when the European Commission made 90-day feeding trials mandatory,[133] China and Russia were the only countries that required such tests for GM food safety assessments.[134] Some companies choose to conduct such tests and submit this data for government safety assessment but these experiments are not mandatory in Canada. Health Canada says that, "Given that the application of genetic modification does not introduce unique

C A 2000 analysis of Health Canada's summary "Decision Documents" by University of Guelph associate professor Ann Clark determined that 70% of the GM crops approved "have not been subjected to any actual lab or animal toxicity testing" and that the remaining 30% of assessments included trials with single purified proteins (as opposed to dietary feeding). None of the studies appear to have been published in the refereed literature. (*Food Safety of GM Crops in Canada: toxicity and allergenicity*, E. Ann Clark. 2000.)

risks, the potential for long term effects of these foods are no different than that for conventional foods which have been safely part of the Canadian diet for a long time. Therefore, there is no current evidence to indicate that long term studies are needed to ensure the safety of foods produced using this technology."[135]

Monsanto has published animal feeding tests on some GM foods now on the market (the longest is 90-days) but the company argues that such tests are not necessary. "As long as the introduced gene protein is determined safe (an initial step in the safety assessment) and the GM and non-GM crops are alike in all respects, the GM crop is said to be substantially equivalent, or 'equal to,' their conventional counterparts and are not expected to pose any health risks. Experts in the field of food safety are satisfied that this approach is sufficient and reliable to assure the GM crops are as safe their conventional counterparts. This expert community does not see a need and thus does not recommend long-term tests in humans in order to establish food safety."[136] The industry-funded group ISAAA (the International Service for the Acquisition of Agri-biotech Applications) argues that feeding high doses of purified transgenic proteins, versus testing whole GM foods, is "sufficient to evaluate the toxic potential of the new proteins."[137]

The necessary length of such tests is also in dispute. **Most animal feeding studies on GM foods have only been short or medium-term in duration**.[138] When they are conducted, 90 days is the general guideline for the length of animal trials.[139] This timeframe is roughly equivalent to 7 years (or ten percent of the lifespan of test animals) while two-year feeding studies are equivalent to 60-65 years and can be considered long-term.[140] The presumption is that any meaningful effects will be seen before the 90-day mark and so further testing is not necessary. Thus far however, there is no clearly stated rationale for ending tests at 90 days. Ulrich E. Loening argues, "One might note that the protocol of 90 days became the norm after it was set arbitrarily by Monsanto in its applications and has been since adopted by others without question or any apparent justification."[141] The Senior Editor of Nature Biotechnology, Laura DeFrancesco, says that "this notion appears to have come from studies carried out in the 1990s by the US National Toxicology Program" and quotes Martijn Katan, emeritus professor of nutrition at Amsterdam's VU University, who says, "Ninety-day rat trials are more or less dogma for the lack of anything else."[142]

While short-term studies can be used to rule out acute toxicity, they do not investigate chronic health issues or provide evidence on long-term safety. The authors of *GMO Myths and Truths* argue, "Effects that take a long time to show up, such as cancer, severe organ damage, compromised reproductive capacity, teratogenicity, and premature death, can be reliably detected only in long-term and multigenerational studies."[143]

There were very few published (peer-reviewed) studies examining GM foods until 2006, after which the number of citations "dramatically increased", though "the number of studies specifically focused on safety assessment of GM plants is still limited".[144] Nature Biotechnology's 2013 survey only found 30 feeding studies assessing chronic effects in the scientific literature.[145] It appears that since this survey and the literature reviews of Domingo and Bordonaba (2011)[146] and Snell *et al.* (2012)[147], there have been two peer-reviewed long-term studies on GM foods (Carmen *et al.* 2013 and Seralini *et al.* 2012/2014 described pages 25-26).

Importantly, in discussing the Nature Biotechnology survey, Laura DeFrancesco noted the same issue that Domingo and Bordonaba, and Snell *et al.* also discussed: that the scientific literature is inconsistent in terms of the kinds of tests performed (methodologies), the questions and parameters studied, the duration of tests, which GM foods were studied, and the choice of test animals (pig vs. mice etc.).[148] Additionally, as discussed by Sheldon Krimsky (2015) when he examined eight literature reviews, reviewers also made different choices about the endpoints they evaluated, the journal articles selected, how they weighted the importance of studies, and how they interpreted the weight of evidence.[149] The authors of *GMO Myths and Truths* are careful to point out that (as is the case in the Snell *et al.* review) **many "big lists" of tests on GM foods also include studies that do not actually examine food safety questions but investigate production issues relevant to animal farming**.[150]

Various reviews come to different conclusions about what the evidence shows.[151] Domingo and Bordonaba note, as of 2010, a balance ("a certain equilibrium") between the number of studies that suggest safety and those that raise concerns.[152] But they also say, "it is worth mentioning that most of the studies demonstrating that GM foods are as nutritional and safe as those obtained by conventional breeding, have been performed by biotechnology companies or associates, which are also responsible of [sic] commercializing these GM plants."[153]

Interpreting the results of studies is often controversial. Many industry studies have observed statistically significant effects in GM-fed animals that the authors have dismissed as not biologically relevant or not adverse.[154] The authors of *GMO Myths and Truths* say that these terms "have not been properly defined with respect to GMOs" and may be used to dismiss potentially relevant and important results.[155] They argue that analyses of the data in many short- and medium-term feeding studies conducted or funded by industry show that GM foods can be toxic, allergenic, or have unintended nutritional changes. For instance, in 2007, Séralini, Cellier and de Vendomois analyzed the data from Monsanto's 90-day animal feeding test on the GM corn MON 863 (the corn had been approved in Europe in 2005 and the data was released as a result of a court case that same year).[156] The scientists argue that the data could not lead to a conclusion of safety. In 2009, Séralini, Cellier, Roullier and de Vendomois examined the data from tests on three commercialized GM corn (NK 603, MON 810, MON 863). Their analysis revealed new side-effects, including some that may be "due to the new pesticides specific to each GM corn. In addition, unintended direct or indirect metabolic consequences of the genetic modification cannot be excluded." This analysis led Séralini to conduct the first long-term test on NK 603.

Séralini's long-term test on GM corn and Roundup (2012/2014) merited intense scrutiny partly because it was so unique. The French regulatory agency ANSES, while responding that Séralini's conclusions were not sufficiently supported by the study data, nonetheless drew attention to "the originality of this study, namely its focus on a subject rarely investigated to date: the long-term effects of GMOs in association with plant protection products."[157] ANSES emphasized "the small number of published studies dealing with the potential long-term effects of the consumption of GMOs in association with pesticides and recommends undertaking research into these issues" (their own literature search found only two long-term studies that were comparable to Séralini's) and called for national or European funding to "enable large-scale studies and research for consolidating our knowledge of insufficiently documented health risks." **In response to the Séralini study, the European Commission launched a two-year combined toxicity/carcinogenicity study of the same GM corn (to be completed by 2018[158])**.

The authors of *GMO Myths and Truths* argue that "What is needed are long-term and multi-generational studies on GMOs to see if the changes found in short- and medium-term studies, which are suggestive of harmful health effects, develop into serious disease, premature death, or reproductive or developmental effects."[159] Following such animal feeding trials, they argue that we also need farm-animal toxicity studies and long-term human trials. The Royal Society of Canada's Expert Panel similarly stated that, "relatively short-term animal tests may yield valuable information, but establishing the impacts of long-term ingestion of a food would involve the systematic monitoring of human populations."[160] Arpad Pusztai said "Animal testing is but a first step and there is no substitute for human studies. If there is no indication of harm to the animals, the results will have to be validated with human volunteers in a clinical double-blinded, placebo-controlled drug-type test. Such studies may have to go on for considerable lengths of time."[161] Such testing would also need to consider the different impacts possible in the sick, young and elderly.

