It’s In My Genes: GMOs, Biodiversity and Farming in Saskatchewan

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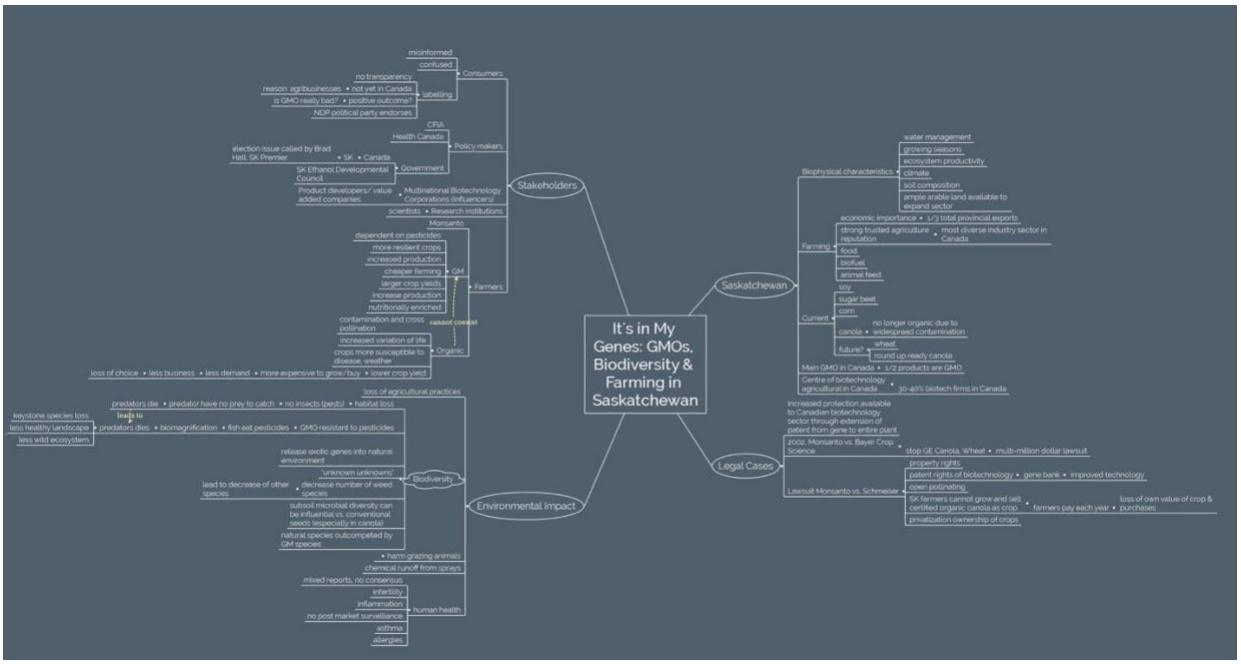
Introduction

Humans have tinkered with plants for centuries, with selective breeding being one of the most important developments to take place in the past 13,000 years (Diamond, 2002). More recently, with the dawn of the Green Revolution, this process has been sped up by the advances of biotechnology, allowing us to select for traits down to the level of individual DNA. With the widespread adoption of agri-biotechnology, genetic modification (GM) has been hailed as the answer to feeding our growing population and combating the negative effects of climate change. However, a large-scale debate surrounds the application of GM on food crops, with concern regarding ethics, economics, society, and the environment.

Framed within this larger GMO debate, this case study focuses on the issue of GM canola production in Saskatchewan. With an estimated 80-90% of the canola grown in Canada being of GM origin, the issue is extremely relevant (Beckie et al., 2011; CCC, 2014). Starting with an exploration of the key dimensions comprising our wicked problem, we will then present the current governance structures and conclude with recommendations of how this problem can be managed.

Framing the Problem

A problem both difficult to define and composed of numerous interdependent issues, the issue of GM crop production is strongly characteristic of a wicked problem (COA, 2007). Additionally, the number of varying public opinions regarding GM crop production is illustrative of the variety of players involved in this industry. Farmers, producers, agricultural biotechnology firms, government bodies, NGOs, non-profits, and consumers are just a handful of those involved. Presented below, in ranking of importance, are the competing factors of this wicked problem. These complex relationships can further be observed in our mind-map and in Figure 1.



