



CANADA  
GRAINS COUNCIL

Plant Breeding Innovation in Wheat

# Canada Grains Council Member Organizations



Conseil de l'orge du Canada



Barley Council of Canada



canola council OF CANADA



CANADIAN CANOLA GROWERS ASSOCIATION



Cereals Canada



CSGA Canadian Seed Growers' Association



Canadian Seed Trade Association  
L'Association canadienne du commerce des semences



Canada Limited  
FORWARD, WE GROW



INLAND TERMINAL Association of Canada



KEYSTONE AGRICULTURAL PRODUCERS OF MANITOBA



PORT of vancouver



Saskatchewan Association of Rural Municipalities



SaskFlax



UNIVERSITY OF SASKATCHEWAN Crop Development Centre



Western Canadian Wheat Growers



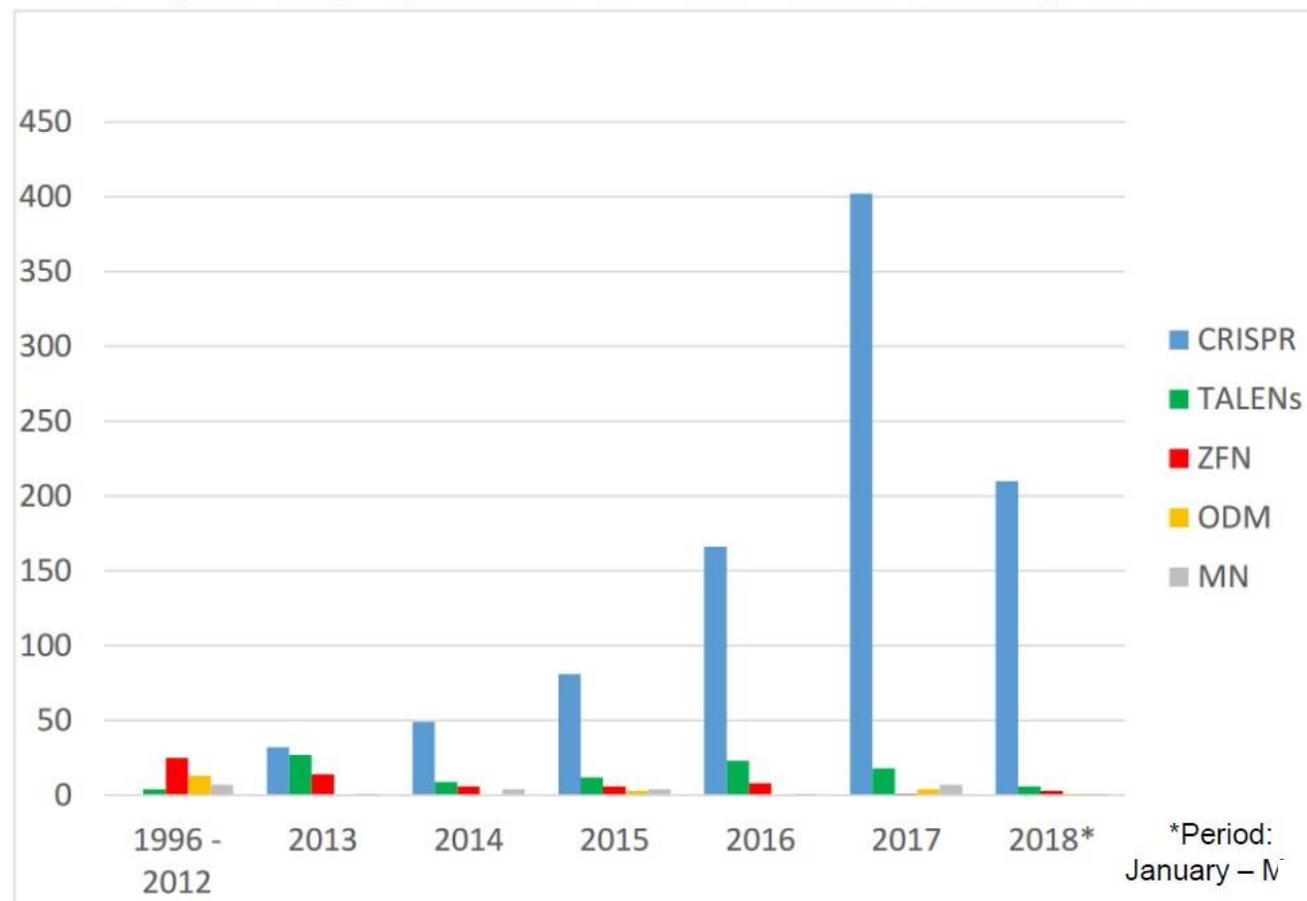
# Global Trends in Plant Breeding Innovation

