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Gene Editing for Improved Nutrition and More Affordable Food

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Modern agriculture faces two significant challenges: controlling natural factors that reduce crop yields and improving nutritional qualities. Gene editing provides opportunities to address both, thereby reducing costs and contributing to improved food affordability for Canadian families.

BETTER PEST CONTROL

Food production can be negatively affected by numerous factors, including weeds, insects, and disease. Without pesticides to control these pests, cumulative yield losses can reach 100%, meaning that entire crops can be lost (see Table 1).

Gene editing is a promising emerging technology for reducing pesticide use. It represents an evolution of existing technologies that have been safely producing food crops, including organic crops, since the 1920s.¹ Its advantage is that it is a very precise tool, allowing for the editing of specific genes in order to increase or decrease specific gene functions.

Gene editing is a targeted approach that precisely enhances or diminishes an existing gene within a species. It differs from genetically modified organisms (GMOs), which involve introducing one or more new genes from another species.

For example, gene editing can be used to increase resistance to plant diseases—powdery mildew, for instance—which threaten wheat² and pea³ crops. When plants have genetically-enhanced defenses against such pests, it contributes to reducing the use of fungicides.

IMPROVED NUTRITIONAL QUALITIES

Gene editing technologies can also increase crop nutrient values. Research has been conducted on improving nutritional quality in various ways, including:

- enhanced protein (canola, corn, potato, rice, wheat);

TABLE 1

Factors affecting crop yield loss in North America

Crop	Weeds	Insects	Plant disease	Estimation of maximum potential losses
Vegetables	8-13% ¹	4-21% ¹	8-23% ¹	20-57%
Soybeans	10-37% ²	0-12% ³	40-60% ⁴	50-100%
Corn	50% ⁵	15-50% ⁶	8-14% ⁷	73-100%
Wheat	3-47% ⁸	22-80% ⁹	0-16% ¹⁰	25-100%
Canola	40% ¹¹	10-50% ¹²	18-99% ¹³	68-100%
Rice	37-50% ¹⁴	28% ¹⁵	15-60% ¹⁶	80-100%
Range	3-50%	0-50%	0-99%	20-100%

Notes: 1. Howard *et al.* 1994. 2. Soltani *et al.* 2017a. 3. Musser *et al.* 2021. 4. Bradley *et al.* 2021. 5. Soltani *et al.* 2017b. 6. Morgan 2021. 7. Mueller *et al.* 2020. 8. Flessner *et al.* 2021. 9. Sadras *et al.* 1999. 10. Ficke *et al.* 2018. 11. Harker 2000. 12. Sekulic et Rempel 2016. 13. Wang *et al.* 2020. 14. Zoschke 1990. 15. Mondal 2017. 16. Baite *et al.* 2019. See Annex on the MEI website for complete sources.

- increased oils and fatty acids (canola, corn, rice, soy);
- improved carbohydrates (corn, potato, sugar beet, soy);
- increased vitamins (potato, rice, strawberry, tomato); and
- increased mineral availability (lettuce, rice, soy, corn, wheat).⁴

Micronutrients such as iron, zinc, selenium, magnesium, calcium, and iodine, along with vitamins like provitamin A and folate, play essential roles in the healthy development of children and in nutrition for nursing women. The bio-fortification of vegetables is increasingly the focus of research addressing these vital nutritional compounds.⁵

Gene editing research targeted at nutritional increases is underway on several Canadian crops. With increased micronutrient content, barley has the potential to become a more common food in human diets.⁶ Biofortification research in wheat has raised levels of zinc and selenium, both of which are important micronutrients, and in one recent case has focused on increased fibre.⁷ Corn research has involved efforts to address beta-carotene, ascorbate, and folate deficiencies, with current research looking to enhance vitamin E⁸ and provitamin A⁹ content.

Yield and nutrition benefits will be most noticeable with fresh produce, with healthier fruits and vegetables capable of improved defence against diseases. For example, tomatoes are being gene-edited to increase lycopene, an antioxidant linked to lower risks of cancer and heart disease.¹⁰ The increased nutrition of grains like barley, wheat, and rice leads to more healthful staple and baked goods.

MORE AFFORDABLE FOOD

Gene editing applications will provide various benefits at the grocery store level. Gene editing can extend food shelf life, for instance.¹¹ Consumers can feel the positive effects of this in their wallets, as the cost of fresh produce spoiling prior to purchase is factored into prices. When spoiled produce decreases, it thus lowers the cost that is passed on, making food more affordable. This technology will also lower in-home produce spoilage, contributing to reduced home food waste, estimated to be 140 kg and \$1,300 per year on average, per household.¹²

Yield increases from gene editing will also benefit consumers by helping to prevent price increases due to drastic reductions in fruit, vegetable, and crop production. For example, in 2021, the Canadian Prairies were plagued by significant drought, resulting in mustard yields two-thirds below normal.¹³ This contributed to some condiment mustard product prices being 75% higher in 2022 compared to 2021.¹⁴ Gene-edited crops that are more climate resilient could minimize such dramatic production declines and food price spikes.

The future of gene editing will be further enhanced by the integration of artificial intelligence. AI technologies can screen plants to identify crucial genes responsible for specific traits (such as yield, disease resistance, drought

tolerance, and nutrition) and then indicate how to edit the genes for superior functionality. The integration of gene editing, gene sequencing, and AI will thus revolutionize plant breeding, enabling the delivery of even more benefits to farmers, processors, and consumers.

Gene editing is transforming agriculture and food production. This is important for the food security of Canadians, and even more so for the citizens of other countries. To ensure that we reap the full benefits of this technology, it is of vital importance that Canada's regulatory system remain science-based. By enabling and facilitating innovations such as gene editing, the future of food production and security in Canada will be on solid footing.

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This Viewpoint was prepared by **Stuart J. Smyth**, Senior Fellow at the MEI, in collaboration with **Gabriel Ciguère**, Senior Policy Analyst at the MEI. The MEI's Regulation Series aims to examine the often unintended consequences for individuals and businesses of various laws and rules, in contrast with their stated goals.

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