

# FERTILE GROUND: AGRONOMIC RESEARCH CAPACITY IN WESTERN CANADA



## FINAL REPORT

*Presented to:*



*Submitted by:*

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## Definitions

AAFC- Agriculture and Agri-Food Canada

Agronomy- Agronomy is the study and practice of field crop production, and the management of land and water resources. It aims to meet the demands of producing food, feed, fuel and bioproducts while maintaining a sustainable environment.

Applied Research Associations (ARAs)- producer directed applied research associations in Alberta and Saskatchewan. . Manitoba uses a model of shared direction by the province and local producers.

Applied Research- adaptive research done for shorter term application (1 to 5 year), often into more specific geographic and farm industry directed needs.

Alberta Innovates Technology Futures- AITF, formerly Alberta Research Council

Capacity- It was taken to mean current internal capability (science and technical expertise, related skills, land, equipment, focus area) of an organization within the agronomy interest.

Capacity-building- the activity completed to raise the current capacity (eg. training, outside advisory services)

Co-location- is a practice of having people located in a common working space for the purpose of improving communication, relationships and the ability to transfer ideas to each other. Benefits include potentially sharing other resources and new opportunities.

Collaboration- a jointly delivered research project involving mutual interest and resources.

Core funds- funds which are known from year to year for basic operations. Are also expressed as A-based funds (government) or hard funds.

Clusters- a term describing a research funding program designed by AAFC and co-funded by AAFC and industry under the overall structure of Growing Forward 1 and 2 (funding programs).

Disciplines- the requisite education, skills and experience needed for agronomy projects including agronomy, crops and cropping systems, soils, entomology, physiology, pathology, weed sciences as defined for this review.

Extension- the practice of extending the new knowledge and new practices learned from basic and applied research findings to the end user (typically a farmer or business). It often involves practice change in learning a new or improved way of doing crop production related tasks. Also described as technology transfer.

Funders- are investors in research programs and projects.

Gap or bottleneck- the resource which is missing to improve or increase current capacity to the required or desired capacity as defined by the organization.

Multi-site – this is the practice of involving several geographic sites in a common experiment across regions to test for robustness/ effectiveness of the research concept and accelerates the research process. .

Network of Sites- an AAFC term meaning its research stations, sub-sites and farms which may be involved in completion of a research project or program.

Protocols- are accepted scientific procedures which are prescribed in a document to manage a research experiment with consistency, standards of good practice and to reduce the source of error. Companies will also use protocols to hire others to do contract research.

Project funds- Typically will be provided by any level of government, granting councils, commodity associations, non-profit funders, and others for the purpose of finding results for a time-limited research project, not usually involving core funds. These are also known as soft funds.

Basic Research- is highly varied in purpose but will involve peer reviewed projects, typically done at universities, public labs and provincial research departments for curiosity, understanding of structure, function, mechanisms of action, longer term effects and replicable experiments which provide broader additive foundational knowledge. This knowledge will add to the global knowledge pool and understanding.

Research Performers- are scientists, although others are typically involved including technicians, data analysts and other service providers. In ARAs, these may not be scientists but are otherwise qualified in the applied research they conduct.

Research and development system- all components (labs, people, programs and services) involved in moving an idea or concept from basic research (lab scale) through proof of concept, piloting, scale-up, developmental, adaptive and finally commercial applications. Roles and scope vary along the R&D continuum.

Sites- AAFC research stations, sub-sites and farms in Alberta, Saskatchewan and Manitoba

## Executive Summary

### Project Objectives

This project provides an inventory (capital and human resources) of agronomic research capacity in Western Canada, and projected capacity to 2020. It also included a review of the collaboration and capacity needs for producer funded research. The inventory itself was completed in 2014 with the specific purpose to inform the research capacity in the agronomy system (except for plant breeding- not included herein). This review of agronomy research capacity involved contacting all relevant organizations in the research (basic and applied) topics in BC, Alberta, Saskatchewan and Manitoba. A review of data, documents, survey and interview information were used to inform on the agronomy system.

### Findings- Current Situation

**Public Research Organizations-** The combined Western Canadian University system, Agriculture and Agri-Food Canada and provincial governments have staff, resources and capacity which are focused on agronomy research and activities.

The three Universities have a total staff (PhD) FTE complement of 20 scientists (University of Alberta-3, University of Saskatchewan-10, University of Manitoba-7.5) in agronomy related disciplines.<sup>a</sup> Alberta is currently short two agronomy scientists and has recently lost an entomologist (deceased). Saskatchewan is in need of both entomology and cropping system scientists. It also needs access to larger scale equipment and some smaller scale seeding equipment. Core budgets are not typically available for these uses and funding is an ongoing challenge. The total University agronomy research capacity also includes about 38 support staff plus graduate students. Some retirements (about 4 positions) are expected in the next 3 to 5 years.

Table E1 – Summary of University PhD FTEs in Agronomy Research

Discipline	University of Alberta	University of Saskatchewan	University of Manitoba
Agronomy	Gap	2	2
Crops	-	1 Gap- cropping systems	1
Entomology	Gap	Gap	.5
Soils	1	3	3
Physiology	.5	0	0
Pathology	.5	2	0
Weeds	1	2	1
Total- FTEs Active	3	10	7.5
Comment	Lack 2 agronomy core positions, have others involved but part-time. Entomology unfilled.	Lack equip and core funds, need 2 positions	Lack core funds for graduate students, technicians and equipment

Source: Survey.

<sup>a</sup> FTE- full- time equivalent positions reflect how the organization is staffed. The approach helps to compare capacity across all organizations, but does not reflect quality of outputs or volume of outputs.

The agronomy graduate students total 167 in the three Universities in the related disciplines.<sup>b</sup> Graduate student counts are noted in the table below, (data sourced from University staff): the University of Alberta has 36 graduate students in the agronomy related areas; Saskatchewan has 66; and Manitoba has 65. (It is noted that other graduate students in related areas may also fill a need in agronomy research projects.) Only 37% (61 of 167) are PhD students which may be a limiting factor to a growing agriculture sector.

Table E 2 – Summary of Graduate Students in Agronomy Research

Discipline	Alberta- MSc	PhD	Saskatchewan- MSc	PhD	Manitoba- MSc	PhD	Totals-MSc	PhD
Agronomy*	5	0	9	1	6	2	20	3
Entomology	1	1	0	0	6	7	7	8
Soils	6	3	17	17	13	7	36	27
Physiology	4	1	1	6	6	3	11	10
Pathology	8	2	8	0	4	8	20	10
Weeds	5	0	6	1	1	2	12	3
Total- Agronomy Disciplines	29	7	41	25	36	29	106	61
Total- All	36 (22%)		66 (39%)		65 (39%)		167 (100%)	

Source: Survey. Classification titles differ by school. Alberta has 59 total graduate students in related breeding, range ecology and molecular areas. Saskatchewan has 137 total plant and soil science graduate students. Most (75%) of these students are in breeding/ genetics, horticulture or plant ecology. Plant breeding students are not included. \* For MB includes 3 cropping systems students.

The table above illustrates fewer agronomy, entomology and weed science students than other disciplines and reflects the university scientist gap noted. (Other graduate students may also be involved in breeding/ agronomy, environment or other soils topics.) The agronomy science plans of these Universities are needed to help inform the broader sector on the desired future state.

In the public agronomic research area, AAFC is the strongest and most integrated organization although some concerns exist about its future plans. AAFC has 39 FTE PhDs and a number of support and other academic staff for other functions. The table below notes the FTE (full-time equivalent) positions.

Table E 3- AAFC Agronomy Research Positions

AAFC- Western Canada	Agronomy PhD FTEs	Comments
Alberta (3 sites)	17	Retirees expected
Saskatchewan (5 sites)	15	Retirees expected and unfilled position (1), farm uncertainty (eg. Melfort, Scott)
Manitoba (2 sites)	7	Retirees and unfilled positions
Total	39	Infrastructure \$1.4 m; 16 retirees; 3 unfilled Entomology and weeds positions-key gaps

Source: Input to WGRF, 2014

<sup>b</sup> For the study, disciplines included: weeds, crops, soils, agronomy, pathology, physiology, entomology.

AAFC has strength in its integrated crop management approach and in the multi-site research projects. A key finding herein is the imminent number of expected retirees of the core and senior level PhD staff in Western Canada. AAFC expects about 16 positions of senior scientists (see appendix) to be vacated within three years. In some disciplines, such as weed sciences, nearly all positions will be vacated. In addition to these positions, another 3 agronomy positions have been unfilled for some time. The potential reduction of about 16 to 20 senior scientists is an important part of this total knowledge creating capacity.<sup>c</sup> This capacity is critical as it represents the “top of the knowledge pyramid”, builds on global research and often helps to identify critical foresight topics.

These senior people are knowledgeable, experienced and are the current leaders or mentors in the agronomy sector. Research by this organization is often multi-site, multi-year and typically involves several disciplines/ scientists.. The AAFC system is viewed as significant with many scientists, sites (stations and farms), equipment and internal assets. No replacement plan for any of these positions is available. For a community and a region that is home to an AAFC (farm) site, the loss of access to the “system network knowledge”, mentoring and information can be substantial. AAFC serves the west as a geographic whole region and strives to look at what is needed over any pressures of maintaining what currently exists. New models and partnerships are the way AAFC will likely proceed. However, a strategic plan from AAFC would help define a chosen path and help reduce the uncertainty for many people.

The most significant impacts of retraction within AAFC will be at Lacombe and Saskatoon (including Melfort and Scott), with entomology and weed research capacity expected to be hardest hit. As senior level researchers retire, both access to current agronomy knowledge and mentoring of new scientists will result in system gaps.<sup>d</sup> Discipline gaps will also appear. A listing of the current likely retirements by 2018 (agronomy system) are noted (for AAFC scientists) given comment/ expectations. The potential reductions include:

- Agronomy- 3 unfilled positions;
- Crops- 4 positions;
- Entomology- 5 positions;
- Soils- 1 position;
- Pathology- 2 positions;
- Weeds – 3 positions;
- Agrometerology -1 position;
- Total 16- reductions plus 3 currently unfilled positions;

Alberta (Agriculture & Rural Development and AITF) has a strong and recognized research capacity in the field of agronomy. In this regard, Alberta has new crop development efforts underway at Alberta Innovates Technology Futures (AITF) and the provincial department has research supports in three divisions: Lacombe Field Crop Development Centre, Food & Bio-Industrial Crops Branch and Pest Surveillance Branch. In total, Alberta has about 15 PhD

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<sup>c</sup> This term is described on pg 17 below and relates to building the global pool of agronomy knowledge.

<sup>d</sup> These 16 staff are productive and produced about 34% of the agronomy research publications for the period reported- see pg 26.

FTEs and 5 MSc FTEs in agronomy. Manitoba completes applied research through 4 Crop Development Centres and operates with producer and community directed boards. Manitoba has 4 PhD/ MSc level staff to support agronomy. Saskatchewan does not have a similar internal research effort but supports agronomy research through the CDC and significant funding programs.

From the survey of these public sector organizations above, a total of 83 scientists are involved in agronomy research projects.<sup>e</sup> This total includes: 39 FTE PhD (full-time equivalent) Agriculture and Agri-Food Canada (AAFC) professionals, about 20 FTE PhD University staff and 24 PhD provincial government staff (Alberta and Manitoba) who are involved in peer reviewed research type projects. These total FTEs are complemented by staff that supports these research activities. In total the public research positions are in the order of 213 people (PhD plus staff).<sup>f</sup>

Table E 4- Summary of FTEs Involved in Public Agronomy Research

Region	Provincial Govt	AAFC	University	Total
BC	0	0	0	0
AB	20	17	3	40
SK	-	15	10	25
MB	4	7	7.5	18
FTE PhD/MSc	24	39	20	83
Staff*	62	42	26	130
Total	86	81	46	213

Source: Survey- 71.5 PhD and 12 MSc. Provincial staff include: AB- 32, SK- 20, MB- 10; total = 62.

### **Applied Research Associations, College and Industry Applied Research and Extension-**

In addition to the research positions noted above, there is another related industry research and extension aspect in the agronomy system. These important organizations include producer directed applied research associations (ARAs), colleges, private companies and agri-businesses.

Most of this work can be classified as adaptation and crop yield improvements and often only in a regional context. ARAs number 10 in Alberta, 8 in Saskatchewan and 4 in Manitoba. Three colleges are also involved in some areas of research and extension. In addition, several specialized companies work in agronomy. The positions include colleges (AB and SK) with 7 FTEs, ARAs- producer directed applied research associations (51 FTEs) and private industry (187 FTEs). Many of the latter positions are in crop advisory functions.

Applied research associations are facing several challenges including the need to retain a

<sup>e</sup> Interestingly, the prior “normal” state would be about 87 FTEs, adding in the 4 unfilled positions.

<sup>f</sup> AAFC has another 98 high paid technical positions associated with their PhDs.



critical mass of workforce, funds for sustainability and in some cases, relevancy. Their bottlenecks include: core funds (low), equipment funding and in some cases, research management. Each should have a trained research manager (MSc level or even PhD) or access to that resource, if applied research is seen as the regional mission. Currently, not all of the associations have this staff capability (some are only part-time). Collaboration and joint projects can be enhanced among the associations and considerable opportunity exists to provide additional sites (for multi-site research and shared resources) among the public researchers.

These ARAs are highly varied in their geography, staffing, equipment resources and land base. Importantly they offer local networks, much opportunity for producer engagement, technical and technology support and an interest to leverage their knowledge. As producer-directed groups they also reflect regional interests for their crops, relative to market trends.

Private industry capacity includes such firms as Agritrend, Ag Quest, ICMS and Western Ag which are more fully described in the following chapters. Interestingly these organizations are increasing in people and projects over time in response to demand for their services. Much effort is involved in crop consulting (Agritrend) and the other two companies offer specialized crop research services. In contrast to the public sector research group which is facing an imminent decline in some retirees, it is interesting to note that the private industry segment's workforce is seen to be expanding.

### **Main System Capacity Issues**

Currently the system has a number of capacity limiting issues or bottlenecks:

- **Workforce** development and more scientists are needed. Additional scientists (likely 4 to 5 in University) are needed in developing people for industry growth and building agronomic knowledge (given the gaps noted above). For a number of producer associations, staff retention is an issue and internal funds often limit their capacity to attract and retain people. An adequate workforce is an issue for all organizations and it is a core strategic investment for research projects. People make things happen (or not);<sup>9</sup>
- **AAFC** core capacity is important. Replacement scientists will be needed (16 to 20) in addition to the unfilled positions. A risk exists with the AAFC network of sites which has been the backbone for many research topics across Western Canada including agronomy. Research sites in the AAFC system (since before the 1900s) offer dedicated locations which can be accessed and experiments are conducted with standard protocols. Keeping these sites (stations and farms) is a strategic advantage for Western Canada. It appears that two operating Saskatchewan sites (research farms and also positions) may be at risk in the near term. Agronomy research positions within the AAFC system will also decline. AAFC indicates it also has an infrastructure and equipment shortfall of about \$1.4 M plus \$600 K annually for site upgrades (over 5 years will be \$3 M);

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<sup>9</sup> AAFC data indicates staff costs from \$370,000 to \$585,000 per FTE scientist. University research staff can be budgeted at about \$300,000 each for salary, technician, equipment and a small research budget.

- An AAFC report indicates that science and innovation investments have declined and are planned to be reduced by 24% by 2015. One concern is the potential gap which may occur should long term agronomy research not be served by AAFC, as others in the system will not likely do this foundational research. The benefit of the network of sites provides accelerated research to gain answers to key questions or issues often within 3 to 5 years. Others may take substantially longer to provide an evidence- based answer to agronomic issues for current and potential crops. Why is the network model not used more among researchers and allied organizations?
- **Equipment** replacements and technology adequacy/ currency are a gap for some organizations. The “technology issue” faces all organizations (need for current/ adequate/ commercial scale and plot scale equipment). Equipment is of various ages, conditions and values, with some having newer equipment and others having older equipment which cannot really be useful on a similar data collection basis. Equipment is a capacity issue for many organizations (Producer directed research associations and Universities indicated some equipment/ replacement needs);
- **Agronomy research funds** appear to have been declining over time (researcher and industry comments). Longer term agronomy research (more than 2 to 3 years) is thought to be at risk by some people. Another view is that Growing Forward (I and II) programs have increased innovation funding since 2009 and agronomy is a beneficiary of this investment. No data has been obtained to describe this agronomy support;
- **Core operating funds** are low based on the survey comments. Applied research associations generally have low budgets (in the order of \$200,000 to \$500,000), although several (3) have larger budgets (of nearly \$1 million). These funds cover all operations, staff, equipment R&M, management and research and extension projects. For the associations, the funding can be highly variable. Given this wide difference in funding levels and internal plans, some applied research associations perform at high levels and some do not. Core funds are low and are a critical success factor;
- In addition, ARAs often cannot pay comparable salaries to government/ industry and hence senior staff retention has been difficult. Some attention to adequate funds for these core operations is needed to overcome the continued bottleneck in people and strategic projects;
- **Land and buildings** are available, although access to some of this capacity may be limited due to prior project commitments.. Land is needed for projects and in some cases this means the organization can be “land rich and cash poor”. Many of the private research companies also lease land. Some of the associations have buildings or access to government buildings for offices and storage. Given the land base available, it seems that more collaboration should occur with land but the trade-off will be the distance (and costs) in travelling to these locations for conducting projects (from the home base);
- **Leadership from Boards and Management** create the ARA vision for agronomy research. For some applied research associations, their capacity can be limited by the

internal leaders. Some associations are growing and others are not. This internal capacity can limit overall agronomy projects with potential partners. This is an important factor to agronomy research projects, outputs, budgets and collaborations. In our experience this is a critical capacity success factor (we did not examine/ audit organizations. However, not all organizations operate at the same level of quality, science and service delivery (however, these aspects can be addressed);

- **Networks and coordination** are needed. There appears to be a requirement to organize/ coordinate the agronomy research approach in Western Canada, and most likely with research associations. An umbrella group can help to consolidate and administer several funding sources to enable some longer term key research projects. It may also: evaluate, train, endorse research partners; address resource options; and help in the dissemination of findings.<sup>h</sup> Coordination (perhaps) through the use of a senior provincial science team on agronomy research would be useful. Within a province or region, access to a core team (can be virtual) of: soil, crop, weed, entomology, physiology and pathology sciences (and economics) for guidance can help;
- **Growing Forward** (I and II) are considered highly successful. Industry and producers can set their priorities and have succeeded with wheat, canola, pulse, barley, beef clusters that all have major agronomy components. There are several Agri-Science Projects (ASP) that address agronomy interests for producer groups. This model provides a “ready built” system for commodity groups and researchers to further their mutual activities;
- **Priority setting** of research is very important for all groups. Producer associations are often tasked with projects for specific end markets, and yield improvements, etc. Understanding the scope of public and producer/ industry agronomy projects is very useful. The use of crop clusters mainly involves AAFC and University service providers, (some applied research associations are now getting involved in clusters).<sup>i</sup> A key question arises: how can producer associations improve their sharing of best practices and research projects across the west?;
- **Communication** of research findings is important. Social media use and communication can be strengthened with more use of websites, mobile applications, data mining and other internet-based tools. These enhancements can appeal to all. It is noted that any new practice or technology needs to “pay to stay” at the farm level. The aspects of farm economics/ impacts/ adoption practices should be included in the research work;
- **Future state discussions are needed.** Comments were offered on clarifying the future state of agronomy research. Is there sufficient research capacity relative to roles to deal with any unforeseen crisis (disease, pests, climate, etc.)? What about the emerging areas

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<sup>h</sup> In 2012-13, the GRDC (AU) invested \$159 million into: markets- 12%, crop yield- 26%, protecting- 25%, farming systems- 19%, resource base- 8%, skills and capacity- 3%, foundational- 6% and management- 1%. (Note crop yield investments alone were about \$41 million.)

<sup>i</sup> The use of crop clusters is used to link AAFC, University and other research organizations.

of climate change adaptation/ mitigation.<sup>j</sup> What will occur given the expected loss of existing Western Canadian capacity and further knowledge generation? There was a common interest in foresight planning for agronomy expressed by several people.

### Summary of Possible Actions

The review of the current agronomy capacity situation shows four main action areas to address certain gaps so as to avoid imminent bottlenecks and to prepare for the change management process. Change management is used to describe the actions, goals and processes used to move from a current state of operations towards a preferred or desired future state (obviously thought to be better/ beneficial/ more impactful. Developing the future state requires a process and much stakeholder input toward a shared vision/ plan.) The action table below summarizes the main ideas which can be considered among a range of options.

**Proposed Action Table**

Capacity Gap	Action Needed	Comment
University- workforce Equipment/ infrastructure	<ul style="list-style-type: none"> <li>• 4 to 5 new scientists to replace/ fill current gaps</li> <li>• Core funds for equip</li> <li>• Stronger interface with ARAs</li> </ul>	Address Agronomy Entomology, Weeds scientist gap; 4 potential retirees, 1 unfilled
AAFC –impending	<ul style="list-style-type: none"> <li>• Clarity from gap analysis on funds, staff needs, sites</li> <li>• Staff and infrastructure plan, strategic plan specific to agronomy</li> </ul>	Address imminent –retirees-16, 3 unfilled positions, Sk sites, \$1.4m infrastructure. Will reduce uncertainty and system “stress”.
Applied Research Associations	<ul style="list-style-type: none"> <li>• Increase core operating funds</li> <li>• Training on research mgmt, best practice, analytics, collaborations</li> <li>• Research &amp; business plans</li> <li>• Develop a new TT network</li> </ul>	Strengthen tech transfer (TT) and extension aspects. Improve quality in applied research. Tie funds more to research outputs. Each strives to have internal MSc staff (or access to.)
Western Canada Agronomy Knowledge/ Integration/ Collaboration	<ul style="list-style-type: none"> <li>• Leadership &amp; agronomy system strategy/ plan with clarity on priorities, roles &amp; funds for enhanced western Canada approach (future state).</li> <li>• Total of 20 retirees imminent (with AAFC) plus 4 unfilled positions will challenge core knowledge capacity</li> </ul>	AU system offers a model. Crop clusters do not integrate producer associations. Public system changes (expected) must better inform private sector/ producers. Improve communication.

Several actions should be considered to address the key bottlenecks (or capacity requirements):

- **Workforce**-the research indicates 4 to 5 new science positions are needed at a University level. Alberta is low relative to other Universities. In addition, industry requires students for a variety of agronomy related occupations. For producer research associations, the issue of staff attraction and retention will require adequate compensation relative to the industry;

<sup>j</sup> Some research stations are examining these climate aspects (Lethbridge for example) and a software program called Holos is available for farm level modelling on farm practices and GHG changes.