Group Mind Map

Conflicting Perceptions

A major problem occupying the GM debate is the variance in public perception. While consumers tend to value the quality of their food, the research produced thus far is conflicting and inconclusive, leading to fear and confusion (Murnaghan, 2015). Today, approximately virtually all corn, canola, soy, and sugar beet grown in Saskatchewan are GM (Strauss, 2015). As large corporations use advertisements, lawyers, and economists to influence the market to accept GM foods, the public's ability to combat this is negligible, perhaps succumbing to the biased results and skewed facts (CBAN, 2015). Furthering this corporate power is the reality that farmers using GM crops must annually buy new seeds from large firms like Monsanto (deClercy et al., 2003).

Legal arguments, such as the landmark case of Monsanto Canada Inc. v. Schmeiser, also arise, where small players compete with multi-million dollar firms. Stakeholders like Monsanto control the economics and politics behind GM, benefitting from the lack of long-term studies exploring the negative effects of the practice (deClercy et al., 2003).

With regards to the scientific dimensions, most research supports that consuming genetically modified foods, when compared to conventional, does not pose increased levels of inherent risk to human health (WHO, 2014). Together, research and public opinion present no clear cut stance but rather, a plethora of smaller, interrelated problems along with numerous questions. This issue is clearly first priority in deserving for its wicked problem label.

Biophysical Characteristics

A major biophysical concern regarding GMOs is the risk of herbicide resistance and the evolution of "superpathogens" (Devos *et al*., 2013). As a result of prolonged herbicide usage, these "superweeds" become resistant to even the harshest chemicals (Glass-

O'Shea, 2011). While numerous studies question the true extent of this problem, current research provides evidence of widespread gene flow, specifically seen in Canadian GM canola (Beckie et al., 2011). In addition, farmers who use herbicides are often forced to use amplified amounts of increasingly toxic chemicals which risk further ecosystem degradation through chemical runoff. Consequently, increased pesticide usage poses the risk of killing beneficial microorganisms in the soil and harming grazing animals in nearby or downstream fields (Beyond Pesticides, 2009).

Countless research studies suggest ill effects upon ecosystems and biodiversity from GM crop production. Pest populations (sometimes beneficial) have been shown to plummet as pesticide-resistant crops develop (Snow & Palma, 1997). A study conducted by Shutler and Mullie (2000) comparing the number of birds on organic versus conventional farms, suggests organic farms to have higher and more varied bird populations. In another study by McLaughlin and Mineau (1995), a higher count of advantageous insects on organic farms were recorded due to a proposed lack of insecticides and the presence of beneficial weeds. Together, these studies suggest that the absence of conventional methods (inclusive of GM crops) are associated with an increase in biodiversity. However, it is important to note that this is not directly related solely to the GM crop absence itself and may be due to other environmentally positive attributes that organic production allows for.

Conversely, proponents of GM production combat these risk-centered concerns, pushing the equally abundant benefits, such as resistance to pesticides, decreased susceptibility to harsh weather, nutritional enrichment, and higher crop yield (Beckie et al., 2011). With ample peer-reviewed research backing both sides of the argument, the biophysical characteristics regarding GM canola production can be seen as both concerning and beneficial, highlighting a fraction of the complexity comprising our wicked problem.

Economic Characteristics

Farming is the backbone of Saskatchewan. Ranking first in terms of available provincial cropland area and accounting for more than 1/3 of total provincial exports, Saskatchewan's economy is rooted in agriculture (GOS, 2015; Statistics Canada, 2014). Canola, the second largest crop grown in Saskatchewan, contributes an average of $8.2 billion annually to the Canadian economy (CCC, 2014).

