

National Pulse Research Strategy

National Pulse Research Strategy Committee

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“A special acknowledgement to Dr. Valerio Hoyos-Villegas at McGill University who was invited to participate on the Committee and provide a perspective from Eastern Canada in the development of the strategy for future research opportunities in the pulse sector.”

Introduction

Canada is a world-leader in the production of high-quality pulse crops, including lentils, dry peas, dry beans, chickpeas, and faba beans. In 2020, pulse crops in Canada were worth over \$3B in farm gate value which represents 7.6% of total crop receipts.¹ In 2019, Canada was the largest exporter of lentils and dry peas in the world (> 2.1 and 3.6 million tonnes, respectively) and was also in the top ten global exporters for dry beans, chickpeas and faba beans.²

In 2017, Pulse Canada set a target for “25 by 25”: 25% of the Canadian pulse industry’s production capacity will go to diversified, new end uses by the year 2025. The main strategy to reach this target is to find new efficiencies in the trade environment and create new opportunities for pulse consumption and utilization.³

The outlook for Canadian pulse crops is bright for several reasons:

- **Value-added and food processing opportunities:** With the growing shift towards plant-based proteins, pulse crops have the potential to play a key role in meeting Canada’s target to capture more value from agricultural products through value-added processing. Increased ingredient processing capacity will also contribute to domestic food security and establish Canada as a front runner in supplying pulses to high value, stable markets.
- **Health and nutrition:** Pulse crops pack a nutritional punch and are a valuable source of protein, fibre, starch, and other nutrients for human and animal diets. Plant-based diets are expected to slow the progress of chronic diseases.
- **Environmental sustainability:** Cultivation of pulse crops in rotations has benefits at several levels, including (a) on-farm benefits to pulses in rotation, (b) agro-ecosystem benefits at the landscape level, and (c) contributions to national efforts to reduce agricultural green house gas emissions.

“Greater emphasis on the production of sustainable crops, such as peas, lentils, canola, hemp and cereals, will reduce agriculture’s carbon footprint and add organic matter and carbon to the soil.”

Protein Industries Canada – The Road to \$25 Billion

Developing a National Pulse Research Strategy

In 2021, pulse sector representatives from across Canada⁴ gathered to develop a national research strategy to coordinate and guide pulse research investments. Research and innovation will be key for Canada to remain competitive as a world leader in pulse production and take advantage of new markets and opportunities. The process to develop this strategy took place over several months and included interviews and a virtual strategy workshop in September 2021. Articulating a national vision for pulse research is an important step in the coordination of research funding and programming to maximize efficiency, increase capacity and improve the ability to adopt new innovative technologies.

¹ Statistics Canada. Table 32-10-0045-01: Farm cash receipts.

² FAOSTAT: Export of Pulses by Country.

³ <https://pulsecanada.com/about/what-we-do>

⁴ See Appendix C for a list of the National Pulse Research Strategy Committee members



The scope of this strategy is high-level and all-encompassing for the pulse sector across the spectrum from discovery to applied research. Certain funding organizations, such as producer groups, may primarily wish to fund more downstream or applied research areas. Conversely, other funding groups such as AAFC, may wish to fund earlier stage and discovery level research. It is anticipated that provincial organizations will continue to have individual strategies to address crop-specific and local or regional research needs.

Purpose and Vision of the National Pulse Research Strategy

Purpose

The goal of this National Pulse Research Strategy is to identify a medium- to long-term research strategy, including national research priorities. This strategy will be used by the sector in the pursuit of research funding and will guide research investments.

Our Vision

- Pulses are a foundational choice for Canadian farms, human health, animal nutrition, and environmental sustainability.
- Pulse research in Canada is on the forefront of new technology; it is nationally coordinated, collaborative, and accelerates progress towards three strategic outcomes.

The following pages describe the three **strategic outcomes** that are the basis of this strategy. For each outcome, we list the **key drivers** that we anticipate will be crucial in leading the progress towards the strategic outcomes. Following that section, the high-level **research priorities** are listed for each of the three strategic outcomes. The final section describes **enabling activities** that will accelerate research progress and the uptake of innovation along the value chain.