In 2014, a Russian non-governmental organization announced the launch of a large, independent long-term study (2-3 years) on a GM herbicide-tolerant corn, to be comprised of toxicity, carcinogenicity and multi-generational (5 generations) animal feeding experiments. The *Factor GMO* project maintains that "there has never been a scientific study that is

comprehensive enough to give them [the public] a clear answer regarding the safety for human health of any one GM food" and proposes, therefore, to conduct such a study.[162] The experiments will cost $25-million dollars and involve scientists testing thousands of rats fed different diets of a Monsanto GM corn and its associated glyphosate-based herbicide. The group expects the study to provide data to answer the following questions:

- Is the GM food (or its associated pesticide) toxic to organ systems over the long-term?;
- Does the GM food (or its associated pesticide) cause cancer, reduce fertility or cause birth defects? and;
- Is the mixture of chemicals present in Roundup herbicide more or less toxic than its active ingredient glyphosate?

Oxana Sinitsyna, Deputy Director of Science at the A.N. Sysin Research Institute of Human Ecology and Environmental Health in the Ministry of Health of the Russian Federation and one of the three scientists on the *Factor GMO* review board, said: "The scale and format of this research project will allow us to create a really objective and comprehensive data set on the mechanics of the impacts of a GM diet on the health of living organisms over the long term."[163]

WHAT THE EXISTING LONG-TERM STUDIES TELL US

As Hilbeck *et al.* (2015) observe, some independent animal feeding studies have revealed toxic effects or signs of toxicity. Critically, "The concerns raised by these studies have not been followed up by targeted research that could confirm or refute the initial findings".[164] Two recently published long-term animal feeding studies tested GM foods that Canadians have been eating for many years. Unusually, the first study did trigger a follow-up study, funded by the European Commission, which is currently in progress.

SÉRALINI *ET AL.* (2012/2014) – NK603 CORN

The long-term (2-year) animal feeding test on GM corn NK603 conducted by a team of scientists in France, led by Caen University molecular biologist Gilles-Éric Séralini,[165] was the most in-depth study ever carried out on a GM food and its associated pesticide. The toxicological study was first published in September 2012 in the peer-reviewed journal *Food and Chemical Toxicology*, and then, following intense controversy, was retracted by the journal in November 2013 and republished in *Environmental Sciences Europe* in 2014 (See page 21 for discussion of this event). This study has been subject to much debate internationally. While Health Canada, for example, states that the statistical methods used by the authors to analyse the data were inappropriate,[166] others defend the integrity of the study.[167] **The Séralini study is particularly important for Canadians because Health Canada approved the GM corn NK603 in 2001, ten years before this first long-term study** (and three years before publication of Monsanto's 90-day feeding trial).

This study is unprecedented, as was acknowledged by the expert team assembled by the French government to analyze it. While they concluded that the data could not corroborate the interpretations of Séralini's team, they acknowledged that, "This study is unique in that over this long period and using several doses, it tests both a GMP [genetically modified plant] cultivated with and without treatment by a plant protection product and the complete plant protection formulation by itself. In this respect, no equivalents have been found in the literature. It is also distinctive in that it monitors a large number of blood and urine parameters and the authors indicate it was undertaken in a GLP [Good Laboratory Practice] environment."[168]

To test the question of chronic health impacts, Séralini's team conducted a feeding trial of the GM corn over two-years (generally the lifespan of lab rats). The corn is genetically engineered to be tolerant to Monsanto's glyphosate-based herbicide "Roundup" (fields of GM corn can be sprayed with Roundup and the weeds die while the GM plants

lives). The rats were fed three different diets: the GM corn alone, the GM corn grown with Roundup (with Roundup residues, reflecting how the corn is grown) and Roundup alone.

The Séralini team observed various effects due to Roundup and to the GM corn itself. Organ damage was detected in rats fed the GM corn, with and without Roundup residues, as well as rats fed Roundup alone in drinking water, at levels below those permitted in drinking water in the EU. The researchers found increased kidney and liver damage and hormone disruption in most treatment groups. Although this study was a chronic toxicity study rather than a carcinogenicity study, the team reported the tumours they observed, as recommended by international guidelines and because some types of tumours may indicate problems that need to be explored.[169] The first tumours were observed one month after the 90-day test mark and peaked at 18 months.

If the results of the study are validated, the implications are serious for the future of GM food safety assessment, and the future of GM foods. There is clearly a need for further research on these findings.

CARMAN *ET AL.* (2013) – MIXTURE OF GM SOY AND CORN

Judy Carman *et al.* conducted a long-term toxicology study on pigs.[170] The pigs were fed a mixture of GM corn and soy: corn with double and triple-stacked GM traits (three GM proteins in total, for herbicide tolerance and insect resistance) and GM soy (herbicide-tolerant Roundup Ready). This mixture reflects a common use of GMOs in the diet of food animals in North America. The pigs were fed the GM soy and corn for five months. The authors maintain that, "unlike most studies done to date we used enough animals to obtain statistical significance for biologically significant results."[171] The authors also note the significance of their choice of pigs because pigs have a similar digestive system to humans, "and because some of the investigators had been observing reproductive and digestive problems in commercial pigs fed GM crops."[172] The authors summarized their findings for the public:

- *"We found that, on average, the **weight of the uterus** of pigs fed the GM diet, as a proportion of the weight of the pig, was 25% higher than the control pigs. We found that this biologically significant finding was also statistically significant. This finding is consistent with observations previously made by some of us on farms."*
- *"We found that the level of **severe inflammation in stomachs** was markedly higher in pigs fed the GM diet. Pigs on the GM diet were 2.6 times more likely to suffer severe stomach inflammation than control pigs. While 22% of male pigs and 42% of female pigs on the GM diet had severe stomach inflammation, when these pigs were compared to pigs on the control diet, it was found that male pigs were actually more strongly affected. While female pigs were 2.2 times more likely to suffer severe stomach inflammation when on the GM diet, males were 4 times more likely. These findings are both biologically significant and statistically significant. This finding is consistent with observations previously made by some of us on farms."*[173]

The authors conclude: "Pigs fed a GMO diet exhibited heavier uteri and a higher rate of severe stomach inflammation than pigs fed a comparable non-GMO diet. Given the widespread use of GMO feed for livestock as well as humans this is a cause for concern. **The results indicate that it would be prudent for GM crops that are destined for human food and animal feed, including stacked GM crops, to undergo long-term animal feeding studies preferably before commercial planting, particularly for toxicological and reproductive effects**. Humans have a similar gastrointestinal tract to pigs, and these GM crops are widely consumed by people, particularly in the USA, so it would be prudent to determine if the findings of this study are applicable to humans."[174]

For 20 years, livestock in North America have also been fed an increasingly steady diet of GM soy, corn and canola (and some GM alfalfa in the US). This study was the first to examine a diet of mixed GM feed, approximating the on-farm reality.

POTENTIAL RISKS TO HUMAN HEALTH

In 2001, the Royal Society of Canada's Expert Panel on the Future of Food Biotechnology categorized the potential direct risks to human health as: the possible creation of new toxicants, possible shifts in the nutrient content of food, and the possible creation of new allergens.[175] These are the commonly named potential health risks and each of these risks must be investigated with each GM food. As documented in detail by the authors of *GMO Myths and Truths*, existing studies show that GM foods can, indeed, be toxic, allergenic, or have unintended nutritional changes.[176] A brief summary of some of these risks is below.