- **Disciplines-** The analysis indicates about 20 core PhD positions will be vacated in the next three years. Specific gaps will emerge specific to agronomy, weed science, entomology and crops. These real bottlenecks will appear soon in several organizations;
- **AAFC** core foundation role continues- This will become a deficiency as senior positions are vacated and internal consolidation continues. A Gap Analysis is to be done to understand the future role. As noted herein, other countries do have a science lead organization to ensure new ideas, innovations and technologies are being studied and developed;
- **Equipment** and infrastructure- AAFC indicates a need for new investment. Producer associations and university comments indicate several specific needs. There is a requirement to create a replacement fund for addressing these areas (which are case by case), although some organizations are addressing this issue already;
- **Strengthen Producer Directed Associations-** A segment which will expand is agronomic research projects provided by producer directed associations and by private companies. While this is useful to a specific target group or region, if the research is not repeatable or well designed, it can have minimal broad-based impact. However, some producer groups are working well in applied research projects and are recognized for their efforts. Co-location, collaboration and resource sharing with public institutions are some of the reasons for higher performance. Specific training and sharing of best practices can help associations;
- **Strategic plans**, boards and management practices- Some producer directed organizations perform better at certain tasks which relates to their plans and board/ management directions. Use of a strategic research plan, board and management training on research management and key performance indicators/ leveraging resources/ best management practices will help. Funders may need to increase their funding along with renewed expectations of outputs. Outside expert assistance may also help in these changes;
- **Collaborations/ partnerships-** Collaboration does occur with several producer groups and more can occur. Typically, collaboration requires like-minded people to focus on a common task. AAFC and University staff commonly will do this. Some producer associations also collaborate with other researchers. Funders can encourage these approaches to leverage resources. To assist producer associations/ industry, specific training and awareness will be needed to bring all participants to a common level of expectations;
- **Agronomy system coordination/ networks/ research focus-** Duplication of crop trials and some research projects is a symptom both of poor awareness and coordination. Creating a Western Canadian network or networks for sharing results of projects can help coordination and research results. The use of the crop clusters model supports AAFC and University collaboration, but are there opportunities to help support and integrate the

producer-directed associations and others' research efforts?<sup>k</sup> A strategic plan/ process is needed to help strengthen the overall system and to build new collaboration and stronger outcomes, given the many stakeholders, research providers and interests. The central question: what is the desired future state to build and leverage overall agronomic capacity?

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<sup>k</sup> The original idea of clusters and networks derives from Dr. Porter's management research (Harvard) on how nations and sectors compete internationally and how the domestic players within the eco-system support each other for mutual benefit.

## Introduction and Background

The Western Grains Research Foundation (WGRF) wished to review the current agronomy crop capacity in Western Canada to understand current gaps and potential areas for improvements. The research system is a mix of public and private organizations providing support and resources into the sector. An independent review was required to understand the overall system, current capacity and issues to 2020.

### Issues

The Canadian crop production sector has a need to maintain research capacity given a number of industry and public sector players are serving their agronomic needs. Some key issues are noted:

- Agronomy research appears to be declining relative to other topics (eg. breeding). Relative to the scope of agronomic research, the need exists for a proper definition of 'agronomy' and 'agronomist'. Currently the term is so broad that many professionals and others employ it to describe their work, including breeders. (This review does not include agronomic activities in breeding work);
- Consequently, funding for research projects can be an issue. Research roles have also changed a lot with more private sector serving the technology transfer and adaptation topics. Research findings provide a base knowledge of what works in practice (or doesn't), the technologies, the inputs and under which crop - soil conditions. It helps to build the understanding of structure- function- utility and feasibility aspects. These research outputs are used by other researchers and the technology transfer and extension groups.
- AAFC research stations are reducing scientists and programs. Further, the general demographic trend of impending senior scientist retirements among many organizations means the human resource capacity is being challenged. Changes in research and in Agriculture and Agri-Food Canada – in terms of their research priorities, funding and the role in the research system continue;
- Research priorities and topics are varied in agronomy. This can include research into specific market- purpose crops in feed, food, food for health and even bio-fuel segments to meet the emerging niche markets. Other agronomic research topics include agronomy, soil, cropping systems, weeds, and for cereal. oilseed and other crop responses to fertilizer and other input products. In response, researchers (basic and applied) are responding as well as they can;
- Currently the knowledge of the current Western Canadian agronomic research capacity, strengths and collaborative networks is not well understood. Within public and private research providers, it is very important to benchmark the current situation for informed decision-making by research funders, performers and producer groups.

## Objectives and Scope

*“The objective is to provide the information that describes the present and anticipated capacity for agronomic research in western Canada. This information will be used to assist producer organizations determine potential opportunities for future investments.”*

The WGRF had several objectives for this study:

- Identification and inventory of agronomic research capacity (capital and human);
- Understanding of research and demonstration capacity and research projects (3 years);
- Understanding of research networks, collaborations and opportunities for partnerships;
- Projected future capacity and needs to 2020 for agronomy research;
- Benchmark report on the research findings.

## Methodology

This review of the agronomy capacity in Western Canada followed a specific process including:

- Agreement on a list of public and private organizations to survey (not audit);
- Use of a standard list of questions and a data collection sheet;
- Conduct of the survey with the selected organizations;
- Review of findings and analysis;
- Reporting and final comments.

The project was carried out over February through August 2014. Crops in this review included: wheat, oats, barley, canola, flax and pulses. BC, Alberta, Saskatchewan and Manitoba were included.

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The project was carried out by:

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- Blaine Canitz, PAg, CMC, Saskatoon;
- Randy Baldwin, CAC, FCMC and Dawn Harris, BSA, MLArch, Niverville.



## Agronomy in Western Canada

Crop production in Western Canada is a major economic engine for Canadian exports, livestock production and many other industry linkages in both rural and urban areas. Agronomy is the study and practice of field crop production, and the management of land and water resources. It aims to meet the demands of producing food, feed, fuel and bioproducts while maintaining a sustainable environment.<sup>1</sup> However, because it is a cross-cutting platform it can be easily missed or overlooked.

Agronomy includes the main interface of soil science and crop sciences concerning the production of crops and also has many other linkages into other disciplines. As a crop is developed, the knowledge on how to grow it under certain conditions of soil, water, climate, with various inputs, equipment and other technology is very important. Other disciplines of interest to the agronomy capacity for this study included: weed sciences, entomology and plant pathology and physiology.

Capacity was taken to mean internal agronomic research capability (technical expertise, land, equipment, focus area) of an organization. The contacts included people involved as performers or recent performers of agronomy research to help provide an accurate situation review.

Capacity can be increased over time if the organization desires to respond to the need. Capacity can also decline if the organization does not fund and provide resources for that agronomic activity. Given this, the definition of agronomy is important as it crosses many science and management disciplines. Research, development and innovation are important aspects for the Canadian crops sector. A recent report on the grain sector indicates a large agenda for action:<sup>m</sup>

*“Innovation will be key to increasing production, particularly with the challenges and constraints of climate shifts, increased scarcity and the rising cost of inputs such as land, water and nutrients. A renewed focus on agricultural research and development (R&D) is called for, including robust support for both basic and applied research.”*

The grain summit report notes some collaboration ideas on research and funding for the crop sector to consider:

- Full system approaches- this approach means reviewing and coordinating all of the R&D elements together, instead of working separately in a chain of production;
- Targeted R&D- fragmentation of R&D resources in this area could be better addressed through collaboration. Financing ideas included a multi-sector model, and more partnerships among post-secondary institutions, governments and the private sector.

The grain summit indicated several ways for the public and private sector to collaborate for more effectiveness including: R&D, new products, system alignment and partnerships. These themes will need to be considered and acted upon.

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<sup>1</sup> University of Manitoba, Faculty of Agriculture and Food Sciences website.

<sup>m</sup> Crop Innovation in the Canadian Prairies, Breadbasket 2.0 Summit, November 2013.

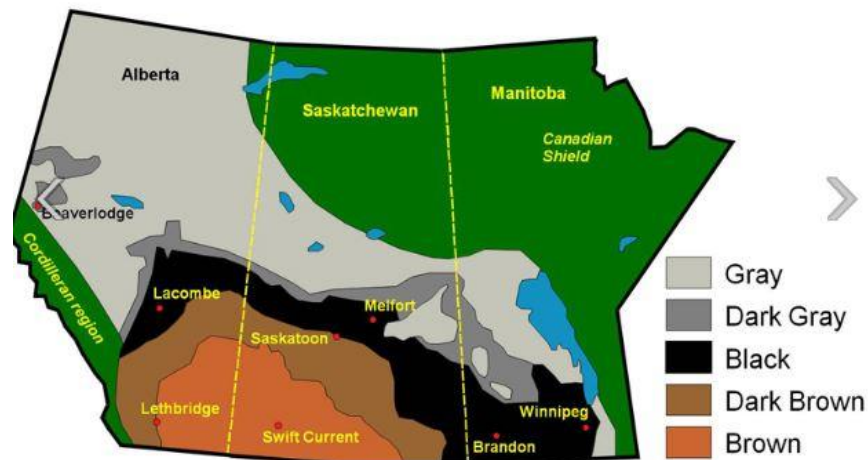
## Western Canada Major Crops and Soils

Western Canada is a very large area with many farms involved in the production of crops. The main crops under review included: wheat, oats, barley, canola, pulse and flax crops. Each crop has its own specific interest areas for production, management and enhancements.

Soils zones across the prairies offer many common (and different) issues for farmers, researchers and suppliers. Because crops need water, fertilizers, pest control and a management package, many cross-cutting and local research issues emerge for many regions of the prairies.

Figure 1- Soil Zones (Source: AA&RD Website)

### Major soil zones of the Prairie Region



## Overview of the Agronomy System

The Western Canada crop agronomy research system has many players which are briefly described below, with more detail to follow. Roles include:

- Knowledge creation is the key to innovation for crops and new crop developments and relies on two foundations - basic research and then applied research. Basic research on plant variety developments for the main crops occurs in Western Canada with both public and private organizations. Basic research is being completed by universities, Agriculture and Agri-Food Canada, many global companies and others. This early stage work may take 5 to 25 years to complete and is very expensive and science intensive.
- Applied research is being completed by producer directed applied research organizations, AAFC, provincial governments, University centres, commodity groups and private companies. Many collaborations are occurring to leverage resources. Applied research is noted as research completed in a 3 to 5 year timeline typically and will involve science, labs, field and plot research, analytics and research design. The results of these projects

will (may) lead to use at the field level and further knowledge dissemination within the targeted farm segment.

- Extension, demonstration and technology transfer as the next stage (and often the final stage) in the crop development and production process to teach, understand and assess how the crop may perform in the field conditions. These extension areas have largely been vacated by the federal and provincial governments and the private sector is responding in filling that gap. These efforts typically operate within 1 to 2 year timelines.
- Funders help performers realize their talents and capacity. Funders include public, private commodity and non-profit interests and are an important priority-setting balance point.
- End-users of the outputs including farmers, commodity groups, agri-businesses, governments, agencies, consumers and society.

The recent past has seen many changes in the agriculture and grains sector, and more changes are occurring. The capacity review was required to assist in understanding the roles, capacity, interest, bottlenecks and future needs for the crop sector. The following sections discuss the findings of the agronomy capacity review based on information gathered directly from the organizations.

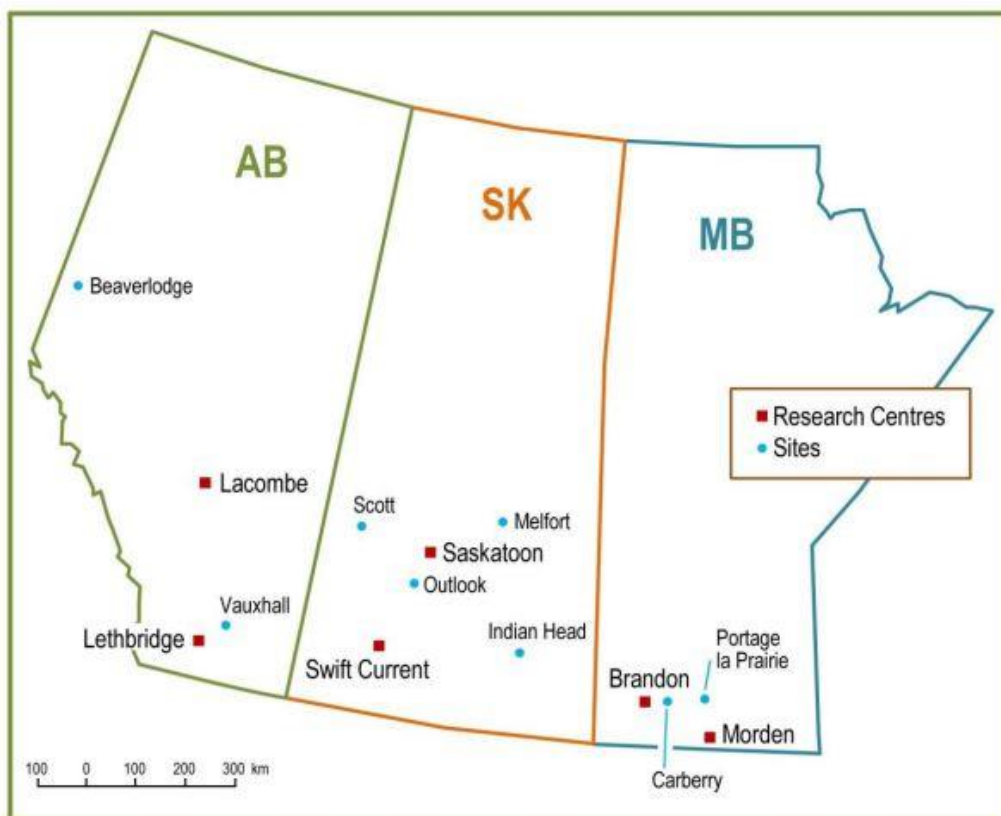
## Agriculture and Agri-Food Canada

Agriculture and Agri-Food Canada (AAFC) is reviewed below as it is the main organization which has been a foundational contributor to many agriculture and food topics including agronomy. The information has been gathered from interviews, data reviews and the submission from AAFC management (see appendix).

### Current Situation

AAFC has research sites (stations, sub-sites and farms) in Western Canada. Research sites reviewed included Alberta, Saskatchewan and Manitoba regions (in a survey approach, not an audit). The findings are noted below in the same format used to describe the other organizations. The appendix contains specific detail on agronomy professionals, publications and some funding issues. The section below highlights the 6 main research sites reviewed herein and then addresses the personnel area of AAFC, within the scope of capacity and potential future changes as far as is currently understood. A map of the sites is shown below.

Figure 2- AAFC Sites  
**Locations and land resources at AAFC Network of Sites, Prairies:**



## 1. AAFC Lacombe

Overview- Alberta has two research stations at Lacombe (and Lethbridge). Lacombe is situated in one of the highest livestock production regions in Canada and is responsible for the development of integrated, sustainable crop, animal and honey bee production systems and crop breeding. The Beaverlodge research site is associated with the Lacombe Research Centre. Research conducted at all locations contributes to the meat industry and the Northern and Parkland agricultural sectors.

Agronomic Capacity- Lacombe focuses on three areas:

- Integrated meat science and production systems: bioactive lipids and nutritional quality;
- Microbiological safety and storage stability of meat;
- Northern and Parkland agriculture focusing on integrated crop, forage, pest and honey bee management strategies.

The Centre has key scientists in agronomy, weeds and pathology. Lacombe and Beaverlodge have 6 PhD FTEs and 4 staff FTEs for a total of 10 FTEs in crop agronomy. They have access to 1,168 ha (2,886 acres) of land and required equipment. Equipment is rated as excellent in Lacombe and very good in Beaverlodge (by AAFC).<sup>n</sup> The station has very good capacity for agronomy projects and publishes research on a variety of projects. It is expected that about two scientists will retire within the near term.

Crop or Topic Focus- cereals, oilseeds, forages, special crops

Collaborations- Lacombe is very collaborative with others including producer groups (BC Grain Producers- analytics), Alberta Agriculture and Rural Development, other AAFC scientists and producers. Lacombe is a centre with a number of allied crop organizations.

See <http://www.agr.gc.ca/eng/research-centres/?id=1181591790641>

## 2. AAFC Lethbridge

Overview- This Centre conducts research in four main areas:

- Beef Cattle Science;
- Crop and Livestock Biotechnology Platforms;
- Sustainable Crop and Livestock Production Systems;
- Environmental Impact of Agriculture.

Agronomy Capacity- Lethbridge has 11 PhD FTEs and another 9 staff FTEs for a total of 20 FTEs and has capacity for agronomy research. Lethbridge is conducting work in greenhouse gases from cropping, crop production systems and has a strong team of scientists. Skills include: agronomy, weeds, pests, soils, crops and pathology. The station has 710 ha (1,754 acres) of land for agronomy projects. Equipment is rated as very good. It is expected that about 3 scientists may retire in the near term.

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<sup>n</sup> AAFC Input, WGRF Agronomy Research Capacity, July 16, 2014

Crop or Topic Focus- cereals, oilseeds, forages, special crops

Collaborators- AAFC works with universities, industry, producer groups and other institutes

See <http://www.agr.gc.ca/eng/research-centres/?id=1181591790641>

### 3. AAFC- Saskatoon

Overview- Agriculture and Agri-Food Canada have two main sites in the province at Swift Current and Saskatoon.

Agronomy Capacity- Saskatoon is focused on research in the five initiatives with a supporting role in agronomy and northern agriculture:

- Integrated crop management for sustainable cropping systems on the Prairies;
- Sustainable management of clubroot on canola;
- Integrated strategies for genetic improvement of oilseed, legume, and forage crops;
- Genetic resource conservation, characterization and utilization;
- Bioproducts and bioresources.

The Centre has 9 FTEs (scientists) and this capacity is likely to decline in the near term due to retirements. Saskatoon includes field sites at Melfort, Scott and Outlook (the latter is with the Province- see following chapter). Land totals about 1,000 ha (2,470 acres) and equipment is rated as very good or good (Scott- excellent, Melfort, Outlook- both as good). In addition, these first two field sites are used by NARF and WARC, both producer associations. Outlook is also a joint operation with ICDC (noted above). Saskatoon has seen a number of agronomy position reductions and a general pull- back in this agronomy work. This is discussed below in more detail.

Crop or Topic Focus- all crops

Collaborations- industry, other AAFC centres, university

See <http://www.agr.gc.ca/eng/science-and-innovation/research-centres/saskatchewan/saskatoon-research-centre/?id=1180626618960>

### 4. AAFC- Swift Current

Overview- activities here are focused on dryland farming systems. Wheat varieties from the station are grown on about 50% of the wheat acreage in Canada. Durum wheat varieties at SPARC account for well over 90% of the Canadian acreage. In addition to a strong effort in wheat research, scientists at SPARC are conducting to further the understanding of integrated cropping systems, especially for pulse and forages.

Agronomy Capacity- Swift Current has 6 FTE PhDs plus technicians. There is research capacity and the centre is well recognized as strong in agronomy. The station has 1,465 ha (3,620 acres) including Indian Head. Equipment is rated as good with Indian Head rated as very good. It collaborates well with IHARF (see next chapter). This is a strong agronomy centre for the province.

Crop or Topic Focus- all crops

Collaborators- industry, producers, University and Provincial Government

See <http://www.agr.gc.ca/eng/science-and-innovation/research-centres/saskatchewan/saskatoon-research-centre/?id=1180626618960>

#### 5. Brandon & Morden Research Centres

Overview – Agriculture and Agri-Food Canada has two remaining research stations in the province following the recent closure of the Winnipeg-based Cereal Research Centre and the relocation of some of its work to the Morden Research Centre. The Brandon Research Centre conducts the majority of the agronomic research done by the federal government in the province. Morden does not have an agronomy program although a flax breeding position has been reallocated to agronomy. They are discussed together.

Agronomy Capacity – AAFC has a complement of 21 FTEs including 7 PhDs. Only one researcher is dedicated specifically to agronomy while the others work in related areas such as soil fertility and quality, plant pathology and water management. They have access to a land base of 3,086 acres and required lab and analytical facilities.

Brandon is currently working at fully capacity given staff availability. Two positions could be added in weed sciences and in soil microbiology. There is interest in expanding agronomy research but funding and staff expertise are limiting this plan.

Crop or Topic Focus – cereals, oilseeds, forages, special crops.

Collaborators – university, producers, industry, provincial government. AAFCs agronomy group across Western Canada is very well integrated, so there is considerable discussion and exchange of ideas. With respect to the University of Manitoba, AAFC often has staff whom are also adjunct professors and work with graduate students

See <http://www.agr.gc.ca/eng/science-and-innovation/research-centres/manitoba/brandon-research-centre/?id=1180705255780>

### **Sites (Station and Farms) Overview**

Personnel involved in the agronomy research comprise many sites and many disciplines (see appendix). For AAFC staff in the Prairie/Boreal Plain Ecozone, agronomic capacity (number full-time equivalents- FTE) exists at Lacombe/ Beaverlodge (6 PhDs in total), Lethbridge (11 PhDs), Saskatoon/Outlook/Melfort/Scott (9 PhDs), Swift Current/Indian Head (6 PhDs), Brandon (5 PhDs) and Morden (2 PhDs).<sup>o</sup>

The main areas of research for AAFC include agronomy (crops, soils, beef grazing, and range management), agrometeorology, weeds, pathology, entomology, cropping system microbiology and of course, the economics of the research conducted under AAFC agronomy capacity. This total is 39 PhD FTEs (not including technicians and other necessary staff. In addition, since 2012,

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<sup>o</sup> AAFC Input, WGRF Agronomy Research Capacity, July 2014

the Science and Technology Branch (STB) have allied professional positions that support development and technology transfer.

AAFC has the unique strength of a network of sites, common equipment, standards, internal protocols and a culture in science. This network seems to be changing and the assets (farms) and senior people (retirees) need to be understood within the system. AAFC is a core player in this and other agriculture topics.

AAFC collaborates with many parties, *“AAFC has unique collaborations at smaller Centres. These collaborations are critical in the maintenance and development of agronomic information in rural areas. Capacity can be leveraged from Federal, Provincial and Industry where a whole is better than the sum of their parts. Currently, Indian Head Agricultural Research Foundation (IHARF), Western Agricultural Research Commission (WARC), and Northern Agricultural Research Foundation (NARF) co-exist under agreements at Indian Head, Scott and Melfort, respectively, as well as the Canada-Saskatchewan Irrigation Diversification Centre (CSIDC) at Outlook and the Canada-Manitoba Crop Diversification Centre (CMDC) in Carberry and Portage la Prairie.”*

In the recent past a new crop cluster research program has been implemented by AAFC and its collaborators under Growing Forward I (GFI).<sup>P</sup> The table below indicates the main crop clusters.