Strategic Outcomes

Outcomes	Key Drivers
<p>1 Pulses are a profitable component of diverse crop rotations that enhance farm sustainability.</p>	<ul style="list-style-type: none"> Innovation drives step-change in yield gains & productivity <ul style="list-style-type: none"> • Yield, quality, sustainable production practices and costs of production contribute to profitable margins for growers Pulse crop production is recognized as a key opportunity to meet Canada’s environmental sustainability goals <ul style="list-style-type: none"> • Pulses add to the sustainability of crop rotations through reducing carbon footprints, lowering GHG and increasing water use efficiency • Pulses add value to crop rotations through positive influence on following crops
<p>2 Growers produce a safe, reliable and consistent supply of Canadian pulses to meet growing demand.</p>	<ul style="list-style-type: none"> Stable and consistent yields of pulse crops adapted to biotic and abiotic stresses <ul style="list-style-type: none"> • Root disease has minimal impact on realized yields and on yield stability • Integrated Pest Management practices and biotic stress resilience mitigate the risks of weeds, diseases and insects • Climate change adaptation and abiotic stress resilience support yield stability along with the expansion of pulse crop areas and crop options • Canadian growers have reliable access to high quality seed supply Innovative products and sustainable management practises ensure a safe supply of pulses <ul style="list-style-type: none"> • Pest management options are safe and effective and include alternatives such as biologicals, variety resistance and new advancements • Continuous improvement in management practises and variety development enhances the harvestability of pulse crops
<p>3 Pulse crops achieve desirable end use quality for domestic and global customers.</p>	<ul style="list-style-type: none"> Quality Canadian pulses fulfill the value-added strategy for whole pulse, processing, flour and fractionation uses for domestic and export markets <ul style="list-style-type: none"> • Desired quality attributes for pulses are clearly defined, along with standardized analysis methods • Quality program is established in Canada for pulses with publicly available data to ensure growers can make informed decisions on varieties and production practises that influence quality • Varieties are developed that target the desired food safety, crop composition and end-use quality characteristics that are fit for purpose, supported by the management practices that optimize these characteristics • Growers receive value for the products produced • Research supports the pulse sector market strategy for human health, animal feed, and processing objectives

Research Priorities

1. Pulses are a profitable component of diverse crop rotations that enhance farm sustainability.

Key drivers:

- Innovation drives step-change in yield & productivity
- Pulse crop production is recognized as a key opportunity to meet Canada's environmental sustainability goals

1A. Increase yield potential and profitability through variety development and the adoption of breeding innovations, with particular focus on high yielding varieties with appropriate crop quality and development of traits that reduce cost of production (e.g., nitrogen fixation, pest resistance).

1B. Expand the adaptability of pulse crops to ensure there are sustainable pulse crop options for every hectare of crop production nationally. Specific targets for increasing adaptability and resilience to climate change include:

- Yield stability under variable climatic conditions (e.g., understanding variety-specific genetics by environment (GxE) impacts) for all pulses
- Drought tolerance in peas, dry beans and chickpeas
- Excess moisture stress resilience in peas, lentils, and dry beans on rainfed eastern prairies, without yield penalty in the absence of stress
- Faba bean adaptation to rain-fed areas, heat tolerance, maturity and post-harvest quality (e.g., staining damage)
- Cold tolerance and early maturity in dry beans

1C. Investigate new crop opportunities to increase the options for pulse crops in diverse and sustainable rotations.

- Conduct feasibility assessments of alternative pulses to determine new pulse crop options in Canada's changing climate, including crop adaptability and marketability

1D. Quantify and increase the sustainability profile of pulse crops, including:

- Develop and evaluate novel technologies to increase the sustainability of pulse crops (e.g., nitrogen fixation technologies, fertility management, no-till practices, cover crop options)
- Quantify the value of pulse crops in rotation, including beneficial impacts on following crops in the rotation
- Demonstrate and update the sustainability profile for pulse crops
- Establish the role of pulses in reducing GHG emissions across crop rotations, particularly with regards to fertilizer use patterns

1E. Quantify the potential yields, actual yields, and yield gaps for Canadian pulses as well as identify the environmental and/or management factors contributing to yield gaps. Use this GxExM⁵ information to establish agronomic management practices to close the gaps, as well as to target traits of interest for genetic improvement.