An economic benefit often tied to GM crops is the potential for higher crop yields, thus higher sales returns (Beckie et al., 2011). Additionally, GM crops, along with other forms of biotechnology, provide employment for upwards of thousands of Canadians. From Table 1 it can be deduced that at least 56% of Canadians working for biotech companies would be jobless if GMO production was to halt. Possible economic drawbacks could be the cost of fixing the damage done on GMOs at present, such as the implementation of labelling systems, education systems to inform the public, or biophysical conservation programs spawned by biodiversity loss.

Economic characteristics are ranked third because the long term consequences of GM cannot currently be weighed. While the economic benefits may be positive, the future of how much GM sources will play a role in economic growth is highly dependent on conflicting perceptions, biophysical characteristics, and how these two will play out in the future.

Governance Framework

Global, International, and Regional Agreements

Regarding international agreements, *The Cartagena Protocol on Biosafety to the Convention on Biological Diversity* is the principal document outlining a universal framework for GM crops. The *Protocol* provides "a comprehensive and holistic approach to the conservation of biological diversity, the sustainable use of natural resources and the fair and equitable sharing of benefits deriving from the use of genetic resources" (SCBD, 2000). In practice, the *Protocol* enables the application of biotechnology aimed at deriving maximum benefit and minimizing potential risks in an environmentally sound manner, applying to trans-border movement and handling of "living modified organisms" (2000). Additionally, as a member of the UN, Canada is obliged to follow the *United Nations Millennium Declaration,* committing to sustainable development, reducing the loss of biodiversity, and decreasing CO_2 emissions (United Nations, 2000). Other relevant international and regional frameworks are the *North American Biotechnology Initiative* (a dialogue-based collaboration between Canada, Mexico, and the U.S.) and the *Bilateral Relations* between Canada and China, and Canada and the U.S. (CFIA, 2015).

Federal, Provincial, and Local Legislation

Internationally, Canada is considered to be one of the initial and principal adopters of biotechnology (Smyth, 2014). Ultimately, the decision-making power lies in the hands of the Canadian government. Canadian legislation regarding the regulation of GM foods and biotechnology was first introduced in 1993 with GM foods falling under the governance of the *Food and Drugs Act* (CFIA, 2014). The foods that fall under this act can be explored further in Figure 2. While the Canadian Food Inspection Agency (CFIA) is the head agency responsible for regulating agricultural products, Health Canada is in charge of the pre-market notification requirement, a seven to ten year assessment process for new GM products (Health Canada, 2005). Additional legislation that relates to the GM debate are the 1999 *Canadian Environmental Protection Act (CEPA),* the *CanadianEnvironmental Management and Protection Act (CEMPA)* (2010), the *Canadian Environmental Assessment Act (CEAA)* (2012) and the *Access to Information Act*(Greenwood, 2013). In Saskatchewan, there are no provincial or local laws, policies, or regulations governing GM canola and other GM crops.

Additional Influential Bodies & Governance Analysis

While the governance of GM crops is solely enacted by the Canadian government, political decisions are influenced by numerous non-governmental players, including but not limited to: biotechnology companies, activist groups, NGOs, consumers, and scientific organizations and councils. Their collective power is wielded through lobbying, purchasing power, and conducting research to further GMO understanding. With 90% of global GM seeds being controlled by Monsanto, this semi-monopoly lends a small number of biotechnology companies significant sway over government policies, research, and the pressure being put on farmers and producers (Strauss, 2009).

There is a large disparity in resources available to farmers and biotech companies for litigation and secret incentives given by the biotech industries to silence farmers when they sign contracts such as Monsanto's licensing contracts. In previous seed piracy cases that Monsanto has filed, the courts have always sided with Monsanto, leaving many farmers threatened and defenseless (Strauss, 2009).

Scientists and research institutions perform environmental impact assessments and conduct research on issues including health and food safety, the effects of increasing bioenergy production and contamination damage, efficiency and improvements in crop production. The reports produced from this research can largely influence all levels of government (Strauss, 2009).

