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CANADIAN SOYBEAN INDUSTRY RESEARCH AND INNOVATION STRATEGY WORKSHOP

June 9-10, 2016
Mississauga, ON
Meeting Notes

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SYNTHESIS
Agri-Food Network

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Soy Canada facilitated a workshop for the Canadian soybean value chain and research community on June 9-10, 2016. The purpose of the workshop was as follows:

- Develop a shared understanding of soybean research and innovation needs and current programs/projects across Canada
- Develop and gain agreement on soybean research objectives/priorities and an overall innovation strategy
- Determine the “best approach” for the industry to collectively position itself for success and to have a co-ordinated approach for future research funding programs/agreements

Rob Hannam of Synthesis Agri-Food Network conducted an on-line survey, facilitated the June 9-10 workshop and prepared this report.

Background and Market Overview

Economic Impact of Soybeans[1]

Soybean is a major crop in Canada that delivers a significant economic impact. In 2014, Canadian growers produced approximately 6 million metric tonnes of soybeans. Between 2005 and 2014, both the industry's production and seeded area increased by 92%, farm cash receipts grew by 201%, and exports climbed by 190%.

Table A summarizes the key statistics for the soybean industry in Canada in 2014.

Table A: Key Statistics for the Canadian Soybean Industry in 2014

Production	Soybean Farms	27,215 (2011 Census)
	Seeded Area	2.3 million Ha*, 5.6 million Ac**
	Yield	2,700 (Kg/Ha), 40 (Bu/acre) ***
	Total Production	6 MMT ****
	GM Production	4.8 MMT
	Non-GM Production	1.2 MMT
	Farm Cash Receipts	$2.3 billion
Processing	Total Soybean Crushing	1.6 MMT
	Soybean Meal Produced	1.2 MMT
	Soybean Oil Produced	0.3 MMT
Exports	Exports of Soybeans (Volume)	3.4 MMT
	Exports of Soybeans (Value)	$2.0 billion

All statistics are based on 2014 data unless otherwise stated and were obtained from organizations such as Statistics Canada, Agriculture and Agri-Food Canada, and the Canadian Oilseed Processors Association.

* Ha – Hectares
* Ac – Acres
** Bu – Bushels (27.22 kg)
*** MMT – million metric tonnes

In 2014, soybean industry activities generated total revenue of $5.8 billion. Based on this value, the Canadian soybean industry is estimated to have generated approximately $12.7 billion in total output, including direct output of $5.8 billion, and indirect and induced output of $6.9 billion.

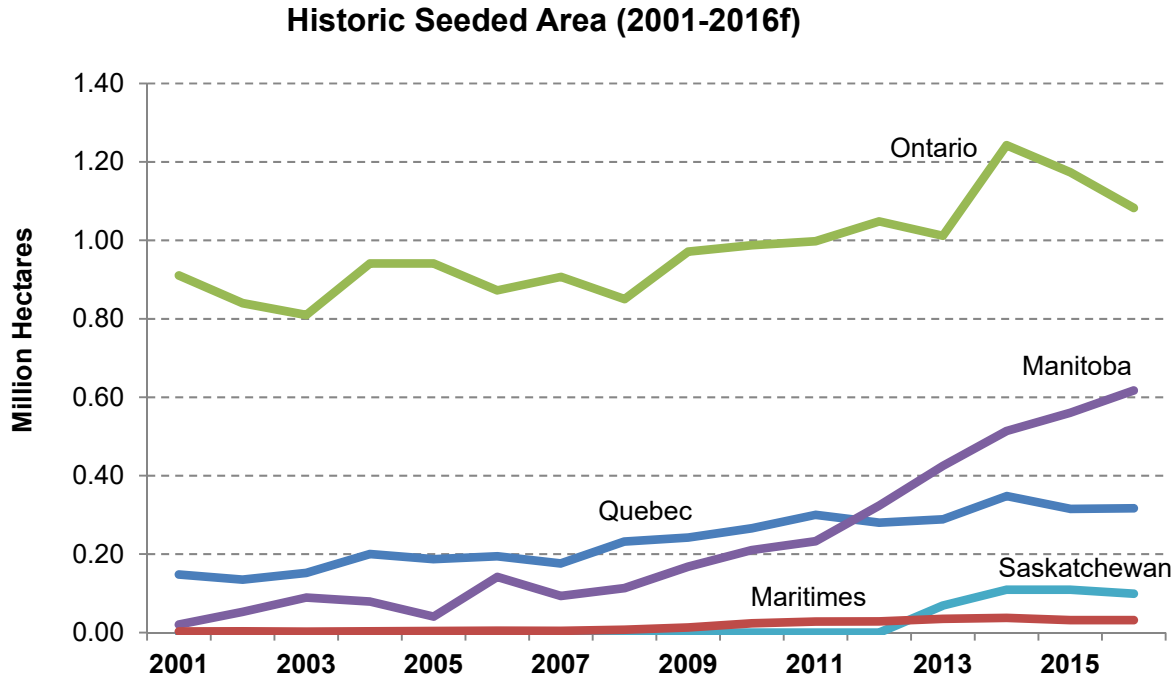
Soybeans generated $12.7 billion in total economic output in 2014

[1] MNP LLP. (2016). Economic Impact Study of the Canadian Soybean Industry – Prepared for Soy Canada (Rep.).

Production Overview

Soybean acreage has been relatively stable in Eastern Canada for the past decade, but has been increasing dramatically in Western Canada. Table B shows historic soybean acreage by province.

Table B: Historic Soybean Acreage by Province



Source: Statistics Canada, 2016; AAFC Calculations.

Eastern Canadian Farmers

Ontario, Quebec, and the Maritime provinces are home to 39,000 grain farmers. Each year, these farmers plant an average of 3.5 million acres of soybeans as part of their crop rotation. It is estimated that 75-80% of these soybeans are genetically modified (GM) varieties and 25-30% are non-GM. GM varieties are used to produce soybean meal and oil; roughly 40% of this production is exported. Non-GM varieties demand a premium, and are used for specialty food-grade end uses or crushed into meal. Approximately 99% of the non-GM production is exported.

Research and development of GM soybean varieties is primarily conducted by private companies, while non-GM varieties are predominantly developed through public breeders such as Agriculture and Agri-Food Canada (AAFC) and the University of Guelph.

Western Canadian Farmers

Manitoba seeds approximately 1.6 million acres of soybeans, the majority of which (1,000,000+ acres) are grown in the Red River Valley. Significant expansion of soybean acres to the west and north in the past two years is expected to continue.

Drought tolerance is of particular concern to western Canadian producers, as there have been a number of years without any precipitation in August. Protein and early maturity are also major priorities from a varietal development standpoint. Non-GM varieties currently only account for 2-3% of production in Western Canada.

Market Overview

Soybean Meal is the main driver for the soy crush market

Oilseed Processing

Oilseed crushing is by far the major end use for Canadian soybeans. It is estimated that 75% to 85% of the soybean crop is crushed domestically or exported for crushing. In 2014/2015, 28% of Canada's soybean crop was processed. Soybean is composed of approximately 78% meal and 22% oil. Over the 10-year period from 2005/2006 to 2014/2015, soybean production increased 92%, while soybean crushing rose by 14%. There are three crush plants located in Eastern Canada. These plants crush both soybeans and canola. Currently, there is no large-scale soybean crush facility in Western Canada.

Table C outlines soybean production, export and domestic use.

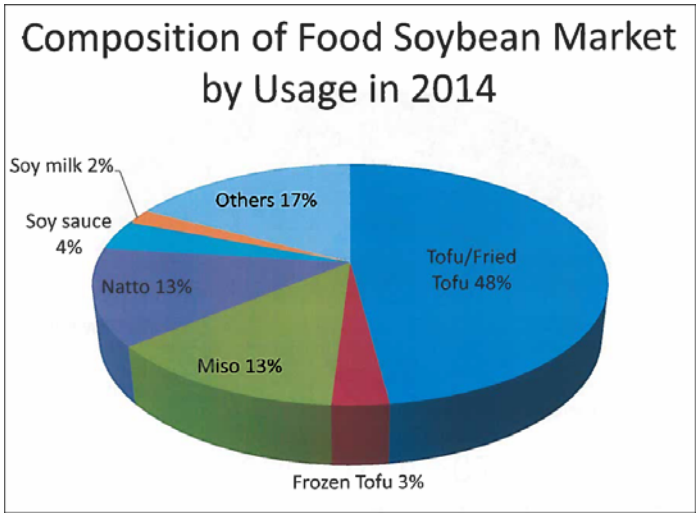
Table C: Canada's Soybean Processing Industry – The Future

	2005	2015	2025*
Soybean Production	3,044	6,049	12,040
Soybeans Exported	790	4,200	n/a
Processing (domestic crush)	1,493	1,567	n/a
Soybean Oil (20-22% oil)	261	282	n/a
Soybean Meal	1,215	1,223	n/a

Values expressed in 000s of metric tonnes.
**Source: Mercantile February 2015*

Food-Grade Soybeans

In addition to the crush/oilseed soybean market, soybeans are used in food-grade applications to make soyfoods. Production volume has historically been 15% to 20% of the total crop. In Eastern Canada, this market has been as high as 30% of the crop in certain years. This is an important market for Canadian soybeans, and often pays the producer a premium price based on specific qualities of the variety (food attributes) or certain production practices (identity preserved system). From a global standpoint, over



half of the food-grade soybean market is for tofu products, followed by miso and natto, each of which comprise 13% of the soybean food market.

Basic requirements for food-grade soybean markets discussed at the workshop are as follows:

- Tofu
  - High protein (42% is the new norm)
  - Components such as 11s/7s
  - Large seed size (over 6.75mm)
  - Tight / round seed coat
  - Typically lower yield, higher premium paid to grower

- Miso
  - High sugar (sucrose)
  - Typically white in colour
  - Low protein is acceptable

- Soymilk
  - Mid-level protein
  - Standard seed size
  - White/(Yellow) demand within same market
  - Components such as low linolenic, lypoxygenase-free, etc.

- Natto
  - Balance of sugar (sucrose, stachyose, raffinose)
  - Firmer seed coat
  - Different “size” markets in Japan
  - Small size, 8-14 grams/100 seeds

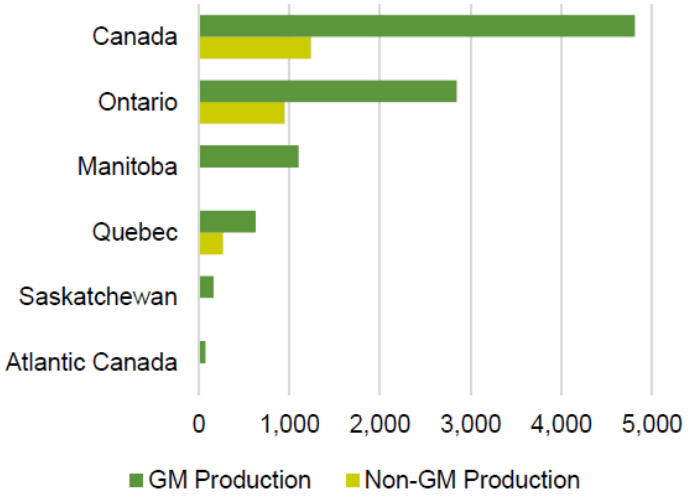
For more in-depth export statistics, please see the appendix.

GM and Non-GM Soybean Production

Soybean varieties in Canada include both Genetically Modified (GM), developed using biotechnology, and Non-Genetically Modified (Non-GM), via conventional plant breeding. GM varieties are typically, but not always, destined for the crush or export market and include traits such as herbicide tolerance that improve productivity for growers. Non-GM varieties often, but not always, are destined for food-grade markets and pay a premium price to the grower. Premium levels fluctuate from year to year based on supply and demand in export markets. The following figure shows an estimate of both types of varieties in each province for 2014.

GM AND NON-GM SOYBEAN PRODUCTION

Figure 3: Estimates of GM and Non-GM Soybean Production by Province, 2014 ('000 Metric Tonnes)



Sources: 1) Statistics Canada. CANSIM Table 001-0010 - Estimated Areas, Yield, Production And Average Farm Price Of Principal Field Crops, In Metric Units, 2014. 2) Agriculture and Agri-Food Canada Industry Estimates, 2014.