⁵ GxExM is a systems approach using the concept that yield is a function of genetics, environment and management

2. Growers produce a safe and reliable supply of Canadian pulses to meet growing demand.

Key drivers:

- Stable and consistent yields of pulse crops adapted to biotic and abiotic stresses
- Innovative products and sustainable management practises ensure a safe supply of pulses

2A. Prevent and/or mitigate damage from **root rot** diseases through a national, coordinated and focussed approach. Specific priorities include:

- Genetic resistance to root rot complexes
 - For peas and lentils: *Aphanomyces*, *Fusarium sp.*,
 - For dry beans: *Fusarium sp.*, *Pythium*, *Rhizoctonia*, *Chalara*)
- Development of diagnostic and prediction tools for root rot infection in peas and lentils, with priority on *Aphanomyces* and *Fusarium*
- Development of new technologies to mitigate yield losses caused by root rots (e.g., new chemical or biological control products, land management strategies that reduce oospore loads, agronomic practices and rotations that mitigate disease pressure)

2B. Develop genetic resistance, herbicide tolerance, and/or Integrated Pest Management (IPM) strategies for control of priority diseases, weeds and insects, listed in [Appendix A](#).

2C. Improve the harvestability of pulse crops, specifically:

- New management strategies and technologies to reduce reliance on preharvest products, including improved genetics for early maturity and uniform maturity
- Improve standability and reduce lodging in peas, faba beans
- Improve canopy and root architecture, increase pod height in dry bean
Improved canopy architecture and agronomic performance of large seeded pulse crops (e.g. chickpeas, kidney beans)

2D. Advance the security of a domestic seed supply through resistance and/or management strategies to control seed-borne disease, including common bacterial blight and anthracnose (with a focus on dry bean seed production).

2E. Take a proactive approach to pest management through developing models for prediction, national coordinated monitoring systems, and investigation of potential new threats (new insects, viruses).

2F. Identify alternative control options for pests that reduce reliance on pesticides and/or develop pesticides/pest control products that minimize non-target effects and are environmentally safe.

2G. Develop management strategies for pulse health to enhance ability to withstand abiotic and biotic stress

- Macro- and micro-nutrient impacts on plant health and ability to withstand stress
- Pulse nutrient management, with particular interest in P management, and N management for new areas of adaptability



3. Pulse crops achieve desirable end use quality for domestic and global customers

Key driver:

- Canadian pulses fulfill the value-added strategy for whole pulse, processing, flour and fractionation uses for domestic and export markets

3A. Develop a quality testing system and market-specific quality goals for pulse crops nationally

- Determine the quality traits needed for current and emerging pulse ingredient uses
- Develop point-of-need diagnostic tests for quality traits
- Implement quality testing in the breeding process

3B. Determine the direct effects of pulses and pulse quality (including the GxExM impacts) in order to support the marketing of pulses for use in feed, fractionation, food ingredients, human health, nutrition, and processing sectors (as shown in [Appendix B](#)).

3C. Food safety contaminants are monitored and managed to meet quality targets and maintain market access (e.g., low cadmium in peas, monitor aflatoxins, other heavy metals).



Enabling Activities

In addition to the research priorities, four topic areas have been identified as critical areas to accelerate research progress. These are intended to be new and specific actions that the sector will take during the course of this strategy. These actions are designed to achieve the following:

- Place Canada’s pulse industry at the forefront of pulse innovation
- Enhance the efficiency of Canada’s pulse research programs
- Capture maximum value from pulse research investment

I. Embrace New Technology & Innovation

To remain competitive in global markets, actions must be taken to rapidly adopt new technologies, such as genomics technologies and AI/machine learning, that can inform the development of new varieties, increase productivity, enhance sustainability and enable decision-making.

Enabling Actions:

- Explore breeding tools and new technologies to identify those that are best positioned to drive advancements in yield gains, including genomics, phenomics and other novel approaches.
- Enable and encourage development of alternative pest management products (i.e., RNAi, biologicals, etc.).
- Strengthen weed science research capacity to develop solutions for pulse crop weed control and harvest management.
- Develop point-of-need pest diagnostic tools to enable timely decision-making.
- Develop national monitoring and surveying program for insects, disease, and weeds

II. Attract New Investment

To realize the full potential of pulses and adapt to changes in funding programs, the sector needs to attract new research investment and develop new funding models that will strengthen and diversify research programming.