TOXICITY

Can genetic modification result in foods that are more toxic than non-GM foods? **Many studies show signs of toxicity (such as in the kidney and liver, which could mark the onset of chronic disease) and some show actual toxic effects (such as damage to organs)**[177] (see the earlier discussion of the Séralini *et al.* and Carman *et al.* studies, for example). Replicating studies can confirm or overturn these results, and further tests could determine the significance of these observed effects for human health as well as begin to identify what factors may be responsible.

The safety of GM foods is largely based on the assumption that DNA in GM foods (transgenes) will be degraded in the gut. The industry-funded group ISAAA says, "toxins of commercialized GM plants are easily digestible in a short time, thus, they are non toxic to humans,"[178] and, in 2002, the World Health Organization determined that the probability of DNA uptake by gut microflora or human cells was minimal.[179] However, in 2007, Terje Traavik and Jack Heinemann added this question to their list as "yet another area of omitted research."[180]

The possibility that toxic, immunogenic/allergenic or carcinogenic molecules may enter the body through cells in the gastrointestinal walls is a concern.[181] If DNA or DNA fragments survive in the gut, genetic material may transfer to gut bacteria itself (including antibiotic resistant genes used in GM transformation). If small fragments of DNA pass through the gut wall, they could enter blood, organs and tissues leading to toxic effects (including the development of chronic disease conditions).

Bt toxins (from the soil bacterium *Bacillus thuringiensis*) are genetically engineered into plants to kill insects, and the assumption is that the Bt proteins are not harmful to humans because they are degraded in the gut, but this is under question via various studies.[182] A 2011 study from Aziz Aris and Samuel Leblanc at the University of Sherbrooke in Quebec found a Bt toxin (Cry1Ab) in the blood of pregnant women and their foetuses.[183] There is dispute over the test used and the study's detection of Bt,[D] but in their response to Monsanto's comment on their study, Aris writes, "since this protein is of bacterial origin and can kill insects, it is legitimate to question whether it can also harm human cells."[184] The authors of *GMO Myths and Truths* say, "This study raises questions as to why GM Bt crops are being commercialized widely without investigating the fate and potential effects of Bt toxin in humans."[185]

The toxicity of the herbicides used with the majority of GM crops is also in need of scrutiny. Globally, 85% of all GM crops are genetically engineered to be tolerant to particular herbicides (the majority to glyphosate-based herbicides) and are therefore grown with those synthetic chemicals. Earlier research by CBAN in the *GMO Inquiry* found that sales of herbicides in Canada increased by 130% from 1994 to 2011, and glyphosate use tripled between 2005 and 2011.[186] Similarly, herbicide use, and glyphosate use in particular, has greatly increased in the US and several countries in South America, as the area under Ht crops has grown. *For details see the GMO Inquiry report "Are GM Crops Better for the Environment?"*

D The origin of the Cry1Ab protein (if this is what was detected) in Aris *et al.* is also disputed (by the New Zealand food safety authority, for example) because the authors did not survey the diets of the test subjects; Is the protein from eating GM Bt corn or exposure to residues from the use of Bt spray in agriculture? However, CBAN's research generally rules out alternative explanations – including because the use of Bt sprays in vegetable farming in Quebec is limited and the use of Bt in tree plantation pest control occurs in the North of Quebec, far from where the test subjects lived.

The UN Codex guideline for GM food safety assessment notes that some GM traits such as herbicide tolerance "may indirectly result in the potential for accumulation of pesticide residues" and recommends that GM food safety assessments take this into account.[187] This has not, however, been fully considered in GM food assessments. Séralini's test of the GM corn NK603 (2012/2014) was the first animal feeding trial to test a GM herbicide-tolerant crop, with and without herbicide residue. Séralini also tested the control feed for pesticide residues and studies have since exposed that diets for rodent testing are also contaminated with agricultural pesticides (possibly compromising the results of animal trials).[188] A 2015 article in the New England Journal of Medicine by Landrigan and Benbrook asks the US National Toxicology Program to "urgently assess the toxicology of pure glyphosate, formulated glyphosate, and mixtures of glyphosate and other herbicides" because of inadequate assessment and increased use with GM crops.[189]

In 2015, the World Health Organization's International Agency for Research on Cancer concluded that glyphosate is a "probable human carcinogen"[190] and that 2,4-D is a "possible human carcinogen".[191] Recent unprecedented testing of the glyphosate-based herbicide formulation Roundup has also found that the formulation is more toxic than glyphosate itself.[192] Of additional concern are the effects of using various herbicides together,[193] such as with Dow's GM corn and soy that are genetically modified to be resistant to both glyphosate and 2,4-D (Dow's "Enlist Duo" herbicide).

Governments determine Maximum Residue Levels (MRLs) of pesticides allowed in/on our food, but how these are set is not clear in Canada, as levels are periodically increased without scientific justification.[194] In Canada, test data used to monitor MRLs is not publicly available. Health Canada's recent re-assessment of glyphosate referenced US diet data from the 1990s[195] despite the fact that glyphosate use has dramatically increased in both the US and Canada. In Canada, monitoring for pesticide residues in grains, pulses and oil seeds falls to the Canadian Grain Commission which tests raw grains (prior to processing) for compliance with foreign requirements, not for domestic residue assessments.[196]

Direct exposure to agricultural pesticides from aerial spraying and contaminated water is also a serious and immediate public health concern resulting from the use of GM crops in some countries. This concern is particularly urgent in South America where the use of Monsanto's glyphosate-based herbicide Roundup has increased dramatically with the wide-spread adoption of GM herbicide-tolerant soy.[197] For example, in Argentina, there is an unfolding health crisis where birth defects and childhood cancers have increased dramatically since the introduction of GM soy.[198] Repeated exposure to pesticide spraying in South America has led to advocacy for the rights of "fumigated people" including a call for an immediate ban on glyphosate and other herbicides that could replace it, as well as demands for reparations to affected peoples.[199] **The health risks of agrochemicals mean that fully assessing the safety of GM foods also requires an assessment of the safety of associated pesticides and the ways in which they are used with GM crops**.[200] An evaluation of the safety of GM foods must include a system-wide evaluation of the possible health, environmental and social impacts of using GM crops.

ALLERGENICITY

The cause of the increase in food allergies[201] in North America is largely unknown.[202] The question of allergenicity remains problematic for GM food risk assessment and, as the Royal Society of Canada's Expert Panel pointed out, the likelihood of allergic risk will rise with an increased range of GM foods on the market and increased dietary exposure.[203]

Food allergies are caused when the body's immune system reacts to food proteins as if they are harmful. An allergic response could be triggered by exposure to a foreign protein that has never been consumed in food before or to an increased level of naturally occurring allergens (an increase in the endogenous allergenicity of a food) triggered by the insertion of new genetic material (as, arguably, seen in the case of the GM salmon discussed below).

The use of genetic material from known allergenic foods is now generally avoided as per the Codex

recommendation.[204] The assessment of allergenicity in such cases is relatively straightforward,[205] as in the case of a soybean that was genetically modified with a gene from Brazil nut. This GM soybean triggered an allergic response in people who had allergies to Brazil nuts. The company that developed the soybean, Pioneer Hi Bred, did not expect to find allergenicity.[206]

The detection of allergenicity in GM foods is otherwise difficult, and there is no single reliable method or test.[207] Allergenicity investigation therefore relies on other available information,[208] including from comparing the structure (amino acid sequence) of the new protein to structures of known allergenic proteins, and assessing the digestibility of the protein.