Source: Julius Kühn-Institut, Berlin  
[www.dialog-gea.de/application/files/4315/3864/5414/180920\\_Anwendungen\\_von\\_Genome\\_Editing\\_in\\_Kultur-\\_und\\_Zierpflanzen\\_aktualisiert\\_bis\\_Mai\\_2018.pdf](http://www.dialog-gea.de/application/files/4315/3864/5414/180920_Anwendungen_von_Genome_Editing_in_Kultur-_und_Zierpflanzen_aktualisiert_bis_Mai_2018.pdf)

## Results: General overview



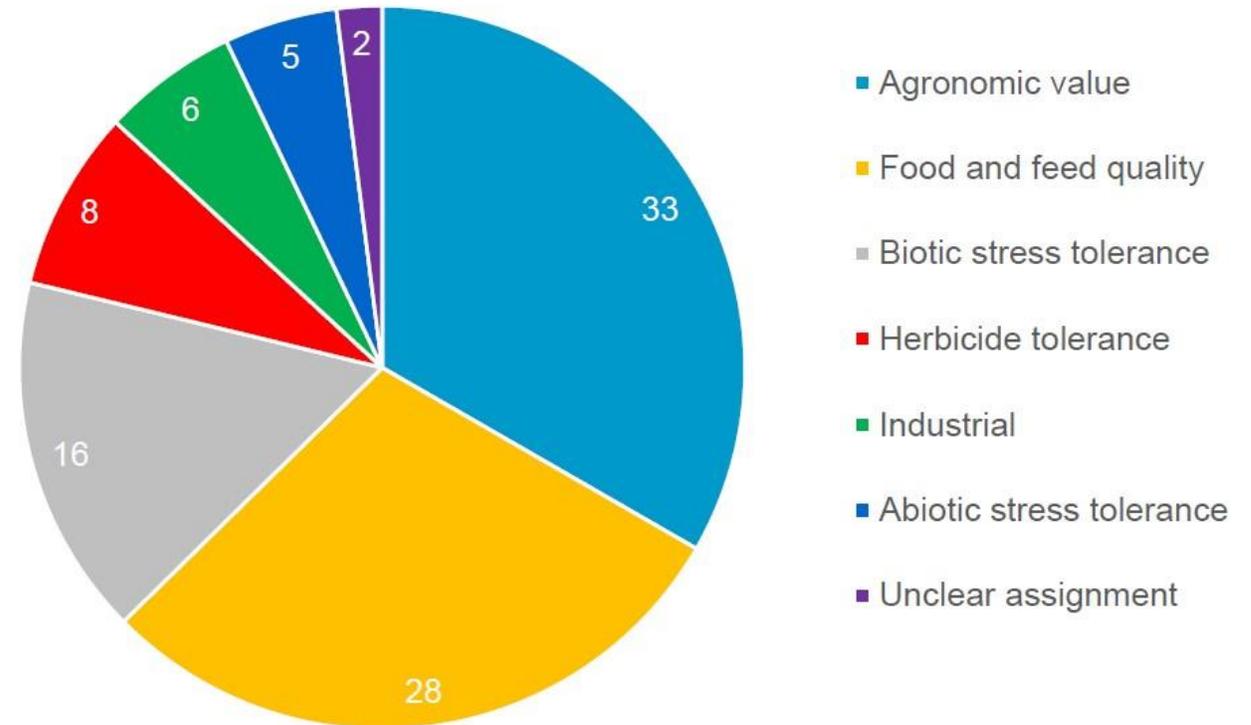
Studies presenting experimental data between 1996 and May 2018



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## Overview about market-oriented applications



# Are Consumer-Focused Traits the Answer?

## Heart-Healthy Tomatoes Developed in Japan after Consumer Consultation



Source:  
<https://sanatech-seed.com>

Our company produces and sells seeds that have undergone selective breeding through the use of gene editing.