Enabling Actions:

- Develop an environment that encourages and attracts new research investment, including piloting new models for pulse variety commercialization
- Explore public-private partnerships to gain faster access to new technology
- Enable technology transfer and entrepreneurship for faster adoption of research outcomes
- Develop partnerships to increase diagnostic capacity for pulse pests and quality traits
- Foster a regulatory and policy environment that attracts new investment (e.g., predictable and effective regulatory approval pathways, value capture for new technologies, protection of existing tools)
- Support and foster a regulatory and policy environment that recognizes the unique contribution of pulse crops to Canada’s sustainability targets
- Coordinate and leverage research with new research funding partners, based on the potential for pulses to contribute to Canada’s environmental and economic goals (e.g., ECCC, ISED, PIC, Genome Canada, NSERC, and provincial sources (ADF, AFC, etc.))
- Leverage consumer trends and the value proposition of pulses to align with the business objectives of industry to facilitate funding partnerships

III. Enhance Research Coordination

To enhance research efficiency and maximize the value of outcomes, research needs to be coordinated across geographies and, in some cases, across cropping systems.

Enabling Actions:

- Establish inter-provincial and/or national coordination to maximize efficiency, increase capacity and optimize funding for innovation. Priorities include:
 - Ensure root rot research is coordinated with other initiatives (e.g. AAFC, WGRF) to encourage efficient cross-agency and inter-disciplinary research
 - Coordinate pulse breeding programs across Canada to increase capacity and enable the adoption of innovative processes
 - Establish a standard quality assessment and evaluation platform across breeding programs in Canada
- Enable collaborations between research organizations (federal, institutional, private), such as:
 - Explore areas of intersection with Protein Industries Canada (e.g., milling research capacity) and other ISED initiatives
 - Coordinate with ALS-Living Labs to layer experiments and data collection, maximize the value of research trials
 - Coordination with the Integrated Agronomy Cluster (WGRF) and the CFCRA cluster soybean activities
 - Farm-scale validation of small-plot research outcomes and recommendations
- Encourage multi-disciplinary teams to work together, as needed, to solve problems (e.g., food scientists, engineers and computer scientists, geneticists and breeders, biochemists, pathologists, agronomists and microbiologists, nutritionists, etc.)
- Human health, animal feed and processing objectives need to be coordinated through a national approach (i.e., Pulse Canada 25 by 2025).

IV. Strengthen Communication

Formalized communication networks will strengthen the competitiveness of the pulse value chain and increase research efficiency.

Enabling Actions:

- Foster stronger relationships between researchers, industry, agronomists, growers, and processors. The pulse sector relies on public researchers and the expectations between these groups needs to be affirmed. Such as:
 - Establish a consistent communication path to transfer customer/end-user experiences back to researchers
 - Host networking events to foster communication between university, government, and private researchers
- Coordinate extension efforts across regions to deliver consistent messaging for crop beneficial management practices and outcomes of research projects to growers and agronomists, supported by accessible and up-to-date resources
- Establish knowledge transfer (KT) pathways to communicate new information to growers and end-users, including equipping agronomists with the knowledge and training to successfully implement new or alternative practices or varieties on the farm
- More frequent connection and collaboration with Bean Improvement Cooperative (BIC), North American Pulse Improvement Association (NAPIA) and other pulse research groups/organizations to access global technologies for the improvement of pulse crops



Appendix A: Pest Priorities

This table lists priority pests for the development of genetic resistance and/or pest management strategies.