Table 1- Examples of AAFC Crop Clusters (Growing Forward I)

Crop	Focus Areas	Collaborators
Canola- Flax Agri-Science	Canola and flax oil research Meal nutrition research Agronomy Crop establishment Crop nutrition Crop protection Harvest management Storage management Integrated crop management Sustainability	Universities-11, AAFC sites-12, ARAs-1, Industry-2, Hospital-1, Provinces-3; total = 30
Pulse Science	Genetic Improvement Agronomy and Sustainable Production Processing and Utilization	Universities-7, AAFC sites-12, Industry-1, Provinces-2; total = 22

Source: AAFC website, <http://www.agr.gc.ca/eng/?id=1316118882467#N10153>

Growing Forward II (GFII) also contains an innovation element. The objective of the AgrilInnovation Program is to support research and development activities in agri-innovation and facilitating the demonstration, commercialization and/or adoption of innovative products, technologies, processes, practices and /or services.<sup>Q</sup> The Innovation Program budget from April 1, 2013 to March 31, 2018 is \$468 million. This includes contribution funding, AAFC research support for collaborative projects with Applicants, and the cost of AAFC Program administration.

<sup>P</sup> AAFC, Growing Forward, Growing Forward was a five-year, co-ordinated federal-provincial-territorial government initiative that supports all aspects of the agriculture industry. It was \$1.3 billion over 5 years.

<sup>Q</sup> AAFC, AgrilInnovation Program Industry-led Research and Development Stream Applicant Guide



## AAFC Situation Outlook

AAFC has a large current and historical presence in the Canadian agri-food system and also in agronomy. The network of 11 sites is highly useful to Western Canada agriculture, because the *“network of sites as well as the potential to collaborate with Universities and other research providers develops confident recommendations in 2 to 4 years depending on the research question. Why? The AAFC Network of Sites can conduct the same trial at 8-10 sites in a growing season, providing 21 to 40 site-years of agronomic data in a 2 to 4 year period of time. Properly conducted, these agronomic trials can make inferences about soil type or geographic region.”*

However, AAFC will lose 16 senior level agronomy scientists within three years, down from the total of 39 professionals. This means that 41% fewer public research performers (AAFC) will exist by 2018. This is recognized but no replacement plan is known yet. A comment from AAFC is important to note on transition and agronomy gap issues.

*“The biggest impact to research capacity will be at Lacombe and Saskatoon; and yet retirements of these world-class scientists could result in a major gap at a Centre such as Brandon. In addition, the number of weed scientists in AAFC could be reduced to one in Western Canada. Of course some scientists have a bigger impact than others; at least 10 of the 14 are globally recognized and the pride of AAFC research. They are irreplaceable as one cannot hire experience, know-how, connections as well as the ability to interact equally effectively with world-class researchers and farmers. If replaced, new scientists will need time to become completely effective. Experienced researchers that remain can play a key role as mentors of newly hired HQP.”<sup>r</sup>*

Professional reductions and workforce supply was of concern to a number of professionals contacted in this review. One observation was that retaining these specialized positions in remote areas (farms) is highly difficult and perhaps an MSc level is more appropriate than a PhD position.

Sites noted to be difficult to staff for AAFC include Melfort and Scott. Melfort has one scientist and apparently used to have 12 scientists and Scott has one scientist and similarly used to have 13 or 14 scientists (from industry comment). In addition Scott also had two other scientists located in Saskatoon who have since been reallocated or reduced. These station reductions in agronomy staff are large. Workforce is an issue for AAFC just as it is for others in the system.

Two key factors identified for the underlying AAFC staff reductions are: longer term federal budget reductions and a change in Research Branch focus towards agri-business and less direct farm level work.<sup>s</sup>

## AAFC Equipment and Other Investments

Investments in the research stations equipment and buildings also need attention. The AAFC input indicates a need for one-time and ongoing funds. One-time funds of at least \$1.4 million for equipment at Swift Current/ Morden/ Outlook/ Portage are needed along with some transition funds

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<sup>r</sup> AAFC Input, WGRF Agronomy Research Capacity, July 16, 2014, pg 11

<sup>s</sup> One comment was that less than 15% of AAFC senior level scientists in the Research Branch now have a direct work linkage to farmers.

for Morden. These investments will bring these stations' equipment capacity up to network capacity with other AAFC sites. In addition, maintenance of about \$600,000 per year for all sites is needed. A five year estimate for these AAFC equipment/ related areas is in the order of \$4.4 million. Buildings are not included. The land base appears adequate. The future of some sites will be assessed in the AAFC Gap Analysis to link to the sector strategy. (It was noted by some other research and extension performers in the survey about the need for new equipment investments and renewals).

### Capacity Enhancements and Communication of Research

AAFC indicates four ways that capacity in the system will need to be addressed:

- AAFC Renewal Plan- a Gap Analysis will be done by fall 2014;
- Training of Qualified People- this role is with the University and College system;
- GF2 (Growing Forward) Clusters and other innovation funds to build collaborations;
- Partnering and Co-location agreements- as is occurring successfully in some sites.

AAFC scientists are collaborating with others in a many agronomy projects and actively communicate research results. A breakdown of recent publications (from these sites) indicates 789 articles in agronomy related research and 956 articles in technology transfer efforts.<sup>†</sup> *“Removing the scientists and their scientific publication and technology transfer activities provides a measure of the impact or the loss if the scientist retires or leaves within the next three years.”*

An AAFC report provides general level indicators for the department trends. Science and innovation investments have declined and are planned to be reduced by 24% by 2015.<sup>‡</sup>

Table 2- AAFC Plans (Source: AAFC, 2013)

AAFC Estimates (Millions)	2010-11 (Actual)	2013-14 (Planned)	2015-16 (Planned)	Change from 2010
Strategic Outcomes, programs, Internal-all	\$2,674.8	\$2,450.5	\$2,278.6	-15%
FTEs- all- staff	NA	5,721	5,425	-5% (of 2013)
Outcome 3- Science, Innovation, Adoption	\$360.3	325.8	272.5	-24%

Source: AAFC Report on Plans and Priorities, 2013-2014,pg15,18

### Discussion of AAFC Future Situation

A listing of the current likely retirements to 2020 (crop agronomy system) is noted (AAFC scientists) given industry comment/ expectations. The potential reductions include:

- Agronomy- 3 unfilled positions – two in Manitoba and one in Saskatchewan;
- Crops- 4 positions;
- Entomology- 5 positions;
- Soils- 1 position;
- Pathology- 2 positions;

<sup>†</sup> AAFC Input, WGRF Agronomy Research Capacity, July 16, 2014, pg 16

<sup>‡</sup> It is difficult to source any detailed agronomic financial research trend data.

- Weeds – 3 positions;
- Agrometerology -1 position;
- Total 16- reductions plus 3 unfilled positions

About 16 senior scientists are expected to retire from AAFC sites. AAFC indicates a total of 39 current scientists in that agronomy knowledge pool, which means that 41% of that senior science capacity will likely retire within 3 years.<sup>v</sup> The biggest impacts will be in Lacombe and Saskatoon. For a smaller capacity site like Scott, one scientist is the only remaining capacity. Weed and entomology scientists will be a high risk to the current capacity. (We note that some of these potential retiring people may continue to work in these science areas.)

From the AAFC Input report, their agronomy PhD staff are highly productive. They have produced about 789 total research publications and 956 technology transfer publications (last three years, 1745 total with an average of 43 publications per scientist). Of the expected 16 retirees, their publications total about 550 or 32% of the total outputs. The expected retirees have produced 267 (34%) research publications and 283 (30%) technology transfer publications. This level of research output will drop (due to fewer scientists, and younger placements). The total person-years of experience lost will be in the order of 560 person-years (assume 35 years each). No replacement plan has been revealed at this time. In addition the need for more infrastructure funds and the role of some sites (farms) in two or more locations needs clarity.

From the industry interviews and available data, concern exists on the level of AAFC future investments in scientists and associated research operating needs. Several key areas for potential bottlenecks are noted:

- **Sites and Core Agronomy Foundation Research Role-** A risk exists with the core role of AAFC system, which has been the backbone to many research areas including agronomy (two operating Saskatchewan research sites (farms and also positions). Research sites in the AAFC system (since before the 1900s) offer a dedicated location which can be accessed and experiments conducted with standard protocols. These sites offer an advantage over research which has to seek out and lease farm lands. Once the assets are disposed of, they are very hard to ever replace and longitudinal (historical) land records are valuable for researchers. Keeping these sites can be a strategic advantage for Western Canada if they are utilized properly.<sup>w</sup> Research positions in the AAFC system are declining over time and we were told that in the Year 2000 the department had about 500 scientists and now is lower at about 250. Agronomy is a niche area within that science pool and it is important for crop production to be maintained for the nation.
- **Highly Skilled People-** Loss of senior AAFC scientists and the culture change- from the research conducted herein it is expected that about 16 or more AAFC senior scientists will depart the agronomy system in the next three years. This is important to understand as the

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<sup>v</sup> AAFC Input, WGFR Agronomy Research Capacity, July 16, 2014, pg 11

<sup>w</sup> AAFC has transferred the dairy program of the Agassiz farm to UBC, sold the Fort Vermilion farm to County of McKenzie, is reducing some sub-site work in southern Alberta (Stavelly), and has reduced science support in Beaverlodge, Melfort and Scott stations. Industry commented about a concern in losing any farms.

person-years of knowledge and capacity loss will be highly impactful. In addition, the ability to mentor, lead and train others in industry and internally will be reduced.

- **Long- term Focus-** AAFC is the only organization with a long-term research focus, with a large developing as they exit this space (no one else does long term work). University research sometimes is more 'academic' while AAFC was more producer- focused. The big player in agronomic research is AAFC at Indian Head (site of Swift Current), and both sites have strong research groups and producer involvement. AAFC stations are important because of their varied locations.
- **Change Management Plans-** A Gap Analysis is to be done by AAFC on the issue of the research stations and the farms as we understand. This will be important for the overall system, retention of senior level expertise and understanding the future role within the agronomy topic and other research topics. It will also be very important for allied organizations which need to make plans for supporting agronomy research and extension activities. Uncertainty currently exists for some sites.
- **Current levels of investment in AAFC-** are not thought to be adequate and have been declining over time. The need for this basic agricultural research does not diminish. Some will argue research from other countries can be sourced and adapted for Western Canadian conditions and in some cases that may be correct. However, the size of the crop sector in Western Canada and the colder climate, shorter growing season and other regional conditions farmers need to deal with does mean Canadian research is needed. The focus and priorities of the research are also important.

## Universities in Agronomy Research

Universities in Western Canada are involved in the agronomy research area to a degree and are briefly reviewed below. Information was provided from the survey and interviews. Three Universities are reviewed including Alberta, Saskatchewan and Manitoba as they were identified as the key ones in this area. A summary of the general profiles is given in the table below.

Table 3- University Agronomy Student Programming and Research

College/ University	Programs	Comments
University of Alberta <a href="http://www.ales.ualberta.ca/">http://www.ales.ualberta.ca/</a> "Agriculture, Life and Environmental Sciences"	Undergraduate and graduate programs; Agricultural, Food and Nutritional Science, Agricultural, Life and Environmental Sciences, Animal Science, Agricultural and Resource Economics, Environmental and Conservation Sciences, Entomology, Forest Economics, Forest Engineering, Forest Science, Human Ecology, Interdisciplinary, Nutrition, Nutrition and Food Science, Plant Science, Renewable Resources, Rural Sociology, Soil Science	120 academic staff, 1,500 undergrad, 500 graduate students. A research intensive faculty, over \$40 m in research funding annually, 11 research stations, 4 research networks, 5 collections. 19 human ecology profs, 72 food and nutrition profs, 21 resource economics & environmental sociology, forest science & mngt
University of Saskatchewan- <a href="http://agbio.usask.ca/">http://agbio.usask.ca/</a> "College of Agriculture & Bioresources"	13 degree Programs: Agribusiness, Agricultural Biology, Agricultural Economics, Agronomy, Animal Bioscience, Animal Science, Applied Plant Ecology, Crop Science, Environmental Science, Food and Bioproduct Sciences, Horticultural Science, Renewable Resource Management, Soil Science.	350 people, including faculty, research scientists, administrative and scientific support staff/ undergrad and graduate students. \$31 m in research. Core areas- soil science, plant science, animal science, applied microbiology, economics. 173 total profs; 40 animal & poultry science profs, 19 bio-resource policy & economics profs, 22 food & bio-products profs, 55 plant science profs, 37 soil science profs & tech, 5 centres
University of Manitoba <a href="http://umanitoba.ca/afs/">http://umanitoba.ca/afs/</a> "Faculty of Agriculture and Food Sciences"	4 Bachelor's degrees: Bachelor of Science in Agriculture, Bachelor of Science in Agribusiness, Bachelor of Science in Agroecology, and Bachelor of Science in Food Science.  The Faculty focusses on these areas of research: Environment, Food and Health, Bioproducts, and Communities.	2013/2014 academic year, the Faculty had 402 degree students; 167 diploma students and 230 graduate students. The Faculty has 73 academic FTEs, of which about 63 have both teaching and research responsibilities. The academic faculty includes: plant science – 14; animal science – 12; soil science – 11; entomology – 5; agribusiness and agricultural economics – 10; biosystems

		<p>engineering – 10; food science – 11. There are 58 technicians to assist researchers. The research budget is about \$16.2 million, while the agronomic research investment is estimated to be \$2.8 million annually. The Faculty operates three research stations and a School of Agriculture.</p>
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Source: Websites

### University Professionals in Agronomy Research

From the survey results, a total of a three FTE scientists (University of Alberta), 10 FTE scientists (Saskatchewan) and 7.5 FTE scientists (Manitoba) are involved in agronomy research.<sup>x</sup> These positions are PhD level and were reported from the survey and are actively involved in agronomy disciplines. The disciplines include: soils, crops, weed sciences, physiology, pathology, entomology and agronomy.

This totals to 20 PhD (and one MSc- Manitoba) level researchers who were identified. It is noted that other scientists may have moved into other research interests and topics of environmental and oil and gas related work. In addition about 38 FTEs including technicians and staff support were reported in related staff positions (technicians, etc.) in supporting agronomy work. Support data of key scientists is in the appendix and the capacity is discussed in the following sections.

The University system has a strong capacity and many experts within the three Universities reviewed below. A key role exists for the development of workforce and new young scientists by training of graduate students.

A summary of the survey results is given below.

#### 1. University of Alberta-

Overview- The University has many related skills in the agronomy area. In the recent past, some of these researchers have also been responding to the need for more work in the oil and gas soil reclamation and remediation areas. A strong team of plant breeders is located at the University (plant breeding is not a focus of this review). The Breton Plots research site is home to two long-term agronomic experiments - the Breton Classical Plots (est. 1930) and the Hendrigan Plots (est. 1980) and the rest of the property is available for contemporary research projects. In the past 5 years, they have had short-term research projects sponsored by Shell, DOW AgroSciences and Viterra.

Agronomy Capacity- The University has a very strong crop variety and breeding area and allied production, livestock and food/ nutrition departments. The agronomy area includes a capacity of about 3 PhD FTEs (within a number of about 9 scientists) plus several allied

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<sup>x</sup> We note that about 9 scientists are involved but not all in a full-time manner in University of Alberta agronomy research.

technicians, totalling 5.5 FTEs. A number of these researchers have been active in soil remediation, reclamation and related topics for the energy industry. Thus people are a bottleneck to more agronomy work, given the other researchers are already engaged.

The researchers (and others) working in the agronomy area have about 36 graduate students enrolled. The total funds involved in the area are estimated at about \$1.4 million annually. Equipment lists were not obtained. Land assets for agronomy projects are about 900 acres but much of it is committed to current crop breeding research programs. The industry comments indicate the University has moved in to other areas of research and reduced its crop agronomy work in favour of more life and environmental sciences. The provincial government assists the University in some agronomy work in equipment, technician support and other areas where the capacity is missing.

Crop or Topic Focus- the University deals with all crops and can address many aspects of a project in a team approach.

Collaborations- the University works with public and private partners on projects.

See <http://www.ales.ualberta.ca/Departments.aspx>

Graduate Students- The University is very strong in crop breeding and soil related research. However, agronomy is thought to be at a lessor active capacity relative to the other two Universities. The University students are noted in a table below and total 36 graduate students in agronomy disciplines (although another 23 are in related topics- breeding, etc.).

## 2. University of Saskatchewan

Overview- The University is located in Saskatoon and has a strong reputation in production agriculture and in crop developments. Plant Science is a core department. An allied group - the Crop Development Centre is located in the department - and is funded by the province and others for new crops. It has made some very interesting and impactful progress. CDC is mainly focused on varietal improvement (release of varieties) and a lesser emphasis on crop management and crop protection. The breeding programs overlap in some agronomy areas. Most of the fertility work is in the Soil Science department.

Agronomy Capacity- Plant Science has strength in agronomy with 6 PhDs, 11.4 staff and about 137 plant and soil science graduate students, of which 66 are in agronomy. They have access to equipment (no list supplied) and have many projects underway. The department is very active in Western Canada in crop agronomy. They are not at capacity and have ability to do more projects on a 3 to 5 year basis. The land base does limit longer term projects. Equipment is current and they use an equipment fund to manage the replacement as needed. They could use larger scale equipment and no- till drills. A concern is the lack of land, people and funding support for more research.

The University does not have small scale or small boom size field equipment to replicate commercial seeding practices like AAFC can (they had two smaller custom seeders made). This bottleneck limits its work in the row space population experiments. The U of S has an inability to conduct properly twinned and mid-row banded trials (seed fertilizer placement)

because it does not have a small air seeder that is typical of commercial seeders. The gap limits wide range of seeding rate-row space options. It was suggested that more land and an adequate sized seeder are needed. Professionals are needed in entomology and cropping systems as these positions are also a bottleneck. The University has 2,500 acres of land but much land is committed. The agronomy research effort is in the order of \$1 million or more of external funds.

Undergraduate training is very important and agronomy is one of the biggest majors. All graduates apparently find jobs and the program involves a basic “how to design an experiment” module.

Crop or Topic Focus- cereals, oilseeds, pulses. They are working in weed biology and control, disease control in pulses, cereals and flax and in pulse crop physiology.

Collaborators- the University works with many groups and researchers including other universities, AAFC, the provincial Government, producer groups and industry. They have access to 10 plant breeders (CDC) as well. Collaborators in Western Canada often work together (as the industry is small). Some researchers do not want not to operate at too many distant sites unless they know the caliber of the remote plots and data quality – as there is no point in having a location with poor data. This “trust” on others to deliver part of a project can be a bottleneck to collaboration (this comment was also expressed by others).

A distant location means they (local staff) have to do all the work, or the researcher has to travel to it to get some of the in-season data. This issue does not work well with experiments needing frequent interval measurements. Results are communicated to the users in various ways- tech transfer events, meetings, media (Top Crop Producer), Western Producer, Grainews, commodity groups, science conferences and publications. Some people note that there seems to be a gap at times between ‘best’ current recommendations (often given by industry with a vested interest) and good solid science (by non-industry, independent scientists).

See <http://www.usask.ca/research>

Graduate Students- The University is very strong in crop and soil related research and agronomy. The University has 78 plant science and 59 soil science graduate students, for a total of 137 graduate students. Of this total, about 66 are in agronomy disciplines.

### 3. Crop Development Centre

Overview- The Crop Development Centre (CDC) is a field crop research organization within the Department of Plant Sciences at the University of Saskatchewan. CDC scientists integrate basic research with genetic improvement (new varieties) of spring wheat, durum, canary seed, barley, oat, flax, field pea, lentil, chickpea, faba bean and dry bean. The Centre has a strong agronomy component to develop production practices. The Centre has developed many new varieties and is a success story.

Agronomy Capacity- The CDC has 3.4 FTEs including 2 PhD FTEs and 1.4 MScs. They access the Plant Science capacity for other resources. The Centre has access to land,



equipment and performs agronomy research for crops. Many collaborations are underway and the Centre is funded by the province. It has strong capacity and notes the need for additional resources. They have access to over \$120,000 of external funds for agronomy research.

Crop or Topic Focus- cereals, oilseeds, pulses, special crops- varieties

Collaborators- the Centre is highly focused on industry needs and researchers work with AAFC, other universities, producer groups and other departments. It is co-located at the University.

See <http://agbio.usask.ca/research/centres-facilities/crop-development-centre.php>

#### 4. University of Manitoba – Faculty of Agricultural and Food Sciences

Overview – The agronomy program at the University of Manitoba is located in an important crop production area of Canada. Students benefit from extensive faculty expertise in sustainable crop development, production, and management, entomology, and soil science. The University has the strongest, most diverse agronomic focus and the most comprehensive complement of soils, entomology and crop researchers of the western universities.

The University has conducted some long-term trials looking at degradation of manures in soil and comparing manure versus synthetic fertilizer over successive years on the same fields. The fertility work will lead to better recommendations regarding residual nutrients and fertilization recommendations. University researchers are also taking a holistic approach to agronomic research, looking at how the various components of agricultural production can complement and integrate with each other.

Funding is an ongoing challenge – especially to buy specialized equipment for conducting trials. There is no core budget for equipment; it must be purchased from project funding. On average, each agronomic researcher represents (to the University) \$300,000 in annual costs (salary and benefits plus infrastructure, lab costs and support staff). New researchers receive \$75,000 in one-time initial funding for program start-up. Researchers are initially allocated ½ a technician and ¼ of a lab.

Agronomy Capacity - The University has a complement of 20 FTEs in the agronomy area, including 6.5 PhDs and 1 MSc as scientists working in the agronomy topic. About 65 graduate students are enrolled in agronomy-related studies. Researchers have access to 1,512 acres of land over three locations – the Ian N. Morrison Research Farm at Carman, the Glenlea Research Station 20 minutes south of Winnipeg, and The Point on the Winnipeg campus. The University contributes \$200,000 annually towards the operating costs of the Ian N. Morrison Research Farm. The annual cost of agronomic research conducted at the University is \$2.8 million.

Crop or Topic Focus- cereals, oilseeds, forages, special crops

Collaborators – Agronomic researchers collaborate within and between departments at the University; with other Universities across Canada and internationally; with AAFC and the provincial crop diversification centres; and private partners (ex. equipment suppliers and Richardson International's Kelburn Farm).

See <http://umanitoba.ca>

Graduate Students- The University is very strong in crop and soil related research and agronomy. The University has plant science, entomology and soil science graduate students for a total of 65. The range of topics in the soils department is quite wide and includes soil fertility, soil ecology, soil remediation, agrometeorology, soil chemistry, soil physics, surface water quality and landscape dynamics.

## Discussion and Summary

The University system includes excellent scientists, undergraduates and graduate students who work in a variety of agronomy research projects. Each of the Universities has from 36 to 66 graduate students for a total of 167 agronomy related graduate students. The descriptors used in each institution for students are a bit different but should be comparable for these findings. As other sectors are expanding (oil and gas, environment) some of the scientists are also moving into research for those industries. The table below indicates the summary University situation from the survey and the bottlenecks or gaps currently identified.