Crop boards or associations can exercise power by setting prices and advocating for farmers. For instance, the Saskatchewan Canola Growers Association advocates in favor of biotechnology that increases productivity and returns for farmers while maintaining that farmers should be able to participate in regulations such as: intellectual property, international trade, marketing, etc. (Pechlaner, 2012; CCGA, 2015).

Moving Forward

Tying all of this together, the debate surrounding GM canola in Saskatchewan is unquestionably inconclusive. Unsurprising, given the definition of a wicked problem, this paper will not present one, succinct solution. Rather, the following presents an overview of the limitations and challenges inhibiting a finite solution and a few recommendations on how the setbacks produced by GM canola can be mitigated and improved upon.

Limitations and Challenges

Currently, the government provides little to no transparency surrounding the environmental, health, and economic risks of GMOs. As previously stated, government policies are heavily influenced by private organizations rather than scientific research. While scientific reports and international agreements hold some weight regarding GMO policy implementation, governance largely favours biotechnology organizations with little regard for smaller farmers and firms. Further, while consumers participate through their purchasing power, the lack of verified available information makes it challenging to generate research-backed change. While social campaigns and advocacy groups, such as the Canadian Biotechnology Action Network, advocate for farmer welfare, biotech accountability for contamination, environmental protection, transparency of health risks, and labeling, current participation is relatively low compared to agri-biotech industry presence. This challenge is further exacerbated by a lack of consistent information regarding GM being put forth by the Canadian government while groups such as the International Services for the Acquisition of Agri-biotech Applications (ISAAA), funded by biotechnology corporations, are providing consistent, publicly available sources of statistical information.

Regarding the governance framework regulating GM crops, there are a crushing number of federal environmental policies (e.g. EMPA, CEPA, CEAA) that minimally differ. Such an abundant number of policies can be stifling and can result in a lack of oversight. In addition, the long chain of command of the Canadian political system, with GM legislation only present at the federal level, not only increases unnecessary operational costs, but also obstructs accountability and enforcement.

When international, federal, and provincial legislation are all considered, some setbacks are apparent. Looking at administrative agreement for *CEPA* between the Federal and Provincial government (Environment Canada, 2013) for example, if an issue arises, who will and should be held accountable? The biggest issue in governance however, lies in transparency. Without access to government-funded scientific information, how can citizens

have an opinion to voice what they want? In the case of *CEAA,* if environmental assessments are conducted by government entities, is it fair that the government gets to decide the criteria of which it is based on? For a democratic nation, the decision makers should technically be the citizens, however this is clearly not the case.

Recommendations

The first recommendation our team proposes is to increase the transparency regarding GM crops and their respective socioeconomic, health, and environmental effects. Given the proliferation of selectively-released, well-hyped, industry-backed research resulting in biased public perceptions of GMOs, we believe it is well overdue for the federal Canadian government to conduct, share and disseminate their own research analyzing GMOs. This could be anything from Statistics Canada reinstating a yearly survey observing biotechnology use and development, previously halted in 2005, to Environment Canada conducting research observing the environment effects of GM canola production (Statistics Canada, 2005).

Our second recommendation regards the issue of accountability. GM crops, such as canola, are now so widespread that it is practically impossible to grow completely GM-free canola as seen in Figure 4. If biotech companies patent their crops, they should be held liable for contamination damages rather than the government continuing to allow them to sneak past accountability issues. One possible method of combatting biotech companies could be for organic farmers to push for comparable strict liability for transgenic drift that ranchers receive from cattle trespassing (Black et al., 2008).

Our final recommendation targets consumer knowledge of GMOs. Currently, labeling of GMOs is voluntary, as outlined by the Food and Drugs Act (CFIA, 2015). Although health and environmental issues resulting from GM food consumption have not been collectively agreed upon, using the precautionary principle, the *potential* risks suggest that it would be harmful to not take action and educate the public. A possible solution to combat lack of consumer awareness and increase the effectiveness of consumer choice, GMO labelling has already been implemented by governance bodies, such as the European Union (European Commission, 2015). Increased education outreach about GMOs should also be enacted so that Canadian citizens can make informed decisions.