Pest Priorities	
Lentils	
Insects	Aphids, grasshoppers, wireworm/cutworm
Disease	<i>Aphanomyces</i> & <i>Fusarium</i> root rots, <i>Anthracnose</i> (fungicide resistant), <i>Stemphylium</i> , <i>Botrytis</i> , <i>Sclerotinia</i> , <i>Ascochyta</i>
Weeds	Kochia, Group 2 resistant weeds, wild mustard, v. canola, NLWB, sow thistle, cleavers, develop genetic herbicide tolerance traits for lentil; wild mustard, Lamb's-quarters,
Field Peas	
Insects	Pea aphid, cutworm, wireworm, pea leaf weevil (hot spots), cutworm, wireworms, grasshoppers
Disease	<i>Aphanomyces</i> & <i>Fusarium</i> , <i>Ascochyta</i> complex (foot rot), <i>Mycosphaerella</i> blight, bacterial blight
Weeds	Group 2 resistant weeds, cleavers & kochia, narrow leaf hawksbead, white cockel, v. canola, tall waterhemp, Canada thistle
Dry Bean	
Insects	Potato leaf hopper, western bean cutworm. Green clover worm, cutworm, seed corn maggot, wireworm; aphids (as vectors), Lygus, spider mites; Storage pests (bruchids and bean weevils)
Disease	Bacterial blight, <i>Fusarium</i> root rot, <i>Sclerotinia</i> , soybean cyst nematode, White mold; <i>Anthracnose</i> ; Common Bacterial Blight; Bean Common Mosaic Virus; Bacterial brown spot; Rusts; Green Patch
Weeds	Herbicide-tolerant weeds, including Canada fleabane, Kochia, Group 2 resistant broadleaf weeds; tall waterhemp; hairy nightshade
Chickpeas	
Insects	Grasshoppers, wireworm
Disease	<i>Aschocyta</i> , root rot complexes, rusts
Weeds	Group 2 resistant weeds, kochia, v. canola, general broadleaf weed management
Faba Bean	
Insects	Aphids, lygus bug, pea leaf weevil, blister beetle, bertha army worm
Disease	Chocolate spot, <i>Alternaria</i> , <i>Stemphylium</i> , vascular wilt monitoring. <i>Botrytis</i> , rusts
Weeds	Cleavers, v. canola, Group 2 resistant weeds, Canada thistle, general broadleaf weeds



Appendix B: Pulse Canada '25 By 25' Strategy

Pulse Canada has determined priorities for the marketing of pulses for the human health & nutrition, animal feed and processing sectors. These market priorities can inform the development of research projects to reach the pulse quality strategic outcome. (Double click on the page to open the full document)



THE CANADIAN PULSE INDUSTRY'S '25 BY 25' STRATEGY

THE '25 BY 25' STRATEGY

Globally, Canada is the largest exporter of pulses and biggest producer of peas and lentils. Although Canadian pulses are exported to over 130 countries, the vast majority of Canadian pulses are exported to a relatively small number of international commodity markets. Reliance on only a few commodity markets can present risk for the Canadian pulse sector and stifle penetration of Canadian-sourced pulse ingredients into the food industry. To diversify markets and grow the value of the Canadian pulse sector, the Canadian pulse industry embarked on a '25 by 25' strategic target in 2017. The overall objective is for 25% of Canadian pulses to be used in non-traditional markets and use categories by 2025. Based on domestic production, the following tonnage targets for incremental use in non-traditional markets/applications were set:

- Peas: 1,100,000 tonnes
- Lentils: 625,000 tonnes
- Beans: 75,000 tonnes
- Faba beans: 100,000 tonnes
- Chickpeas: 100,000 tonnes



Figure 1. 25 by 2025 crop targets.

These tonnage targets were used to guide the development of crop-specific strategies that would achieve high volume incremental use in line with the target based on modelling. Consideration was given to typical inclusion rates for different pulse formats in end-use applications, global volume consumption of these products, and Canada's position in export markets. Using reasonable assumptions on possible market penetration for new products using pulses/pulses ingredients, the crop-specific strategies have identified the formats, end-use applications, and regions/target audiences that would have greatest potential to achieve the tonnage targets (see Figure 1). In the case of chickpeas, forecasted growth in demand suggests that we're on track to meet the 2025 target without needing a focused market development strategy. Therefore, the current emphasis for chickpeas is on addressing Canadian production issues.

Appendix C: National Pulse Research Strategy Committee (NPRSC) Members

The following NPRSC members participated in the development of this strategy:

Daryl Domitruk	Executive Director	Manitoba Pulse and Soybean Growers
Leanne Fischbuch	Executive Director	Alberta Pulse Growers Commission
Valerio Hoyos-Villegas	Assistant Professor of Plant Breeding & Genetics	McGill University
Chris Marinangeli	Senior Director, Research & Regulatory Affairs	Pulse Canada
Jennifer Mitchell	Project Manager	Ontario Bean Growers
Sherrilyn Phelps	Director of Research & Development	Saskatchewan Pulse Growers
Carl Potts	Executive Director	Saskatchewan Pulse Growers
Jenn Walker	Research & Extension Manager	Alberta Pulse Growers Commission

