

GM Crops and Economic and Environmental Sustainability

Growing SA 2018 Conference
Adelaide, Australia
September 14, 2018

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Economic and environmental sustainability in agriculture



Challenge:
How to
ensure
science
isn't lost to
social
pressures

Canadian environmental benefits from GM canola

- The use of min-till and zero-till land management strategies have greatly increased
- In 1999, conservation tillage was 11% of canola production, in 2006 65%
- Tillage costs related to canola production in 1999 estimated to have been \$214M
- Estimated cost of tillage in 2006, \$60M

Canadian environmental benefits from GM canola

- 95% of farmers report that weed control has improved or stayed the same following GM canola
- 76% of farmers report that the management of herbicide resistance in weeds is less of an issue
- Control of volunteer canola has not changed from pre-GM
- 74% of producers report that control of volunteer canola is the same as prior to GM canola or easier

Canadian environmental benefits from GM canola - 2006

- 65% of the canola grown on the prairies is done through minimum or zero tillage
- 83% of producers have experienced increases in soil moisture
- 86% have experienced a reduction in soil erosion
- 41% are seeding canola onto erodible land

Canadian environmental impact of canola chemicals - 1995

Herbicide	El _f /ha	El _c /ha	El _e /ha	El/ha
Ethafluralin	16,500	6,600	53,900	25,630
Trifluralin	7,200	4,400	33,600	15,040
Clopyralid	1,210	1,210	5,806	2,737
Sethoxydim	3,010	662	7,344	3,672
Ethametsulfuron	120	90	684	299
Cumulative impact	26,052	12,962	101,334	47,378

Source: Smyth et al. 2011. Environmental Impacts from Herbicide Tolerant Canola Production in Western Canada. Agricultural Systems 104: 5: 403-410.

Canadian environmental impact of canola chemicals - 2006

Herbicides	El _f /ha	El _c /ha	El _e /ha	El/ha
Glyphosate	5,573	3,483	22,988	10,658
Glufosinate	5,724	3,816	19,366	9,635
Imazamox	118	118	626	287
Imazethapyr	229	156	476	288
2,4-D	9,959	2,905	12,864	8,590
Cumulative impact	21,603	10,477	56,320	29,458

Source: Smyth et al. 2011. Environmental Impacts from Herbicide Tolerant Canola Production in Western Canada. Agricultural Systems 104: 5: 403-410.

Difference between 1995 and 2006

Comparison	1995	2006	Change
El/ha	13,789	6,436	-53%
El _f /ha	7,877	3,545	-55%
El _c /ha	3,782	2,191	-42%
El _e /ha	29,797	13,603	-37%
Grams of ai/h	648	399	-38%
Total AI (M kg)	3.4	2.1	-1.3

Distribution of benefits from GM crops

- Canola: Farmers 43%, Firms 48%, Consumers 5%
- Soybeans: Farmers 32%, Firms 34%, Consumers 25%
- Corn: Farmers 59%, Firms 30%, Consumers 11%
- Cotton: Farmers 75%, Firms 21%, Consumers 4%
- Brookes and Barfoot's (2018) report on GM crops in 2014 identify the cumulative economic benefit has reached **\$186 billion**

Global benefits from GM crops

Klümper & Qaim (2014) conducted a meta-analysis of 147 studies on the impacts of GM crops, finding:

- Chemical pesticide use decreased by 37%
- Crop yields increased by 22%
- Farmer profits increased by 68%

Economic benefits from GM crops

- Hutchinson et al. (2010) found GM corn in the US created \$6.8 billion in extra value, with 60% going to non-adopters
- Subramanian & Qaim (2010) Bt cotton adoption in India raised vulnerable household incomes (<\$2/day) by 134%
- Gusta et al. (2011), GM canola resulted in annual benefits of \$350 - \$400 million in Western Canada
- Vitale et al. (2014) found Bt cotton adoption in Burkina Faso resulted in a profit of \$150/ha vs \$70/ha for conventional cotton

Hutchinson et al. 2010. Science 330: 222-225.