Table 4– Summary of PhD FTEs in University Agronomy Research

Discipline	University of Alberta	University of Saskatchewan	University of Manitoba
Agronomy	Gap	2	2
Crops	-	1, Gap- cropping systems	1
Entomology	Gap	Gap	.5
Soils	1	3	3
Physiology	.5	-	0
Pathology	.5	2	0
Weeds	1	2	1
Total- FTEs Active	3	10	7.5
Comment	Lack 2 agronomy core staff, have others involved but part-time	Lack equip and core funds, need 2 positions	Lack core funds for graduate students, technicians and equipment

Source: Survey.

The total University agronomy research capacity is 20 FTE researchers and about 38 support staff plus the graduate students. Some retirements are expected in the next 3 to 5 years for about 4 positions. The situation includes:

- University of Alberta- a need for a core agronomy position (or two) and entomology;
- University of Saskatchewan/ CDC- a need for an entomology position and some equipment funds;
- University of Manitoba- a need for some core funds for several needs.

The graduate student counts are noted in the table below, with the data sourced from the University staff. The University of Alberta has 36 graduate students in the agronomy related areas,

Saskatchewan has 66 and Manitoba has 65. (It is noted that other graduate students may fill a need in agronomy research projects.)

Table 5– Summary of Graduate Students in Agronomy Research

Discipline	University of Alberta- MSc	PhD	University of Saskatchewan- MSc	PhD	University of Manitoba- MSc	PhD	Totals- MSc	Totals- PhD
Agronomy*	5	0	9	1	6	2	20	3
Entomology	1	1	0	0	6	7	7	8
Soils	6	3	17	17	13	7	36	27
Physiology	4	1	1	6	6	3	11	10
Pathology	8	2	8	0	4	8	20	10
Weeds	5	0	6	1	1	2	12	3
Total- Agronomy Disciplines	29	7	41	25	36	29	106	61
Total	36 (22%)	-	66 (39%)	-	65 (39%)	-	167 (100%)	-

Source: Survey. Classification titles differ by school. Alberta has 59 total graduate students in related breeding, range ecology and molecular areas. Saskatchewan has 137 total plant and soil science graduate students. Most (75%) of these students are in breeding/ genetics, horticulture or plant ecology. Plant breeding students are not included. \* For MB includes 3 cropping systems students.

The table above shows a need for entomology and agronomy students and is similar to the professor gap noted earlier. The retirees from the system by 2018 or so also shows where the workforce gap will be short for entomology and weed sciences. Some students are completing joint breeding and agronomy research projects.

Some of the highlights of the University input includes:

- The University of Alberta has moved to a stronger environmental faculty focus. Saskatchewan and Manitoba are seen to be stronger in agronomy research;
- The University of Saskatchewan and the Crop Development Centre have seen many successes and are valued. It also has a strong undergraduate agronomy program. The University has strength in crop agronomy knowledge creation and education of new professionals. Students and the development of more professionals in the agronomy disciplines is seen to be very important and annually all students are being hired;
- Researchers need replicated research plots in different soil and climate zones for strong results. However, some remote sites have not been accessed in the last two years as researchers (University of Saskatchewan) lacked technical staff (and funding);
- Workforce development by universities (students and new scientists) is a very important area for all industries. Attracting and retaining highly qualified people was expressed as a challenge, and opportunities exist for talented agronomy professionals and often other industries will draw people away from agriculture. A potential future agronomy resource gap exists for MScs and PhDs with Canadian experience. This is the key role for Universities and colleges;

- Universities and colleges have retirements upcoming also. Highly qualified people (PhD trained) with Canadian experience are going to be retiring and replacements will be needed;
- People are needed and are seen to be a bottleneck. It was suggested that 2 to 4 new University positions in crop agronomy topics/ disciplines are needed, given the problems on higher yields, understanding climate change issues, technology and equipment management areas and weed and disease threats (Australia has a high priority on weed control). (From the review, a University researcher is in the order of \$300,000 per unit (science, technician, lab, office, research fund) and in AAFC as estimate of about \$400,000 per position is generally used.)

### **Future of this Research Capacity**

No interviews indicated a major change away from the current research levels in the University system and if the current trend continues the strength should continue to be quite strong. Infrastructure (buildings, equipment) will need to see some investments and more collaboration can be attempted with producer directed research associations which have capacity and an interest. In addition, continued collaborations with AAFC and provincial government staff are expected.<sup>y</sup> Some comments were offered on the need for some specific equipment and for the need of a longer term funding approach.

The development of highly trained professionals and graduate students shows additional capacity for the workforce demands of both research and industry organizations. This is important given the feedback obtained in this review. It would be highly useful for industry, producers and other stakeholders to understand where each university plans to take its current agronomy related science efforts.

Some comments were offered in the survey on other research themes. Agronomy research themes for a Western Canada focus can include: characterization of yield zones, (i.e. are there differences in agronomic requirements of crops in specific areas of western Canada?) and crop systems research (crop trait, pest management, agronomy and interactions of these factors).

More resources will be needed for: people, capital, funding and aspects of data generation for variables such as soils, moisture, temperature and how each of these factors interact. (It was noted that some smaller producer directed research organizations often do not have this internal lab/ analytical capacity. They do have access to land and technicians which can complement University resources and some ARAs (perhaps 3 or 4) already are involved in some joint work.

Some of the other areas which agronomy research may address:

- Genomic potential now exceeds actual yields - agronomy is the key to extracting the unachieved potential;

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<sup>y</sup> In Alberta, AA&RD collaborates with and assists the University in equipment, land and technical support as they often do not have this capacity to realize a successful experiment.

- More research on the root zone, rhizosphere, root hairs, (beneficial and harm of:) microbes, bacteria, insects; interactions in the ecosystem;
- Crop rotations, complex area of potential impacts and cropping systems;
- Seed coatings and the corresponding changes in practice with their use is important agronomic work;
- Biologicals and inoculants- large companies realize it is easier to engineer/sell these products than GMO products;
- DNA is now a possible diagnostic tool (speeds diagnosis, shortens research cycles)
- Equipment: imaging, GPS, modifications in technology for production;
- Communications- overall understanding of priorities, a strategy and coordination of agronomic research direction and producer awareness of the importance of agronomic research.

The graduate students coming out are likely to be in demand and a need for several new positions (4 to 5 in several disciplines) is noted from the survey feedback. About 37% of the students (61 of 167) are PhD candidates and certain disciplines may have limited numbers available in the near future.

## Provincial Governments

Provincial governments are involved in agronomy work through programs, support funds, policy, professional staff and land and lab resources, A brief overview is given on these agronomy efforts. Alberta and Manitoba (in crop diversification centres) have specific efforts in applied research in agronomy and related crop production topics. The provinces are also involved in the crop clusters as collaborators.

### Alberta

Alberta has agronomy and crop production support offered by Alberta Innovates Technology Futures (Prior Alberta Research Council) and the department of Agriculture and Rural Development. Each main organization is described below.

#### 1. AITF- Alberta Innovates Technology Futures

Overview- AITF is within the department of Enterprise and Advanced Education. It previously was known as Alberta Research Council. It has locations in Edmonton, Vegreville, Devon and Calgary. Crop agronomy work is carried out at Vegreville and Edmonton. The organization has a technology development interest in new crops and technologies.

Agronomy Capacity- AITF has 4 PhD FTEs and a total of 15 FTEs in the crop agronomy area. AITF has taken a lead role in the province on new crops for industrial and new uses and crop work has been completed in industrial hemp, Jerusalem Artichoke, flax and other crops. Some current work is being completed with Lakeland Collage on biochar and crop effects. A total of 600 acres are available for projects. The annual research effort is in the order of \$800,000.

Currently the capacity is seen to be able to participate in research projects but is not active in the mainstream crops. AITF is getting a GLP rating (Good Lab Practice) and Dow (region 14) has approached them for work because of their needs. Others cannot do this work. AITF has capacity in crop development, technology development to early stage market commercialization. They are also strong in plant pathology. They have more capacity and lack people for summer work.

Crop or Topic Focus- canola, hemp, Jerusalem Artichoke, flax.

Collaborations- AITF collaborates with local and global companies, Universities, producer groups and research institutes. It has extensive global linkages for technology developments. It is involved with the canola- flax cluster.

See <http://www.albertatechfutures.ca>

#### 2. AA&RD- Alberta Agriculture and Rural Development

Overview- The department provides crop production information on all crops including agronomy, disease, weeds, inputs and policy and programs. It has three main divisions of interest: Lacombe Field Crop Centre (Feed Crops), Food & Bio-Industrial Crops Branch and

Pest Surveillance Branch (this group has regulatory and surveillance responsibilities as well including noxious weeds, invasive weed species, monitoring insects and disease).

Agronomy Capacity- The department has 37 FTEs including 10 PhD FTEs, 5 MSc FTEs and 22 other FTEs (agronomy related) located in Lethbridge, Brooks, Edmonton, Spruce Grove and Barrhead. The department has access to about 1,025 acres for research projects and works in all crops. They have an annual research budget in the order of \$2.5 million.

The department is unique in Canada for its internal research capacity, does supports others (University, other provinces and industry) and can support or lead projects. An emerging area is in biological mitigation for climate change issues (adaptation, cropping systems, technologies) and unique funds may offer new collaboration potentials (New Endowment Fund \$200 million, CCEMC-Climate Change and Emissions Management Corporation). Agronomy will play a role here in synthetic fertilizer use in crop placement, leaching and runoff areas.

Crop or Topic Focus- cereals, oilseeds, forages, pulses, special crops

Collaborations- University, AAFC, industry and producer groups

See <http://www.agric.gov.ab.ca/app21/rtw/index.jsp>

## **Saskatchewan**

The Ministry of Saskatchewan Agriculture department has a number of regional offices throughout the province to support and guide crop production and related activities.

Agronomy Capacity- the department has about 20 FTEs in the area of crop production and agronomy but is not active in the research area. It is more involved in extension and technology transfer activities. The complement includes 2 PhD FTEs, 9 MSc FTEs and 9 other staff. The capacity is in industry developments, disease surveillance, policy, programs and related supports. Staff are located in Regina and in 10 regional offices.

The province is involved in technology transfer, identification and diagnosis of disease pest issues and in other extension work. It supports applied research through the Agriculture Development Fund and the ADOPT program (Agriculture Demonstration of Practices and Technologies) which help to fund others. These funds have helped greatly to accelerate crop development and extension and research activities and had many several comments.

Crop or Topic Focus- the department serves all crops

Collaborators- the department works with all public and private organizations in the crop production program areas. It actively supports the CDC and others through programs.

See <http://www.agriculture.gov.sk.ca/crops>

## **Manitoba**

Manitoba Agriculture Food and Rural Development (MAFRD) provide staff and funding support to four crop diversification centres (CDC).

The four CDCs are: Prairies East Sustainable Agriculture Initiative, Arborg (PESAI); Parkland Crop Diversification Foundation, Roblin (PCDF); Westman Agricultural Diversification Organization, Melita (WADO); and Canada-Manitoba Crop Diversification Centre (CMCDC), Carberry, Portage La Prairie, Winkler. Each site is owned/ or operated in a separate entity: PESAI, PCDF, WADO and Winkler by local farmer and industry groups. Carberry is operated by a group of local industries and Portage is operated by the federal government. Carberry and Portage have 128 ha (70 ha irrigated) and 65 ha of land respectively.<sup>z</sup> This system is different from the other two provinces in the way it involves local groups with the crop centres. The focus is on extension and adaptation projects.

**Agronomy Capacity** – The CDCs have a total owned land base of 440 acres. Land at Melita is rented. The CDCs have a total of 14 FTEs including 1 PhD, 3 MScs and 10 others (including seasonal). The budget for the CDC program is in the order of \$1 million annually. The value of equipment is \$750,000. The CDCs mainly do extension and technology transfer activities.

**Collaborators** – universities, industry, AAFC, producers.

See <http://www.gov.mb.ca/agriculture/crops/index.html>

## Discussion

The review of the provincial departments shows that Alberta is different due to staffing for applied research and related adaptation efforts in agronomy research. They have a complement of about 37 people including 15 FTEs in PhD/ MSc research positions. Furthermore, the provincial department in Alberta has a land base of about 1,025 acres for crop research. They have lead and support roles in research projects in three branches. Key scientists include: crop production, agronomy, pathology, plant physiology within the Food & Bio-industrial Crops Branch, The Pest Surveillance Branch and The Field Crops Branch.

Saskatchewan does not have similar internal government department research efforts but focuses on program, funding and strategic supports for crops. Manitoba has 4 PhD/ MSc government researchers and a total of 14 FTEs in the agronomy area. They deliver services through the four crop diversification centres to support applied research in crops and agronomy.

Provincial governments are important to the agronomy research topic and assist in many different ways. The future capacity does not appear to see any large changes to 2020 given the interview comments provided.

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<sup>z</sup> AAFC Input, WGRF Agronomy Research Capacity, July 16, 2014



## Applied Research Associations, Colleges and Industry

These groups are allied groups to the agronomy research which is carried out by the core public research providers (AAFC, University and Provincial Government). They (producer associations) are located mainly in Alberta and Saskatchewan with a minor presence in northern BC and Manitoba. Some colleges and other industry players are also involved in the testing, evaluation and extension of research results. Some associations are heavily involved in extension and others have a balance of applied research, adaptation trials and extension. Industry (companies) provides services on a defined contract requirement and service delivery basis. These producer directed groups have become an important vehicle for regional approaches and some are proving to be growth oriented in responding to the need for their services in applied agronomy projects.

### BC

#### 1. BC Grain Producers

Overview- BC Grain Producers are located in Dawson Creek. This is the single BC producer research association conducting this type of work with two major field sites in Dawson Creek and Fort St John. They are serving a vital regional need for crop production.

Agronomy Capacity- the organization has 4 FTEs and carries out many crop trials each year. They have a modest operating budget and a set of plot equipment. They have access to 92 acres on a crop rotation basis. The organization is a bit isolated and the BC government has minimal support for the region, which has caused the farmers to provide funds via a levy for their total equipment and research operations. They have been very active in the region since 2000 and have responded to the regional needs well. They are at full capacity now and need time to scale up if more projects are to be done. Equipment is seen to be current but they can use funds to get a second combine. They will need more people and equipment to expand.

Crop or topic Focus- cereals, oilseeds, forages. They are working on sustainable agriculture in northern BC with local research with others.

Collaborations- with producers and AAFC (Lacombe) on data analysis. They have about 18 scientists (plant breeding) involved with them on agronomy work. They collaborate by approaching people and try to get joint funds. They do the field work and data collection and others do the analysis for joint results. Results are in printed form provided at the AGM and also on the website.

See <http://www.bcgrain.com/research.html>

### Alberta

Alberta has a number of research associations (10) and two colleges which are included below to understand the demonstration and applied research within the varied regions of the province.

### Colleges

#### 2. Lakeland College-

Overview- Lakeland College is located in Vermilion and Lloydminster and has some capacity in crop agronomy production and education. The College is currently developing its plans for this area within its programs.

Agronomy Capacity- The College has a land base of 85 acres and some equipment available for crop research projects. It has about 2.4 FTEs in the area (no PhDs) and a small research budget of about \$203,000 for this area. A small supply of farm equipment is at the farm with a plot seeder and potato planter. The College received a \$2.3 m grant from NSERC for agriculture research including \$1m for crop projects. Plans are underway to develop this new research program. Currently the capacity is limited for this area. They need a research scientist and equipment.

Crop or Topic Focus- cereals, oilseeds, forages. They are interested in management intensity return on investment, and Jerusalem Artichoke.

Collaborations- the College collaborates with AITF, other Colleges and industry and producer groups. Results are communicated by the website, field days and annual reports.

See <http://www.lakelandcollege.ca>

### 3. Olds College-

Overview- Olds College is located in Olds and has a satellite campus in Calgary. The College has a strong agriculture production program offerings and some expertise in agronomy work. Olds has about 1,500 FTE students and about 30 agronomy students annually.

Agronomy Capacity- Olds College has several instructors with related experience and about 3.5 FTEs in the crop agronomy area (two PhD, two MSc, and staff). The College has a large land base of about 2,000 acres and plot seeder equipment for research projects in addition to commercial farm equipment. The research effort is estimated at about \$550,000 in this area (external) and the College is highly interested to expand its agronomy research work. Currently the College is seen to be at about capacity for their agronomy staff. Much land is available for projects and they desire to add projects.

Crop or Topic Focus- The College has experience in cereals, oilseeds, forages, horticulture and some new crops. The focus is in training students and supporting industry projects. The College also has a well-regarded School of Innovation with allied research capacity in bio-diesel and bio-products. This area and horticulture are key strengths. Projects include: alternative feedstocks for biodiesel; phytotoxicity trial for industrial by-products, Integrated pest management - focus on horticulture & landscape; extension, water quality and constructed wetlands; remediation, sustainable turfgrass in the Canadian Prairies Project. They have a NSERC grant of \$2.3 million and \$800,000 from CFI.

Collaborations- the College has collaborations with AITF, University of Alberta, other colleges, industry and producer groups. It welcomes collaborative projects and has received funds from NSERC and other funders for project work.

See <http://oldscollege.ca>

## Applied Research Organizations/ Producer Groups

4. ARECA- Agricultural Research and Extension Council of Alberta (ARECA) is a provincial association of non-profit producer groups. ARECA has about 11 members currently as (apparently) two members have recently pulled out. The Alberta Government annually provides about \$1.5 million among these associations (about \$150,000 each) for crop production applied research projects.

ARECA provides a forum for producer research and networks, oversees province-wide initiatives including the Sustainable Regional Variety Trials, Integrated Pest Management and Risk Management Strategies in Wheat and Other Cereals, the GPS Industrial Site Monitoring Project, and the Alberta Forage Industry Network. It also represents about 1,500 producers in the province, with about 50,000 producers receiving information through newsletters and events. The association provides a means to connect industry and government to the producers, and with agricultural researchers.

ARECA does not normally conduct applied research of crop agronomy but does facilitate the topic. The members vary quite a lot in their internal capacity/ assets of land, equipment, science capacity, analytics and applied research efforts. From the review, It appears that several (say 3-4) members have internal capacity in the applied research aspects and the others are more focused on extension, technology transfer and crop trials for regional interests. However, the system offers potential to leverage multi-site projects within an agronomy program if it is designed and managed that way. Comments indicate a need for stronger research design over more crop trials that repeat prior findings. This is commented on later.

See <http://www.areca.ab.ca>

### 5. Farming Smarter

Overview- Farming Smarter is located in Lethbridge and is operated privately and is seeing strong success. It is working with about 150 producers and a number of industry clients. It is derived from prior organizations (SARA). It is striving to *“support profitable, environmentally sound Southern Alberta agriculture by creating innovative opportunities, adapting to merging issues and disseminating unbiased information.”* This is a very interesting and growing association.

Agronomy Capacity- The organization is working actively in applied agronomy research and has about 12.25 FTEs, including a contract PhD (.25), two Masters and technical staff. They annually conduct many projects in the region. They have access to 200 acres currently but can access more land. They have a large amount of research activity. They are at capacity now but the capacity is increasing (last 6 years by 600%). Equipment is current and they have been saving to reinvest in the equipment. They need more people to increase capacity and are seeking world class scientists. This is a well operated group.

Crop or Topic Focus- cereals, oilseeds. They look for new ideas, innovation in crop production, novel crops, cropping systems (s), field scale research and precision agriculture

Collaborations- Farming Smarter works with AAFC, AITF, Provincial Government, industry, producers and other associations and they are quite comfortable with applied research and crop production needs. They are seen to be a very strong applied research model. They work with over 150 organizations. Results are communicated by website, crop walks, field schools, conferences, workshops, trips, videos/ youtube, Facebook, twitter, e-newsletters, a magazine (2x per year) and other extension means.

See <http://www.farmingsmarter.com>

## 6. SARDA

Overview-SARDA (Smoky Applied Research Association) is located in the Peace River Region (Falher) and is actively involved as applied research and extension group. It operates in a very large northern portion of the province. SARDA is not part of ARECA currently. SARDA has developed a strong capacity after it developed a plan for growth and has focused on serving a large region in northern Alberta.

Agronomy Capacity- SARDA has 4 FTEs and access to land in the region for crop projects. It has a reasonable budget and works in locally directed crop projects. SARDA is active in extension and crop demonstration projects. SARDA has developed a strong applied research approach and has been expanding its operations in the recent past.

Crop or Topic Focus- cereals, oilseeds, forages, water

Collaborations- SARDA works with other members, producers, industry, AAFC and the Provincial Government. The approach has helped to develop a source of varied funders.

See <http://sarda.ca>

## 7. West Central Forage Association

Overview- West Central Forage Association is located west of Edmonton and has a focus on livestock needs and forages. WCFA is a non-profit agricultural organization based in Evansburg. Since 1978, WCFA has aimed to serve the needs of forage and livestock producers in the region by demonstrating new agricultural technology and production practices through extension activities, applied research and knowledge sharing

Agronomy Capacity- The organization has 3 FTEs and 16.5 acres for plot trials and some plot equipment. It has a small operating and demonstration budget from a few funders. It has a focus on extension activities.

Crop or Topic Focus – forages, special crops

Collaborations- They have done projects with University, producers, industry and other research associations.

See <http://www.westcentralforage.com>

#### 8. CARA

Overview- CARA (Chinook Applied Research Association) is a producer-directed society dedicated to expanding agricultural research activity in the Special Areas and MD of Acadia. It has operated for over 30 years. The program of applied research, demonstration and extension projects provides a link in the transfer of knowledge and technology between research and the producer. Producers, industry, government and others can access reliable data on crop, livestock, soil and water projects that is relevant to the area and its soil and climatic conditions. CARA is located in Oyen.

Agronomy Capacity- CARA has 1 PhD and 2 other FTE staff for a total of 3 FTEs. CARA has a full line of small plot equipment and the capability to conduct quality applied research and demonstration projects. CARA has a small operating and research budget. It provides a large extension activity for regional producers. They are at capacity now and have functional equipment and need to upgrade it.

Crop or Topic Focus – cereals and forages. They address annual crop trials, agronomics (seeding, herbicide, fungicide), forages and pasture rejuvenation.

Collaborations- CARA collaborates with many regional groups including producers, industry, the Provincial Government, and has a number of funders for these projects. They partner with others such as AAFC, and several companies as well. Results are communicated to producers by reports, newsletters, field days, tours, site tours, seminars and one on one meetings. A website, Facebook and emails are also used.

See <http://chinookappliedresearch.ca>

#### 9. Gateway

Overview- Gateway Research Organization (GRO) is located in Westlock (north of Edmonton). GRO aims to improve yield and efficiency for producers in the areas of forage, livestock, and crops, in an environmentally sustainable, economical manner, while at the same time meeting consumer demands for premium quality product.