[2]

Ontario Production Estimate

GM varieties make up 70% to 80% of production; 40% of that production is exported

Non-GM varieties make up 20% to 30% of production; 95+% of that production is exported

Estimate provided in GFO presentation

Protein Levels

Protein level of soybeans was discussed at length during the June soybean research workshop with a particular focus on protein level in Western Canada. Low protein levels are a significant challenge when it comes to competing in soybean meal markets. Soybean meal is sold on a 47.5% protein guarantee. At 12% moisture, dry soybeans need to be no less than 40% protein to meet the guarantee, or they are subject to discounts based on trading rules defined by the Canadian Oilseed Processors Association. At 37.2% protein, western Canadian soybeans are consistently below protein levels necessary for meeting quality specs for soybean meal. Ontario soybeans are more consistently at or above the 40% protein level, depending on the year. Protein levels are the key determinant of soybean meal value in the marketplace.

Table D on the following page shows protein levels by province for the past 8 years.

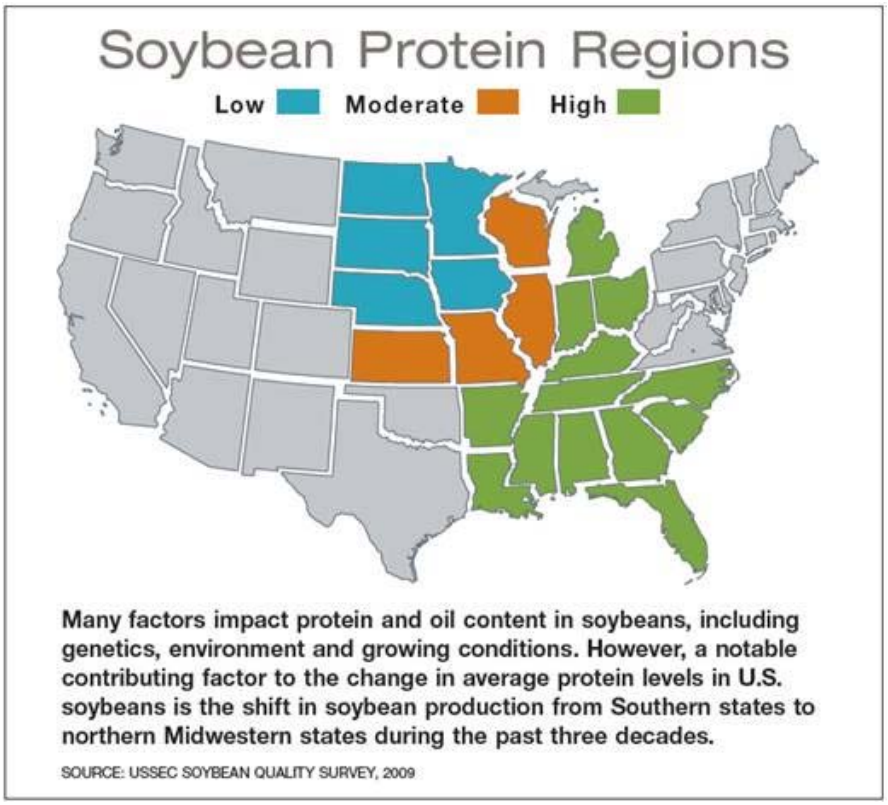
[2] MNP LLP. (2016). Economic Impact Study of the Canadian Soybean Industry – Prepared for Soy Canada (Rep.).

Table D: Soybean Protein Levels

Protein Levels, Non-Food Grade #2								
	2008	2009	2010	2011	2012	2013	2014	2015
MB	37.7	37.8	37.3	36.5	36.3	39.7	37.2	38
SK	33.8	36.3	38.1	40.1	38.1	39.6	37.6	38.4
ON	40.7	40.2	40.8	38.3	39.9	40.4	41	39.8
QC	41.3	41.1	41.1	40.9	40.8	41.3	40.1	41.1

Source: CGC Quality of Canadian oilseed-type soybeans

For reference, low protein is not a unique challenge for Western Canada. The following graphic shows protein levels of US soybeans and indicates that the Northern Midwestern states such as North Dakota also produce lower protein levels.



Current Research Programs and Projects

Each year in Canada, millions of dollars are spent on soybean research in both the public and private sector. This overview provides a summary of the main sources of funding for soybean research and active areas of soybean research in Canada.

Publically Funded Research

At the federal level, the main source of soybean research funding is AAFC's Growing Forward 2 **(GF2)** program. This program provides funding through a variety of mechanisms, including federal programs as well as provincial programs. An example of a federal GF2 program is the AgriInnovation program for industry-led research and development. Currently, soybean research is funded through the Agri-Science Cluster Program (up to $20 million) via a $10.3 million investment in the Canadian Field Crop Genetics Improvement Cluster, led by the Canadian Field Crop Research Alliance (CFCRA). In addition, the Agri-Science Projects program provided $3.3 million to the Eastern Canada Oilseeds Development Alliance (ECODA). The Natural Sciences and Engineering Research Council of Canada (NSERC) also funds basic and industry-led research relevant to the soybean value chain, including $500,000 in 2015 to support the Senior Research Chair in Biomaterials (Trent University), as well as approximately $1.7 million between 2012-2015 for soybean-related basic research.

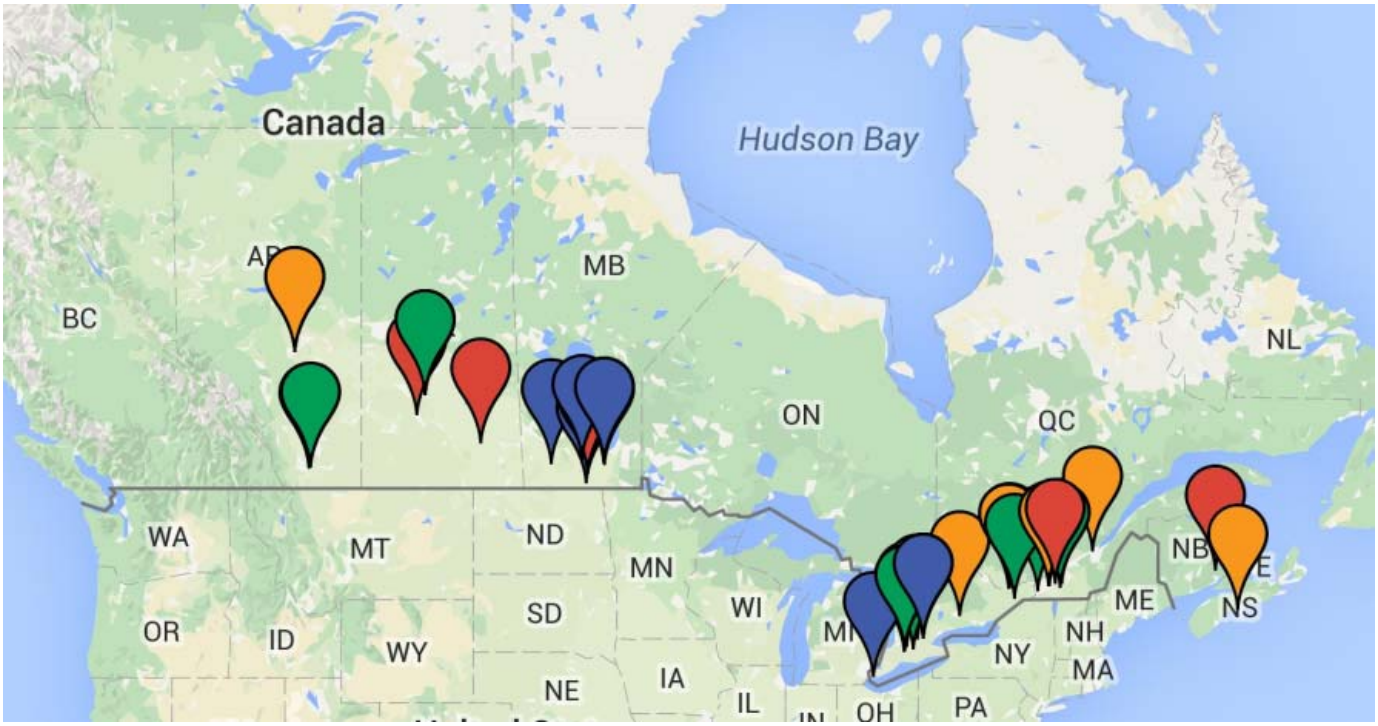
Genome Canada is a not-for-profit organization funded by the federal government. Recent Genome Canada grants for soybean-related research include:

- Francois Belzile and Richard Belanger (Université Laval) received $8.3 million from a combination of sources, including Genome Canada and the Western Grains Research Foundation, for a genetics project: *Soyagen: Improving Yield and Disease Resistance in Short-season Soybean*. (2014)
- Randall Weselake (University of Alberta), in partnership with Arcadia Biosciences, received $0.34 million for the *Application of Genomics for Increasing Seed Oil Content*. (2013)
- Vladimir Vujanovic and Jim Germida (University of Saskatchewan), in partnership with Symbiota, LLC received 1.9 million for *Augmenting the Crop Microbiome to Improve Crop Yield and Stress Resilience*. (2013)

Provincial governments are also actively funding soybean research both through GF2 federal-provincial programs and through independent programs. Industry associations that fund soybean research include:

- Atlantic Grains Council
- Grain Farmers of Ontario
- Les Producteurs de *grains* du *Québec*
- Manitoba Pulse and Soybean Growers
- Saskatchewan Pulse Growers
- Western Grains Research Foundation

In Canada, private sector investment in soybean research and breeding is projected to be $9.5 million in 2017 (similar to 2012). In 2012, 1,517 people were employed by private sector plant breeding (all crops) and private companies also contribute to publically funded programs.
The map below shows the location of government, university, private sector and soybean research programs.



Legend:
Red – associations/partnerships
Blue – government
Green – private
Orange – university

Soybean Innovation Framework

The following overall framework was developed at the workshop as a way to organize national soybean research priorities:

Soybean Innovation Goals

A. Increase yield potential (yield, net return/acre, adaptation to new areas)
B. Protect yield and quality from pests and stresses (yield stability, climate change)
C. Improving quality to meet customer needs and ensure access to markets
    - Crush, Food-grade, Bio-Diesel/Bio-products
D. Enhance Cropping System Sustainability

Soybean Research Themes

	Link to Goals			
Research Themes and Focus Areas	**A**	**B**	**C**	**D**
1. Basic research (Genetics / Genomics) • Develop new tools and knowledge to increase plant breeding efficiency and progress • Advance crop adaption to expand soybean to new areas and to mitigate the impacts of stresses such as climate change and plant pests	✓	✓	✓	✓
2. Plant Pests (Pathology / Entomology / Weed Mgmt.) • Developing agronomic and genetic controls to mitigate the impact of pests and disease		✓		
3. Plant Breeding • Developing germplasm/varieties with enhanced yield, defensive traits and quality • Expand soybean production to new areas (early maturity)	✓	✓	✓	✓
4. Agronomy • Improving adaptation of soybean in a sustainable crop production system (address regional specific needs)	✓	✓	✓	✓
5. Quality – Crusher / Export / Bio-products • **Crusher / Export -** Meeting customer needs for soybean meal and oil quality • **Food Grade -** Meeting customer needs for food attributes in high value soy food markets • **Bio-products -** Adding value to soybeans with new uses / new markets (such as biodiesel and bioindustrial)			✓	

Cross-Cutting Themes

Research Capacity - Infrastructure and highly qualified personnel (HQP)	Research Coordination – Programs and projects	Collaboration Public/Private where possible	Knowledge Transfer

Research Priorities

Participants were split into groups near the end of the first day and asked to identify short-term (3-5 year) and long-term (5-10 years) research priorities in six different areas. These areas were reviewed by the designated group, and then all participants were given an opportunity to add to the list the following day.