Subramanian & Qaim. 2010. Journal of Development Studies 46: 2: 295-311.

Gusta et al. 2011 AgBioforum 14: 1: 1-13.

Vitale et al. 2014. Cotton. Handbook on Agriculture, Biotechnology and Development, 604-620. Edward Elgar Publishing.

Environmental benefits from GM crops

- Subramanian & Qaim (2010) found Bt cotton reduced pesticide use in India by 41%
- Huang et al. (2010) found Bt cotton in China reduced insecticide use from 14kg/ha to 4kg/ha overall, with 40kg/ha to 10kg/ha in non-Bt fields
- Smyth et al. (2011) document that GM canola reduced EIQ by 53% in Western Canada
- Brookes and Barfoot (2018) show CO₂ emission reductions equal to removing 16.75 million cars for one year

Sources: Subramanian & Qaim. 2010. *Journal of Development Studies* 46: 2: 295-311.

Huang et al. 2010. *Science China: Life Sciences* 53: 8: 981-991.

Smyth et al. 2011. *Agricultural Systems* 104: 5: 403-410.

Brookes & Barfoot. 2018. *GM Crops: Global socio-economic and environmental impacts, 1996-2016.*

Health benefits from GM crops

- Gruere & Sengupta (2011) document a reduced suicide rate among Indian farmers following the release of Bt cotton
- Gouse (2013) found GM corn results in 10-12 fewer days of female hand weeding per season in South Africa
- Vitale et al. (2014) estimate Bt cotton in Burkina Faso results in 30,000 fewer cases of pesticide poisoning per year
- Kouser & Qaim (2014) found Bt cotton reduced pesticide poisoning in India by 2.4-9 million cases a year, saving \$14-51 million
- Pellegrino et al. (2018) found that GM corn reduces cancer related mycotoxins by 30%

Sources: Gruère & Sengupta. 2011. *Journal of Development Studies* 47: 2: 316-337.

Gouse. 2013. Project report to the Program for Biosafety Systems, International Food Policy Research Institute.

Vitale et al. 2014. *Handbook on Agriculture, Biotechnology and Development*, 604-620. Edward Elgar Publishing Ltd.

Kouser & Qaim. 2011. *Ecological Economics* 70: 2105-2113.

Pellegrino et al. 2018. *Scientific Reports* 8: 3113: 1-12.