Agronomy Capacity- Gateway has a small capacity in this area with 2 FTEs and mainly focuses on crop trials and demonstration plots for producer benefit and education. It has a small operating budget and has completed projects on wheat, peas, forages, disease management and seed placement. Equipment is varied from two to 30 years old and in a state of repair. Have a new seed drill. They are not at capacity now.

Crop or Topic Focus – Cereals, oilseeds, forages.

Collaborations- Gateway collaborates with regional groups, commodity groups and other research associations and the Provincial Government. They communicate by annual reports, producer meetings, newsletters, ARECA website and other meetings.

See <http://www.areca.ab.ca/grohome.html>

## 10. NPARA

Overview- North Peace Applied Research Association is a non-profit, producer driven organization (since 1988), serving agricultural producers of the County of Northern Lights (Manning). NPARA is a research and extension-based society conducting applied agricultural research, demonstration trials, research plots and extension. It serves an area of about 616,000 acres.

Agronomy Capacity- NPARA has 1 MSc and 2 other FTEs for a total of 3 staff. It has access to 140 acres of land for projects and focuses on applied research and extension. They completed crop trials in wheat, barley, oats, canola and tried some soybean trials. They have a modest research and extension operating budget and a full line of equipment for plots. They are at capacity now with somewhat current equipment. More people, equipment, analytics and labs would be needed.

Crop or Topic Focus – cereals, oilseeds, forages. They have work in row crops, forages and specialty crops.

Collaborations- industry, research associations, Provincial Government. Communicate reports to members.

See <http://www.areca.ab.ca/nparahome.html>

## 11. Peace Country Beef & Forage Association

Overview- Peace Country Beef & Forage Association (since 1982) serves livestock producers in the Fairview and Hines Creek area for the purpose of demonstrating new forage varieties and technology.

Agronomy Capacity- Peace has 1 PhD and 2 other staff for 3 FTEs and access to 6 acres for projects. Projects include sainfoin/ alfalfa, corn, soybeans, forages and fertilizer trials in the region. They have modest research capacity and a small operating budget. They are at capacity now. Equipment is current but is very limited. They have 4 pieces- mower, soil sampler, Greenseeker. To expend need more people and equipment and have more projects than staff now.

Crop or Topic Focus – forages. They work in beef, forages, perennials, alternative annuals and whole farm processes (soil quality to forage production)

Collaborations- Peace collaborates with other research associations, Provincial Government, producers and industry. They collaborate with other researchers (phone, email). Results are communicated in an annual report, extension events and on the website.

See <http://peacecountrybeef.ca>

## 12. LARA

Overview- Lakeland Agricultural Research Association (LARA, in Bonnyville) conducts agricultural research and extension programs in order to achieve a profitable and sustainable future for producers.

Agronomy Capacity- LARA has a small staff of 2.5 FTEs and access to 20 acres of land. LARA serves an area of about 24,000 sq. kilometres in north-east Alberta. They have done some work in bale grazing, winter wheat, fenugreek and canola trials and focus on extension.

Crop or Topic Focus – cereals, oilseeds, forages

Collaborations- Provincial Government, industry, producers, other associations

See <http://www.county.stpaul.ab.ca/LARA>

### 13. MARA

Overview- MARA is located the furthest north part of the Province. MARA conducts applied agricultural research, demonstration trials and rural extension in Mackenzie County.

Agronomy Capacity- MARA has taken over the Fort Vermilion research farm and has 2 contract PhD researchers (one non agronomy). Projects include: Regional Cereal, Flax and Field Pea Variety Trials, Prairie Canola Variety Trials, Polish Canola Co-op Trials, Barley Seed Treatment Evaluation, Alberta Pest Survey, Sunflower, Winter Wheat in Rotations, Effect of Seeding & Fertilizer Rates on Canola and Barley Stands, Reducing Wintering Costs for Cattle Producers -- Swath & Bale Grazing, Alfalfa Winter Hardiness, Trial Corn for Silage in Northern Alberta. They have 410 acres, equipment and are re-organizing due to prior staff changes. They will have capacity in the near future.

Crop or Topic Focus – cereals, oilseeds, forages

Collaborations- regional and commodity groups and other researchers

See <http://www.areca.ab.ca/members/marahome.html>

## Private Companies

### 1. Agritrend

Overview- Agritrend is a private company which provides crop consulting, extension and some research projects for farmers. It operates across Western Canada and has a number of agronomy services.

Agronomy Capacity- Agritrend has grown across Western Canada and in Alberta with a large focus on crop production and agronomy. It has about 99 FTEs, including 19 FTEs with PhDs (8) and MScs (11). Several of these professionals have active research programs underway with producers and industry. With USA professionals included, the firm has access to about 29 PhD and MScs, about 3.3 million acres and 100 agri-coaches. The firm

has no dedicated land or equipment for plots and research but can access land from producers they may serve. (Agritrend staff are counted in Alberta regardless of location.)

Agritrend has an interest to enter the applied research market for crops. It has links into the USA and is developing field based tools for crop analysis and databases. They offer services in precision farming, crop planning, agronomy consulting, grain marketing, carbon credits and also in database management of land data. The firm has recognized a need in the sector for more short term producer based research projects and is actively pursuing the developments. The firm sees a need for more collaboration among the R&D community for greater impact and is seeing more farm level research projects emerging.

Crop or Topic Focus- cereals, oilseeds, forages, special crops

Collaborations- industry, producers, Provincial Governments

See <http://www.agritrend.com>

## **Saskatchewan**

Saskatchewan has a number of research associations (8) and one college which are included below to understand the demonstration and applied research within the varied regions of the province.

### **Colleges**

#### **1. Parkland College**

Overview- Parkland College was the first regional college in Saskatchewan. Today, Parkland College is Saskatchewan's primary provider of professional firefighter training, multi-mechanical trades and the most diverse off-campus University offerings. It has a small agriculture training offering. It has 7 locations in east-central Saskatchewan. The College has recognized an opportunity to address applied research in east-central Saskatchewan and is working with the ECRF (see below) to jointly conduct projects and share resources.

Agronomy Capacity- The College has a small effort in the order of 1.3 FTEs and about 104 acres of land, with an interest in developing this area. The College has minimal capacity for agronomy research at this time. They are not at capacity and need new equipment. To add capacity they need equipment, labs, analytics and other items. They are just starting out. Had 5 projects last year and have 14 for this year. They have secured an NSERC grant and are building their research capacity.

Crop or Topic Focus- cereals, oilseeds, forages. They are examining seed opening technologies, variety trials, and demonstration projects with canola, soybeans, forages and cereals.

Collaborators- producers, ECRF and industry. Other Agri-ARM sites and some companies. Information is communicated in the Agri-ARM meeting. A website is being developed.

See <http://www.parklandcollege.sk.ca>



## Applied Research Organizations/ Producer Groups

The province has a total of 8 producer research sites which vary by focus and capacity in the R&D system. The organizations which responded are noted below. The system is similar to the Alberta system with a mix of applied research efforts, extension, technology transfer and collaborations.

### 2. Indian Head Agricultural Research Foundation (Indian Head)

Overview- The Indian Head Agricultural Research Foundation (IHARF) was incorporated in July 1993 and is directed by a nine member Board of Directors. IHARF's mission is to promote profitable and sustainable agriculture by facilitating research and technology transfer activities for the benefits of its members and the agricultural community at large.

Agronomy Capacity- IHARF has two MSc FTEs and conducts research in collaboration with AAFC, industry and producers. It is seen to have a very good applied research program and is limited in capacity due to a lack of resources. (The recent loss of the key co-located AAFC scientist has placed some uncertainty on the position and future plans.) The reputation and results of the organization are quite strong. The IHARF scientist is co-located with the AAFC farm office (part of Swift Current) at the Indian Head site. IHARF has worked extremely well as a research program, seen a high producer buy-in and demonstrated its ability to partner in research. IHARF has some farm land near to the AAFC site (320 acres).

Crop or Topic Focus-cereals, oilseeds, forages

Collaborators- IHARF responds to regional needs but works with AAFC, the University and industry and producers. IHARF was noted as a very good model of collaboration and applied research projects.

See <http://www.iharf.ca>

### 3. Irrigation Crop Diversification Corporation (Outlook)

Overview- The Irrigation Crop Diversification Corporation (ICDC) was established under The Irrigation Act, 1996. Its purpose is to research and demonstrate to producers and irrigation districts profitable agronomic practices for irrigated crops. The Board of Directors includes representatives from irrigation districts across the province. ICDC is an industry partner at the Canada Saskatchewan Irrigation Diversification Centre (CSIDC) in Outlook. Together, the ICDC and the Saskatchewan Irrigation Projects Association (SIPA) host an Annual Irrigation Conference in December.

Agronomy Capacity- This centre is very active in irrigation developments and crop production. ICDC has one MSc FTEs and also a number of staff (6) available from the province and AAFC for agronomy projects. The centre needs more technical staff for projects and has capacity for more work. They have a budget in the order of \$3.2 million.

Crop or Topic Focus- the ICDC has a specific focus on irrigation and works in cereals, oilseeds and forages and special crops. Irrigation production, scheduling, water, use, systems, variety trials, higher value crops, agronomy (fertility, fungicides, insecticides, seed treatments, salinity, production).

Collaborators- the centre collaborates with AAFC and the Provincial Government in addition to producers and industry. It is a full partner with AAFC, Saskatchewan Agriculture, the University and SIPA. Joint projects are conducted with these groups. Other projects are done for fee for service. Communication is by reports, program reports, publications, fact sheets, extension meetings, workshops, conferences and field days.

See [http://www.irrigationsaskatchewan.com/ICDC/icdc\\_index.htm](http://www.irrigationsaskatchewan.com/ICDC/icdc_index.htm)

#### 4. Northeast Agriculture Research Foundation Inc. (NARF- Melfort)

Overview-The Northeast Agriculture Research Foundation (NARF) was formed in 1996 as a farmer-managed and directed vehicle to conduct local applied research and demonstration. Projects have been co-located at the AAFC Melfort Research Farm and the surrounding district. The facility also contributes land and access to equipment, technical support and an administration office.

Agronomy Capacity- NARF has 3.8 FTEs including a 1.3 PhD FTEs. It has more research capacity than similar regional organizations in the province. The site is with AAFC assets but the future is not clear and has been a topic of many interested producers and researchers. It has offered a good farm research site for agronomy projects to date. Future capacity is limited by attracting and retaining qualified staff. They are not at capacity now and have increased their research over the last four years. NARF uses AAFC equipment and does not have equipment. A gap is a research agronomist and also some plot equipment. This site has had staffing issues (retention at AAFC PhD science level) with their prior staff levels having been significantly reduced.

Crop or Topic Focus- cereals, oilseeds, pulse and forages. They look at validating technologies for producers, and so small plots and field scale research.

Collaborators- University, AAFC, industry and producers. They collaborate with AAFC in Melfort, with other Agri-ARMs and with colleges in other provinces. Research results are communicated by field, days, meetings, website, radio, newspaper, workshops, crop diagnostic schools, and other meetings.

#### 5. South East Research Farm (SERF- Redvers)

Overview- The South East Research Farm (SERF) was incorporated as a non-profit producer corporation in 2001 and is located on 160 acres southeast of Redvers. SERF's mission is to provide quality applied research and demonstrations (producer-driven) with results to improve agricultural sustainability and encourage environmental stewardship.

Agronomy Capacity- the farm has a land base and some equipment. The staff totals 1.6 FTEs and are interested in projects. They have a modest budget. They are not at capacity.

The equipment is not current (15 yrs old) and they would need people, labs and equipment. Are getting a new program on data collection. This site has a modest effort in agronomy.

Crop or Topic Focus- cereals, oilseeds, forages. Crop diversification, new crops and sustainability are interests.

Collaborators- producers and researchers. They get protocols and follow them. Results are shared to RMs in the annual report and to commodity groups. They communicate by the website, Facebook, an annual report, and directly to Rural Municipalities.

#### 6. Western Applied Research Corporation (WARC- Scott)

Overview- Western Applied Research Corporation (WARC) is a producer based organization that facilitates applied research and demonstration projects as well as ensures the transfer of technology from research to the farm level. Affiliation with Agriculture and Agri-Food Canada (AAFC) at Scott and Saskatchewan Agriculture at North Battleford provides WARC with some resources to support projects which benefit the producers in northwest Saskatchewan. As is the case with Melfort, Scott has also significantly reduced its AAFC science staff to a minimal level.

Agronomy Capacity- the capacity is very limited at one FTE (MSc) and uncertainty exists at this site also on the future plans and resources. They are at capacity now. Equipment is current and more people and equipment would be needed to add capacity. A constraint will be in retaining and having adequate staff in an uncertain future. AAFC has significantly reduced their staff levels here.

Crop or Topic Focus- WARC indicates no particular focus exists and work examines crop and input management practices which may benefit producers. Cereal, oilseed, pulse and alternative crop agronomy, weed and disease control have been completed.

Collaborators- AAFC, Provincial Government and producers. They work with other Agri-ARM sites and are a sub-site to others. Results are communicated in extension meetings, in the winter, annual field day at Scott, on the website and in newsletters.

#### 7. Wheatland Conservation Area Inc. (Swift Current)

Overview- The Wheatland Conservation Area Inc. was incorporated in 1983. The organization manages an applied research site in the brown soil zone of southwest Saskatchewan (since 1997). This program has been widely accepted by producers, industry, and other funding sources. Success is due to quality research coupled with a business development strategy, and an extension program to producers.

Agronomy Capacity- current capacity is one FTE and projects are carried out for regional producer needs. They have access to 480 acres. They are at full capacity and have current equipment. More people and equipment would be needed for expansion. They have some applied research capacity but less than some of the other groups.

Crop or Topic Focus- cereals, oilseeds, forages. They also look at local applied research and demonstrations of new crop, products and technology.

Collaborators- Producers and industry. They partner in a network with applied research sites, CDC, AAFC and commodity groups. They communicate by website, annual conferences, summer tours and radio.

8. Conservation Learning Centre (Prince Albert)

Overview- The Conservation Learning Centre (CLC) was established in 1993 through the Parkland Agriculture Research Initiative and Green Plan. In 1997, it was incorporated as a non-profit corporation with charitable status. The CLC encompasses 480 acres in the R.M. of Prince Albert. The applied research activities at this site are reported as environmental stewardship, and public and agriculture educational programs. A constraint to this site is the land base and difficulty in doing replicated trials because of the landscape. No response was received from this group. It appears to be inactive in agronomy research but they have had agronomic research at the site.

9. East Central Research Foundation (Canora)

Overview- Agriculture, Development and Diversification Boards 12, 13, 18 and 19 joined to form the East Central Research Foundation (ECRF) in 1996. ECRF is an incorporated organization with the research farm located on 185 acres west of Canora on land leased from the town. The applied research activities at this site include projects on flax and crop residues, as well as manure management and forages. No comments were provided as the Board declined to respond. It does not appear active in agronomy research. Recently the association has been working under the direction of Parkland College with a joint agreement. Under the terms of the 2013 agreement, ECRF would hire a farm technician while the college would employ summer students or work experience students. College instructors will be the scientists involved in the new joint projects to provide more capacity into the region.

## Private Companies

10. Western Ag

Overview- Western Ag group of Companies is a private and growing group that was established in 1994. It is located at Innovation Place Research Park in Saskatoon.

Agronomy Capacity- The company has 9 FTEs including one PhD and 4 MSc FTEs and conducts some applied research projects in addition to general agronomy services. They are at full capacity. The equipment is not current and they would need more people and equipment for more capacity.

Crop or Topic Focus- cereals, oilseeds, forages, special crops. They have a focus on soil fertility and cold tolerance on crops.

Collaborators- they collaborate with industry, producers and some research organizations. They communicate by the website, reports, a network, and in scientific papers.

See <http://www.westernag.ca/agronomy>

## **Manitoba**

Manitoba has four crop diversification centres discussed above and two strong specialized private companies in agronomy research and demonstration.

### **Manitoba Crop Diversification Centres**

Overview – Manitoba Agriculture Food and Rural Development (MAFRD) provides staff and funding support to four crop diversification centres (CDC) to demonstrate the use of new technologies in crop production.

The four CDCs are: Prairies East Sustainable Agriculture Initiative, Arborg (PESAI); Parkland Crop Diversification Foundation, Roblin (PCDF); Westman Agricultural Diversification Organization, Melita (WADO); and Canada-Manitoba Crop Diversification Centre (CMCDC), Carberry, Portage La Prairie, Winkler. Each site is owned/ or operated in a separate entity: PESAI, PCDF, WADO and Winkler by local farmer and industry groups. Carberry is operated by a group of local industries and Portage is operated by the federal government. Carberry and Portage have 128 ha (70 ha irrigated) and 65 ha of land respectively.<sup>aa</sup>

This system is different from the other two provinces in the way it involves local groups with the crop centres. The focus is on extension and adaptation projects.

Agronomy Capacity – The CDCs have a total owned land base of 440 acres. Land at Melita is rented. The CDCs have a total of 14 FTEs including 1 PhD, 3 MScs and 10 others (including seasonal). The budget for the CDC program is in the order of \$1 million annually. The value of equipment is \$750,000. The CDCs mainly do extension and technology transfer activities.

Crop or Topic Focus – The CDCs focus on two areas:

1. Evaluating optimal agronomic practices for adaptation of new/emerging crops (e.g. seeding, fertility, pest control, harvest)
2. Specific agronomic issues/methods for existing crops (e.g. no-till dry bean production; fertilizer rates/placement, etc.)

Collaborators – universities, industry, AAFC, producers.

See <http://www.gov.mb.ca/agriculture/crops/index.html>

### **Private Companies**

1. Ag-Quest Inc.

Overview – Ag-Quest, Inc. began operations in 1983 with the aim of providing top quality, cost effective research to the agricultural industry. Ag-Quest has gained the confidence and respect of national and international clients by focusing on three key areas:

- application of sound scientific principles to field trials,
- application of knowledge and experience in commercial farming to protocol development, and

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<sup>aa</sup> AAFC Input, WGRF Agronomy Research Capacity, July 16, 2014

- maintaining a competent, professional staff.

**Agronomy Capacity** – The company has two locations in Manitoba (Minto and Elm Creek), one in Saskatoon, Saskatchewan and one in Taber, Alberta. Ag-Quest has 480 acres owned or rented and access to a further 5,500 in Manitoba and 80 acres in Taber. The permanent workforce, including management, is 22 FTEs including 3 PhDs, 3 MSc and 16 with degrees/diplomas. Up to 45 staff is hired seasonally. Ag-Quest is at full capacity for 2014 research projects, and is training additional Research Associates to increase capacity for 2015.

AgQuest is upgrading to zero-till equipment (Technotill seeding system), has acquired a precision corn planter, and upgrades other equipment to meet business needs.

**Crop or Topic Focus** – As a contract research organization, the company focusses on residue, efficacy and varietal testing. Ag-Quest would be interested in expanding into agronomic research.

**Collaborators** – As the work it conducts is proprietary, Ag-Quest disseminates information only to its clients. Work is published by clients as they need - work contracted by public bodies may be published and made available by those bodies.

See <http://www.agquest.com>

## 2. ICMS, Inc.

**Overview** – Since establishing in 1985, the ICMS team of professionals and owners has remained focused on fulfilling the need for confidential, quality, independent crop and environmental research services in Canada. With five research stations across Western Canada and the assistance of quality-conscious associates in Eastern Canada, ICMS provides clients with national capabilities.

ICMS research stations are recognized as GLP-compliant facilities by the Standard Council of Canada. Continuous formal training of staff, an in-house quality assurance unit and a full range of standard operating procedures (SOPs) enable ICMS to remain the supplier of choice for clients looking to obtain expert services in environmental fate studies in compliance with OECD Good Laboratory Practices (GLP).

**Agronomy Capacity** – ICMS has a staff of 25 FTEs, including 2 PhDs, 8 MScs and 13 degree/diplomas in management and research. Sites are located at Portage La Prairie, Manitoba; Saskatoon, Saskatchewan; Fort Saskatchewan, Alberta; and Okanagan Falls and Abbotsford, British Columbia. An additional 25 to 30 people are employed as seasonal or term staff. The preference is to offer permanent positions to those who have worked as seasonal research technicians.

Traditionally new recruits have been Canadian farm kids with an agriculture degree; initially MSc grads and then BSAs. Recently, with the heavy demand for agriculture grads, positions have been opened to agriculture diploma, environmental science or general science grads. ICMS also sources a number of permanent staff from the Internationally

Educated Agrologists Post-Baccalaureate Diploma Program (IEAP) and new Canadians, which has both benefits and challenges.

Crop or Topic Focus – As a contract research organization, a large percentage of work that ICMS does is pesticide-related: efficacy and residue testing. Other main areas are plant breeding-related: adaptation trials and disease resistance, plants with novel traits (PNT). A smaller part of its research is in niche or specialty products.

Collaborators – As the work it conducts is proprietary, ICMS, Inc. disseminates information only to its clients. At times, the company undertakes work “swaps” with AAFC or universities if one has a more suitable site or capacity.

ICMS is also known for working with clients to develop unique and forward thinking research. ICMS recently worked closely with a client to develop and conduct one of the first canola pollen and nectar studies in Canada. Many of the major chemical companies are now conducting these studies.

<http://www.icms-inc.com/>

## Discussion

The producer associations have developed to support the need for agronomy work which was not being done by the public sector agencies and specifically in the areas of adaptation, regional trials, extension and evaluation of new products and practices in crop production.

An area of comment is made on how these associations are directed and managed. Most of these organizations are short on funds, can have the farmer board members who are resistant to paying higher salaries and as a result staff retention and attraction can suffer. In a number of interviews, these association jobs were sometimes called “entry jobs” towards another career path (in government, commodity groups or industry).

The applied research associations vary in financial strength and approaches across the provinces. BC has an active producer association and collaborates with AAFC on analytics and field research. The industry of applied research associations has a variety of regional projects, different topics and different levels of funding and leadership. From what was reported in the survey process, the producer associations may have revenues (each) of from \$200,000 to up to \$1 million (for all operational, staffing, equipment and other annual costs). Annual planning is not easy.

Most of these groups are likely \$300,000 or less in annual funds. Funds can be sourced from provincial programs, municipal governments, commodity groups, direct levies and from contracts with private organizations or joint projects.<sup>bb</sup> There is no certainty in these funds. About 8 FTEs (PhD or MSc) exist in Alberta and 5 in Saskatchewan. (Manitoba positions are in the provincial government.)

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<sup>bb</sup> No financial statements were accessed and no audits were performed. However, the data has been validated with several knowledgeable industry sources.

The Alberta association finances were commented on by several managers. The average is about \$300k-350k, of which about 40% is core GOA funds and the balance projects/ events/ etc. For the larger ones, the core funds fall to only say 15% or so as they have much more project funding. For about 10 years the manager pay was about \$12k-15k below a comparable GOA job and \$20k below industry. (This is for managers so many did not stay.)