Our first product will be tomatoes with 4-5 times the usual GABA (gamma-aminobutyric acid) content. Increased GABA content in foods is known to lower blood pressure, so these high-GABA tomatoes can be called "heart-healthy tomatoes." We are planning a test market in 2019, ..

# Potential Applications of Gene Editing in Wheat

<b>Reduced Gluten</b>	Sánchez-León, Susana; Gil-Humanes, Javier; Ozuna, Carmen V.; Giménez, María J.; Sousa, Carolina; Voytas, Daniel F.; Barro, Francisco (2017): Low-gluten, nontransgenic wheat engineered with CRISPR/Cas9. In: Plant biotechnology journal. DOI: 10.1111/pbi.12837
<b>Drought and Stress Tolerance</b>	Kim, Dongjin; Alptekin, Burcu; Budak, Hikmet (2018): CRISPR/Cas9 genome editing in wheat. In: Functional & integrative genomics 18 (1), S. 31–41. DOI: 10.1007/s10142-017-0572-x.
<b>Increased Yield (Grain Weight)</b>	Zhang, Yi; Li, Da; Zhang, Dingbo; Zhao, Xiaoge; Cao, Xuemin; Dong, Lingli et al. (2018b): Analysis of the functions of TaGW2 homoeologs in wheat grain weight and protein content traits. In: The Plant Journal 94 (5), S. 857–866. DOI: 10.1111/tpj.13903.
<b>Powdery Mildew Resistance</b>	Zhang, Yunwei; Bai, Yang; Wu, Guangheng; Zou, Shenghao; Chen, Yongfang; Gao, Caixia; Tang, Dingzhong (2017): Simultaneous modification of three homoeologs of TaEDR1 by genome editing enhances powdery mildew resistance in wheat. In: The Plant journal : for cell and molecular biology 91 (4), S. 714–724. DOI: 10.1111/tpj.13599

# Potential Applications of Gene Editing in Wheat



Company ▾ Crops Innovation ▾ Newsroom ▾ Contact

Crop Platform Products by Launch Year	Today	2020 - 2023	2023+
Canola	- Cell Model Complete - MOA 1	- MOA 2 - Pod Shatter Reduction - Oil Quality - Disease Resistance	
Rice	- Cell Model Complete	- MOA 1 - MOA 2	- Disease Resistance
Flax	- Cell Model Complete	- MOA 1	
Potato	- Cell Model Complete		- Disease Resistance - MOA 1
Corn		- Cell Model Complete	- MOA 1 - MOA 2 - Disease Resistance
Wheat		- Cell Model Complete	- MOA 1 - MOA 2 - Disease Resistance

Source:  
<http://www.cibus.com>



# Applications of Gene Editing in Wheat

## CIMMYT - Examples of Traits for Gene Alteration:

Source:

<http://www.ilsijapan.org/ILSIJapan/LEC/biotech/GenEd2017/03Dhugga.pdf>

- **Wheat**

- Disease resistance
  - Rust (Lr34 and Lr67)
  - Powdery mildew
- Plant height reduction by alternative mechanisms from Rht genes
- Biofortification
  - Phytate downregulation for increased Fe and Zn availability



 **CIMMYT.**

# Potential Applications of Gene Editing in Wheat



Source:  
<http://www.calyxt.com/products>



## High Fiber Wheat:

- Addresses growing consumer demand for high-fiber food
- “non-regulated” by USDA
- Launch “as early 2020-2021”

# Canada Grains Council Policy Objective:

The regulatory and policy environment for plant breeding innovation must deliver on the dual goals of driving innovation in the crop sector while maintaining market access abroad.

<https://canadagrainscouncil.ca/wp-content/uploads/2018/01/CGC-PBI-policy.pdf>





# Global Regulatory Approaches Continue to Develop

Canada: Case-by-case regulation of products developed using any plant breeding method.

Norway: Proposal for a 3-tier system to assess gene-edited products.

EU: May revise regulations in 2019+ to allow more innovation, currently all gene-edited plants fall under “GMO” rules.

USDA: Gene-edited plants that mimic conventional breeding are exempt from “GMO” regulation.

Japan: Plants with no foreign DNA are likely to require simple notification only.

China/India: Uncertain direction, but regulation anticipated in some form.

South American block: Efficient notification process to determine if gene-edited plants are “GMOs”.

Philippines: Proposal to exempt plants with no foreign DNA from “GMO” rules.

Australia: Simple gene-edited products will be exempt from “GMO” regulations.