Conclusion

In the coming years the agri-biotechnology industry will continue to expand with new GM crops entering the market and scientific advancements, making transparency ever more important. Given the previously mentioned limitations and challenges currently facing the GM crop industry coupled with the complex nature of this wicked problem, there is no one solution. Alternatively, it is necessary for the Canadian government to conduct further research, enact policies, educate the public, and encourage dialogue in search of increased transparency, accountability, and participation through collaboration with industry and consumers.

Appendix

Tables

	Total Employees	Biotech Employees	% Biotech employees/Total
British Columbia	7558	1191	16
Alberta	3347	574	17
Saskatchewan	na	289	–
Manitoba	635	357	56
Canada	62667	7695	13

Table 1. Employment in Core Biotechnology Firms (number of employees in 1999). De Clergy, Greenberg, Gilchrist, Marchildon, McHughen 2003.

Figures

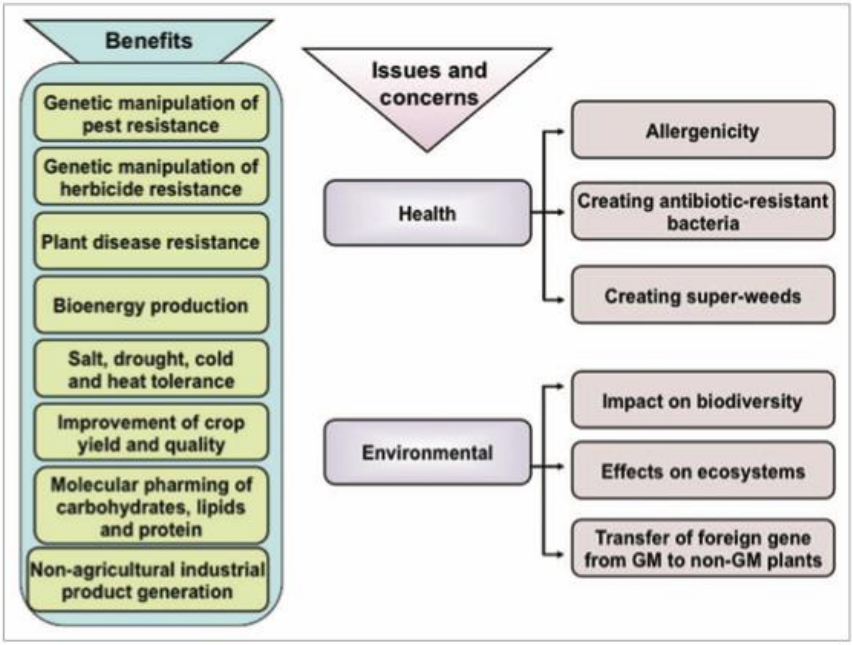


Figure 2. Pros and cons of the GM technology.

Figure 1. (Basu et al., 2010)

This table consolidates the CFIA's list of approved "Plants with Novel Traits" (PNTs), with additional information from Health Canada's list of "Novel Foods", to explain which of these PNTs are GMOs, and which are on the market.

	CROP	GMO	MARKET (COMMERCIAL) STATUS	GROWN IN CANADA	IMPORTED TO CANADA	GM TRAIT(S)
1	Canola	✓	Grown in Canada	✓	✓	Herbicide tolerant
2	Corn	✓	Grown in Canada	✓	✓	Insect resistant Herbicide tolerant
3	Soy	✓	Grown in Canada	✓	✓	Herbicide tolerant
4	Sugar Beet	✓	Grown in Canada	✓	✓	Herbicide tolerant
5	Papaya	✓	Grown in the US and China	✘	✓	Virus resistant
6	Squash	✓	Grown in the US	✘	✓	Virus resistant
7	Cotton	✓	Grown in the US, India, China, and others	✘	✓	Insect resistant
8	Alfalfa	✓	Grown in the US	✘	Imported as animal feed	Herbicide tolerant Low lignin
9	Apple	✓	Approved March 20, 2015	?	?	Non-browning
10	Potato	✓	Not grown anywhere in the world	✘	✘	Insect resistant
11	Rice	✓	Not grown anywhere in the world	✘	✘	Herbicide tolerant
12	Flax	✓	Deregistered in Canada. Not grown anywhere in the world	✘	✘	Herbicide tolerant
13	Tomato	✓	Not grown anywhere in the world	✘	✘	Delayed ripening Insect resistant
14	Lentils	✘*				Herbicide tolerant
15	Sunflower	✘**				Herbicide tolerant
16	Wheat	✘*				Herbicide tolerant