1. Basic research (Genetics / Genomics)

Focus areas:

- Develop new tools and knowledge to increase plant breeding efficiency and progress
- Advance crop adaption to expand soybean to new areas and to mitigate the impacts of stresses such as climate change and plant pests

The following comments are research priorities, needs and topics raised

Short-Term (immediate, smaller projects)

- Meta-analysis/review of all breeding technologies in the pipeline to identify regulatory concerns of each technology – will inform direction of breeding programs (i.e., genome editing)
    - UofS is looking at whether Crispr-CAS9 is under regulatory scrutiny
- Look into using IP system to send varieties created with specific breeding technologies to world markets that accept them

Long-Term (longer-term than described – probably 10+ years to tackle these well)

- Genomic work that has started should continue
- Implement genomic selection capacity for public and industry access
- Validated markers for early maturity, high protein & high yield together
- Abiotic stress tolerance (frost tolerance, drought, saturated conditions)
- Bioinformatics – Big Data applications
- Yield stability (abiotic stress tolerance also fits in here, including sclerotinia)
- Genetics, genomic and physiology are key research areas that need focus
- Phonemics / Phonology was mentioned as a possible area for focus

2. Plant Pests (Pathology / Entomology/ Weed Mgmt.)

Focus Area:

- Developing agronomic and genetic controls to mitigate the impact of pests and disease

The following comments are research priorities, needs and topics raised:

- Key diseases mentioned include SCN, SDS, root rot, sclerotinia, foliar, stem rot
    - Several of these diseases are also present in the US and there is good collaboration in place with US researchers to learn and share information
    - While mould (sclerotinia) was mentioned as a priority for Canada and is, to some extent, a Canadian only problem and thus required more focus
    - Iron chlorosis – need to continue work to address

Sclerotinia is a key issue and somewhat unique to Canada

- Disease control strategies with xenobiotics – new cultivars, new chemistry
- Key insect pest include aphids
- Pest monitoring / surveillance (scientifically sound) was mentioned as a key need to track intensity and population shifts such as:
    - Race changes
    - Pest changes
    - Molecular tools, visual rating, culture
    - “Climate change effects”
    - Modelling
- Breeding linkage (linkage to breeding programs)
    - Marker assisted breed noting new sources of resistance
- Rotation, tillage, fertility (agronomy side) interacts on pests
- Economic thresholds (determine clearer economic threshold as decision support for growers)
- Weed control / management was mentioned as a key challenge for both Eastern and Western Canada
    - Resistant weed concerns (or potential)
    - Soybean not as “competitive” as other crops in West, thus weed control is key to success
    - Lack of new chemistry (new actives)

“Weed control in soybeans is our greatest threat.”

3. Plant Breeding

Focus Area:

- Developing germplasm/varieties with enhanced yield, defensive traits and quality
- Expand soybean production to new areas (early maturity)

Plant breeding in soybeans is conducted by both the public and private sector. Seed companies have significant breeding programs investments across Canada in both GM and non-GM. The public breeding organizations are also active and tend to focus on germplasm development, early maturity, niche markets (such as food grade soybeans) and new uses.

The following comments are research priorities, needs and topics raised:

Short-Term

- Early maturity for Western Canada – advance early lines from program (short and long term)
- Phenotyping sites
    - Test material in adapted environment
    - Shared sites – Public and private collaboration
- Marker Assisted Breeding
    - Privately developed markers could be made available to the public
    - Work on collaborative capability

Early maturity with high yield (and high protein) is the ultimate goal for several breeding programs.

Long-Term

- Stable, long-term funding to support public breeding
    - Encouraging conventional germplasm enhancement
- High protein levels for Western Canada
- Protein by environment interaction
- Biotic – Agronomics / diseases – root problems in cool, wet conditions
- Abiotic – drought tolerance
- Germplasm development
    - New genetic sources, novel diseases, genes, genetic diversity
- Training of new breeders – need to develop talent (HQP)
- Utilise new plant breeding techniques
- Marker assisted selections (MAS)
- Predictive breeding tools
    - High-powered statistical tools
    - High throughput genotyping / phenotyping
    - Advanced analytics tools – looking at weather data

"Plant Breeding is a long term activity. Need stable, long-term funding to make progress"

4. Agronomy

Focus Area:

- Improving adaptation of soybean in a sustainable crop production system (address regional specific needs)

Agronomy research and knowledge transfer has regional difference between Western and Eastern Canada due to the level of experience with growing soybeans. Soybean are well established in Eastern Canada and while there is some room to expand the crop to new areas, the agronomy needs are mainly related to specific management challenges such as weed management. In Western Canada there is a wide range of grower experience and thus a large need for agronomy research to understand how to establish and manage soybeans in various soil zones and early maturity areas. The following is a summary of agronomy research needs.

Short Term - Western Canada[3]

- Row spacing and plant population
- Land preparation – zero-tillage, residue management
- Seed establishment – heat unit accumulation (soil temp) without high erosion – technology
- Fertility - Nitrogen, Phosphorous, Potassium, Inoculation

Long Term – Western Canada

- Crop rotations - Previous crop, Where fit best, Economic
- Soil fertility
- Pest surveillance – proper modelling and monitoring
- Weed management including herbicide resistance weeds
- Soil health – producing plant protein, good for the soil?
- Need to use agronomic research to support social license
- Soybeans – increase biodiversity, but bring in more diseases
- Root disease issue and correlation with pulse crops (Western Canada)

Short Term - Eastern Canada

- Weed management is a key agronomic concern in the East
- Eastern Canada – nutrients / phosphorous issues (this is not soybean specific, related to the overall cropping system/rotation)
- Develop solid Best Management Practices (BMPs)

"Growers need to manage soybeans with more intensity, not more intensively."

Note: A challenge mentioned is that agronomy work is sometimes not considered "innovative" and thus does not qualify for funding which inhibits work to expand soybeans to new areas.

[3] Additional information on the agronomy needs for Western Canada are included in the pre-survey results of the appendix of this report.

5. Quality

Focus Areas:

- **Crusher / Export -** Meeting customer needs for soybean meal and oil quality
- **Food Grade -** Meeting customer needs for food attributes in high value soy food markets
- **Bio-products -** Adding value to soybeans with new uses / new markets (such as biodiesel and bioindustrial)

Quality in soybeans can be categorized into three specific market streams based on the end use of the crop. The following is a summary of the quality research priorities discussed at the workshop:

Quality – Crush Market

Short term

- Protein 40% (focus to increase protein in Western Canada)
- Increase bean size in general to avoid high fibre

Long term

- Protein 40%
- Biodiesel desired traits
- Modify fatty acid profile to improve oil stability
- "Super" soymeal – targeted amino acids
- Non-GMO trend (watch to see how this develops and any potential impacts on soybeans)

Quality – Food Grade[4]

- Addressing both export markets and domestic markets – whole bean consumption
- Soybean annual quality assessments for food grade (currently conducted at AAFC Harrow Research Station)
- Research and technical intelligence gathering for all markets to inform research – Europe, Asia, and Domestic
    - Lead time (varieties and technology)
- Stability of characteristics of the soybean genetics by environment (G X E)
    - E.g. seed size, shape, composition
- Organoleptic characteristic – conferred to end products and senses (mouth feel, flavor, aroma) - quantify these to better target consumer needs

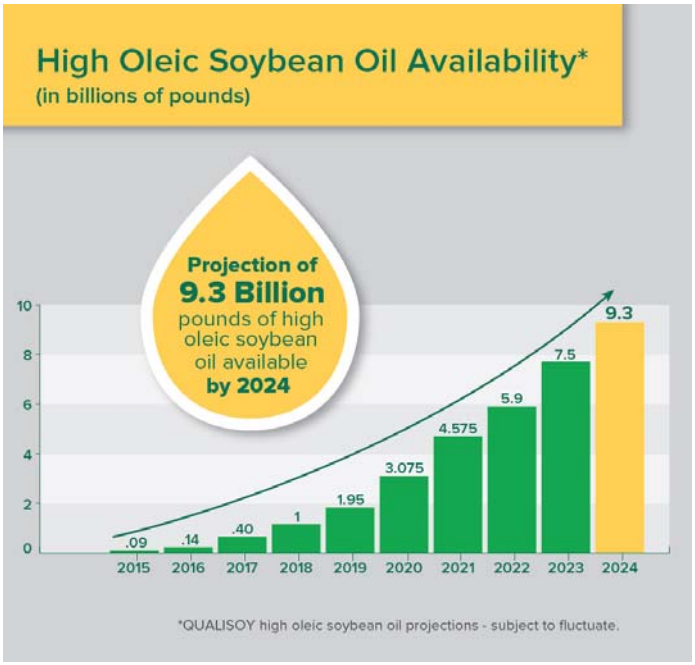
[4] Additional information on specific quality aspects for food grade soybeans is included earlier in this report and in the appendix (pre-survey)

- As a source of plant-based protein / whole soy product for food product development – new uses
- Increased domestic consumption compete with other protein sources
- Nutrition / digestibility – stay ahead of what the markets are asking for
- Soy – soy allergies

Quality – Bioproducts

- Bioproduct uses for soybean oil to replace petrochemicals (eg: high oleic soybean oil, high linoleic soybean oil, etc). will play an important role in opening new market applications for Canadian growers

A presentation at the workshop showed the need and opportunity for advancing new oil profiles in soybean varieties adapted to Canada. The US United Soybean Board (USB) projects a rapid increasing demand and supply of High Oleic soy.



Other Comments / Notes:

Regulatory environment for long-term research

- How will new breeding techniques be regulated? Where we can go?
- Social license related issue about consumer acceptance of science and technology

Collaboration – Across Canada and Internationally

- Genomics – sequencing opportunities – there is an international effort, be open to what is elsewhere and collaborate, don't reinvent

Precision Agriculture

- Precision agriculture was mentioned as a developing area. The group did not specific where this fits in the research priorities and whether this is a public sector or private sector. This topic needs further discussion by the sub-committee.
  - Drones, images, nutrient deficiencies, U.A.V., robotics, sensors
  - Digitized soil map and aerial images – doesn't exist today

Social License

- The issue of social license (public/consumer trust) was raised by some participants as an issue impacting the industry however there was no clear direction or consensus on whether this should be a research priority for soybeans
- There appears to be a need for research/science based information on sustainability of current production systems. This topic also needs further discussion by the sub-committee to determine how this issue might impact the research priorities.

Miscellaneous

- U.S. Soybean research database – https://www.soybeanresearchdata.com/ (Louise)
- Asia – Center of diversity for soybean germplasm is Asia
- St. Louis soy breeders workshop has been a very good learning and networking opportunity for Canadian researchers

Best Approach – Research Co-ordination

The group discussed ideas on the "best approach" should be for the soybean industry to maximize research efforts and funding in the future. Comments discussion included the following topics:

Long Term Approach Needed

- Long-term multi-environment testing is needed
- Stability or research funding will be a benefit – push toward longer term funding for programs / projects
- Has been trend to shorter term projects recently, difficult to accomplish big projects / challenges
- Engaging the customer , customer interaction with breeders is needed
- Talking about extending time-frame from 5 to 10 years for GF3 – good!

Growing Forward 3 / Next Policy Framework Timeline

- Overall policy to be established – July 2016
- Bilaterals with provinces – Mar 2017
- Consultations – more than for GF2, strategic policy branch will lead – online meetings, events, survey
- Need to build a strong case for funding, there will be more requests that funding available

Research Funding Administration

- Continuity of research programming that is working well is desired by the group, "Tweak" the administration part to make further improvements
- Approval process – was too lengthy in the past
- Industry funds get tied up in the guidelines that AAFC sets out which can be limited in some cases
- More flexibility is better – total envelope, total milestones
- Flexibility a fund use? Hiring, AAFC – couldn't hire others than students
- Programs branch does the administration, important distinction that it is not the science or policy branch
- Funding ratio has been an issue in some cases 25:75, 50:50, 75:25 – all over the place, Comment was made that this will likely be similar in the future

Research Co-ordination

- Soybean have several examples of coordinated approaches – cluster, agri-innovation projects

- Overall the group felt that soybean research has been well co-ordinated in the past but there is additional room for improvement, information sharing and co-ordination
    - CFCRA = success story, GFO to provide database and success stories
    - Soyagen – genetics work, very good communications
    - Strong leadership has been shown by researchers to drive applications and co-ordination (example: Francois Belzile, Laval)
- Multi-crop vs. national crop approach? Response - don't need to be concerned, can have flexibility
- Soy Researcher workshops every 2 years recommended, Soy Canada coordinated event to bring the national sector together
- Soy Canada research strategy roundtable, recommended to continue this kind of forum, every few years (more leading up to funding framework)
- Better opportunities for agronomy and research co-ordination among public and private organizations
    - Possible co-ordination on BMP development and validation
    - Public / private work on white mould
    - Shared testing sites for pre-competitive projects?
    - Needs further discussion but there appears to be opportunities

Best Approach

- Clearer priorities (national and regional) are needed for soybeans
- Industry strategy – coherent strategy, industry driven
- Strong recommendation that is it best to have "one voice" form the soybean crop, need coordinated approach for approval of funding
- Can have multiple applications within an overall strategy (cluster, Agri-innovation, etc.), but prefer co-ordinated overarching strategy
    - Applications that align with the strategy
- Soy Canada can be the coordinator for the overall strategy (outcome of the group discussion)
    - Need to develop common messages about the research needs, strategy, market opportunities
    - Get industry agreement on long term direction / strategy for the industry
    - Collection view of research priorities developed by industry
    - Multiple crops – can incorporate this if needed (as per the cluster)
    - National but regional differences can be reflected in the overall strategy
    - Pre-competitive areas, need to clarify scope
    - Determine "Where things should go" for GF3, Genome Canada
- Multi-crop approach – comment that for QC, ON – better to have multi-crop approach together
- Leverage industry funds – Soy Canada to coordinate discussions where possible for best use and co-ordination of research