# Examples of CGC International Outreach

- CGC is active in IGTC and GAABT to help align global industry policy positions and have productive discussions with seed trade
- CGC often presents internationally on the importance of regulatory alignment and trade considerations as global regulatory approaches are established
  - April, Colombia, presentation at IICA-sponsored workshop for regulators of the Americas
  - August, Australia, presentation at APEC-HLPDAB
  - September, Brazil, presentation of grain trade perspective to LMC workshop including 15 countries
  - October, Berlin, meetings with IGTC and ISF on Information Sharing, German regulators on EU direction post-ECJ decision, German oilseeds processors association and Liberal party members.
  - December, China, presentation at ISF workshop with regulators and seed industry

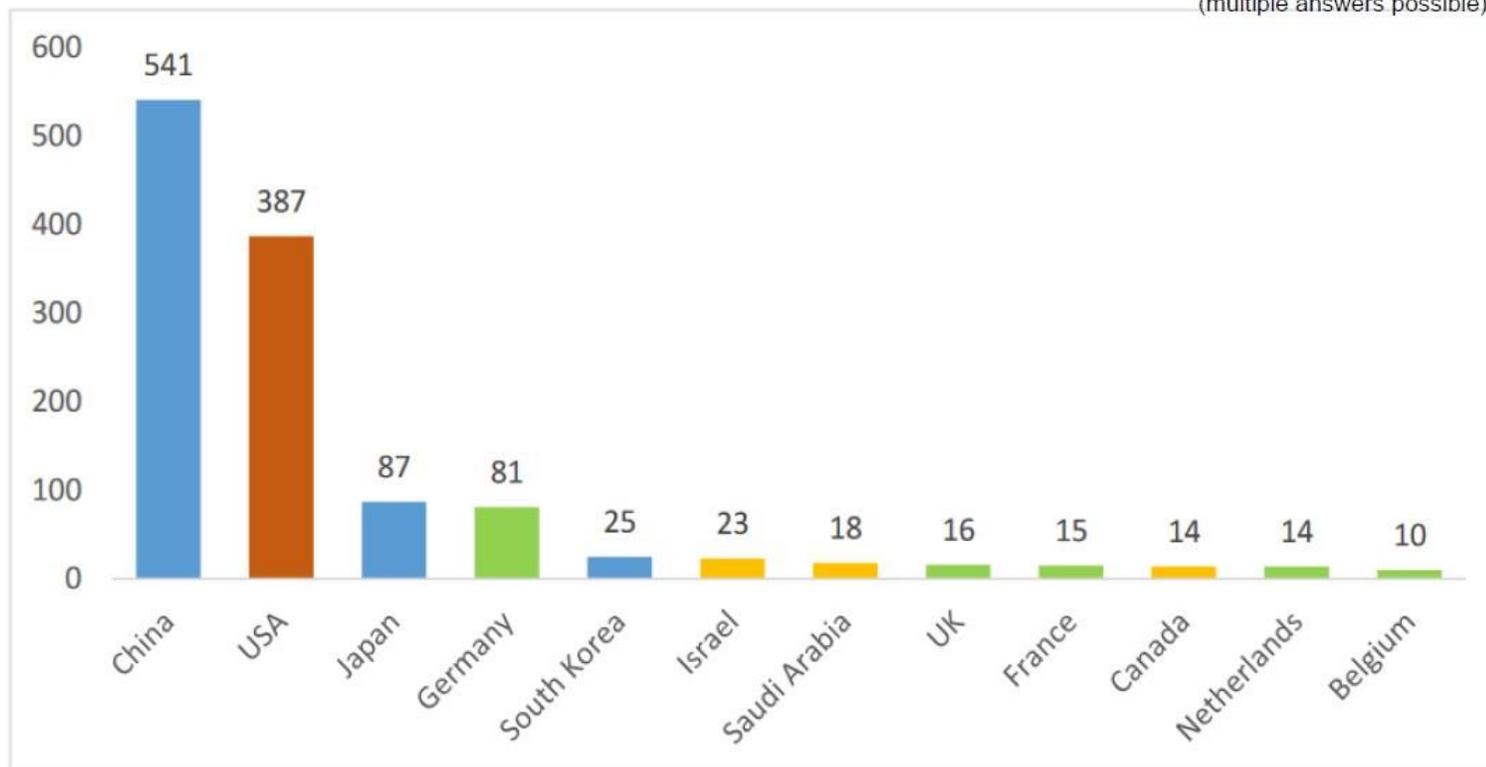
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## Results: General overview