The typical manager now seems to be a wife of a person with a local (adequate paying) job or a senior person (+60 yrs) who is less financially pressed. The recent GOA funds are meant to fix the salary gap. Saskatchewan associations are said to be worse, with lower core funds (\$75,000). This means the research manager core capacity can be quite limited. Most ARAs do not own their land and thus need to find land for projects, which is a difficulty. Equipment funding is also a big issue, given the high costs. The real challenge indicated was when the GOA and AAFC got out of extension and assumed the ARAs could fill the gap, but did not give support them with adequate funds. Developing a minimum critical base core funding model would help these associations.

Equipment lists were obtained where possible and are reported in the appendix by organization. The equipment will vary quite a bit based on the organization funds, manager, crop topics and ability to pay. Equipment is a constant issue for these groups (and for others). The level of investment in buildings and equipment (per association) is estimated to be \$200,000 to \$750,000, and the age and condition will vary as well. This can be a bottleneck for some research efforts.

A review of the research publications was done to understand the focus and research outputs. The table below indicates a variety of research and technology transfer/ extension efforts. It provides a possible indicator of applied research effort over time in a general sense only. It can also indicate the level and depth of any collaboration with other groups. Most of the work is in crops, crop systems and in weeds and herbicides. The crops focus varies to reflect the local priorities.

Table 6- Summary of Research Report/ Activity (Organization- Listed Reports)

Organization (2011-2014)	Crops	Soils	Crop Systems	Weeds, Herbicide, IPM	Grazing beef	Crop Focus
BC Grain Prod	37-tt			4-tt		w-10, b-1, c-5, f-4, o-5, p-4, other-4
Lakeland College	1-tt		1-tt			other-2
Olds College			3-r	1-r		c-3
U of A	6-r		4-r	7-r		w-1,f-2, p-1, other-3
AITF	7-tt					f-2, c-2, other-2
CARA	10-tt			1-tt		w-2, b-1, c-1, o-1, p-3
NPARA	60-tt					w-6, b-4, c-4, f-1, o-4, other-25
Peace Beef		4-tt			32-tt	b-4, o-2, other-30
SARDA	13-r/tt		6-r/tt	4-tt	4-tt	w-6, c-3, p-4, o-5
Farming Smarter	37-r/tt			5-r/tt		w-2, b-1, c-1, p-11, other-27
ICDC	599-tt (1997-2014)					W, p, other



Wheatland	15-tt			4-tt		w-2, b-1, c-1, p-11, other-27
NARF	75-tt			6-tt		w-9, b-3, c-18, o- 4, p- 3, f-1 other- 20
SERF	29-tt					w-4, b-2, c-3, f-3, other-10
WARC	32-tt			20-tt		w-10. b-2, c-13, p-9, other-6
IHARF	31-tt			2-tt		w-6, f-1, c-5, o-4, other-4

Source: reports reviewed include the ones listed herein, obtained for this project.

Note: 1. w=wheat, f=flax, oat=oat, b=barley, p= peas, beans, c=canola, other= camolina, triticale, Jerusalem artichoke. Coding assessed from titles. No financial costs per report were obtained, unless noted in the organization section. Crop numbers may not equal total projects as some reports do not identify crop focus.

2. r=research- peer science publication, tt=technology transfer/ extension- trial, presentation, pub.

It would be useful to have associations annually classify their projects within a taxonomy that matches up with AAFC and University outputs to ensure stronger cross- links and transfer of ideas. This can help in linking projects to themes and build from the core research findings. It can also help funders in understanding and tracking efforts in both current and emerging priorities.

The colleges included in the review have specific roles in education as a first priority and for some colleges applied research is a newer role. In the agronomy area, Lakeland is developing its approach and has a very minor current research effort. Olds College has a longer history in some agronomy areas with a focus on pests, biofuels and turf grass. It does educate a number of students annually in crop production and agronomy topics. Parkland has a modest effort in agronomy projects. The colleges are interested in a larger role and can offer leveraging of students and other assets under their management. Colleges have about 3 FTE positions in agronomy.

### Global Company Agronomy Interests

We also contacted some of the global companies for information on their agronomy activity and report the aggregated data that is indicative of their interests in the area. Much of this effort is in proprietary product development, seed traits, testing and in registrations. Traits and yield improvements are a key focus and canola, corn and soybean are top interest areas. They also have a strong interest in agronomy and have a number of research / demonstration farms.

These efforts may see some collaboration on specific projects but not in general farm information. All are involved in a variety of research activities in trait and product developments. The industry comments indicated continued public support in agronomy work and other areas for crop production improvements and technology applications are needed.

Table 7- Global Company Agronomy Interests-Canada

Monsanto, Dow, Syngenta, CPS, Agrium, Pioneer	PhDs	MSc	Staff	Total	Research Farms- across W Canada	Acres
Totals	15	17	138	170	7 farms;3 centres;6 sites Breeding centre/ farms; 4 sites	1,420

Source: Survey.

The efforts of the many allied organizations reviewed above shows the breadth of the system which complements the pure/ foundational research areas in agronomy at University and AAFC research stations. This industry group has about 32 PhD and/or MSc positions which are working in the crop production, plant trait and agronomy related areas.

These private organizations also help to provide farmers, industry and service providers with knowledge and practices to address sustained crop production within a varied Western Canada landscape and production systems.

### **Future Capacity and Needs**

The capacity for these college, private sector and producer groups have the potential to be further engaged in research projects. The extent of this added engagement will vary depending on r location, annual plans and the direction provided from the board and management. Some associations are quite strong and outward focused while others some seem to be more locally focused in the research priorities and delivery of projects. Funding for core operations and staffing is a bottleneck for sustainability and for higher retention of staff.

One industry comment relates to the board and management of the producer directed research associations. The survey of the Alberta and Saskatchewan associations indicates several high performing and recognized applied research groups which can be “trusted” to carry out good work on time and correctly.<sup>cc</sup> Another indicator used in the industry is the quality of research work completed. Some associations are only conducting crop trials or demonstrations and some are repeating work that others have already done in a similar region.

One of the benefits of these associations is that they are directed by volunteers who work in a rural community for broad-based regional projects and resulting benefits. In comparison, all others in the system are paid (AAFC, University, provincial government). The regional benefit may be obvious but not recognized - direct farm leadership, higher engagement and higher buy- in potentials. However, for broad-based agronomy research in the west more consideration of multi-site and multi-year projects should also be a goal, but for these groups, planning is really a year by year approach. Overcoming the bottleneck for those multi-year joint projects within this novel network to access their expertise and assets will be a challenge.

Funding and success in these groups often also derives from the leadership of the board of directors and their managers. These were comments offered in the survey process. Relative to capacity for the system for regional work, this factor can limit potential and be a bottleneck. Alberta has recently indicated its core funding will increase to help in internal ARA capacity. In addition a capacity building program with professional assistance will help.

Alberta has recognized the ARAs need to be strengthened in their capacity for higher quality research and internal operations. In the current fiscal year, special grants are being made available for this purpose and in 2015 onwards the AOF funds will be doubled to \$3 million annually. The

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<sup>cc</sup> Trusted is a term one manager used to indicate whether he would collaborate with others.

special grant can be applied to salary, equipment and training materials for the applied research associations. In addition, about \$500,000 is being made available to hire three new people (2015) who can coach, advise and work with these associations to increase their internal capacity.<sup>dd</sup> The positions will be geographic (north, central, south) and help in connecting other researchers with these ARAs who have land and ability to conduct field work for other academic researchers. Higher outcomes will also be expected with these new capacity building approaches.

Overcoming this association issue can entail several additional actions including training and workshops, outside reviews for board strategic plans and advice and identifying best management practices among the industry. It can also lead to a stronger research and operating business plans and challenging the current ways of doing regional association research and extension.

It is very likely more can be done with both producer directed associations and industry. The current cluster model does not really integrate their assets yet it appears (IHARF was the only one involved in Growing Forward I but more are becoming involved in Growing Forward II).

New or additional agronomy networks will help build these possible opportunities in adaptive research projects. Issues of intellectual property, service sharing, roles, revenue sharing, joint investments and other areas will need to be assessed for greater private sector involvement,

Producer association research can be increased with attention to matching requirements with the research interest, people and assets to be involved. This new collaboration approach will also require some industry liaison process to start, build and maintain access to the capacity.

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<sup>dd</sup> Fred Young, AOF and Ag Society Program, AA&RD, personal communication. Funding from the new Alberta Endowment Fund (\$200 m- established in 2014)

## Summary of Western Canada Agronomic Research Capacity

The section below summarizes and discusses the agronomy capacity for the West based on contacts with the organizations and in understanding science, land base, equipment and other comments on the current agronomy research projects. It is noted this information is not audited but has been validated within the industry comments and interviews. Each province is reviewed briefly below to show the variety of public organizations and the total estimated capacity in agronomy.

### Provincial Summaries

#### Alberta and British Columbia

Alberta has a strong agronomy research and extension capacity with a mix of public and private sector providers (which were discussed earlier). Alberta has a highly varied landscape and soil zones with many crop production interests for dryland and irrigated crops. Thus the development of the varied public and private applied research system for addressing crop, livestock and other new uses of crops. Alberta has both research performers and technology transfer/ extension topics within the public and private sectors.

Roles in the Alberta system vary with the knowledge creation and training of new professionals occurring at the University and Colleges. AAFC also is heavily involved in the province at three sites. Technology development and new niche crops (eg. hemp) are being piloted at AITF (Alberta Innovates Technology Futures). Technology transfer and extension is being completed by the provincial department and by applied research farm organizations and the private sector. The provincial government is unique in its strength in applied research, agronomy and crop production. The area of agronomy capacity (issues and priorities) is a current interest for the Alberta sector and a number of workshops have been held in 2014 by ACIDF<sup>ee</sup> (500 farmers) on priority setting and agronomy interests. Others contacted in the review are also interested in this project (eg. AI Biosolutions).

A total of 40 FTE (full time equivalent PhD, MSc) public sector research performers (University, AAFC, provincial government) are found within the total of 134 FTE public research personal (includes research associations). These estimates include the FTEs identified from the survey process. BC has 4 FTEs in northern BC and is included.

From the survey, Alberta has an estimated total investment of about \$19.8 million annually in agronomy related work in all organizations. The research land base in Alberta is about 10,048 acres. Crops under study include: cereals, oilseeds, pulses, forages, special crops, corn and a number of new crops (hemp, Jerusalem artichoke, others). Equipment varies by organization as does buildings, labs and other items.

A summary of all organizations is given below from the data collected.<sup>ff</sup> Alberta may see a reduction of about 7 research professionals (PhD) in the near term. Alberta has a total of 134

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<sup>ee</sup> Alberta Crop Industry Development Fund, Lacombe

<sup>ff</sup> We have tried to be as accurate as possible but note the dynamic nature of the system. Since the study start date, 3 fewer people are in the Western Canada agronomy system.

FTEs in the agronomy research system. The total land base involved in agronomy projects is about 10,000 acres.

Table 8- Alberta and BC Public Agronomy Research Capacity

Organization	Scientists				Agronomy	Land	Current	
	FTE-full time equiv						Graduate	Crop
	PhD	MSc	Staff	Total	Students	acres	Research Focus	Collaborations
<b>Alberta Public Research</b>								
1. U of A	3		2.5	5.5	36	900	1,2,3,4	1,2,3,4,5,6 NSERC
2. AA&RD	10	5	22	37		1,025	1,2,3	1,2,3,4,5,6
3. AITF	4	1	10	15		600	2,4	1,2,3,4,5,6
4. AAFC-Leth	11		9	20	2-students	1,754	1,2,3,4	1,3,4,5,6
5.AAFC-Lacombe	6		4	10		2,886	1,2,3,4	1,2,3,4,5,6
Total Public Research	34	6	47.4	87				
<b>Allied Organizations</b>								
6.Lakeland College		0.4	2	2.4		85	1,2,3,4	NSERC 5,6
7. Olds College	1	2	0.5	3.5	30-students	2000	1,2,3,4	NSERC 1,2,3,5,6
8. ARECA			1	1			1,2,3,4	3,6
9. West C Forage			3	3		16.5	3,4	1,3,4,6
10.CARA	1		2	3			1,4	3,4,5,6
11.Gateway			2	2		6	1,2,3,4	3,5,6
12. NPARA		1	2	3		139	1,2,3,4	1,3,4,5,6
13.Peace Beef/Forage	1	1	1	3		6	1,2,3,4	3,4, 5, 6
14.LARA	1		1.5	2.5		20	1,2,3,4	3,4,5,6
15.MARA	1		1	2		410	2,3	6
16.SARDA	1		3	4			1,2,3,4	3,4,5,6
17.FarmingSmarter	0.25	2	10	12.25		200	1,2,3	3,4,5,6
18. BC Grain Prod			4	4		92	1,2,3	6
Total	40.2	12.4	81.5	134		10,048		

Notes: 1. Research focus- crop type; approach: cereal=1, oilseed= 2, special crop= 3, other = 4

2. Collaboration- with whom/ organizations: University=1, college=2, provincial govt=3, AAFC= 4, industry= 5, producer group= 6

In summary, Alberta has a well- developed agronomy R&D system including performers, technology transfer and teaching organizations. The sector includes:

- University of Alberta and its research plots and farms. It is not as strong in agronomy and has 36 graduate students;
- Colleges- Olds and Lakeland, available land and an interest to do more;
- Agriculture and Rural Development- four main locations, and AITF (Vegreville);
- Agriculture and Agri-Food Canada- two main sites (plus Beaverlodge);

- Applied research associations-10;
- The top producer groups in applied research noted are BC Grain Producers, SARDA, CARA and Farming Smarter due to their interesting approaches;
- Private companies- several exist but are mainly in extension/ crop consulting;
- Total capacity- all crops are served; estimated FTEs total 134. Total agronomy investments annually are about \$20 million (Alberta) with about 10,048 acres of available land.
- BC has a small capacity of 4 FTEs, an annual budget of slightly over \$500,000 and is collaborating with AAFC Lacombe on certain projects.

## Saskatchewan

Saskatchewan has both breadth and depth in agronomy capacity in a number of public and private organizations. It is quite strong in agronomy topics and training and also has a specialized Crop Development Centre which is supported by the province. Saskatchewan has about 66 FTEs in research of which about 25 (PhD/ MSc) people are in the applied research area of agronomy at public organizations (University, AAFC).

The province has an investment in the order of \$13.2 million annually in public agronomy research activities as reviewed herein. They have a land base of about 9,800 acres involved these areas of crops research, adaptation, trials and demonstrations. A total of 12 organizations are involved including the public and private sector.

The main highlights include:

- AAFC with two sites (and three sub-sites) collaborate with producer associations (IHARF, NARF, WARC) but uncertainty exists on the Scott and Melfort sites (farms);
- A number of AAFC retirees are expected in the next three years;
- The producer directed associations are not as well supported or organized as the Alberta system, and have no provincial association like ARECA;
- The top performing associations are seen to be operating well due to co-location, quality of research projects, strong producer support and an interest in collaboration and joint projects;
- Bottlenecks include a number of scientists (AAFC, University), core equipment funds and infrastructure gaps;
- The University is recognized for strength in crop development and agronomy and has 66 graduate students.

A summary of the profile is noted in the table below.

Table 9- Saskatchewan Public Agronomy Research Capacity

<b>Saskatchewan Public Research</b>	PhD	MSc	Staff	Total	Graduate Students	acres	Research Focus	Collaborations
1. U of S	6	1	10.4	17.4	66	2500	1,2,3,4	1,3,4,5,6
2.CDC	2	1.4		3.4			1,2,3,4	1,3,4,5,6
3.AAFC-S Current	6		6	12		3620	1,2,3,4	1,3,4,5

4.AAFC-Sktoon	9		9	18		2470	1,2,3,4	1,3,4,5,6
Total Public Research	23	2.4	25.4	50.8				
<b>Allied Organizations</b>								
5. Parkland College	0.1	0.4	0.8	1.3		104	1,2,3	5,6
6.ICDC		1		1		160	1,2,3	1,3,4,6
7. Wheatland			2	2		480	1,2,3	3,4,5,6
8. NARF Melfort	1.3	0.3	2.3	3.8			1,2,3,4	1,2,3,4,5,6
9.SE Research Farm		0.6	1	1.6		120	1,2,3	
10. WARC Scott		1		1			no focus	6
11.IHARF		2		2		320	1,2,3,4	1,3,4,5,6
12.East Central			1	1				
Total - province	25.3	7.6	34	67		9,774		

Notes: 1. Research focus- crop type; approach: cereal=1, oilseed= 2, special crop= 3, other = 4

2. Collaboration- with whom/ organizations: University=1, college=2, provincial govt=3, AAFC= 4, industry= 5, producer group= 6

## Manitoba

Manitoba has a varied soil, climatic and topographical conditions and is able to produce a wide variety of crops. The province's farmers have been early adapters of non-traditional prairie crops such as corn and soybeans. The table below summarizes the agronomy capacity in the province. It includes AAFC with two sites, a strong University and provincial Crop Diversification Centres.

Table 10 – Summary of Manitoba Public Agronomy Research Capacity

Manitoba Public Research	PhD	MSc	Staff FTEs	Total FTEs	Graduate Students	Acres	Research Focus <sup>1</sup>	Collaboration <sup>2</sup>
1. U of M	6.5	1	13	20.5	65	1,512	1,2,3,4	1,3,4,5,6
2. CDC/ MAFRD	1	3	10	14		440	1,2,3,4	1,3,4,5,6
3. AAFC	7		14	21		3,086	1,2,3,4	1,3,4,5,6
Total Province	14.5	4	37	55.5		5,630		

Notes: 1. Research focus: crop type/approach: cereal =1; oilseed = 2; special crop = 3; other = 4.

2. Collaboration: with whom/ organizations: University = 1; college = 2; provincial govt. = 3; AAFC = 4; industry = 5; producers = 6

Manitoba has breadth and depth of recognized agronomic capacity. Some of the highlights include.

- It has about 18.5 PhD/ MSc FTEs in public sector agronomy research and 55.5 FTEs in total in the province. A total of 65 graduate students are at the University.
- The University is seen to be strong in agronomy disciplines;
- Manitoba is headquarters for two strong contract research firms with locations across the West. They have capacity for agronomic research and some staff work in other provinces.

- Agronomy investments in the public sector noted herein total about \$9.9 million and involves 5,630 acres of land.

### Discussion of the Western Canada System

The data collected has been aggregated for Western Canada and is discussed below. Agronomy research is changing along with the roles and capacity to create knowledge and extend that knowledge. Producer associations and the private sector have moved into extension and public sector agronomy research efforts are also changing. The capacity of the system and current and potential bottlenecks are reviewed below.

### Public Agronomy Research Efforts

Public sector agronomy research providers include provincial departments (Alberta and Manitoba), Universities and Agriculture and Agri-Food Canada (AAFC). A summary of these groups is noted below in the table. Agronomy (for this study) involves a number of crop production and yield enhancement disciplines including soils, crops, physiology, pathology, weeds, entomology for the main field crops. (Crop breeding and genetics were not included).<sup>99</sup>

From the survey of public sector organizations, a total of about 83 PhD/ MSc scientists are involved in agronomy research projects. This total includes: 39 FTE (full-time equivalent) Agriculture and Agri-Food Canada (AAFC) professionals, about 20 FTE University staff and 24 provincial government staff (Alberta and Manitoba) who are involved in peer reviewed research type projects. These total FTEs are complemented by other staff who support these research activities and are estimated at 53 (AAFC-27, University- 26). Therefore in total the public research positions are in the order of 136 people.

Each University has graduate students, totaling 167 students. (Note AITF is included but mainly works on new crop developments like hemp, Jerusalem artichoke and some other niche crop topics. However they do have potential capacity.) It is noted that about 4 to 5 new scientists are needed (University).

Table 11 -Public Sector Agronomy Research FTEs in Western Canada

Region	Province	AAFC	University	Total
BC	0	0	0	0
AB	20	17	3	40
SK	-	15	10	25
MB	4	7	7.5	18
FTE- PhD/MSc	24	39	20	83
Staff	62	42	26	130
Total	86	81	46	213

Source: Survey- PhD and MSc. Others may be involved in agronomy work, part-time.

<sup>99</sup> Per the study scope requirements.



An estimate of the total public agronomy research investment for western Canada is about \$43.4 million (including BC- \$0.5m, Alberta- \$19.7m, Saskatchewan- \$13.2 m and Manitoba- \$10 m). These estimates include AAFC, University, ARAs and colleges that are reviewed herein. Data was gathered from the survey process, public sources and through interviews.<sup>hh</sup> ARAs were reviewed and by far are the smallest organizations involved in this research area.

Colleges, producer directed applied research associations, private companies and agri-businesses also provide related applied research and extension work. Most of this work can be viewed as adaptation and crop yield improvements and often is performed only in a regional context. These people use the knowledge identified and created in the research areas and extend it, trial it and adapt it for producers and industry to use.

### **Allied Private Agronomy Research Efforts**

Several other groups are involved in the generation and use of agronomy topics for use primarily in a more limited manner. The Canola Council of Canada has 8 agronomy professionals in the extension system. Private industry includes Western Ag (9 positions), Agritrend (99 positions), Ag Quest (38) and ICMS (33).

The scope and mission of each of these companies differs from crop advisory/ database/ testing to product and crop testing. Interestingly these organizations are increasing in people and projects over time in response to demand for their services. So in contrast to the public sector research group which is facing an imminent decline with some retirees, this segment is expanding.

### **Agronomy Investment Trends**

The estimated agronomy research effort in the provinces for the public sector organizations included in this review totals about \$43.4 million (annually). These totals reflect the total science effort and investments estimated from the agronomy survey (no audit was done).

The hard funds (known annually) are typically within a University, provincial Government and AAFC organizations as the others need to source funds annually for their work. Some receive funds from farm levies, municipal governments and industry programs/ sources. The split of these funds is about 68% for hard funds and about 32% for project funds. It is noted that AAFC and University contributes to the majority of these costs. Many people commented on the need for more longer term funds in order to carry out longer term research and not only 1 to 2 year projects.

Funding is noted as a current bottleneck for AAFC (see above section), applied research associations and for several University positions. The two main common areas of need seem to be in people (attraction and retention) and in modernizing/ updating equipment to meet current

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<sup>hh</sup> AAFC data indicates staff costs from \$370,000 to \$585,000 per FTE scientist. University research staff can be budgeted at about \$300,000 each for salary, technician, equipment and a small research budget.

research in a commercially oriented user base.<sup>ii</sup> Judging the level of funds at about \$43 million compared with the crop industry outputs is very low, at .3% (of the annual crop receipt average). Typically an industry (or company) will target to invest from 5% or more into innovation and developmental work (clearly depends on the product or technology area).