Next Steps

Workshop Report

- Notes from the meeting, framework for the strategy, presentations, send to all attendees, target 2 weeks

Research Priorities

- Sub-group to co-ordinate and organize the priorities for each theme in more detail (for review by the full group), will need regional differences / value chain representation
- Priority-setting subgroup selected:
    - Jim Everson – Soy Canada
    - Dan Wright - Monsanto
    - Josh Cowan - GFO
    - Francois Labelle - MPSG
    - Dave Harwood – Dupont Pioneer
    - Yvonne Lawley - University of Manitoba
    - Lorna Woodrow – AAFC
- July call/meeting, pull something together by mid-August, deal with pre-competitive topics only
- Target by the CFCRA – Aug 3-4 WPG

Research Project Database

- Research database (excel) was sent to app parcipipants by email
- Submit errors / omissions to Chris at Soy Canada

GF2 feedback

- Success stories are needed, also suggestions on areas for improvement
    - What worked well? Success stories? Changes?
- Send to Jim at Soy Canada

Best approach for co-ordination / alignment

- How do we continue to talk about co-ordination within the industry?
- GF3 / speaking with single voice
- GF3 timeline – priorities to fall September 2016
- Opportunities for Private/Public collaboration (eg: white mould, BMPs, etc)
- Sub-group looking at research priorities to discuss possible next steps in this area

Soy Research Forums

- Researcher workshops every 2 years, recommended for Soy Canada coordinated event
- Soy Canada roundtable (like this workshop), continue this kind of forum for overall market needs and strategy development

Appendix

Agenda

Canadian Soybean Industry - Research and Innovation Strategy Workshop
June 9-10, 2016 - Orange Conference Room
Alt Hotel - 6080 Viscount Road, Mississauga, ON

Purpose:
The purpose of this workshop and process is as follows:

- Develop a shared understanding of soybean research and innovation needs and current programs/projects across Canada
- Develop and gain agreement on soybean research objectives/priorities and an overall innovation strategy
- Determine the "best approach" for the industry to collectively position itself for success and to have a co-ordinated approach for future research funding programs/agreements (ex: GF3)

Day 1 - June 9 (half day)

12:00 pm Working Lunch (please arrive promptly at noon)

12:30 pm Welcome and Introduction
- Welcome, purpose & intent – *Jim Everson, Rob Hannam*

12:45 pm Current Situation
- Review pre-survey results
- Presentation about the current research

1:00 pm Research Priorities presentations
- Farmer needs – east presentation – *Josh Cowan*
- Farmer needs – west presentation – *Francois Labelle*

1:45 pm Break

2:00 pm Research Priorities presentations
- Crusher / Exporter presentation – *Rolf Mantei*
- Food-grade presentation – *Andrew McVittie*
- Seed Company presentation – *Dan Wright*

3:00 pm Break

3:15 pm Research Priorities Group Discussion
- Research (genetics and genomics)
- Plant Pests (pathology, entomology, etc.)

- Plant Breeding
- Agronomy
- Quality - End-use crusher / commodity export
- Quality - End-use food grade / specialty

4:45 pm Break

5:00 pm Wrap up and Day 2 thoughts starter questions:
- Summarize information into initial priority list for each of the 5 research categories (short term 3-5 years and longer term 5-10 years)
- Thought starter questions to think about for Day 2

5:30 pm Adjourn meeting

6:30 pm Dinner and networking (Moxie's Bar and Grill – Cab ride to 55 Reading Ct, Toronto, ON M9W 7K7)
Sponsored by Syngenta

Day 2 - June 10 (full day, adjourn by 2:30pm)

8:00 am Day One Recap and Summary

8:40 am AAFC Update on research and GF3 - *Dr. Michèle Marcotte*

9:10 am Best Approach Group Discussion
- Scan of current research co-ordination
- What is the best plan for a co-ordinated approach for future funding?

10:00 am Break

10:15 am Industry Innovation Strategy
- Pull together elements of a draft Soy Innovation Strategy
- Determine common messages

12:00 pm Lunch

1:00 pm Wrap-up and Next Steps
- What is the path forward for the industry to finalize the strategy?

2:00 pm Adjourn

Attendees

- Jerome Auclair - La Co-op Federee
- Gino Becerra - Elite Grain
- Elroy Cober - AAFC
- Josh Cowan - Grain Farmers of Ontario
- Matthew Czerwinski - Grain Farmers of Ontario
- Jim Everson - Soy Canada
- Leanne Fischbuch - Alberta Pulse Growers
- Martin Harry - Secan
- Dave Harwood - Pioneer
- Ken Hester - Grain and Oilseeds Industry Engagement Branch
- Mark Huston - Grain Farmers of Ontario
- Connor Kent - Bunge
- Kelley Knight - OMAFRA
- Francois Labelle - Manitoba Pulse and Soybean Growers
- Yvonne Lawley - University of Manitoba
- Jeff Loessin - Dow AgroSciences
- Rolf Mantei - Bunge
- Michele Marcotte - AAFC
- Richard Martin - Atlantic Canada
- Lisette Mascarenhas - SaskPulse
- Don McClure - Soy Canada
- Andrew McVittie - London Agricultural Commodities
- Louise O'Donahuge - CEROM, Quebec
- Carl Potts - SaskPulse
- Istvan Rajcan - University of Guelph
- Jeff Reid - Canadian Field Crop Research Alliance (GFO)
- Eric Richter - Syngenta
- Jennifer St Jean - La Co-op Federee
- William Van Tassel - PGQ, Quebec
- Tom Warkentin - Saskatoon Crop Development Centre
- Lorna Woodrow - AAFC
- Dan Wright - Monsanto
- Rob Hannam - Synthesis
- Michael Black - Synthesis

Export Statistics

2001-2016 Soybean Statistics

Production ('000 Metric Tonnes)

Province	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
PEI	4.4	6.7	5.4	6.5	9.3	11.1	11.1	17.1	33.1	40.7	49.0	51.4	61.5	60.1	47.2
Nova Scotia										6.6	8.2	10.6	12.0	14.8	12.8
New Brunswick										9.1	8.9	9.3	13.2	13.6	12.2
Quebec	315.0	315.0	390.0	520.0	505.0	535.0	472.0	600.0	530.0	823.0	800.0	843.0	847.0	898.0	1,000.0
Ontario	1,279.1	1,905.1	1,728.2	2,476.6	2,585.5	2,667.1	2,000.3	2,476.6	2,619.5	3,129.8	3,189.7	3,401.9	3,238.6	3,791.1	3,592.5
Manitoba	36.7	108.9	149.7	40.8	55.8	252.3	212.3	242.2	321.1	435.4	413.7	770.2	1,068.2	1,107.7	1,390.7
Saskatchewan													118.4	163.3	179.6
Alberta															
B. Columbia															
Canada	1,635.2	2,335.7	2,273.3	3,043.9	3,155.6	3,465.5	2,695.7	3,335.9	3,503.7	4,444.6	4,466.5	5,086.4	5,359.0	6,048.6	6,235.0

Seeded Area ('000 Hectares)

Province	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
PEI	2.8	3.0	2.4	3.2	4.0	4.6	4.5	7.3	12.9	17.8	20.7	20.8	24.3	26.3	21.9
Nova Scotia										2.0	3.6	3.8	4.0	4.9	4.5
New Brunswick										3.8	3.6	4.0	6.5	6.1	5.3
Quebec	148.0	135.0	152.0	200.0	187.0	194.5	176.0	232.0	242.0	266.0	300.0	280.0	288.5	348.0	315.0
Ontario	910.5	839.7	809.4	940.9	940.9	872.5	906.5	849.8	971.2	987.4	997.5	1,048.1	1,011.7	1,242.4	1,173.6
Manitoba	20.2	52.6	89.0	78.9	40.5	141.9	93.1	113.3	167.9	210.4	232.7	323.7	424.9	514.0	560.5
Saskatchewan													68.8	109.3	109.3
Alberta															
B. Columbia															
Canada	1,081.5	1,030.3	1,052.8	1,223.0	1,172.4	1,213.5	1,180.1	1,202.4	1,394.0	1,512.9	1,558.1	1,680.4	1,869.0	2,251.0	2,190.1

Yield (Kg/Ha)

Province	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
PEI	1,571.4	2,233.3	2,347.8	2,031.3	2,325.0	2,413.0	2,466.7	2,342.5	2,565.9	2,300.0	2,200.0	2,500.0	2,500.0	2,300.0	2,200.0
Nova Scotia											2,700.0	2,800.0	3,000.0	3,000.0	2,800.0
New Brunswick											2,100.0	2,300.0	2,000.0	3,100.0	2,300.0
Quebec	2,164.9	2,377.4	2,565.8	2,613.1	2,715.1	2,772.0	2,689.5	2,620.1	2,226.9	3,100.0	2,700.0	3,000.0	2,900.0	2,600.0	3,200.0
Ontario	1,420.6	2,279.6	2,146.0	2,660.7	2,759.9	3,094.1	2,221.6	2,921.2	2,702.7	3,100.0	3,200.0	3,200.0	3,000.0	3,100.0	3,100.0
Manitoba	1,816.8	2,070.3	1,682.0	1,007.4	1,453.1	1,781.8	2,330.4	2,176.1	1,983.3	2,100.0	1,800.0	2,400.0	2,500.0	2,200.0	2,500.0
Saskatchewan													1,800.0	1,600.0	1,700.0
Alberta															
B. Columbia															
Canada	1,529.8	2,281.4	2,167.9	2,593.9	2,708.2	2,885.0	2,301.1	2,790.6	2,535.2	3,000.0	2,900.0	3,000.0	2,900.0	2,710.0	2,900.0

Source: Statistics Canada, 2016

Canadian Soybean Exports (2010-2015)

	Quantity (Metric Tonnes)					
Country	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
China	205,143	179,989	809,789	800,098	586,685	1,162,815
United States	388,442	305,398	376,765	572,354	579,065	499,539
Japan	370,723	358,174	378,829	381,337	368,546	357,430
Netherlands	518,214	614,863	562,754	409,026	648,753	276,248
Bangladesh	0	0	89	52,500	52,182	214,900
Italy	20,717	53,610	102,382	134,857	123,484	186,303
France	58,770	78,846	32,738	67,299	121,002	156,097
Belgium	165,905	141,586	228,948	143,805	200,059	146,112
Turkey	63,935	16,258	5,500	19,658	195	141,571
Malaysia	95,608	92,675	70,947	68,200	98,091	136,880
Iran	0	68,252	37,977	0	66,000	134,938
Norway	55,000	61,900	57,752	62,295	99,948	104,805
Viet Nam	17,818	88,242	55,955	36,009	65,623	94,104
Germany	145,569	69,622	224,755	217,969	14,879	86,035
Pakistan	0	0	0	0	20	79,708
Egypt	66,767	150,289	160,516	121,255	69,827	66,265
Thailand	23,607	30,582	43,909	32,493	43,764	54,377
Indonesia	7,266	1,148	10,744	12,363	41,919	43,707
Greece	40	0	0	0	0	30,130
Taiwan	3,974	6,100	8,909	11,406	20,294	29,105
Hong Kong	30,036	25,786	26,618	27,620	27,934	26,266
Republic of Ireland (Eire	565	243	121	4,822	4,556	20,488
Singapore	17,226	14,571	17,729	14,928	21,720	17,690
South Korea	3,462	12,397	10,514	17,474	11,196	13,199
Philippines	9,063	6,328	7,680	8,632	8,122	9,245
Peru	41	1,270	499	0	1,675	4,182
Spain	144,226	88,260	58,817	84,964	124,112	3,531
Ukraine	307	1,111	157	1,220	2,674	2,887
Israel	1,312	1,432	7,618	1,996	2,308	2,448
Poland	816	633	999	773	878	1,346
Saudi Arabia	1,003	1,142	30,606	1,287	1,375	1,332
New Zealand	988	641	660	821	860	1,142
Russian Federation	44,213	0	466	180	2,795	986

AAFC Oilseed Science Strategy Expected Outcomes (Current)