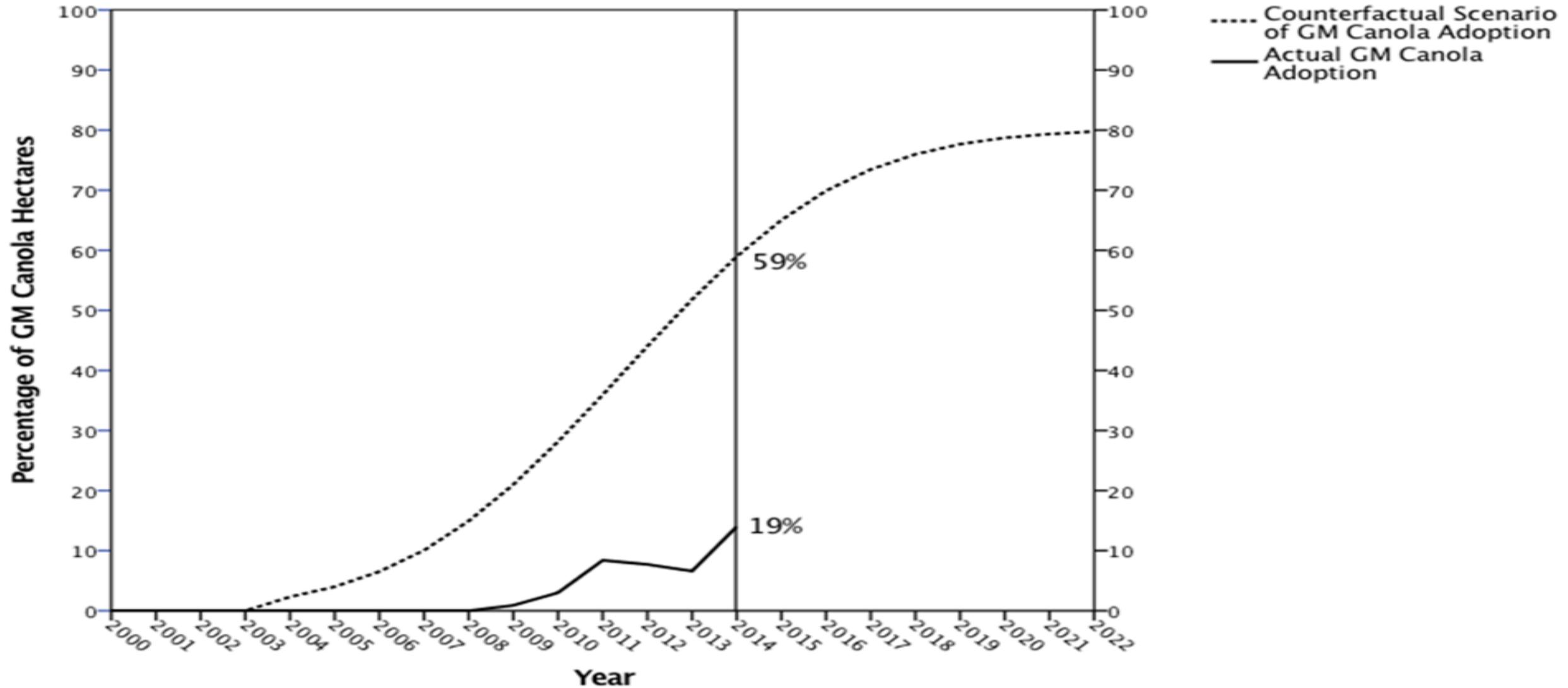
Impact of GM crops

- Every developing country that has adopted GM crops has experience at least one of, if not all of:
 - Increased yield
 - Reduced chemical use
 - Fewer cases of pesticide poisoning
- With hundreds of studies quantifying the benefits, where is the holdup? Why is adoption in developing countries not happening at a faster rate than it is? What or who is responsible?

Cost of Australia's GM canola moratorium

- Highlights opportunity cost of delay from including socio-economic considerations (SECs) in GMO policy
- Evaluates the continuation of current varieties over adoption of new agricultural innovations
- The increase in development and complexity of agricultural innovations needs consistent regulation in evaluation for continued innovation

Australian Actual and Counterfactual Adoption



Australian Environmental Opportunity Costs of Moratoria, 2004-2014

Impact category	Actual	Scenario	Difference	Percentage change
Chemical active ingredient (kg)	53 million	46.5 million	6.5 million	12.3% decrease
Environmental Impact	1.1 billion	944 million	158 million	14.3% decrease
Field equipment passes (ha)	104 million	97 million	7 million	6.8% decrease
Fuel (liters)	202 million	194 million	8.7 million	4.3% decrease
GHG and compound emissions (kg)	562 million	538 million	24.2 million	4.3% decrease

Australian Economic Moratoria Opportunity Costs, 2004-2014

Economic category	Actual	Scenario	Difference	Percentage change
Yield (mt)	25 mt	26 mt	1.1 mt	4.2% increase
Contribution margin (AU\$)	\$10.7 billion	\$11.1 billion	\$485.6 million	4.5% increase

Concluding thoughts

- GM crops have been safely grown and consumed in over 30 countries for 24 years
- Canadian farmers gaining an estimated \$350-400 million per year
- Some fields that have been zero-till for 20 years now, with farmers reporting soil depth increases of up to 6 inches
- Moisture conservation has improved and soil erosion has been reduced
- The cost of SEC moratoriums staggering for farmers and the environment

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