If the proteins in GM food are not broken down in the gut, the food could trigger an allergic response. Bt proteins, originating from the soil bacterium *Bacillus thuringiensis* are used to develop GM insect-resistant corn. The potential for Bt to be a food allergen is supported by the case of Bt "StarLink" corn that was approved in the US for animal feed but not for human consumption because of its suspected allergenic potential. The company's initial studies found that the Cry9c protein (unique to StarLink and not currently on the market) was stable/did not digest rapidly in simulated gastric fluid, and the US Environmental Protection Agency (EPA) concluded that it was therefore likely to survive processing and digestion, to possibly interact with the human immune system.[209] The EPA could not conclude "reasonable certainty of no harm."

In the case of the GM Atlantic salmon, Consumers Union in the US argues that company data shows the GM salmon has a higher allergenic potency than non-GM salmon.[210] Consumers Union is also asking the US Food and Drug Administration to get data from GM salmon reared in the same conditions where it will be produced (Panama) to ensure that the production conditions do not increase the levels or potency of allergenic proteins. This request is consistent with Codex guidelines.[211] The concern that environmental conditions may alter transgene expression and protein content was validated by a 2015 test (the first test of its kind).[212]

There is no reliable way to discover if a GM food is allergenic before it is released onto the market.[213] (see page 33 on tracing and monitoring).

USE OF ANTIBIOTIC RESISTANT MARKER GENES

Genetic engineering makes use of selectable marker genes to determine if the new genetic material was successfully inserted into the host organism – antibiotic resistant marker genes are inserted as part of the genetic sequence (the gene-cassette) and the cells that survive antibiotic treatment are those that carry the new genetic material. Though the use of antibiotic resistant genes is widely discouraged, especially because there are other marker genes and other methods of selection available, most of the GM foods on the market in Canada make use of such genes, including the newly approved GM non-browning apple.

Antibiotic resistance in disease-causing bacteria is an increasingly serious global problem that puts the future of antibiotic medical treatment at risk. Bacteria develop resistance to antibiotics by creating antibiotic resistance genes through natural mutation and the concern is that bacteria living in the guts of humans and animals could pick up an antibiotic resistance gene from a GM food before the DNA is completely digested. While both the World Health Organization and the European Commission describe the probability as low, they discourage the use of such genes.[214] The European Commission (EC) says, "Even if resistance genes from GMOs were transferred to bacteria in a few cases, the rise in the number of antibiotic resistant bacteria in our environment would be immeasurably small."[215]

While the World Health Organization maintains that the transfer and functional integration of DNA from GM foods to cells in the body or gut bacteria is a minimal risk, it nonetheless marks this as important in relation to the use of antibiotic resistant marker genes. Codex says, "the possibility of such events cannot be completely discounted."[216] The EC also notes, "if GM plants with antibiotic resistance genes are planted over a very large area, the rare event of gene transfer to other organisms (horizontal gene transfer) could become significant."[217]

In 2013, new European Commission regulations reiterated that companies should "aim to develop GMOs without the use of antibiotic resistance marker genes."[218] In 2001, the Royal Society of Canada's Expert Panel recommended that, especially in light of available alternatives, "antibiotic resistant markers should not be used in any GM food intended for sale in Canada."[219] **Since 2001, Health Canada has approved GM foods that use antibiotic resistant marker genes**.

The approval of the use of such genes is now differentiated in relation to their clinical use of the antibiotics.[220] Genes that are resistant to the antibiotics kanamycin and ampicillin are the most commonly used marker genes. Because ampicillin is still widely used in both human and animal medicine, the European Food Safety Authority (EFSA) recommends not approving the use of ampicillin for GM plants.[221] EFSA lists kanamycin as rarely prescribed and so EFSA has no objection to its use[222] (as used in the GM non-browning apple). However, kanamycin is used to treat multi-drug resistant tuberculosis and is listed by the World Health Organization in a category called "critically important" for human medicine because, along with other aminoglycosides, it is a sole or limited therapy for certain conditions.[223]

THE ROLE OF DIETARY EXPOSURE

Our exposure to GM foods is increasing and it is also changing in form over time. It is increasing with the expanding agricultural use of GM traits, including the commercialization of plants with multiple GM traits stacked together. It is also changing over time as different types of GM foods, such as whole fruits and vegetables (as in GM sweet corn) rather than processed food ingredients (such as GM grain corn that is processed into food ingredients and used for animal feed), enter the marketplace.

The Royal Society of Canada's Expert Panel noted the necessary role of considering dietary exposure in risk assessment: "Toxicological effect is related not only to the food we are exposed to, but to the amount of exposure as well."[224] The Panel said that the potential risk of developing toxic or allergic reactions to GM foods would likely rise with increased exposure. Monsanto acknowledges this question as relevant when it says that, for example, "Cry1Ab [Bt protein] has been subjected to extensive safety assessment accounting for human exposure with a large margin of safety."[226]

Minutes from a 2002 Health Canada meeting identified the need to assess the cumulative effect of exposure to GM foods and the need to examine food consumption patterns.[227] However, **government regulators in Canada do not know our level of dietary exposure to GM foods**. There is no monitoring of human consumption of GM foods in Canada. Further, the Canadian government does not have precise data on how much GM corn, soy, canola and sugar beet is grown, does not have any data on which GM traits are currently in use and how much, and does not track the form in which these foods are consumed.[228] For example, in Monsanto's challenge to the Canadian Aris and Leblanc (2011) study on Bt in the blood, the company said that human consumption of the GM Bt protein Cry1Ab (via GM corn) is "expected to be quite low."[229] However, scientists and the public have no access to the information behind Monsanto's expectation. Companies hold proprietary knowledge of GM trait sales that, in the absence of government tracking, could help determine dietary exposure.

CBAN's first report in the *GMO Inquiry 2015* determined that almost all of the canola (approx. 95%) and sugar beet (almost 100%), a large proportion of the grain corn (over 80%), and approximately two thirds (at least 60%) of the soybeans grown in Canada are GM.[230] There is a very small, unknown quantity of GM sweet corn grown in Canada. GM papaya and squash are also imported from the US. Most of our meat and dairy comes from animals fed a steady diet of GM feed.

It is not clear from Health Canada's short (1-3 page) Decision Documents, that our current dietary exposure (both in volume and form) was fully considered in early GM food approvals (the Decision Documents summarize approval decisions and are the only information on specific GM food safety assessments

released by the department). In communication with CBAN, Health Canada's regulators maintain that their evaluations "are based on the most conservative estimate of exposure to ensure the continued safety of these products regardless of how they are subsequently bred" and that "dietary exposure is calculated taking into account every use of corn that exists, which would include whole kernel consumption."[231] Nevertheless, Health Canada's summary of its 2001 decision to approve the GM corn NK 603 notes dietary exposure only through animal feed and processed corn ingredients. Health Canada explicitly states that, "The 603 line of transgenic corn is not a sweet corn,"[232] however, in 2012 Monsanto introduced NK 603 into sweet corn varieties in Canada (no separate approval for applying the GM trait to sweet corn was required).[233]

> *"**The 603 line of transgenic corn is not a sweet corn**, but rather, a field corn intended mainly for use in animal feed. However, some human food uses are relevant for field corn. The 603 corn hybrids would typically be either dry- or wet-milled into various processed corn products. The genetic modification of 603 corn will not result in any change in the consumption pattern for this product. **Consequently, the dietary exposure of Canadians to this product is anticipated to be the same as for other lines of commercially available field corn**."*[234] — *Health Canada, Roundup Ready® Corn Line 603. 2001. (emphasis added)*

Corn is a staple food, consumed in different forms across the world. Such consumption patterns should be highly relevant to safety assessments. For example, corn syrup solids comprise 42.6% of some infant formulas sold in North America.[235] In twenty years, the use of corn in processed foods has skyrocketed to about a quarter of North American groceries.[236] Most of this corn is now genetically modified.