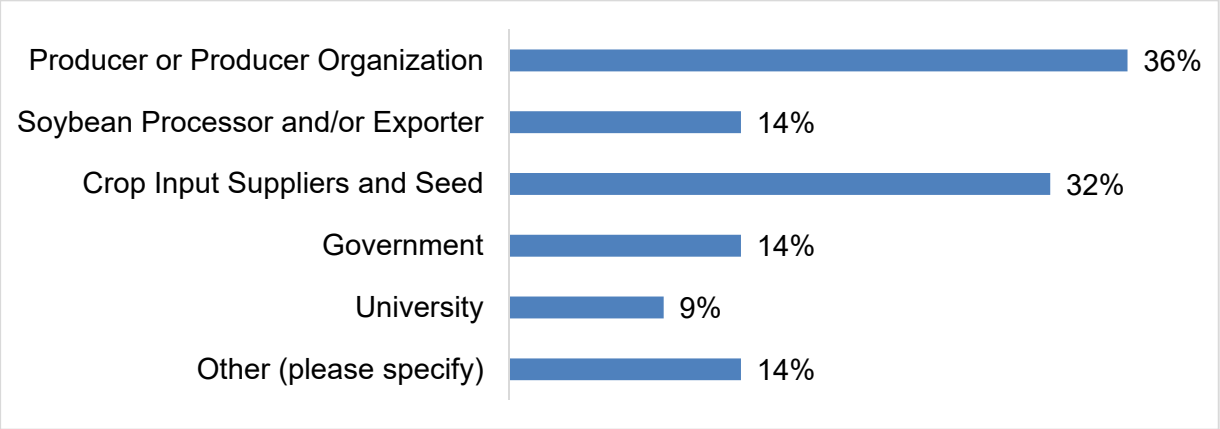
Strategic Objectives	Focus Areas
Increase agricultural productivity	▪ Increase the yield potential of oilseed crops and mitigate the impacts of abiotic (environmental) stresses, using genetic improvement, germplasm development, the creation of new breeding tools, and variety development ▪ Decrease the yield gap for oilseed crops by supporting integrated production systems, involving agronomy, crop protection, biology and early-generation and variety testing for crop adaptation to regional conditions
Enhance environmental performance	▪ Enhance sustainable oilseed production practices ▪ Improve nutrient and water use efficiency ▪ Develop sustainability metrics for oilseed crop production
Improve attributes for food and non-food uses	▪ Respond to market demands and requirements for specific oilseed crop quality traits through genetic improvement, germplasm development, the creation of new breeding tools, variety development, and enhanced production methods
Address threats to the value chain	▪ Develop new knowledge and tools to mitigate threats to oilseed value chains including new and emerging biotic stresses (i.e. insect pests, diseases, weeds)

- Genome Canada - SoyGene
- Work toward enhancing research support in the Oilseed Sector
- Look to industry / producer groups for input into the next Policy Framework (follow-on to GF2)
- Top priorities today:
    - Controlling threats to the sector; particularly diseases and pests
    - Increasing yields through breeding and agronomics
    - Expanding soybean into the prairies
    - Improvements of soybean food attributes
    - Better knowledge translation of AAFC research results to farmers:
        - BMPs from research plots into practice
        - What farmers are getting for the producer group funding going into oilseed research

Pre-Survey Results

Canadian Soybean Industry
Soybean Research and Innovation Workshop
Pre-Survey Results
May 2016

Please select in the stakeholder group you represent (22 responses).



Other: included government public research, trade association, Not-for-profit research centre

In your opinion, what are the DANGERS facing the Canadian soybean industry in the next 5-10 years?
Note: asterisks denote identical or similar responses by that many additional respondents
Trade / Market Access

- Sustainability - Adoption of new consumer/marketplace-driven requirements*****
    - US efforts to make an “elite” feed soybean (commodity bean)***
    - Sustainability – US marketing “sustainable soy” as a product (not just a characteristic), and not just to Europe, pushing Asian markets to think “sustainability” as well
    - Greater and strong push from ASA (American soy Association)
    - Some EU feed markets have already closed to any soy that is not “sustainable”
- Low protein soy in Western Canada (market access/price danger)
- Japanese population decreasing; caloric intake lowering
- Increasing foreign regulation including the adoption of new safety and quality monitoring in export markets
- Lack of Low Level Presence (LLP) policy
- Pesticide Maximum Residue Limits (MRLs)
- Other SPS concerns (i.e. heavy metals, trace elements, mycotoxins, microbiological)
- Non-GMO testing requirements
- Challenges related to receiving Phytosanitary Certificates and need for more flexibility.

Technology Acceptance / Market Access

- Lack of uniformity in trait approval process globally****

- Japanese steering away from generic soy products; population decreasing; caloric intake lowering
- Need for a national approach to commercial launches in Canada that have not received approval in key export markets (example of Xtend soybeans)

Other Market Access

- Anti-GMO movement - consumer backlash against our current trait packages***
- Social license and acceptability of soybean production methods***
    - Soybeans not considered great for soil health
    - Pesticide use concerns
- Potential loss of non-GM acres because GM soybean production is less risky and $ applied to breeding and to innovation in chemistry are shrinking.
    - Maintaining production base of specialty production (i.e. non-GM and IP growers). Includes balancing premiums required to attract/retain specialty growers, yet remaining at par (or below) competitors.
- Existing market data gaps (i.e. specialty potential in select markets, capabilities of competitors, etc.).
- Not maintaining investments in foreign branding/market development.
    - Erosion of CIPRS and the Canada brand
- Not keeping pace the transitions to new soybean oil profiles.

Research and Technology

- Limited research dollars in the future, short term thinking, less people for cutting edge research******
- Multinational seed company mergers – may lead to reduced private research investment**
- Soybean competitiveness vs. other crops - soybeans genetics do not keep pace with advances in other crops
    - Canola varieties with enhanced protein being developed to compete with soy
    - Introduction of hybrid wheat and resurgence of wheat acreage
- Differences in agricultural inputs regulation across provincial jurisdictions, i.e. restriction of neonicotinoid seed treatments in Ontario.
- Loss of insect protection products
- Dev. of early maturity (is a challenge)
- Few apparent economically-viable agronomic solutions to boost yield (it is stagnant)
- Growers experimenting with soybeans and failing, before varieties suited for their area.
- Limit biodiversity (bee pollination/habitat)

Pests and Diseases

- Continued increase in severity and geographic scope of agronomic pressures on the crop. SCN, White Mould, SDS, BSR, BLB, Gly resistant weeds******
    - Soybean Cyst Nematode (SCN), breakdown of SCN resistance in varieties in the US****
    - Resistant weeds – new variety development that allows for different chemistries to be used***
    - New and emerging pests for soybeans in Western Canada (SCN, root rot diseases, foliar diseases, new insect pests)
    - SDS (sudden death) increasing in incidence and importance
- Weather and climate challenges in new and existing growing regions.

    - Shorter growing season in new production regions in Prairies (leading to increased risk factors, leading to lower protein levels
- We need to be able to forecast better new and emerging diseases in a context of climate warming.

Competitiveness

- Could get surpassed by other countries with better and better oil varieties***
- Increased European/Chinese/Brazil soybean production (suppressed prices), future Russia? Ukraine? ***
- Lag in negotiation and/or acceptance of FTAs vs. competitors.
- Uncompetitive freight rates
- Lack of coordinated Canadian industry which will allow competitors to take market share in overseas markets.
    - Non-collaborative industry (due to fears of losing competitive advantage
- Declining visibility in markets dominated by on-line promotion.
- Changing preferences of importing markets for IP products and commodities

Infrastructure

- Transportation congestion and reliance on existing rail corridor for transportation to port positions**
- Switch to shorter shipping windows for rail shipments (for movement to port positions)**
- Lack of a crusher in Western Canada.
- Excessive processing capacity (region/area not specified)
- Highly dependent on a limited number of processors. Vulnerable to decisions to consolidate crush capacity / fewer facilities.
- Reduced government involvement in safety-related monitoring.

Other

- Declining farmer population – the current average age of farmers is around 54, in 10 years a number of these farmers may be out of farming
- Climate change (drought, affecting crop quality and sustainability)
- Strong Canadian dollar (could be a risk)

In your opinion, what are the OPPORTUNITIES facing the Canadian soybean industry in the next 5-10 years?

Western Canada Production

- New soybean acres in Western Canada ********
    - Continued growth of short-season varieties in the Prairies, including future potential to grown non-GMs and handle via pulse processors
    - More knowledge by farmers on how to grow soybeans in western Canada and trained extension staff to support those farmers
    - Adding another crop option for farmers across western Canada, which can be beneficial for profitability and for sustainability of crop rotations.
    - Manitoba/west could lead to market opportunity in western animal feed market

Research and Technology

- High value soy products with specialized quality parameters*******
    - Bioeconomy – soy-based oils, lubricants, greases, plastics**

    - High Oleic soybeans, new high stability oil profiles****
    - Development of value added traits in both GM and non-GM types
    - Compete with canola with better profiles for bioproduct use (i.e. HOS).
    - Expansion of acreage/supply with short season varieties
- New technology / breeding techniques*****
    - Chemistries and techniques including RNAi
    - genome technologies, biotechnology
    - CRISPR CAS9
    - genomics offers excellent opportunities to accelerate development
- A greater number of soybean varieties, Breeding for yield and increased protein****
    - Targeting high value markets, be agile in developing cultivars with new traits in an accelerated way and understand market signals.
- Adoption of technology to reduce burden/create efficiencies.
- Facilitate no-till production systems
- Mitigate climate change (increase sustainability)
- Reduce greenhouse gas emissions (reduction N fertilizer use)

Trade & Market Trends

- Growing global demand for protein / plant based protein****
    - Growing global meat production will continue to lead to a growing demand for soybean protein and Canada can benefit from this demand growth
- Food grade / conventional soybean / IP markets are a strength to build****
    - Non-GM food and feed markets, organic soybeans / higher value segments
    - The high number of conventional soybean breeders in Canada, give us a niche to supply genetics to the world,
    - Non-GM and organic are likely to have stronger demand especially if GM labelling becomes a reality. Canada has strong reputation in quality of non-GM
- Canada has the best IP players in the world, need to keep this going***
    - Specializing in traits and niche markets
    - Leverage IP system broader than non GMO. If we can truly IP something how can we build even more? Should we limit it to non GMO?
- Sustainability – develop and market “sustainable soy”***
    - take advantage of markets desiring that label to acquire market access before it becomes standard for everyone to comply with
- New / Alternative markets
    - Diversifying specialty export markets away from traditional bases, such as Japan.
    - New FTAs.
    - Potential for Korean exports, new markets for Korean specific products
    - Aquaculture market?
- Be alternative supplier of GM soybeans to main suppliers (U.S., Brazil, and Argentina)

Infrastructure

- Opportunities for specialty crushing and refining (producing non-GM meal and oils).
- Increase local processing (crushing facility)

Other

- Canada is a stable country for investment compared to other world areas**
- Potential change in acceptance of GM crops for soy food products across major markets
- Canada is known for clean wholesome vision...we need to use it
- Lower Canadian dollar

- Relatively stable environmental conditions (minor variability between years)

In your opinion, what are the current STRENGTHS of the Canadian soybean industry? |

- International reputation of supplying high quality, traceable, safe soybeans***
    - Very good international reputation for high quality products, quality control, credible government institutions (CFIA, CGC, AAFC), reputation as a 'clean' natural growing environment.
    - Excellent reputation for our soybeans overseas, especially Japan
- Great soybean characteristics - good protein, sugar etc.***
    - Quality product - IP or commodity***
    - Beneficial climate for higher protein specialty varieties for food and feed uses.
    - High quality soybeans compared to other areas of production
    - Large land base
    - Consistent yield (low number of crop failures) helps make soy a profitable crop
    - Limited production constraints (few pests)
- Research capacity and facilities****
    - Good cooperation among researchers
    - Strong investment in research to drive new variety development on non-GMO types that meet needs of both producers and end-users.
    - 10 plus conventional soybean breeders, both public and private
    - Strong public food-grade breeding programs, Harrow Research
    - Private breeding company investments in GM soybean development
    - Strong investment by private sector in seed and technology development to bring improved varieties to Canada
- Excellent, innovative farmers***
- Access to ports for transportation / infrastructure***
    - Locational/freight advantage to large markets such as China.
- Diversity and Size. Enough variety to serve customer interests and enough size to be nimble but not cumbersome***
    - Small, agile, targeting specific small and high value niche markets
- Strong investment in IP and commodity programs***
    - Excellent IP system in place and strong food-grade market access (but need to defend that access)
    - Infrastructure and mindset to do IP and do it well***
    - Specialized value chain grower through to exporter/end-user
- CIPRS and private traceability/IP programs to maintain quality**
- Grower/industry willingness to innovate in Western Canada**
- Organizations / Collaboration
    - Strong national value-chain organization bringing together all groups
    - CSTA working well with CSGA and breeders including public
    - Strong producer groups such as GFO
- Positive regulatory environment / standards - streamlined and future focused relative to other countries ***
- Top of the line processing equipment
- Relaxed registration of soybean varieties without merit testing
- Stable economy and government and low tax.
- Biodiversity (providing alternative oilseed/legume option)

List any soybean research areas that are currently being worked on and should continue in the future.