Workforce is an imminent bottleneck issue given the expected retirements. Another soft indicator is the level of graduate student activity and University scientists, which is said to be lower than required. We were told that all agronomy students are being hired by industry and that all segments face a lack of a trained workforce, with Canadian experience for the very large crop sector.

As shown below, the crop sector is worth over \$15 billion to Western Canada and is a foundation to many allied industries and rural economic impacts. Crops are also one of the biggest exports for Canada. (Note: Alberta BioSolutions is planning for about \$3 million or more annually for sustainable production systems research to 2017).

Table 12- Crop Profile in Western Canada (2013)

Region	Crop Receipts (\$M) Averg 2007-2011	Crop Receipts 2013 (\$M)	Census Farms 2011	Crop Acres-million 2011
BC	\$1,168	\$1,290	19,759	1.5
AB	\$4,316	\$5,849	43,234	24.1
SK	\$6,870	\$8,850	36,952	36.4
MB	\$2,609	\$3,207	15,877	10.7
Totals	\$14,963	\$19,196	115,822	72.7

Source: Farm Cash Receipts, Statistics Canada, 2013 Table B.7 (a)

It is difficult to assess the magnitude of an agronomy investment trend as we have no data to report. In a prior report in 2000 for Alberta the plant products area was reported to be in the order of \$28 million for plant products, with 134 FTEs- performers.<sup>jj</sup> An update in 2008 for Alberta showed about 376 FTEs and \$30 million in plant products.<sup>kk</sup> No data for agronomy capacity are noted (or for other provinces).

Statistics Canada reports agriculture spending by province in the Databook and research and extension is noted in the table below. No agronomy or crop data split is reported. From comments received in the review, agronomy research funding was said to be declining from 2000 to 2014 due to higher priorities seen in genomics and other high value areas.

<sup>ii</sup> Some ways to consider leveraging these mutual research funding needs include: more system coordination, joint projects, shared personal among groups and more specialization (field work vrs, office, labs, analytics, reporting etc).

<sup>jj</sup> Alberta Agriculture & Food R&D and Technology Transfer System, For AARI, Serecon, Toma & Bouma, SJ Campbell, 2001, pg 42

<sup>kk</sup> Agriculture Innovation System Investments in Alberta, Millennium + 8, Serecon, 2008, pg 7

Table 13- Agri- Research Funds by Province (\$000s)

Region	Provincial funds	Federal funds
BC- Research	-\$0	-\$0
- Extension	-\$87	-\$813
Alberta- Research	-\$27,949	-\$26,779
-Extension	-\$31,295	-\$6,235
Saskatchewan- Research	-\$27,848	-\$29,370
-Extension	-\$646	-\$9,289
Manitoba- Research	-\$3,765	-\$20,633
-Extension	-\$376	-\$5,023

Source: Agriculture and Agri-Food Canada, Data Book, 2013, Table C.2.

A number of commodity groups are also highly interested in the agronomy production topics, especially barley, canola, wheat and pulse. Gray states wheat research is in the order of less than .4% of sales, pulse is about 1.2% and canola is about .3% (funds from public and farm levies). It is not clear how much will be going into agronomy research.<sup>11</sup>

### Future Capacity to 2020

Assessing the future capacity level is difficult given the R&D sector (performing) is highly based on the public funding at provincial and federal sources. However, some comments are made. The main capacity issues are.

- Professional capacity to be maintained requires several new research positions (4 to 5) and the related retirees (20 within three years). Performers in the Provincial Government and University systems will likely be at similar levels to 2020 (unless a major policy change or budget event occurs). The core agronomy capacity must be maintained to sustain knowledge creation. In some cases, new positions are also needed, such as in cropping systems, weed sciences and entomology in University positions. Some positions (4 total) are also unfilled. If these staff are not replaced, a very large science constraint will develop;
- Technology and equipment are capacity issues too. Comments were offered on the need to access current equipment and new technologies as commercial farmers are using many tools such as precision farming, automation, GPS, mapping, mobility apps and other innovative means to enhance their yields and farm production. Researchers indicate this is a continued area of catch-up and accessing these tools for current experiments is an issue. AAFC needs in the order of \$4.4 million (next five years) for equipment, and buildings are not included but also need attention. Other organizations also have equipment needs (and this relates to both the board directions and their research plans);
- Current levels of equipment are not well reported in the survey as many organizations declined to respond. However, older equipment was often said to be functional but not always technically current. In addition, equipment was not always standard so for replicated experiments, can be an issue. (The equipment lists obtained for the survey are noted in the

<sup>11</sup> Dr. Richard Gray, Future of Crop Innovation in Canada, 2013

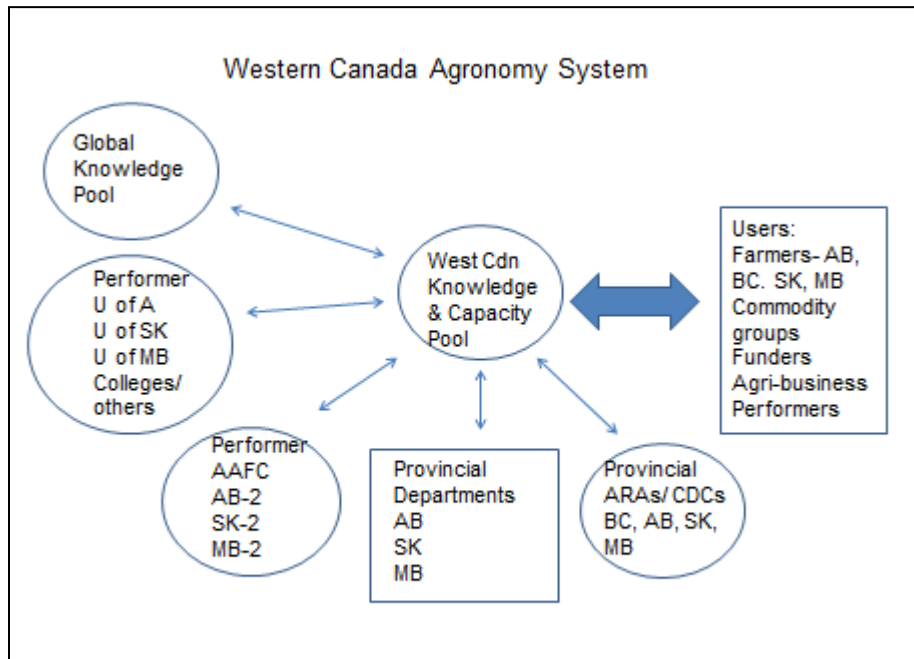
appendix). Improvements can also be made in analytics and data mining/ communications among organizations and in technology transfer/ extension;

- A segment which is expanding is in research projects provided by producer groups and by private companies. While this is useful to a specific target group or region, if the research is not repeatable or well designed, it can have minimal broad-based impact. In addition, the sharing (and collaboration) of these results is low compared with University research. Hence one would expect similar projects to continue (same problem addressed in another region) and in some cases, the wrong advice may even be given (due to a lack of access to broader results). Some producer groups and private businesses are doing extremely well in the applied research areas due to good science practice, collaborations, co-location and resource sharing;
- Private agronomy extension and technology transfer efforts are expanding with the growth of private sector suppliers to supplement provincial efforts. The barriers to entry are low compared with public labs and others in peer reviewed science. The trend appears to be moving quickly to industry (company) extension and technology transfer of information. One of the concerns is the generation of new knowledge for Western Canadian agriculture to maintain competitiveness. This potential gap was noted above;
- Research plans must contain a communication element. Social media and new methods can help communicate and transfer knowledge. Use of good websites, mobile applications, data mining and other analytics can be improved with many organizations. As scientists, producers and industry are actively seeking out more uses via the internet, how can this dynamic and knowledge sharing system be used more effectively by all/ for all?;
- More collaboration is needed to share limited resources including equipment, land and expertise (where it is possible). Capacity is available in some organizations and it is highly likely more benefits can be derived from collaborations and shared projects. Active scientist participation and co-location are valid strategies which are seen to work well in Alberta (eg. FarmingSmarter near AAFC Lethbridge), Saskatchewan (IHARF with AAFC Indian Head), and the University of Saskatchewan and CDC with industry collaborations;
- The successful producer research groups appear to be co-located (eg. IHARF, ICDC) and also have producer group and AAFC scientists with common interests/ goals. Saskatchewan has several example groups that work well. In Alberta, co-location is not common but some good examples also exist. Research managers at these ARAs (applied research associations) are said to be difficult to retain and some people may use it as an entry level job to other jobs. Compensation and other reasons will affect retention;
- Funding seems to have moved away from long term agronomy projects. This is a limiting factor as knowledge generation for climate adaptation and agronomy developments. It is noted that a move to crop clusters (wheat, canola, pulse, barley) with AAFC and University performers mainly involved in the work;

- Roles in the system are defined and highlighted by the capacity of the performer. They can also be changed as a business plan is developed and followed. Implementing standards and common practices (applications, communication, performance measures) can help improve capacity for some groups. In other cases, matching up the strength of one group with another can leverage the resources and overall capacity for more effective roles.

The diagram below summarizes the main players in the current system.

Figure 3- Western Canada Agronomy System



Is there a need to organize/ coordinate the agronomy research approach in Western Canada? Can an umbrella group help to consolidate and administer several funding sources to enable some longer term key research projects and/or Research Chairs? Can it provide a single contact point for researchers to reduce the administrative burden inherent in a fractionated funding system? It may also: evaluate, train, encourage research partners; address land options (eg. pulse growers lease of land to CDC); and help in the impartial dissemination of findings<sup>mmm</sup>.

### Applied Research Performer Capacity Discussion

This review highlighted the public research providers and the allied research and extension performers in Western Canada. There are several centers of research capacity and also regionally focused extension agents. Funds for the applied research organizations are often used for

<sup>mmm</sup> We note that Alberta reorganized its R&D system post the 2001 report to focus on several themes and to develop a funders table to help syndicate proposals with joint interest. Since 2000, many other technology tools for communication have also developed. Much opportunity exists but requires a clear strategy/ plan and consultation to address it for benefit to farmers and the public.

demonstrations and/ or extension activities. Several private companies do have capacity for projects and are at capacity but are also expanding over time.

Trends indicate more private research (short- term) and less public research (long- term). However, the private sector usually has a focus on specific seed traits and products. One can then expect to see subsequent agronomic research (by them) as this is a pillar for yield improvements. Public research had a tendency to work on more foundational agronomic practices. This appears to be at a real risk of decline.

AAFC has had the greatest capacity for long term agronomy research but has been moving to more industry funded projects. As such, this change has also meant a move away from known budgets towards more “soft funds”. Data is not easily obtained but comments and some of the data does support this conclusion. One of the concerns is the potential gap which may occur if the long term agronomy research window is not served by AAFC, as others in the system will not likely do this foundational research. <sup>nm</sup> AAFC will complete a Gap Analysis which can help clarify the issue.

Provincial departments are also involved to a degree and have rebuilt previously lower capacity. University agronomy capacity is strongest in Saskatchewan and Manitoba, it seems. Alberta has the strongest internal provincial government research group and some interesting allied online resources. The Alberta Climate Information System (ACIS) provides local temperature, precipitation, wind, humidity and soil temperature and the province is assisting Manitoba in this area. The province also has some innovative online soil mapping (industry comments).

Producer associations and applied research groups vary in their role and approach in agronomy. Their capacity often reflects regional issues and expectations. Some groups can be improved as noted herein. Nearly all groups are involved in crop projects, and typically in extension (appendix). More can be done with these groups with a coordinated approach to involve joint projects which do not duplicate prior work.

The Western Canada agronomy system has many players in it- performers, funders, users and product and technology developers. Currently the system has several limiting issues:

- Reduced levels of funds- funds have been declining over time, but recently funders have also noted this issue. Long term agronomy research is seen at risk (industry comments);
- To overcome this gap, research Chairs (eg. Agronomy) and a new science network with Teams (as noted herein) and funders’ collaboration in 3 to 4 focus areas can help. The crop clusters may also provide a mechanism;
- It is noted that any new practice or technology needs to “pay to stay” at the farm level. The aspects of farm economics/ impacts/ adoption practices should be included in research work. The emerging areas of climate change adaptation and mitigation should also be addressed. Some research stations are examining these climate aspects (Lethbridge for example) and a software program called Holos is available for farm level modelling on farm practice changes;

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<sup>nm</sup> One researcher (Garven) notes AAFC is “exiting” the breeding space, see Breadbasket ppt, 2013.

- The system across the provinces- coordination, collaboration, co-location- performance in research projects and research results can be better coordinated or matched for leveraging resources and research results to avoid duplication potentials;
- Workforce- as noted above, the demographic issue is facing several organizations, in addition to a potential for several core functions;
- Equipment replacements and technology currency/ adequacy- the “technology treadmill”. Equipment was noted to be of various ages and differing functionality for experiments. Equipment replacement budgets are needed and some organizations are behind in this matter;
- Within a region, access to a core provincial team (can be virtual) of: soil, crop, weed, entomology, physiology and pathology sciences (and economics). It was commented that a core provincial team or network to guide, assist and validate this research can help;
- Among the provinces, the access to a stronger network of both performers and funders. Across the provinces, agreement on shared priorities (as possible) as well as a need for local priorities within common themes of agronomy interests. This shared vision approach can help leverage limited resources for all involved.<sup>oo</sup> Soil zones continue across borders.

We briefly discuss two other national research systems which were identified by some senior professionals during this project. These systems are similarly foundational, national in scope and appear to provide some best practices and lessons learned. They are comparable to the AAFC national system in some ways and can offer ideas for consideration.

### **Max Planck Research System**

Agronomy research needs to include both soil and crop aspects and the other allied sciences to inform the farm sector on competitive and innovative research. Comments were offered that the Canadian system is moving away from this long term research. A comparison was made about the German industrial research system which has foundational research conducted by the Max Planck Foundation and the technology transfer work conducted by the Fraunhofer Institutes. AAFC has been the core provider in this space but is noted as reducing its focus in this area of science.

The Max Planck Institutes conduct basic research in the service of the general public in the natural sciences, life sciences, social sciences, and the humanities. Max Planck Institutes focus on research fields that are particularly innovative, or that are especially demanding in terms of funding or time requirements. Germany's most economically successful research institution is the Fraunhofer Society. Its network of 60 technology centers is co-financed by the government and businesses. (Note: Canada has a system of NRC/ IRAP offices which help in some of these areas.)

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<sup>oo</sup> See Dr. Richard Gray, Future of Crop Innovation, 2013 on crop research high benefits and similar issues. He suggests a 3P model for the broad sector benefits.

Interestingly the Breadbasket report suggested moving to a more innovative agri-food research system as the same research/ innovation gap was recognized. Four core actions are noted: new product developments, research system alignment, more partnerships and collaborations and a new funding mode (P3).<sup>PP</sup> Innovation and many related areas to it have been a concern for many who study the area in Canada.

## **GRDC Lessons**

During the research the GRDC (Grain Research And Development Corporation) was noted by a few people and it is briefly reviewed below as a model for grain industry research.

Australia (AU) has created the GRDC model, which is jointly government and farmer funded. They have a similar set of priorities in capturing international grain markets with competitive production systems. They have geographic farm panels for setting priorities, an internal senior leader group, a board of directors and four internal business groups. This provides a strong capacity for planning and priority setting on a long term view for improvements.

In 2012-13, the GRDC invested \$159 million into: markets- 12%, crop yield- 26%, protecting- 25%, farming systems- 19%, resource base- 8%, skills and capacity- 3%, foundational- 6% and management- 1%. (Note crop yield investments alone were about \$41 million.) The GRDC has approved a capacity building program of \$5.2 million (AU) for 2013-14. It will be used for education, training and other awards.

They have set 6 priority areas for their research:

- Meeting market requirements;
- Improving crop yield;
- Protecting your crop;
- Advancing profitable farming systems;
- Improving your farm resource base;
- Building skills and capacity.

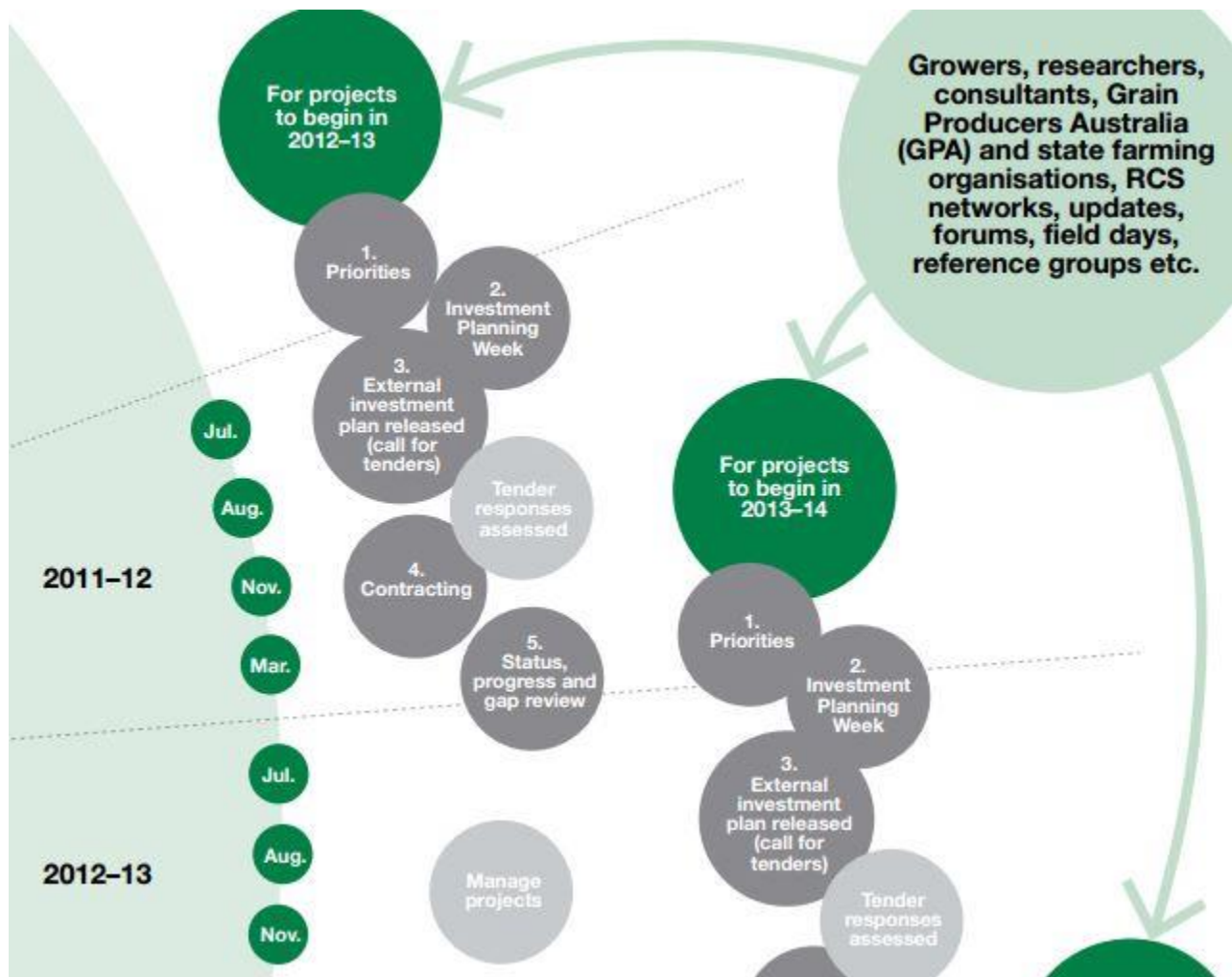
The GRDC offers a national approach with regional priority input and a collaborative investment model. Figure 4 shows the multi-year priority setting process GRDC employs to engage the many stakeholders.

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<sup>PP</sup> Crop Innovation in the Canadian Prairies, Breadbasket 2.0 report, 2013, pg 6



Figure 4- GRDC Priority Setting Process (Source: Annual Report)



Agronomy investments are important as the crop sector produces about 34 million tonnes of grain annually. They have online tools and have developed some apps for farmers to manage their crop, climate and soils data. They conducted 1,153 R&D projects in the last year. The GRDC serves about 22,000 farmers (Western Canada crop farmers are greater in numbers), and serves about \$13 billion in production (Western Canada is larger with \$15 billion and about 116,000 census farms in the west).<sup>99</sup>

These lessons from the GRDC are that a small country can develop a strategic focus with grain industry priorities and address many crop production and marketing issues. Agronomy is part of their mandate area. They offer some competitive ideas for consideration.

<sup>99</sup> If one uses a per capita level, AU farmers are at \$7,227 each annually. (\$159 million for 22,000 farmers.)

## Summary of Possible Actions

The review of agronomy capacity shows current Western Canada capacity is clustered in certain research/ extension performing organizations. In the agronomy space one can see published researchers, provincial researchers, colleges, and producer associations which do research and others who are conducting extension activities.

Several main gaps have been identified from this survey and analysis and can be strengthened. This effort in change management will require both public and private sector review, discussion and actions.

The review of crop agronomy capacity shows four main action areas to address gaps.

**Proposed Action Table**

Capacity Gap	Action Needed	Comment
University- workforce Equipment/ infrastructure	<ul style="list-style-type: none"> <li>• 4 to 5 new scientists to fill gaps</li> <li>• Core funds for equip</li> <li>• Stronger interface with ARAs</li> </ul>	Address Agronomy, Entomology, Weeds scientist gap, 4 potential retirees, 1 unfilled position
AAFC –impending	<ul style="list-style-type: none"> <li>• Clarity from gap analysis on funds, staff needs, sites</li> <li>• Staff and infrastructure plan</li> </ul>	Address imminent –retirees-16, 3 unfilled positions, Sk sites, \$1.4m infrastructure. Will reduce uncertainty and system “stress”.
Applied Research Association	<ul style="list-style-type: none"> <li>• Increase core operating funds</li> <li>• Training on research mngt, best practice, analytics, collaborations</li> <li>• Research &amp; business plans</li> <li>• Develop a new TT network</li> </ul>	Strengthen tech transfer (TT) and extension aspects. Improve quality in applied research. Tie funds more to research outputs. Each strives to have internal MSc staff (or access to.)
Western Canada Agronomy Knowledge/ Integration/ Collaboration	<ul style="list-style-type: none"> <li>• Leadership &amp; agronomy system strategy/ plan with clarity on priorities, roles &amp; funds for enhanced western Canada approach (future state).</li> <li>• 20 retirees imminent (with AAFC) plus 4 unfilled positions will challenge knowledge capacity</li> </ul>	AU system offers a model. Crop clusters do not integrate producer associations. Public system changes (expected) must better inform private sector/ producers. Improve communication.