Health Canada's Safety Assessment

The safety of GM foods cannot be assumed. That is why, for the moment at least,[E] Health Canada assesses the safety of each GM food before allowing it onto the market.

Health Canada does not conduct any safety testing but approves GM foods for human consumption based on industry-submitted information. This information is often entirely industry-generated and rarely peer-reviewed. The data package submitted by companies to Health Canada is classified as "Confidential Business Information" and cannot be accessed by the public or independent scientists, even through Access to Information requests. As discussed, peer review is the process whereby scientists assess the work of others, and it is a fundamental and defining practice of science. **Without peer review, the data behind Canada's GM food approvals cannot be assumed to be good science, or indeed "science" at all**.

The assessment carried out by government regulators is based on a set of questions that companies are required to answer, but no specific tests or methodologies are set out. For example, animal feeding trials are not required. The approval is summarized to the Canadian public in a 1-3 page "Decision Document" but in the absence of additional details, **precisely how Health Canada assesses GM food safety is unknown**.

The regulation of GM crops and foods in Canada will be investigated in the GMO Inquiry report "Are GM Crops and Foods Well Regulated?"

E See page 32 for a description of Canada's proposal to accept a "low level presence" of contamination from GM foods without being first approved by Health Canada. See further at **www.cban.ca/llp**.

HEALTH RISK FROM GM CONTAMINATION

GM contamination can happen because of any number of factors, including human error. Genetically modified organisms are living pollution that self-replicate and are difficult, or even impossible, to control. Each GM crop and animal has a different contamination potential based on its biology and use. Contamination is likely, and in some cases inevitable. The World Health Organization recognizes the health risk that accompanies the threat of GM contamination.[237]

Food system contamination events from experimental, unapproved GM crops and animals have occurred in Canada. There have been two separate contamination incidents with experimental GM animals (pigs). In 2004, genetically engineered (pharmaceutical producing) pigs from the now-defunct Quebec company TGN Biotech were accidentally turned into chicken feed instead of being incinerated as biohazard, and in 2002, pig embryos from experiments at the University of Guelph with the so-called "Enviropig" were accidentally fed to chickens and turkeys in Ontario.[238]

There is one major contamination incident with a GM crop that stands out because the health risk was identified and the contamination resulted in a major food recall in North America. GM insect-resistant "StarLink" corn was approved in the US for animal feed but not for human consumption (the risk is described on page 29). However, contamination from the GM corn spread through the food chain and was discovered in 2000 by tests conducted by Friends of the Earth US. Several large food companies rapidly recalled corn products,[239] and the contamination eventually led to the recall of nearly 300 food products.[240]

Starlink was not approved for any use in Canada but the Canadian Food Inspection Agency (CFIA) found traces of it in Canadian food, feed and seed corn.[241] The CFIA responded by recommending that the industry test food supplies and that whole grain corn imports from the US be guaranteed free of Starlink.[242] After the Starlink contamination incident, the Canadian government established a policy whereby any GM crops approved for growing must be approved for human consumption first.

"Low Level Presence" Exceptions to Health Canada's Safety Assessments:

ASSUMING THE SAFETY OF GM CONTAMINATION IN IMPORTS

Contamination will continue to be a problem with GMOs, and Agriculture Canada is now proposing a solution: accept contamination. The Canadian government wants to allow a percent (0.2% and higher) of our food to be **contaminated with genetically modified (GM) foods that have not yet been approved by Health Canada** but have been approved by another government that Health Canada has deemed trustworthy.

Canada would be the first country in the world to adopt this **"Low Level Presence" Policy**. Agriculture Canada argues that this "low level" of contamination from unapproved GM foods is not harmful.

The stated aim of the policy is to "provide a model that could be adopted globally."[243] Adoption of this policy would support Canada's ongoing request that other governments around the world accept GM contamination from Canada as safe – even when regulators in those countries have not yet assessed the safety of the particular GM food.

For more information see **www.cban.ca/llp**

Food system contamination events from experimental, unapproved GM crops and animals have occurred in Canada.

TRACING AND MONITORING

Post-market surveillance of GM food consumption can be used for risk management if a specific risk has already been identified and a consuming population can be surveyed.[244] Post-market monitoring can also be used to monitor changes in nutrition levels with a GM food that has a new nutritional profile.[245] The European Commission (2013) says that post-market monitoring should only be considered in cases that may require confirmation of expected consumption patterns, to monitor application of conditions of use, or to track already identified effects such as a known nutritional difference or a "likelihood of increased allergenicity due to the genetic modification."[246]

In 2001, the Royal Society of Canada's Expert Panel endorsed the concept of post-market surveillance of GM foods as "prudent" in order to monitor for unanticipated allergic effects, especially where a transgenic protein is novel in the human diet and as "essential" where a GM food is identified as having a medium to high-risk allergenic potential.[247] The Panel said that, "There should be mechanisms to record, evaluate and fully investigate complaints of suspected allergy."[248] No such mechanisms are currently in place.

In 2002, Health Canada hosted "The First International Conference on Post-Market Surveillance of Genetically Modified Foods" in Ottawa and at the end of 2004 the department was still assessing options for post-market surveillance.[249] At that time, Health Canada's Centre for Surveillance Coordination housed the Biotechnology Surveillance Project (BSP), but this initiative no longer exists for GM foods. The project was "developing a national surveillance system to monitor potential late health effects on humans of biotechnology products regulated in Canada," and included "the post-market surveillance of bio-engineered vaccines and therapeutics, and post-market surveillance of genetically modified foods."[250]

The US Society of Toxicology says that "verified records of adverse health effects are absent, although the current passive reporting system would probably not detect minor or rare adverse effects, nor can it detect a moderate increase in common effects such as diarrhea."[251]

Consumers Union in the US supports mandatory GM food labelling, including for the purposes of tracking any potential adverse human health or nutritional impacts.[252] While mandatory labelling alone would not achieve this, it is required for any tracking system or post-market study to be implemented.

The Panel said that, "There should be mechanisms to record, evaluate and fully investigate complaints of suspected allergy." No such mechanisms are currently in place.

WHY AREN'T GM FOODS LABELED?

> The impact of Mr. Caccia's bill [for mandatory GM food labelling] should it proceed into law as an amendment to the Food & Drug Act, would be extremely significant and damaging for the Canadian food industry and may ultimately prevent Canadians from having access to many current and future benefits of this fast-developing technology.
>
> — Pillsbury Canada Limited, letter to Member of Parliament Karen Kraft Sloan, April 18, 2001[253]

> There is no question that mandatory labelling at this time is driven in large part by perception. People are always afraid of what they do not understand. The question becomes: should legislation be implemented in response to public perception at a particular point in time, or should legislation be the result of enlightened governance?
>
> — Pierre Nadeau, VP, National Dairy Council of Canada, letter to Member of Parliament Charles Caccia, April 23, 2001[254]

> The hope of the industry is that over time the market is so flooded [with GMOs] that there's nothing you can do about it. You just sort of surrender.
>
> — Don Westfall, biotech industry consultant & vice-president of Promar International, quoted in the *Toronto Star*, January 9, 2001[255]

In 1994, the government department Industry Canada commissioned a poll that showed that 83-94% of Canadians wanted labeling of GM foods (depending on how the question was asked).[256] Between 1997 and 2003 the federal government spent over $1-million polling Canadians on biotechnology.[257] For the twenty years that GM foods have been on the market, polls have consistently shown that between 81% and 95% of Canadians want GM foods labeled.[258] Most recently, **a poll commissioned by CBAN (conducted by Ipsos Reid) in August 2015 found that 88% of Canadians want mandatory labelling**.[259]

Despite consistent public support for GM food labels, Canada and the US stand out as the only developed nations without a mandatory labelling scheme. Sixty-four countries around the world now have some form of mandatory GM food labelling.[260]

The most recent political attempt to achieve mandatory labelling in Canada was the 2013 motion introduced by an NDP Member of Parliament. This follows a succession of Private Members Bills in the House of Commons: 2008 from a Bloc Quebecois MP, 2001 from an NDP MP, and, in 2001 (and again in 2002) from Liberal MP Charles Caccia.