Research (breeding, genetics and genomics)

- Plant breeding, genetics and genomics for soybeans adapted to the various agro-environmental conditions of Canada
- Variety development********
    - Mostly GM soybeans through private breeding programs
    - Mostly conventional soybeans through public breeding programs
    - Very early maturity variety development, public and private breeding programs
    - Variety development (led by private sector)
    - Variety trialling/evaluation
    - Germplasm development to expand soybean production in northern climate and in the western prairies (very very very short season)
- Breeding and marker development *****
    - New breeding techniques
    - Market Assisted Selection
- Genotyping by sequencing*****
    - Genomics and genetics (Genome Canada grant, Laval)
    - Genomic selection system for public breeding programs
- New soybean uses (bioproducts, food uses, etc.)**
- Genetic enhancement for existing production areas as well as expanding into new areas.
- Disease resistance work focused strongly toward SCN and SDS resistance (among others)
- New traits, biotechnology
- Water stress tolerance
- Iron deficiency chlorosis resistance
- Better oil profiles and yield improvements
- Cold stress tolerance
- Conventional soybeans for export and source of germplasm for future
- Root rot

Plant Pests (pathology, entomology, etc.)

- Pests and Diseases (and Treatments)*****
    - Pest management and basic agronomic and rotational aspects to improve pest control strategies and quality
    - Pathology and SCN in western Canada
    - SCN, SDS, seedling diseases, SMV, grower communication materials
    - Root diseases, Root rot (surveys and varietal tolerance)
    - White Mould resistance/management through innovative technologies.
    - Foliar disease survey
    - Monitoring for new pests or changes in races of disease**
    - Aphid control by beneficial insects
    - Soybean aphid and bean leaf beetle work
    - Entomology
    - Disease management work, and linkages with the North Central Soybean Research Program in the USA
- Weed control work, including herbicide resistant weed control*****
    - Weed control (volunteer canola, critical weed free period), new modes of action.
    - Weed management in soybeans and volunteer management of soybeans

Agronomy

- Soil fertility management - phosphorus, nitrogen fixation****
- Agronomic research (herbicides, fungicides, insecticides)***
- Cropping rotation, crop system interactions (how does soybean fit into and contribute to a viable crop rotation system?)***
- Cover crops and soil health***
    - Residue management
- Agronomy and cropping systems (rotations, tillage systems) in western Canada
    - Ultra-early soybean management. - making soybeans more competitive with Canola
- Seeding practices (seeding rates, land preparation, straw mgmt., soil temperature, stubble height)**
- Agronomy – need to explore outside of the box, and maybe focus more on physiology, agronomic factors can contribute more viably to yield in future
- Organic production
- Foliar fungicides
- Hail damage
- Seed treatments

Quality - End-use crusher / commodity export

- Increased protein****
- Seed composition
- Soy quality work from a processing standpoint

Quality - End-use food grade / specialty

- Food grade data analysis , Harrow food Grade Data program***
    - Ongoing quality analysis for specialty types.
- Enhancement of food traits for specialty markets***
    - Protein, sugars
- Nutrition and End-Use
- Cholesterol lowering effects
- IP quality research and how to maximize our advantage in the world markets
- Processing to improve palatability and digestibility

Other

- How to involve new players in public private partnerships
- Impact of production practices on harvestability
- Soybean physiology – environmental stress tolerance (i.e., drought tolerance) – Hugh Earl 2009-2011 project, 2011-2014 WUE, and a current project (finishing in 2017) focuses on rooting traits leading to improved drought tolerance
- Cadmium accumulation
- Improvement in inoculum / inoculants**
- Special inputs
- High yielding conventional germplasm which can be adopted quickly to new trait platforms
- Development of small scale measurement techniques for quality parameters in finished products.

Is there any soybean research being done currently that, in your opinion, should be decreased or discontinued? If so, please list the research topic/area and explain.

- No*******
    - We assess our research program and priorities annually and discontinue unnecessary projects as we see fit
- Rust has not developed as many predicted but I think research in this area has already been reduced or discontinued as the threat remains along the US gulf coast
- I feel that there are so many different customers with unique needs - it's important to have a diversified breeding program.
- We focus on funding work we think has value. My only comment here would be to further weed out work that doesn't have the ability to be transferred to someone downstream (whether it be another researcher or a grower, etc.) – i.e., marker development work that never results in a practical marker for a breeder (even when the marker itself is effective). It doesn't mean that pie-in-the-sky work should not be done, but rather than any work that is done should have a next step in mind.
- Isoflavones
- Genomic studies in many areas taking greater percentage of research dollars.....long term gain potential versus shorter term objectives always an issue of balance, but breeding and agronomic studies still best bang for buck.
- Row spacing, population studies
- Perhaps food types for the very early season areas - i.e. Western Canada - given the difficulty in servicing the food market from MB and SK

List any gaps in soybean research and new research areas that should be considered for the future.

National Agronomy Network

- While not all agronomy project should be national in scope, regions would benefit from knowledge of all projects and there is a place for a national agronomy network and a network manager. Currently there seems to be more small unconnected agronomy projects.
- Regional agronomy projects need to incorporate all the former smaller projects into a multiyear multi location coordinated project (this will likely involve primarily public researchers and producer funding)

Integrated Pest Management (IPM)

- Projects recognizing the importance of an IPM system that utilize chemical, cultural and mechanical methods to manage, prevent and delay pest occurrences and outbreaks. Research aspects pertaining to pests that impact soybean crops should lead to effective and sustainable pest management systems. Pests of particular importance to soybean crops in Manitoba include: Glyphosate resistant weeds (kochia, others with potential to develop), difficult-to-manage weeds (biennial wormwood, ragweed), Sclerotinia, Phytophthora and root rot complex (Pythium, Fusarium, Rhizoctonia) and soybean cyst nematode.

Identification, surveillance and modelling of crop pests and beneficial organisms

- Identification, monitoring and modelling of insect, disease and weed populations in pulse and soybean crops in Manitoba or, projects that may lead to developing predictive

models and decision making tools to manage pest populations and improve crop production. Projects that study the role and importance of beneficial organisms and practices that affect their population.
- Industry wide approach to solving specific disease and pest issues - screening and joint research approach

Soil health and microbial communities
- Studying soil health and quality factors that contribute to our ability to grow consistent, nutritious and productive pulse and soybean crops is an emerging priority. Soil is recognized as a fundamental component to crop production and an important resource that is impacted by production practices. Identify soil parameters and production practices that improve and maintain our ability to grow soybean crops with specific interest in:
- Quantification, improvement, efficiency and maintenance of Rhizobium to promote symbiosis with pulse and soybean crops
- Impact of soil erosion on crop production: identification of production practices that minimize erosion while maintaining and improving crop production
- Identification of soil parameters that correlate to crop productivity, and development of soil testing methods to measure these soil parameters
- Understanding the relationship between soil microbial communities and crop production

Genetic improvement for high yielding varieties with quality and agronomic traits
- Breeding should be increased
- In additional to yield, an emphasis is put on maintaining or improving quality aspects and incorporating agronomic traits. Quality traits are those that are important for the end-user. Agronomic traits are those that improve ease of production (disease resistance and pest resistance, harvestability etc.).
- Of emerging interest, is to improve tolerance to environmental stress related to changes in moisture and temperature patterns. Traits of particular importance to soybean crops in Manitoba are: protein, non-gm nutritional qualities for the food market, disease resistance (Sclerotinia, Phytophthora, soybean cyst nematode), environmental stress tolerance (moisture excess or deficit, high or low temperatures during critical reproductive stages) and tolerance to iron chlorosis.
- Adapted varieties is largest priority for West
- molecular marking
- DNA analysis at some levels
- Incorporate high-throughput phenotyping/genotyping procedures into research projects to tease out interaction effects (the big-data concept)
- High protein varieties (above 45% on DM basis)

Crop establishment
- The management practices and factors leading up to crop establishment (pre-seeding, seeding and immediately after seeding) warrant further study to optimize farmer profitability, yield potential and maintain soil quality. This may include testing and adoption of new technology or equipment, relationships among seeding factors (depth, date, and rate), understanding the effect of soil factors (texture, temperature, moisture, fertility etc.) and crop residue. Soil potassium levels and potash fertilization for soybeans are becoming an increasing concern.
- Agronomic research in ultra-early production areas, the basics of seed rates, dates, row widths, seed treatments, inoculants, strip till, rotation etc.

- Weed management for all types of resistant weeds
- Weed control - particularly related to new HT systems such as dicamba resistance.

Nutrient Management / Agronomy

- fertility work (N and P management) and its opportunity to improve yields
- Nutrient management - alternative ways to manage P in soil for soybean production
- N management strategies in soybean

Crop physiology and phenology

- Knowledge of the critical yield determining stages of soybeans, physiological mechanisms that are involved and the effect of various environmental factors will be useful to: help identify risks and risk mitigation opportunities for the industry, as well as identify production practices and breeding opportunities to enhance growth, development and yield.

Optimization of agronomic potential with technology

- Proposals that seek to explore potential synergy between agronomic practices, equipment, genetics, technology and environment will also be accepted. This may include validation and implementation of precision agriculture as an agronomic research tool to improve efficiency, productivity and profitability for pulse and soybean farmers.

Agronomic challenges and opportunities for niche crops – non-GM soybeans and novel production systems

- Resolve agronomic challenges or identify production opportunities for edible beans and non-GM soybeans will be accepted. Specific agronomic challenges or opportunities include:
- Weed management in non-GM soybeans (chemical control, cultural practices etc.)
- Opportunities for transition to organic production, i.e. basic agronomy.
- Irrigation
- Intercropping, relay cropping etc.

Marketing and End-Use

- Improve understanding and messaging around soybean quality parameters for market preference
- Understanding reasons for lower protein content in soybeans in Western Canada and developing strategy to improve
- Projects that aim to significantly increase demand for soybean crops: study and identify new environmental, societal, health, medicinal, or functional benefits of soybean crops. Specific food and functionality priorities include:
- High protein varieties (above 45% on DM basis)
- Research into seed traits important for bioproducts industries
- Nutraceutical traits
- Low / No lipoxygenase varieties
- Increase focus for animal studies for health benefits (other than lowering cholesterol)
- Human Clinical Trials for health benefits (other than lowering cholesterol)
- Research in processing (extrusion) to produce meat analogs (with appropriate texture) using soy proteins.

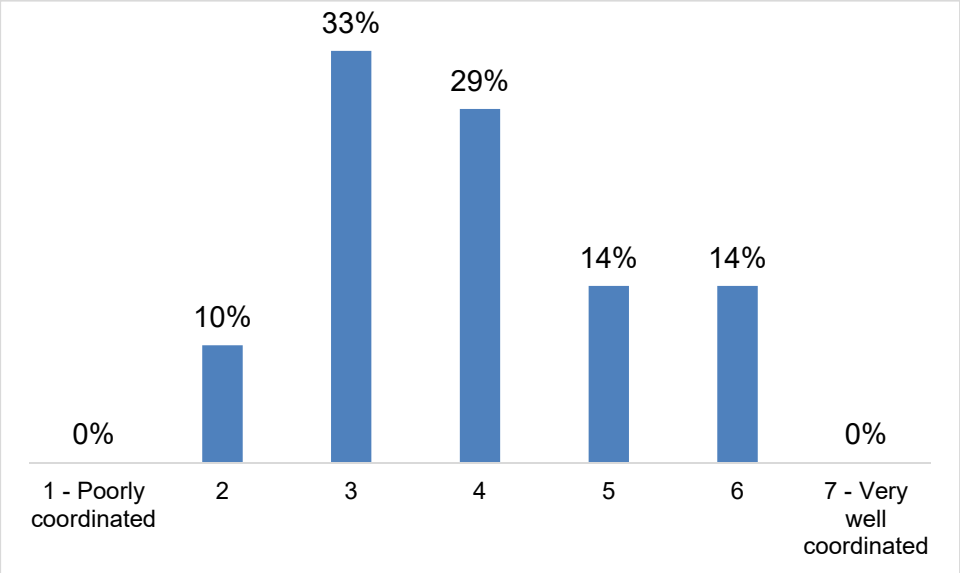
Post-Harvest / Handling / Marketing

- Projects that have the potential to assist and positively impact farm business decisions related to post-harvest handling, storage, infrastructure, logistics, transportation, economics and crop rotation.