GMO — On the market

Grown in Canada

* Product of chemically induced seed mutagenesis

** Product of conventional plant breeding

Figure 2. (CBAN, 2015)

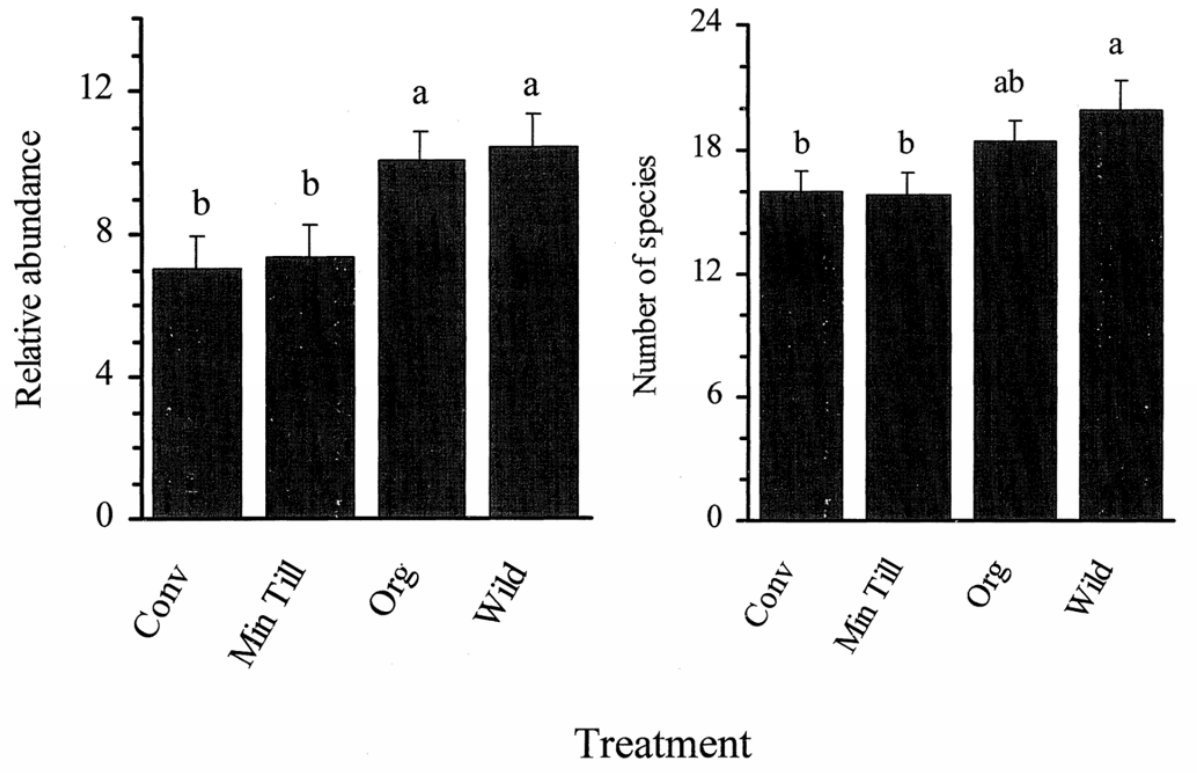


Figure 3. Comparison relative to landscape treatment (Conv, conventional farms; Min till, minimum tillage farms; Org, organic farms; Wild, wild plots) of bird communities of wetlands and their margins in Saskatchewan. Bars are least-square means (±SE, controlling for covariates described in text) of relative abundance (average number of individuals per survey) and the cumulative number of species recorded from four surveys. Bars sharing the same letters are not significantly different (Tukey-Kramer tests).