The public call for mandatory labelling in Canada was particularly intense between 1999 and 2001, culminating in the October 2001 vote on Charles Caccia's Bill C-287. The Bill appeared close to a win but was defeated. The story of this defeat exposes some of the political and economic pressures that explain why, twenty years after GM foods were first approved in Canada and despite polls consistently showing Canadians want mandatory labelling, these foods are still not identified on our grocery store shelves.

A common question sent to the *GMO Inquiry 2015* from the public was "Why don't we have GM food labelling in Canada?"

In 1996, Chris Mitchler, the then-Chair of the Food Committee at the Consumers' Association of Canada (CAC) told the House of Commons Standing

Committee on the Environment and Sustainable Development, "CAC believes that labelling is a problematic and impractical way to meet a consumer's need to know."[261] The CAC's position was in conflict with that of Consumers International (CI), the umbrella group to which it was a member. In 2002, Julian Edwards of CI told CBC TV, "I know of no other consumer groups that have publicly lobbied for voluntary as opposed to mandatory labelling of genetically modified foods."[262]

The CAC's position against mandatory labelling was used by the biotechnology industry to successfully undermine the political impact of consumer polling and the work of numerous public interest groups over several years. This active opposition to mandatory labeling from English-Canada's main consumer group provided important political cover for an anti-labelling position and legitimacy to the argument that "consumers don't really know what biotechnology is."[263] The CAC received extensive funding between 1996-2000 from both government and industry for consumer education activities on biotechnology.[264] In 2001, Monsanto hired CAC's spokesperson Lee Ann Murphy as its Director of Public and Industry Affairs.[265]

Government Funding for the Consumers' Association of Canada

The federal government provided multiple grants and contracts to the Consumers' Association of Canada (CAC) to communicate to the public about biotechnology. The CAC opposed mandatory labelling until 2003 when the organization changed their position.[266]

The Canadian government funded the CAC to the tune of $1.3-million between 1997 and 2002.[267]

- In 1996, the Canadian Food Inspection Agency (CFIA) provided $20,000 for the CAC to produce the "Information Kit on Food Biotechnology" in partnership with the Food Biotechnology Communications Network[268] to "provide consumers with user friendly information on agriculture and biotechnology" and "to help address the needs and concerns of consumers. This information will also be made available to MP's, teachers, the general public and both national and international organizations."[269] CAC sent the kit to members of the House of Commons Agriculture and Sustainable Development committees and stated, "**Industry Canada is assisting us to distribute the kit to all MPs and Senators**."[270]
- In 1999, the CFIA asked to make a presentation at the CAC Annual General Meeting. A memo from the CFIA describes the meeting as one of the "project deliverables that the CAC would provide to CFIA in return for funding" ($5000).[271]
- The CAC was funded by the CFIA in 1999-2001 for activities that the CAC proposed as part of what it called **"CAC-CFIA Partnership Opportunities"**. These included "coordination of a CAC-CFIA priority setting meeting". The CFIA paid $16,562.65 for the "Planning Session with Consumers' Association of Canada".[272] This included $12,000 to bring 16 members of the CAC to Ottawa, plus accommodation, meals and meeting rooms.
- In 2000/2001 the CFIA provided $40,000 to pay the salary of a CAC Research Associate on food issues[273] and also helped fund a "new Food Safety Fact Sheet for a series produced by the CAC" ($1920).[274]
- In 2000, the CAC got $82,000 from Industry Canada's Office of Consumer Affairs and Agriculture and Agri-Food Canada to conduct market research to help the biotech industry sell its message and image better to Canadian consumers including "recommend changes in approach and communications styles".[275]

As early as 1993, the federal government supported the emerging biotechnology industry, including by assuring Canadian consumers that GM foods are safe. In 1993, Health Canada held a "Workshop on Food Biotechnology: An information session to increase awareness of food biotechnology within Agriculture Canada." At that workshop, Health Canada's Scientific and Policy Liaison said, "A recent survey in Europe indicated that 40% of the population did not know or understand biotechnology. Clearly, these people may carry the concept of the killer tomato into their own reality. As regulators therefore, we must do something to bridge the gap, to ensure the confidence in the industry, and to instil confidence within the population, that these types of products are safe."[276] (In 1993, Health Canada had not yet approved any GM foods as safe.)

In January 1999, Health Canada rejected Monsanto's request for approval of its recombinant Bovine Growth Hormone. This was the result of ten years of opposition from consumers and farmers that culminated in Senate hearings where Health Canada scientists spoke about the pressure they faced from department managers to approve the product despite their safety concerns.[277] Soon after this event, the government and industry started to coordinate a new public relations campaign to reassure Canadians that the technology was safe.

In April 1999, the federal Minister of Agriculture convened a private "Roundtable on Communications and Agricultural Biotechnology" with industry.[278] The Minister invited representatives from the Prime Minister's Office, government departments, and the biotechnology industry, including the head of Novartis, the President of Monsanto Canada, the Executive Director of the industry-funded Food Biotechnology Communications Network, and Joyce Groote of the industry lobby group BIOTE-Canada.[279] The Minister described it as "an informal meeting to discuss how government, industry and consumers can formulate a strategy to improve public awareness and communications about food biotechnology."[280] An internal briefing described the goals: "to share ideas and views on how best to meet the public need for reliable and credible information about food biotechnology, and to counter sensational media stories about 'Frankenstein foods.'"[281] Groote's notes say that the meeting **"helped to highlight the need for immediate coordinated action to deal with this crisis at hand."**[282]

In fact, after the meeting, the Deputy Minister met with BIOTECanada and was advised in a briefing note before the meeting that "The need for a coordinated communications plan as suggested by Ms. Groote is obvious and worthy of AAFC [Agriculture and Agri-Food Canada] support."[283]

After this meeting, under coordination from the public relations firm Hill and Knowlton, the Food and Consumer Products Manufacturers of Canada, Canadian Council of Grocery Distributers, Canadian Federation of Independent Grocers and the Canadian Federation of Agriculture formed a Task Force on Food Biotechnology. In discussing the need for a Task Force, Groote said, **"We have moved from issues to crisis mode. This likely translates into a 2 year window to deal with the communications issue."**[284] The Task Force met three times with Deputy Ministers in Health and Agriculture Canada in 1999.[285]

At this time, the federal government played an active role in funding and implementing biotechnology communications. Access to Information documents gathered by Canadian Health Coalition researcher Bradford Duplesea show that **the federal government spent at least $13-million on public relations to support biotech between 1997 and 2002**.[286] Some funds were directed to the industry lobby group BIOTECanada ($5.7-million) and the Consumers' Association of Canada ($1.3-million).