Other Comments

- Increase efforts toward raising soy protein levels in regions faced with low protein
- Identify research targets that may be required to market a 'sustainable soy'
    - Ensure the feed soybean remains competitive (given the US effort to improve it) – we would miss the market if it disappeared
- Most established soybean pathology expertise is in the USA currently (not sure if this is actually a problem, or rather something to continue to leverage through the North Central Soybean Research Program)
- Knowledge transfer of research results is an area needing improvement (and GFO is overhauling its involvement in this area)
- climate change impacts on pests, diseases and crop management
- soybean diseases found in other jurisdictions but not here
- Research in protein quality of soybean and other beneficial component (GABA etc.)

Please rate the level of coordination among research programs to meet the overall industry needs (21 responses).



Average – 3.9

In terms of the current processes, co-ordination of research and communication (knowledge sharing), what is working well and/or should continue?

Knowledge Transfer

- Knowledge sharing and transfer is working at a regional/provincial level**
- Knowledge transfer effective in breeding*
    - Breeding efforts in the GF2 Cluster and related projects like the Genome Canada grant for soybean (many breeders collaborate),
    - Companies pick up the varieties produced by public breeding programs
- Knowledge transfer is most effective in pathology side
    - Albert Tenuta's involvement in the North Central Soybean Research Program
- Knowledge transfer working well between public and private industry - share material and ideas
- Good informal / ad-hoc communication among soybean industry*
- The strategy used depends on the area of research. Agronomy research can be done well at a provincial level but varietal development, nutrition and endues could use more national coordination to achieve commercialization to affect market development.
- Knowledge transfer in agronomy could be improved, and many other areas need more improvement in knowledge transfer
- More technology transfer from researchers required (especially from Agriculture and Agri-Food Canada)
- Working well for commodity organization who have invested in internal staff to conduct knowledge transfer. This is in response to diminished tech transfer capacity of Manitoba Agriculture and other public institutions.
- Collaboration between AAFC and U of S breeders
- Agronomic work in Ontario is pretty well communicated via OMAFRA.
- Sask Soybean Cropportunity team input from value chain to identify priorities and share information.

Research

- CFCRA**
    - Public breeding programs funded through the CFCRA (a GF1 DIAP project and a $10.3 million GF2 Cluster) are well coordinated and the funding partnership (producers + SeCan) has been effective (in place since 2010 and well-respected by members and AAFC)
    - GFO provides the project management services for the CFCRA
    - Grain Farmers of Ontario is exerting leadership.
    - GFO is also the lead of the Canadian Field Crop Research Alliance through the CL-23 in which all the organizations (Sask Pulse Growers, Manitoba Pulse Growers, Quebec Growers, etc.) are involved.
    - CFCRA's delivery/management of federal research funds for soybean going into GF3 is working well
- Priority setting
    - Interact with farmers, industry to identify short and long term needs
    - Works well at the regional level (provincial)
    - Co-ordinated by MPSG
- Identify researchers and projects
    - Build relationship and knowledge of research capacity
    - Manitoba has limited capacity in this area due to lack of agronomic research capacity (researchers, infrastructure)

- Apply for or collaborate to leveraged funds
    - More collaboration required between provincial organization
- Administer funds and agreements
    - Significant improvement required for turnaround time for proposal review, funding notification, agreement set up and payment
    - This is currently the largest and most frustrating limitation for groups that are administering funding
- Reporting*
    - Researchers are spending too much time on research administration and reporting. Streamlining these processes while maintaining accountability will improve research output.
    - Significant improvement required for coordination among funding agencies to synchronize reporting schedules
    - Written and financial reports are the most frustrating limitation for researchers
- Regional Variety Trials in Western Canada
- Research meetings e.g. Ontario Soybean and Canola Committee*
    - The Soy Canada meeting is also promising
- More collaboration required between provincial organizations*
    - There seems to be less robust coordination of research efforts beyond the provincial level – each provincial producer group seems to set priorities independently and manage projects independently and funding structures vary by province.
    - Could enhance this by a formal conference to bring all aspect of research together
- There is no 'soybean research cluster' at the federal level. There are two private/public partnerships that do receive federal funding, with the rest of programs being primarily private (by companies) or public via institutions.
- The research on soybean is extremely well coordinated when compared to some other sectors.
- Occasional sharing of project details happens between ON and MB, with occasional joint funding of projects.
- Currently, commodity organizations are playing an important role in coordination of research projects and funding applications. This has created new expenses for these organizations with the need to hire staff to manage research projects and reporting.*
- Involvement of grower associations in funding of research (e.g. through the clusters)
- Not aware of current coordination efforts and processes**
- Having national research projects and finally a national organization to speak in the issues
- Private industry cooperation is limited other than work to introduce traits to a broader range of germplasm.
- Duplication of research - Better co-ordinated we may be able broaden the research.
- There is clearly a national leadership. However there are multiple projects that were also approved.
- There is a need to integrate all of the projects along the value chain.

Can you provide an example of a successful research project that involves multiple organizations or multiple provinces? What were the success factors for this project? (I.e. why did it work so well?)

- The CFCRA-CL23 cluster has a suite of projects that involve multiple organizations (AAFC labs, CEROM, UoG, CDC) and multiple projects (Saskatchewan, Manitoba, Ontario, Quebec)
    - Francois Belzile's genomic project started in the CFCRA DIAP and continued in the Cluster involved multiple organizations and provinces. It worked since it allowed for research to be done that individual labs could not do on their own.
    - Canadian Field Crop Research Alliance Cluster – Maritimes through to Saskatchewan + SeCan for soybean (other additional organizations for other crops); Everyone is engaged in decisions and has their voice heard, and the goal on everyone's mind is the improvement of Canadian soybean production/value chain (it was already everyone's goal from the start)
    - Annual update meetings from the Cluster, and bare-bones management that keeps the focus on the Cluster project and not on other distractions. Everyone also came together to access federal funding starting back in 2010, as AAFC wanted national scope for projects
    - Within the Cluster, there is also a soybean genomic selection project led by Francois Belzile (ULaval) as the genomic selection lead, with three breeders involved across ON and QC (Istvan Rajcan, Elroy Cober, Louise O'Donoughue)
    - Was also the core around which a successful and large Genome Canada application for soybean was developed to take the work a step further and include more pathology component
- NSERC and the molecular marking program
- Tom Walacky SCN research
- Genome Canada Soyagen project - involvement of growers, seed industry, strong research team that are used to working together thanks to previously successful collaboration through cluster and DIAP projects
    - SoyaGen project funded by Genome Canada and involving QC, ON, MB, SK; CFCRA from Growing Forward 2
- CFCRA. Right people sitting down.
- ECODA. AAFC SCN work.
- CSEA 'tofu testing program' (at Harrow)
- Example: Dr. Don Flaten's recently complete research project "Phosphorus Beneficial Management Practices for Manitoba". This project included collaborations among the university and Manitoba, Manitoba Agriculture, the crop diversification centres, farmers and Manitoba Pulse and Soybean Growers.
    - MPSG was proactive in informing farmers of progress and developments of the project as well as completing production recommendations and resources to implement BMPs on farm. Because of the success of the project, Saskatchewan Pulse Growers and the applied research network have implemented a similar study to substantiate the results in Saskatchewan.
- Cereal crops - shared screening of disease - i.e. fusarium between locations and provinces. Fusarium recognized as a major threat with no one entity having a monopoly on the solution.
- No, don't know****

Thinking about the communication of research results: Can you provide an example of research results that were effectively communicated and successfully adopted by industry? What were the success factors for this knowledge transfer? Why were the results adopted so quickly or easily?

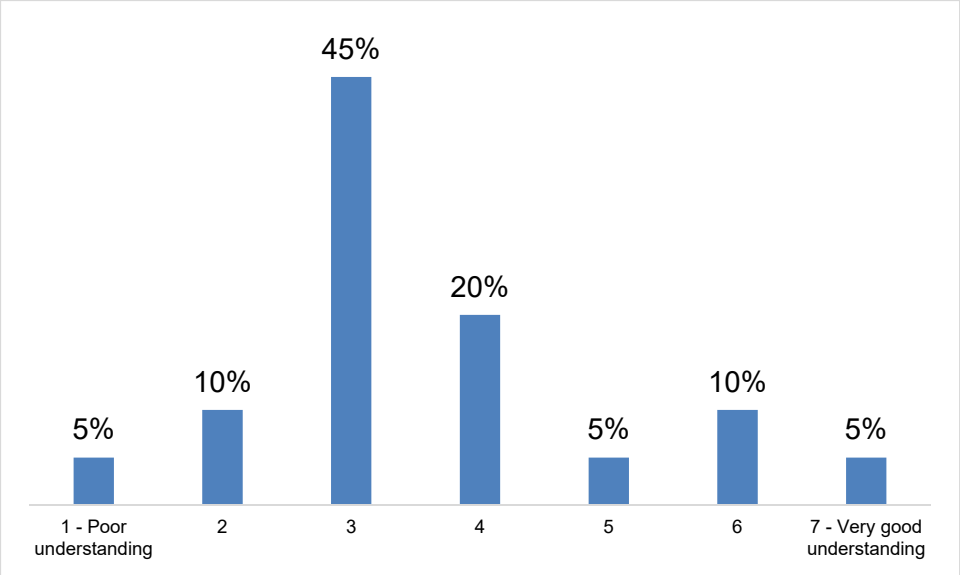
- Communication of risks and treatments for soybean aphid worked well. The problem was potentially large and devastating.
    - Scouting and spray triggers needed to be communicated. OMAFRA, the private sector and other public researchers cooperated and put out a consistent message.
    - H. Bohner does a good job sharing the results of his high yield work.
- Recent investments by MPSG in a Production Specialist and extension material (web video, radio, bean report) have helped to communicate research results to farmers and agronomists in timely way
- Research conducted to determine optimum seeding rates was recently completed and results were quickly adopted on farm. The research was well set up, i.e. across multiple cropping systems. Results were clear and concise. Results were incorporated into MPSG production resources (ex. Bean App)
- USA North Central Soybean Research Program (NCSRP)
    - Many north-central US states + Ontario have been involved in this soybean research initiative (Ontario's involvement mostly through Albert Tenuta at OMAFRA). Again, similar goals within each organization is the starting point, and the initiative also pools expertise across the region.
    - NCSRP – outcomes translated to fact sheets/publications and an online website.
    - Knowledge translation was a goal from the start, research was relevant to industry
    - Many people involved (significant expertise pooled together), including some more dedicated to knowledge transfer, like Albert Tenuta (not leaving the core researchers with all of the responsibility)
- Fluency agent. filled a need and was available in a timely manner to address a hot button topic
- G. Hnatowich work on inoculants now widely known and making way into recommendations by agronomists.
- Development of Midge Tolerant Wheat in Western Canada - Formed a Stewardship team representing all segments of the industry and got behind a common message and communications strategy
- Through the CFCRA CL-23, there is a clear uptake path for the cultivars that are developed through the inclusion of SeCan.
- New cultivars developed for cool climate regions, resulted in adoption by industry in parts of Quebec and Maritimes which resulted in dramatic increase in production and establishment of new industry in these regions and crushing plant for soybean and canola in Quebec.

How can the processes, co-ordination, administration and communication of soybean research be improved? What are the gaps that need to be addressed?

- Develop Canadian Soybean Research workshop***
    - Every two years, alternating east and west
    - Annual research meeting. Open sharing of ideas across disciplines, setting of priorities
    - Better understanding of work going on across provinces, and where priorities overlap, perhaps work toward coordinated investment in those particular areas.
    - Model after Canadian wheat fusarium workshop and Canadian Wheat Alliance
    - How are priorities being determined?
    - Joint review of research priorities and identification of common themes
- Researcher networks
    - Could be strengthened, potentially allowing for more robust projects across many more field sites
    - I'd be looking to ever-greater coordination of public and private research. Canada has modest financial and human resources relative to competitors
- Database
    - Identification of areas where collaboration across organizations makes sense
    - Needs to be greater coordination of research which would be improved with a national database of research across country. This would help reduce any potential duplication and maximize benefit from research investment; plus would help with linking researchers across country.
- Communication / Education / Knowledge Transfer
    - Regular review and information sharing of status of research and results.
    - Clear knowledge transfer strategies should be developed for each project from the proposal stage (something GFO is now working toward)
    - More targeted information delivery. if there is a herbicide resistance project focus on the problem areas with targeted communications
    - Communication/extension strategies established at the initiation of projects, not just waiting until the end.
    - More outreach activities are desired.
    - Educate the broader extension community on soybeans - thinking specifically that in western Canada, the education need is high.
    - An electronic newsletter by Soy Canada, similar to what AIC, Top Crop Manager and Germination publish but with a focus on soybean would be useful.
    - Over last number of years there seems to have been a reduction in communication of research results.
- Administration
    - Someone in charge to gather and disseminate the information on a regular basis
    - Administration should be kept as lean as possible, so that the projects and their outcomes remain the main focus – the CFCRA is already communicating with AAFC Programs Branch about ways to improve the efficiency and practicality
- Other Comments
    - Via a single body such as Soy Canada or perhaps by the formation of a set of committees that span the value chain for both GM & non-GM. Better understand the research challenges and accordingly target/develop appropriate priorities, also helping to eliminate duplication and perhaps share results/best practices.
    - Lack of centralized funding system has resulted in duplication of research project being conducted by different scientists on the same priority.