Overview of the global applications of Genome Editing\*  
\* By corresponding author (multiple answers possible)



→ Studies from **31 different** countries



# A recent survey of Canada's plant breeding community shows that Canada's novelty approach:

- **Results in lost opportunities** – Nearly half (47%) of respondents have chosen not to undertake a research proposal after having self-determined the innovation to be novel.
- **Affects how and where research takes place** – 31% of respondents have conducted or considered conducting field work outside of Canada to avoid the confined research field trial program.
- **Needs to be updated**- The majority of respondents (87%) believe that regulatory requirements need updating as we learn more about the safe use of technology.

# Recap of Recent Advocacy Efforts:

**April 2018:** Seed and Grain VCRTs wrote to Minister MacAulay to ask for improvements to the administration of programs for novel foods, feeds, and plants with novel traits

**June 2018:** Minister MacAulay made a commitment to support an industry-government dialogue (regulators agreed to begin this dialogue on October 12)

**August 2018:** Plant Breeding Innovation is a top three priority for the Canada Grains Council's submission to the TBS Regulatory Review, and is a top Seed Synergy priority

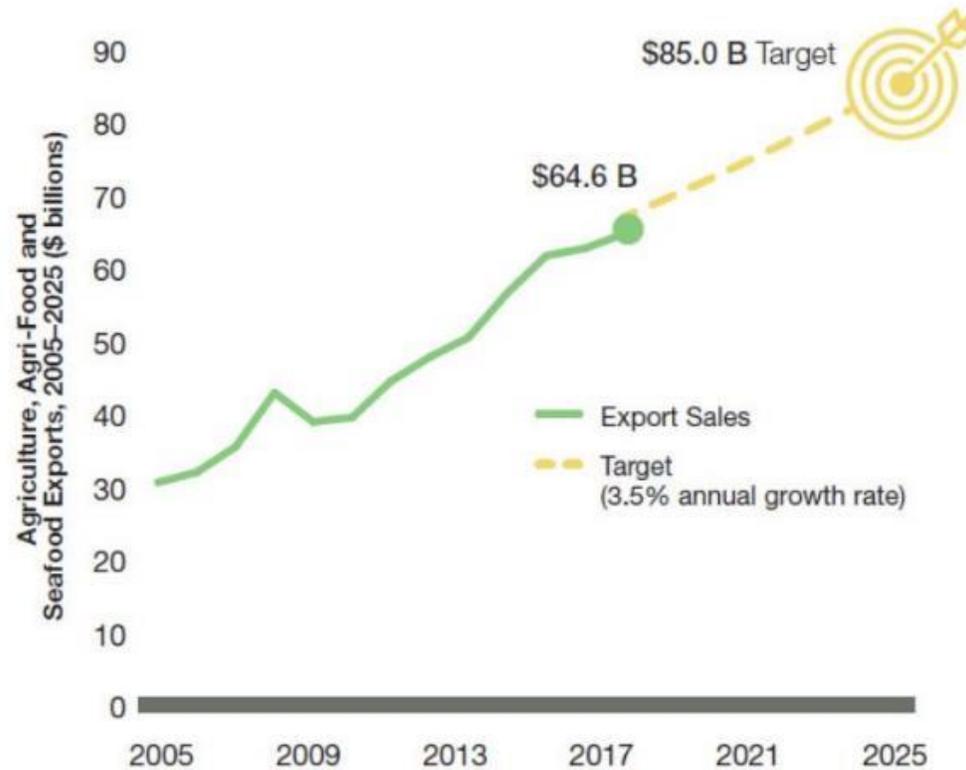
**September 2018:** Economic Strategy Table Report sets ambitious growth targets for the ag sector and identifies plant breeding innovation as an issue for “immediate action.”



# How Will Canada's Agriculture Sector Benefit from Plant Breeding Innovation?

## Agriculture, Agri-food and Seafood Exports, 2005–2025

Canada's Economic Strategy Table Report Sets Export Targets Beyond Barton and Budget 2017



Source: Report of Canada's Economic Strategy Table [www.ic.gc.ca/eic/site/098.nsf/eng/00022.html](http://www.ic.gc.ca/eic/site/098.nsf/eng/00022.html)