This amount also included **$2.5-million for the government to develop the booklet *Food Safety and You* and distribute it to every household in Canada**. The booklet put information about "foods derived from food biotechnology" in a broader discussion of food safety and government regulation: "This brochure is about the important role the Government of Canada plays in food safety."[287] In 2000, the Liberal Minister of Agriculture stood up in the House of Commons in response to a motion for mandatory labelling and said: "The government believes that it is important to respond to the public's desire to understand biotechnology and the safety of its products. The government has done a good

job in developing widely used materials, such as Canada's Food Guide and the recent *Food Safety and You* brochure which was sent to every Canadian household across the country."[288] At the same time, he said, "The government is not opposed to labelling, but it has to be credible, meaningful and enforceable." *The booklet can be viewed at* ***www.cban.ca/PRarchives***

Major Government Public Relations Initiatives on Biotech

- In 2000, the federal government sent their booklet **"Food Safety and You"** to every household in Canada, at a cost of $2.5 million.[289]
- The booklet **"A Growing Appetite for Information"** was distributed in an issue of *Canadian Living Magazine* in October 1999 (and *Coup de Pouce*).[290] It was developed by the industry front group, the Food Biotechnology Communications Network,[291] with the Consumers' Association of Canada. Its' development was funded FBCN members[292] and the Canadian Food Inspection Agency (CFIA) at $6000;[293] the CFIA edited the material[294] and the CFIA paid $300,000 to insert it into the magazine.[295] 1.2 million copies were distributed by the end of 2001.[296]
- Agriculture Canada funded the Food Biotechnology Communications Network (FBCN), whose paying corporate members included Monsanto and other major biotechnology companies, to the tune of $120,000 in 1997/98 (which was 44% of the FBCN's budget that year).[297] The CFIA helped fund the "installation and promotion" of the **toll-free line for the Food Biotechnology Communications Network** at the cost of $12,000.[298] The telephone number was provided at the end of a 1999 article in *The Globe and Mail*, one of the first major articles on GM foods.[299] The article ended, "The federal government, industry and non-governmental organizations have co-operated to put together a toll-free line for consumers. The Food Biotechnology Communications Network has a registered dietician answering questions at 1-877-FOODBIO (366 3246)."
- The CFIA also supported the development of the **FBCN website**, database and resource sheet development ($19,000).[300]

These and other public relations materials can be viewed at **www.cban.ca/PRarchives**

Despite these coordinated efforts to reassure the public that GM foods "go through a rigourous and thorough review process before they can be introduced",[301] the public continued to call for mandatory labelling. Activists leafleted outside grocery stores across the country, including, in October 1999, in St. John's, Charlottetown, Fredericton, Halifax, Ottawa, Toronto, Hamilton, Windsor, Winnipeg, Saskatoon, Regina, Calgary, Edmonton, Salmon Arm, Richmond, and Vancouver. By April 1, 2000, there had been three such national days of protest, the last with actions in over 30 communities.[302] In 2001, Greenpeace and local group GeneAction (a founding member of CBAN, now No More GMOs Toronto) unfurled a 30-square-meter banner at a Loblaw store in downtown Toronto, urging the Minister and Loblaw to put "Labels on GE Food Now".[303]

In the face of the constant, visible call for mandatory labelling, **in 1999, the Canadian Council of Grocery Distributors initiated a process to create a standard for labelling, but under a mandate for voluntary rather than mandatory labelling**. This process inside the government's Canadian General Standards Board (CGSB) was then used by the industry as a rationale for not moving forward with mandatory labelling. The process was co-chaired by the Consumers' Association of Canada but most of the environmental and consumer groups (28) that were invited to participate boycotted.[304] At the time, Cindy Wiggins of the Canadian Health Coalition said, "Voluntary labelling will not protect the consumer. Mandatory labelling is the only way to track potential health impacts of these foods."[305] Twenty-one groups joined together to demand that the committee change its mandate from voluntary to mandatory labeling.

The CGSB process to develop a standard for voluntary labelling was explicitly used to circumvent calls to establish mandatory labelling. In particular, it was used to undermine political support for Private Members Bill C-287 for mandatory labelling, which was tabled in 2001 by now-deceased Liberal MP for Davenport (Ontario), Charles Caccia.[306]

Industry lobby groups, CGSB participants, and the Consumers' Association of Canada all used the CGSB process to request political delay on mandatory labelling. CGSB members coordinated a letter to all MPs in April 2001[307] and in a similar letter BIOTE-Canada said that Bill C-287 would "pre-empt" the work of the CGSB. In a letter to Charles Caccia, BIOTECanada said, "We believe it would be premature for Parliament to enter into legislative debate on this matter before the CGSB Committee has completed its work. So we have asked Members of Parliament to not support your Bill at this time. We respectfully ask that you withdraw support for this Bill."[308]

In an email to MPs asking them to vote against the bill, Lorne Hepworth of the industry lobby group the Crop Protection Institute of Canada (later renamed CropLife Canada) said, "Consumers and scientific experts agree that mandatory labelling is not the answer."[309] Hepworth quoted CAC testimony to a 2000 House of Commons committee hearing where a CAC representative said, "We hope the discussions will achieve a consensus document for voluntary labelling. We would urge the government to wait and consider the outcome of the CGSB discussions and how that work might be incorporated into a mandatory label before taking action on any mandatory scheme."

MP Charles Caccia told the *Ottawa Citizen*: "Governments are coming under increasing well-organized pressure from the corporate sector. Governments have to make a choice between serving the corporate sector and serving the public."[310] In addition to the flurry of letters and meeting requests from industry groups, an industry flyer appeared on the desks of all Liberal MPs in the House of Commons chamber on the evening of the vote, a distribution that is highly unusual and would have required the permission of the Party Whip. The flyer "Vote against Bill C-287 and support Canada's Agri-food business" was produced by the industry Task Force on Foods from Biotechnology. *The flyer can be viewed at* ***www.cban.ca/PRarchives.***

Dennis Bueckert of the Canadian Press described "a cabinet strategy to dodge the issue" when the Ministers of Health, Agriculture, Industry and Trade wrote a joint letter asking the House of Commons health committee to hold hearings on labelling.[311] Barry Wilson, reporting in *The Western Producer,* described the final vote as the result of "some political manoeuvring and old-fashioned arm twisting".[312]

At that time the Liberal Party formed the Government and did not support mandatory labeling.[313] Under a great deal of public pressure however, the Health Minister told CBC, "I like the idea of knowing what's in the food I'm eating, my family's eating. As to labelling GM foods, let's find out if it's feasible and, if so, how it's best done."[314] He said, "We should be looking at the question of mandatory labeling… The bottom line is consumers want to have the information and they want to have a choice and to understand what they are eating. I think any government should facilitate that. It

is about time government caught up to the will of Canadians to be reasonably informed about what they are putting in their bodies."[315] However, the Minister was not present in the House of Commons to vote for the Bill.

Bill C-287 was defeated 126 to 91, in a free vote (MPs could vote as they wished rather than based on Party policies).[316]

After defeat of the bill, as requested by the Ministers, the House of Commons health committee began hearings into labelling. A spokeswoman for the Minister of Health said that he supported labeling and referenced this hearing as another reason for waiting: "The Minister has made it very clear that he does support mandatory labeling. The bill that was defeated is not the only way to get there. A number of ministers have asked (Parliament's) health committee to review this. The forum now for mandatory labeling to be considered is through the health committee."[317]

Charles Caccia reintroduced his Bill in 2002 but it was voted down at second reading.[318] In 2004, the voluntary labelling standard was completed and called the standard for "Voluntary Labeling And Advertising of Foods That Are and Are Not Products of Genetic Engineering".[319] To our knowledge, **no company has ever used the standard to voluntarily identify any GM food**.

The defeat of the 2001 bill undermined public momentum in the call for mandatory labelling and compromised the ability of groups to mobilize subsequent public action. Other GM food issues rose to prominence and began to be debated. Since 2001, consumer and farmer protest in Canada has stopped the introduction of Monsanto's GM herbicide-tolerant wheat, Monsanto's GM insect-resistant potato, the GM "Enviropig" and, more recently, delayed the introduction of GM alfalfa. In 2006, Canadians also played an important role in protecting and strengthening the UN moratorium on Terminator technology (GM sterile seed technology).