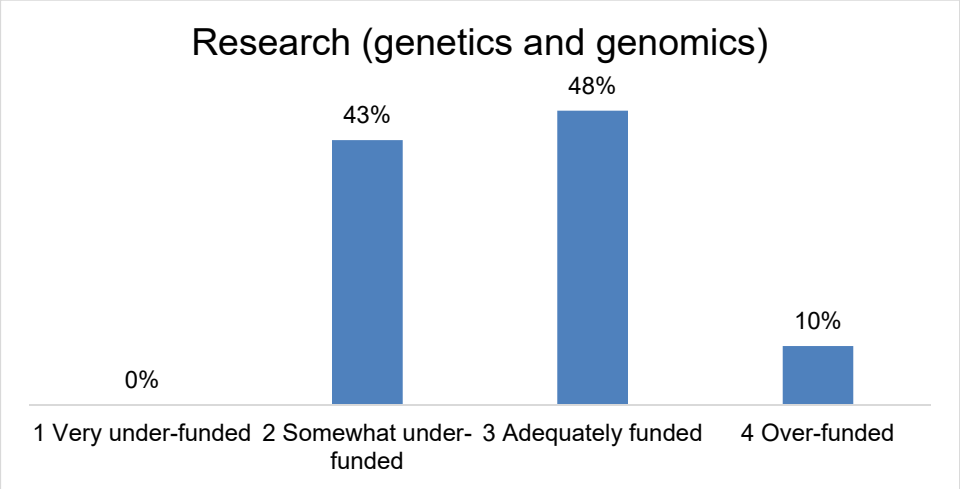
- Need to develop a clear understanding of what research should be proprietary (individual company good) versus industry wide (public good) before we can make much progress in this direction.
- Much of the research done today is by private companies. Some is for their own competitive advantage, but much of the agronomic work is general and may be able to be shared if a venue existed.

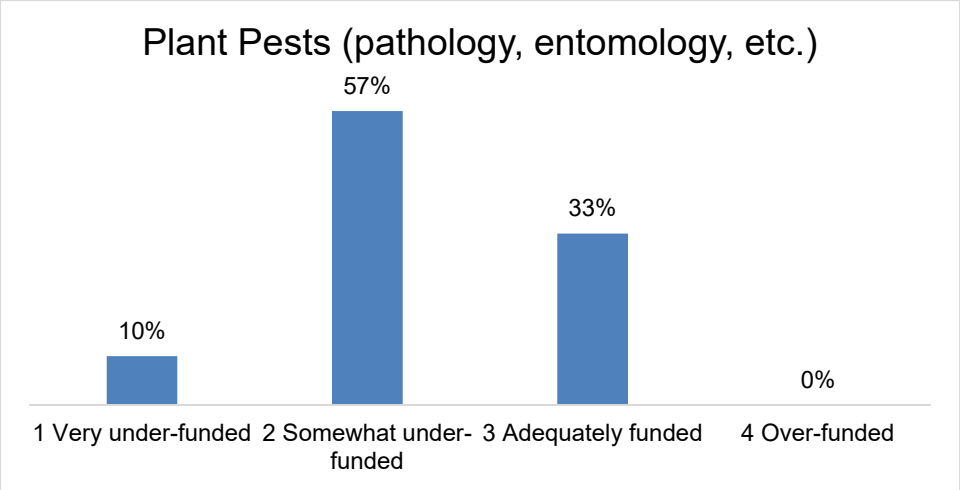
Please rate your level of understanding of current research programs and projects outside of your province (20 responses).

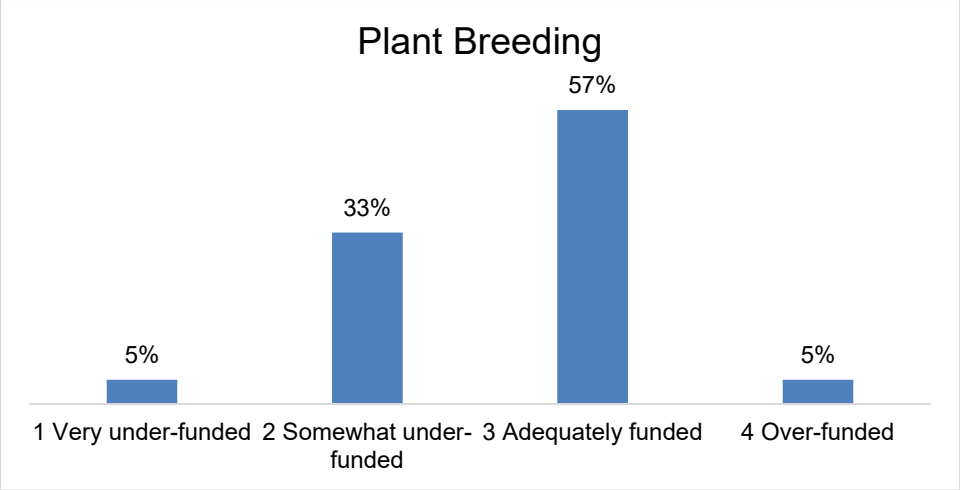


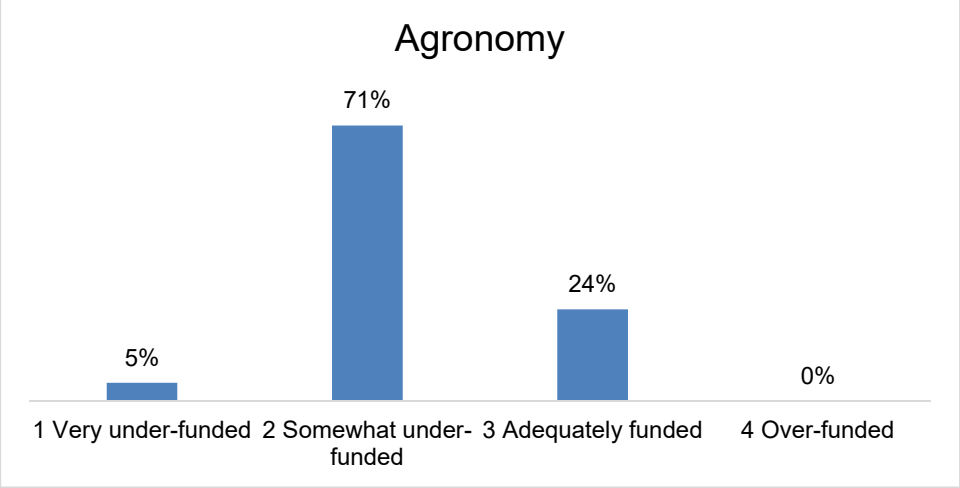
Average – 3.6

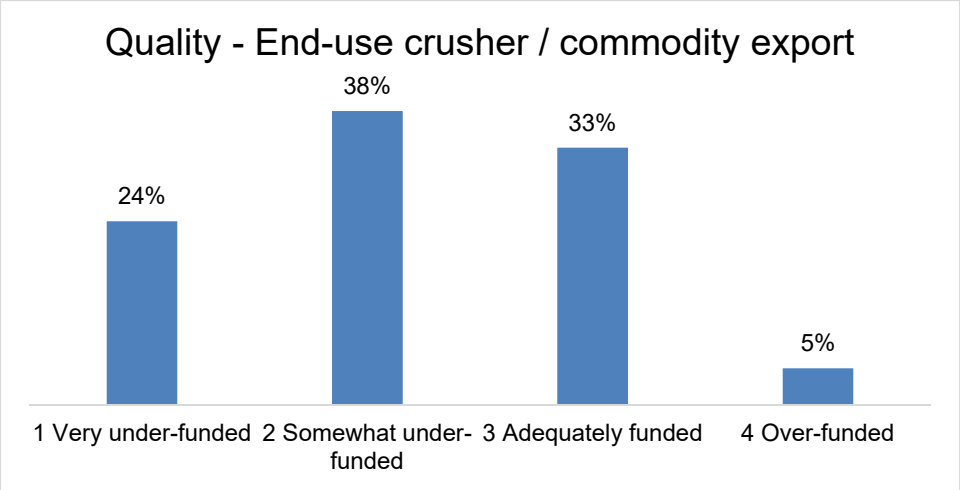
Soybean Research Funding ranking (21 responses)

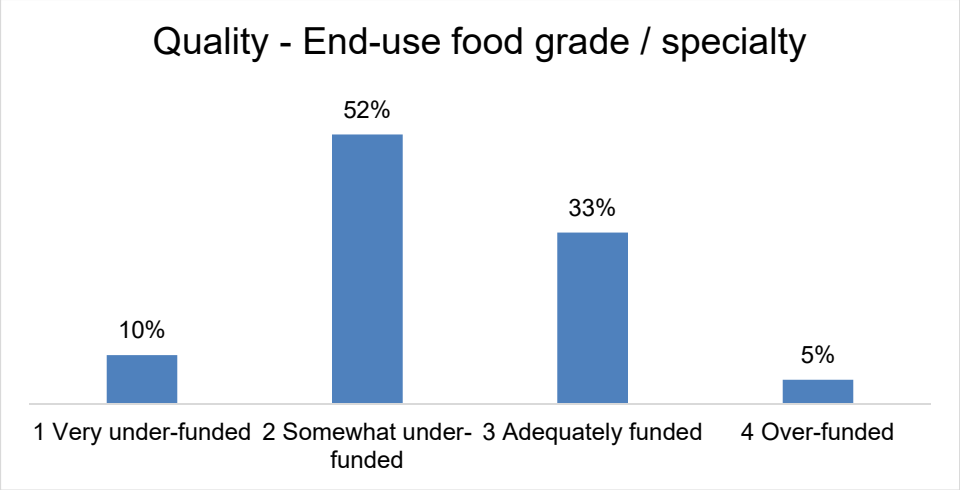



Plant Pests (pathology, entomology, etc.)
57%
33%
10%
0%
1 Very under-funded
2 Somewhat under-funded
3 Adequately funded
4 Over-funded


Plant Breeding
57%
33%
5%
5%
1 Very under-funded
2 Somewhat under-funded
3 Adequately funded
4 Over-funded


Agronomy
71%
24%
5%
0%
1 Very under-funded
2 Somewhat under-funded
3 Adequately funded
4 Over-funded


Quality - End-use crusher / commodity export
24%
38%
33%
5%
1 Very under-funded
2 Somewhat under-funded
3 Adequately funded
4 Over-funded


Quality - End-use food grade / specialty
10%
52%
33%
5%
1 Very under-funded
2 Somewhat under-funded
3 Adequately funded
4 Over-funded

Do you have any additional comments about soybean research priorities and processes?

- We need long term, low paperwork research funding
- Simply that there needs to be better coordination to understand the national set of challenges, the current state of research capacity and funding mechanisms
    - Needs to be a mechanism to regularly collect and establish the key priorities to address issues and seek opportunities to improve competitiveness, while minimizing overlap/duplication.
- I listed agronomy as underfunded because we seem to be running into walls of what could economically work to improve agronomic contributions to yield
- End-use crusher work is also noted as underfunded in the sense that the low-protein soy, particularly in western Canada
- What role should Soy Canada play in research?
- Is there an effective communication tool for end users to let breeders know what is required?
- The opportunity for soybeans is large in Canada, but we need to make sure that end user markets are developed that have a connection back to Canadian production. We are not likely to be the lowest cost producer (vs. Brazil, Argentina) so we need to ensure that there is a connection to the customer that adds value.
- Number one priority is to get alignment on what problems need to be solved, and whether these are viewed as proprietary or public good by all players. Hard to make progress on topics where people will not share in finding solutions.