Figure 3. (Shutler & Mullie, 2000)

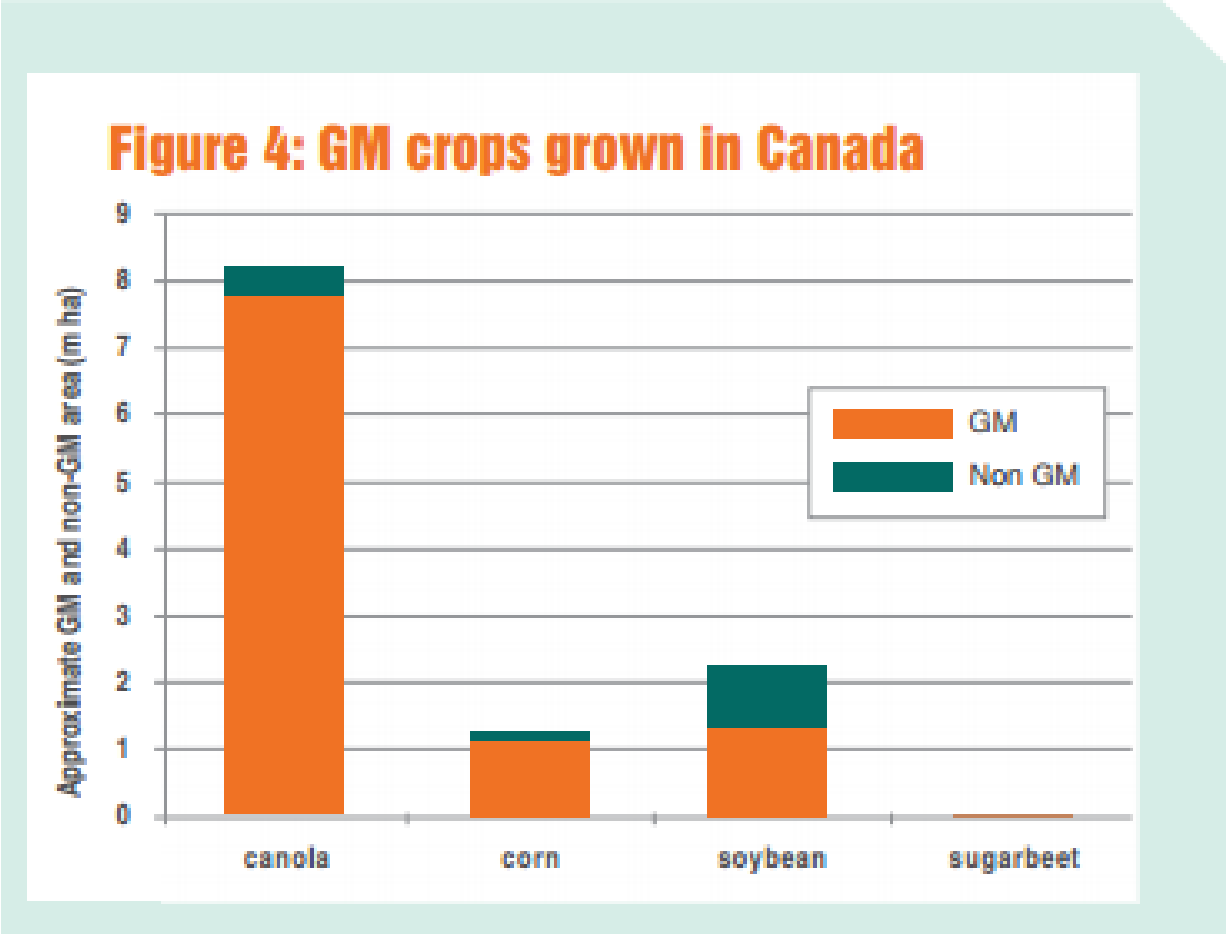


Figure 4. (CBAN, 2015)

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