In the absence of national mandatory labelling, there were serious attempts in both British Columbia and Quebec to move labelling forward at the provincial level. In 2003, the Quebec Premier promised labelling and a 2004 all-party agricultural commission unanimously recommended labelling.[320] In 2007 an NDP member of the British Columbia Legislature introduced a Private Members Bill.[321]

In Canada, polls continue to show strong public support for mandatory labelling and there is new attention being brought to the demand, most-prominently by the *Kids Right to Know* campaign started by teenager Rachel Parent.[322]

Over the past five years, the call for mandatory labelling in the US has come into sharp focus, culminating in the 2012 state referendum Proposition 47 in California. Californians narrowly voted against labelling in that ballot initiative after food and biotechnology companies spent a total of $46-million in advertising against labelling.[323] In 2013, an initiative to label GM food in Washington (state) failed in a popular vote 51 to 49, after the food industry spent over $20-million to defeat it. In 2015, the Grocery Manufacturers of America proposed a process for establishing national voluntary labelling, a strategy that mirrors the successful intervention of the Canadian Council of Grocery Distributors in 1999, described above.

To our knowledge, no company has ever used the standard to voluntarily identify any GM food.

Identifying GM Foods in Canadian Grocery Stores

Without mandatory labelling in North America, the only way to identify GM foods on grocery store shelves is to check for ingredients that come from the GM foods on the market: corn, canola, soy, white sugar beet, papaya, squash, cotton and limited use of Bovine Growth Hormone. (see page 11 for what foods this can include). **cban.ca/gmfoods**

THERE ARE FOUR MAIN WAYS THAT GM CROPS END UP IN OUR FOOD SYSTEM:

- Processed foods will often have corn, canola and soy ingredients and these will be GM unless they are certified organic products/ingredients. Organic food is grown according to the organic standard that prohibits the use of GMOs.
- Dairy, eggs and meat are produced from animals that are fed a steady diet of GM feed (GM soy, corn, canola and sometimes GM alfalfa in the US).
- Sugar in North America can be processed from GM sugarbeets. Cane sugar is not GM.
- There is a very small amount of GM sweet corn that may still be grown in Canada and the US. The produce section in Canada still remains GM-free except for some GM sweet corn (grown in Canada and the US), GM papaya (imported from Hawaii) and GM squash (from the US).

For more details see Where in the World are GM Crops and Foods?

*The **price-look up (PLU) code** is the string of numbers on produce stickers but it is **not** a way to identify GM foods. The prefix 8 was initially set aside for identifying GM foods but the number 8 is changing to indicate conventionally grown food.[324] The number 9 at the beginning of the code indicates organic food, but these products are already labelled.*

NON-GM FOOD LABELS

There are two main non-GM food labels on the North American market. Both labels are backed by strong certification programs. Some products carry both labels but they are two very different programs.

ORGANIC LOGO The national organic standard in Canada (and the US) prohibits the use of GM seeds and other GM products including the feeding of GM grains to livestock and dairy cows. Farmers pay a fee for third-party certification of their farm and paperwork. The organic standard outlines a range of production practices that farmers follow. These practices go far beyond prohibiting GMOs and include prohibiting synthetic pesticides, which then requires farmers to use alternative pest and weed control methods. Organic farming is a defined model of ecological farming that, for example, also lays out soil conservation practices and animal welfare standards. Choosing organic foods can help consumers address a number of food safety and environmental concerns at once. See **www.thinkcanadaorganic.ca**

NON-GMO PROJECT LOGO The Non-GMO Project verifies products as non-GM. The Project standard requires testing of all ingredients that could be at risk of GM contamination with a maximum contamination level at 0.9%, aiming to reach zero. The Project also requires traceability and segregation practices from farm to table. While these foods are not produced with the use of GMOs, unless they are **also** certified organic, they can be (and likely will be) produced with the use of synthetic pesticides. See **www.nongmoproject.org**

WHAT IS THE FUTURE OF GM FOODS?

While mandatory labelling has eluded Canadians, consumer concerns have had a dramatic impact on what GM foods are actually on the grocery store shelves. Consumer and farmer protests stopped the introduction of Monsanto's recombinant Bovine Growth Hormone (1999)[325] and GM wheat (2004)[326] in Canada, and negative consumer reaction led Monsanto to remove its GM insect-resistant potatoes from the market (2001).[327] Since its inception in 2007, the Canadian Biotechnology Action Network (CBAN) has coordinated a number of strategic campaigns that have successfully amplified the voices of Canadian consumers. Consumers and farmers stopped the University of Guelph from pursuing the GM "Enviropig" (2012)[328] and delayed the introduction of GM alfalfa in Canada (as of September 2015).[329] Vocal consumer concerns also appear to have kept the production of GM sweet corn to a very low level in both Canada and the US.[330] The rejection of these products was led by consumer safety concerns as well as environmental, ethical, social and economic concerns.

A 2015 Ipsos poll conducted for CBAN shows that a large majority of Canadians say they are aware of GM foods and have a range of concerns about their impacts. Almost all Canadians agree that mandatory labelling of GM foods is necessary.

Consumers will decide the future of GM foods, with or without mandatory labelling. The first ever GM food animal (a GM Atlantic salmon) could be approved in Canada and/or the US any day, and the first GM fruit to be grown in Canada is now approved (a GM non-browning apple). However, there appears to be little market demand for these products and, more importantly, rejection from almost half of Canadians.[331] It is clear from the history of GM foods in Canada that government product approval does not necessarily mean market acceptance.

In the absence of mandatory labelling, consumers are successfully seeking out and creating non-GM food options that are changing the marketplace. In addition to the growing organic food market[332] (organic production prohibits the use of GMOs), consumer demand has prompted many companies to provide non-GM choices, notably through the Non-GMO Project.

In 1993, Bob Ingratta of Monsanto Canada said, "Future availability [of food biotechnology] will require two things, regulatory approval and public acceptance."[333] While Health Canada continues to approve new GM foods, there is no assurance that Canadian consumers will accept these products, and so far, there is every indication that they will not.

CONCLUSION

Genetic engineering is one example of how the corporate profit motive can change how science is conducted and communicated. There is a lot of money to be made by bringing new GM seeds, animals and foods to market, and a lot at stake if something goes wrong. The fact that we can directly change the genetic structure of organisms is a triumph of human innovation - the fact that this powerful technology has been brought to market without independent, long-term testing is a triumph of hubris over precaution. The industry commitment to keeping North American consumers in the dark is insurance against the failure to convince consumers that GM foods are safe, ethical, and/or beneficial/necessary. Consumers are demanding independent verification of safety as well as transparency and democratic debate. **Releasing GMOs in our food system and environment is an experiment that is still in need of testing and evaluation**.

MORE RESOURCES

For more details on the main questions examined in in this report, CBAN recommends:

- *GMO Myths and Truths*, EarthOpenSource earthopensource.org
- *Genome Scrambling*, EcoNexus www.econexus.info
- *Pesticides and Our Health*, Greenpeace International, www.greenpeace.org/international/en/publications/Campaign-reports/Agriculture/Pesticides-and-our-Health/
- History of Labelling Polls in Canada, www.cban.ca/labellingpolls

cban
Canadian Biotechnology Action Network

For all reports in the *GMO Inquiry 2015*
www.gmoinquiry.ca

- For information and updates on various issues www.cban.ca/Resources
- For updates on GM foods on the market in Canada www.cban.ca/gmfoods
- To take action www.cban.ca/Take-Action

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Collaborative Campaigning for Food Sovereignty and Environmental Justice