The actions which can address the key bottlenecks and capacity requirements:

- Workforce-the research indicates 4 to 5 new science positions are needed at a University level. For producer associations the issue of staff attraction and retention means adequate compensation relative to the industry. The analysis indicates about 20 agronomy PhD positions will be vacated in the next three years. Specific gaps will be seen in agronomy, weeds science, entomology and crops among others. These real bottlenecks will appear soon in several organizations. This is a bottleneck to avoid (as the 16 senior level AAFC researchers retire in addition to another 4 University positions), and this reduced research output will be significant;

- AAFC core foundation role- this will become a pressing issue as some positions are vacated and infrastructure deteriorates. A Gap Analysis is to be done to understand the future role. As noted herein, other countries do have a science lead organization to ensure new ideas, innovations and technologies are being studied and developed;
- Equipment and infrastructure- AAFC indicates a need for new investment of about \$1.4 million plus annual upgrades. Producer associations and University comments indicate several specific needs. There is a need to create a replacement fund process for addressing these areas (which are now managed internally on a case by case basis);
- Strategic plans, boards and management practices- some producer directed organizations perform better at certain tasks which relates to their plans and board/ management directions. For system improvement, use of a strategic research plan, board and management training on research management and key performance indicators/ leveraging resources/ best management practices will help. Funders may need to revise their funding upwards along with renewed expectations of outputs. Outside expert assistance may also help;
- Collaborations/ partnerships- collaborations do occur with several producer groups and more can occur. Typically, collaborations require like-minded people to focus on a common task. AAFC and University staff commonly will do this. It appears the crop clusters do not typically involve applied research associations or others in the service delivery. Funders can encourage these approaches to leverage resources. To assist producer associations/ industry, some specific training and awareness will be needed to bring all participants to a common level of expectations;
- Agronomy system coordination/ networks/ focus- duplication of crop trials and some research projects is a symptom of fragmentation and poor awareness and coordination. Creating a network or networks for sharing results of projects can help coordination.

To address the agronomy capacity issue, the Western Grain Research Foundation and others will want to consider these findings. A strategic planning process and plan to address the real imminent gaps and upcoming issues as reviewed herein is needed.

Many people are keenly interested in the agronomy topic and how they can participate. Agronomy research (and extension) are integral to successful crop production and attaining potential crop yields in a competitive world.

## Appendices

Appendix 1- Data From Study

Appendix 2- AAFC Input to WGRF July 2014

Appendix 3- Western Canada Crop Related Research Industry List

## Appendix 1- Data From Study

### Contacts and References

#### Contacts

- BC
  - BC Grain Producers Association- Clair Langlois
- Alberta
  - University of Alberta- Dr. Stephen Strelkov, Dr. Linda Hall, Dr. Miles Dyck
  - University of Calgary- Marcus Samuel
  - Alberta Innovates Technology Futures – Dr. Jan Slaski
  - Alberta Innovates Biosciences- Dr. Stan Blade, Dr. Cornelia Kreplin
  - Olds College – Tanya McDonald
  - Fairview College – Dr. Bruce Rutley
  - Lakeland Colleges – Larry Bingham
  - ARECA – Dr. Ty Faechner
  - Farming Smarter – Ken Coles, Lethbridge
  - Gateway- Michelle Holden
  - CARA- Diana Westerlund
  - LARA-website
  - MARA- Dr. Jim Ludwig
  - SARDA- Vance Yaremko
  - Peace Beef- Morgan Hobin
  - NPARA- Tom Fromme
  - West Central Forages- Carla Amonson
  - Agriculture and Agri-Food Canada –
    - Lacombe- Beaverlodge
    - Lethbridge- Dr. Brian Beres
  - Alberta Agriculture and Rural Development – Len Kryzanowski
    - Lacombe
    - Lethbridge
    - CDC South, Brooks
    - CDC North, Edmonton
- Saskatchewan
  - University of Saskatchewan – Dr. Bruce Coulman, Dept. Head of Plant Sciences, Dr. Rosalind Buchert, Dr. Chris Willenborg, Dr. Jeff Schoneau
  - Crop Development Centre – Dr. Bruce Coulman
  - Irrigation Crop Diversification Corp – Garth Weiterman, Garry Hnatowich
  - Saskatchewan Agriculture- Doug Billet, Regina
  - Agri-ARMs
    - Indian Head Agriculture Research Foundation – Danny Petty
    - Western Applied Research Corp – Laryssa Grenkow
    - Wheatland Conservation (Swift Current) – Brian Naybo
    - Northeast Agriculture Research Farm (Melfort) – Stewart Brandt
    - Southeast Agriculture Research Farm (Redvers) – Lana Shaw

- Canora/ Parkland Regional College- Gwen Machnee
    - Conservation Learning Centre (Prince Albert) – Curtis Braaten
  - AAFC –
    - Saskatoon
    - Swift Current- Henry de Gooijer
    - Melfort
    - Scott
    - Indian Head
- Manitoba
  - University of Manitoba- Dr. Karin Wittenberg, Dr. Don Flaten, Dr. Paul Bullock, Dr. Robert Currie
  - AAFC –
    - Brandon-Dr. Byron Irving
  - Provincial
    - WADO, Melita
    - Parkland Crop Diversification Foundation
    - Manitoba Agriculture and Rural Development, Daryl Domitruk
- Private companies-
  - Agritrend, Rob Saik, Elston Solberg
  - ICMS – Brent Wright
  - AgQuest – Dana Maxwell
  - Agrium– Emile Demilano, Ray Dowbenko
  - Crop Protection Services– Tim Ferguson
  - Dow – Dr. Rory Dagenhardt
  - Pioneer/DuPont- Dave Harwood
  - Syngenta- Randy Retzlaff, Allen Terry
  - Canterra -Erin Armstrong
  - Western Ag –Dr. Eric Bremer
- Others-
  - Dr. Keith Downey, Saskatoon
  - Dr. Wilf Keller, Saskatoon
  - Dr. Bryan Harvey, Saskatoon
  - Alan Hall, ACIDF, Lacombe
  - Ross McKenzie, Lethbridge
  - Ward Toma, Alberta Canola Commission, Edmonton

## References

AAFC, Databook, 2013  
 AAFC, Input to WGRF- Agronomic Capacity, July 16, 2014  
 ARECA Website  
 Agriculture and Agri-food website, reports  
 GRDC Annual Report and Plans  
 Producer Association Websites  
 Statistics Canada website

## **University/ College Key Researchers**

University of Alberta

Dr. Linda Hall- agronomy, weeds

Dr. Lloyd Dosdall- agricultural entomology (Deceased June)

Dr. Miles Dyck- soil physics

Dr. Jocelyn Ozga- plant physiology

Part-Time

Dr. Steve Strelkov- canola plant pathology

Dr. Dean Spaner, crops, agronomy

Dr. Edward Bork- forages

Olds College

Dr. Ken Fry- Integrated Pest Management

Dr. Paul Tiege- analytics, soils, crops, pests

University of Saskatchewan

Dr. Steve Shirtliffe- weed biology

Dr. Chris Wittenborg- weed control

Dr. Bruce Coulman- agronomy/ forage crops

Dr. Rosalind Bueckert- agronomy/ crop physiology

Dr. Fran Walley- soil nutrients

Dr. Diane Knight- soil microbiologist

Dr. Jeff Schoneau- soils/ agronomy

Dr. Doug Waterer- crops

CDC

Dr. Sabine Banniza- pulse crop disease management

Dr. Randy Kutcher- cereal and oilseed disease management

University of Manitoba

Dr. Don Flaten- soil fertility

Dr. Paul Bullock, agrometeorology

Dr. Mario Tenuta, soil ecology

Dr. Martin Entz - agronomy and organic cropping systems

Dr. Yvonne Lawley, agronomy and cropping systems

Dr. Robert Gulden, weed management

Gary Martens, MSc, cropping systems

Contributing researchers

Dr. Alejandro Costamagna, entomology

## **Agronomic Researchers By Organization (PhD)- not all full-time FTEs**

1. AAFC ICM (Source: AAFC, Input to WGRF, July 16, 2014)

Agronomy- crops, soils- 14 scientists (crops- 7, soils- 4, grazing-2, range-1)

Agrometeorology-2

Cropping Systems Microbiology-2

Economist-2  
 Entomology- 7  
 Pathology-8  
 Weeds- 4  
 Related Capacity  
 Environmental Soil Agronomy-2  
 Remote Sensing-1  
 Development/ Technology Transfer- 10  
 To retire next 3 years-16

2. University of Alberta-  
 Agronomy, crops, forages, weeds- 1  
 Entomology- unfilled- 1  
 Plant physiology- .5  
 Plant pathology-.5  
 Soils-1

3. University of Saskatchewan/ CDC  
 Agronomy, crops- 4  
 Plant diseases- 2  
 Soils-3  
 Weeds-1

4. University of Manitoba  
 Agronomy- 2  
 Crops- 1  
 Entomology- .5  
 Soils-3  
 Weeds- 1

Summary of Research Report/ Activity (Survey of Producer Associations) from Listed Reports

Organization (2011-2014)	Crops	Soils	Crop Systems	Weeds, Herbicide, IPM	Grazing beef	Crop Focus
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BC Grain Prod	37- tt			4-tt		w-10, b-1, c-5, f-4, o-5, p-4, other-4
Lakeland College	1-tt		1-tt			other-2
Olds College			3-r	1-r		c-3
U of A	6-r		4-r	7-r		w-1,f-2, p-1, other-3
AITF	7-tt					f-2, c-2, other-2
CARA	10-tt			1-tt		w-2, b-1, c-1, o-1, p-3
NPARA	60-tt					w-6, b-4, c-4, f-1, o-4, other-25
Peace Beef		4-tt			32-tt	b-4, o-2, other-30
Farming Smarter	37-r/tt			5-r/tt		w-2, b-1, c-1, p-11, other-27
ICDC	599-tt (1997-2014)					W, p, other
Wheatland	15-tt			4-tt		w-2, b-1, c-1, p-11, other-27
NARF	75-tt			6-tt		w-9, b-3, c-18, o-4, p- 3, f-1 other-20
SERF	29-tt					w-4, b-2, c-3, f-3, other-10
WARC	32-tt			20-tt		w-10. b-2, c-13, p-9, other-6
IHARF	31-tt			2-tt		w-6, f-1, c-5, o-4, other-4

Source: reports reviewed include the ones listed herein, obtained for this project.

Note: 1. w=wheat, f=flax, oat=oat, b=barley, p= peas, beans, c=canola, other= camolina, triticale, Jerusalem artichoke. Coding assessed from titles. No financial costs per report were obtained, unless noted in the organization section. Crop numbers may not equal total projects as some reports do not identify crop focus.

2. r=research- peer science publication, tt=technology transfer/ extension- trial, presentation, pub.

## Industry comments Offered in the Survey Process

Alberta comments:

- Each research centre needs to have compatible equipment across ecosystems for good practice, a long list of equipment may be needed and rust out of equipment is occurring;
- Two years out, we will have fewer people in agronomy and weed science;
- Systems agronomy is needed and the private sector is not going to do this work. They are concerned with the product performance;
- Research needs to be peer reviewed and transferable. Others in extension projects have the validation parts missing;
- The canola people see a need for it and the cluster has helped in agronomy;
- Farmers on the funding boards often miss having general farmers on the boards as some people are seed growers and thus focus only on breeding needs;
- ARAs conduct more crop trials than research and the system has much turnover of ARA staff. However the provincial system lacks coordination, and collaborations. Many ARAs are not qualified to do research work. Not sure how the ARAs will evolve;
- The training of new people in agronomy is not occurring at the University and it is a shrinking area. Agronomy is not currently a strength. Provincial capacity is okay but all groups do their own thing, with no real program approach;
- 2020 capacity will depend on industry demand as producers and industry still will need the work to be done;
- Other provinces have capacity issues too and we need more doers. University of Saskatchewan and Manitoba are the strongest;
- For funding, canola and pulse producers are funding agronomy and barley growers also provide some funding. The Alberta Wheat Commission has agronomy research projects. AI Biosolutions does not do much here on current products, but has funded a corn breeding program for \$1m. ACIDF is the biggest funder, but needs to more open to projects. The climate change fund is looking to fund biological solutions to emissions (agronomy may fit);
- Research needs to be well funded and much time is wasted on applications. Three of four people get turned down;
- A better way is to have 4 to 6 research sites in the province, and create a strong science team of soils, crop, agronomy, pathology, entomology and weeds. There is duplication and need overarching coordination;
- There are similar problems across Western Canada that need research. Montana has a system of 6 to 7 centres as part of Montana State University to coordinate the work and to get quality extension fact sheets;
- “AAFC is pulling back to a state of no relevance and have no staff left for work”;
- There is a lack of capacity and need to add to it. Need more mapping of yields and fertility and do field level research too;
- Need one person for each crop as a lead- canola, barley, pulse, etc. Alberta Agriculture can lead agronomy more as they have a strong research group. The new Agriculture Endowment Fund (\$200 million) can help. Data mining is a new evolving area;
- Farmer sources of agronomy information are: Alberta Agriculture, Agriculture Canada, and industry. Industry will conduct proprietary work/ local trials, and limits the sharing of knowledge across provinces;
- ARAs- forages are 80% extension and 20% applied research, crops are 50/50;

- Alberta has a unique agronomy research strength through the department;
- “We do not have enough agronomy work compared with the USA or Australian research systems”;
- A new change is in producer based research as some farmers have equipment to do this work. There are no public models for testing products, so some growers do it themselves and pass it through to their own farm networks. But it is not reported or available to others. This is a result of the federal government pull back;
- With AAFC, many senior people are leaving and people are not sure of replacements;
- A coordinating role is needed as many association managers do not know research, and there are also too many groups. Need to coordinate the priorities and reduce the paperwork. Future will have less public and more private research and maybe only 5 to 6 groups (ARAs- applied research associations);
- Two key priorities are yield response and efficiencies as high farm land costs challenge producers. The environmental areas has a focus on sprays and practices (traceability etc);
- Australia is often seen to be the model. Here it is too piecemeal and wasting high quality people’s time on proposals. Also there is too much competition/ low collaboration;
- One concern is the lack of standard procedures and protocols across ARAs. Some ARAs are poor at demonstrations too (industry comment);
- A key issue is how to get field scale land for projects. AAFC assets are in a different federal department. No one is really addressing this issue of maintaining AAFC research station (non- core) satellite sites in the system. Some of the industry themes offered about Alberta included (see appendix for more):
- Agronomy- is important to crop production in view of changing practices and products. Funding is an important aspect to continued agronomy work and processes need to be updated. When funding for weed research and weed ecology diminished with the entry of herbicide tolerant crops, most weed scientists (AAFC and Universities) moved into agronomic work. A good definition for agronomy is needed. The word is so broad that everyone in the field seems to be an agronomist, including breeders;
- Funding agencies need to recognize the difference of research, extension and crop consulting. It would be useful to update funding “envelopes” that separate out these activities and players. The holistic, systems approach to agronomy loses out if it has to compete with extension and consulting;
- Each research centre needs to have compatible equipment across ecosystems for good practice, a long list of equipment may be needed and rust out of equipment is occurring;
- Two years out, we will have fewer people in agronomy and weed science;
- Systems agronomy is needed and the private sector is not going to do this work. They are concerned with the product performance;
- Research needs to be peer reviewed and transferable. Others in extension projects have the validation parts missing;
- Farmers on the funding boards often miss having general farmers on the boards as some people are seed growers and thus focus only on breeding needs;
- ARAs conduct more crop trials than research and the system has much turnover of ARA staff. However the provincial system lacks coordination, and collaborations. Many ARAs are not qualified to do research work. Not sure how the ARAs will evolve;

- The training of new people in agronomy is not occurring at the University and it is a shrinking area. Agronomy is not currently a strength. Provincial capacity is okay but all groups do their own thing, with no real program approach;
- Other provinces have capacity issues too and we need more doers. University of Saskatchewan and Manitoba are the strongest;
- A better way is to have 4 to 6 research sites in the province, and create a strong science team of soils, crop, agronomy, pathology, entomology and weeds. There is duplication and need overarching coordination.

#### Saskatchewan comments:

- ADF funding is highly valuable as they allow new projects; however funds are also limited. Collaborative funding with industry partners is expected and can be a good funding source, but means both extra application and administration time.
- Industry partners cannot always be found (ex. Inoculants are hard to research as company funding decisions are outside Canada, with no local interest).
- Each partner requires reporting, often in different formats and often at different deadlines. May also have different funding periods. (creates administration). Federal funders (and others) often want copy of reports/agreements held with other funding partners.
- NSERC funding can be problematic as crop plot research which is more expensive, is often benchmarked against other lab research in different industries. It is not comparable on benchmarks of cost, number of students trained, etc.
- Canola and other crops appear to require more agronomic research. Producers report lack of research on the combinations of seeding rates, dates and row spacing. Producers need to know to react to changing conditions.
- Industry recognizes a need for agronomy knowledge creation and extension.
- Uncertainty about the future plans for the AAFC research farms and the core capacity which has been developed to date does exist.
- Retirements in several key agronomy positions are expected.
- Most industry research is at a Master's level, but is not sufficiently replicated and often too narrow in focus. A large void also exists in organic crops research. A problem with short term research, regardless of funding source, is that a year can be lost to drought, flooding, etc. The 2001 and 2002 droughts are examples.
- A canola research Chair is likely needed, to allow independent evaluation and results. This is a very large cash crop. Other expertise is also needed.
- More large plot research lands are needed. Arkansas University, for example, has been bequeathed large farms and ranches as the donors received preferential tax treatment. The Pulse Growers own some research lands which are leased to the University for research.

#### Manitoba comments offered:

- There is a definite need for agronomic research and accompanying enhanced funding. Funding is a big challenge because agronomic research is often site specific, so many sites are needed to produce useful data (and more costs are incurred).
- There has been a lack of optimization work in the agronomic area. There needs to be exploration of a variety of approaches to an agronomy problem to arrive at best practices.

- With the introduction of GMO traits, there has been a tendency to rely on traits alone to improve crop productivity, resulting in a belief that agronomic research can be reduced.
- Human resources are and will continue to be a challenge.
  - Agronomic research is not a “9 to 5” job; it’s hard to find people willing to put in the necessary hours in the summer.
  - Where will the future agronomic researchers come from? There is a lack of students pursuing agronomy and many job offers from industry for grads (this means few pursue grad studies).
  - There are fewer people coming out of school who are “integrators” that is, can integrate research with “farm needs”.
  - With more agriculture students coming from non-farm backgrounds, their interests tend to be in pure sciences or environmental issues.
- There is a lot less “blue-skying”, “crystal-balling” or “what if-ing” going on than there used to be – definitely a lot of innovation still going on at the farm level – but a lot less at the public research institutions and manufacturers.
- In terms of management systems, little or no agronomic research work is going on in wheat, oats and barley because an impression exists that it has all been “figured out”.
- Too often limited or localized trials are done and the results are extrapolated to all soil types and conditions. This does not necessarily reflect the actual efficacy of the procedure or product.
- There is a major problem dealing with publicly/ near-public funded projects due to the accompanying large volume of paperwork required. The government tendering and reporting process resulting in its projects costing at least, say 30% more than an equivalent private project. Inexperienced government staff also makes these projects very frustrating.
- Commodity groups have become a key source for priority setting. Government has become increasingly short-term focused, and universities have become increasingly focused on patentable inventions (not supportive of much of the agronomic research priorities).
- Agronomy research and practices need to consider not only how methods affect the farmer but also how the broader community is affected – no offsite deleterious impacts.
- Another big change is the scale of farms – size has dramatically increased. Scale has a huge impact on how things are done. A better job needs to be done in agronomic research related to scale. How should agronomic principles be applied in this new larger production environment? Results from many complex systems research projects have been too difficult for implementation on large farms.
- There is a need to find ways to improve adoption. For example: Precision Ag has lots of technologies but a lack of understanding of how to systematically use it; variable rate nitrogen application has been shown to work but uptake in the community has been slow.
- Many researchers are not good communicators. One who is good at presenting proposals and results can attract interest from funders (especially farmer check-off funds) but may not be the best extension agent.
- It is unclear who has the future mandate to conduct agronomic research. Twenty years ago it was all done by Agriculture and Agri-Food Canada and universities. Now there are disparate players conducting their own efforts in an uncoordinated way and likely duplication exists. With more players entering this agronomy space (provincial wheat and barley Commissions), there will be even more need for coordination and collaboration to avoid overlaps and gaps.

## AAFC's investment\*: Field crop improvement

Crop	No. of Professional FTE <sup>1</sup>	Total Salary Budget (\$M) <sup>2</sup>	Total NPO Budget (\$M) <sup>3</sup>	Total Budget (\$M)
<i>Wheat</i> <sup>4</sup>	35.0	14.9	5.6	20.5
<i>Brassicas</i>	24.8	7.6	5.3	12.9
<i>Pulses</i>	11.8	3.4	2.2	5.6
<i>Soybeans</i>	12.1	3.1	1.4	4.5

\*Based on 2011-12 figures **Pre-Budget 2012**

**Includes:**

<sup>1</sup>Pathology, entomology and quality professionals

<sup>2</sup>20% benefits

<sup>3</sup>15% administrative overhead

<sup>4</sup>WGRF long-term commitment to AAFC wheat research

**Source:** Drs. Stephen Morgan Jones and George Clayton, AAFC and the Future of Cereal Breeding

## Organization Capacity

### 1. BC Grain Producers

The organization has 4 FTEs, a land base of 92 acres and some equipment aged 1998 to 2012; Value- \$55,000. They currently collect data for 22 private and public breeding institutes, two pesticide efficacy companies, plus in-house studies in agronomy (see [www.bcgrain.com](http://www.bcgrain.com) for full listings)

#### Equipment-

- Small-plot Wintersteiger® Elite combine
- Small-plot Fabro® no-till planter
- (no-till modifications 2004, RCBD fertilizer cone 2001)
- CO2 pressurized 4-nozzle hand-boom sprayer
- 3-pt hitch modified field sprayer (blanket sprays)
- envir. controlled germinator
- one 40 & one 50 hpr tractor
- heavy harrow (10 ft)
- Hegge top-dress research fertilizer unit
- 3 electronic scales (2 @ +/- .005 g, 1 @ +/- .05 g)
- 2 electronic "live" weather stations using WeatherFarm
- (one at Fort St. John site, one at Dawson Creek site)
- various lab equipment for TKW & HLW analysis

#### Projects- Most in support role

2013

- Regional Performance, Alex Fedko - AAFRD-CDC North, Edmonton
- Collaborative Lentil Trial (AB/BC Peace Initiative), SARDA, MARA, BRRG, BCGPA collaboration
- Western 2-Row Barley, Dr. Aaron Beattie
- Western 6-Row Barley, Dr. Ana Badea - Ag Canada - Brandon
- B-Y5 Barley Co-op, Pat Juskiw/J. Nyachiro - AAF CDC Lacombe
- Viterra - 2-Row Barley Marketing, Jim Anderson - CPS, Calgary
- Dry Bean Variety Adaptation Trial, Dr. Parthiba Balasubramanian - AAFC Lethbridge
- Ag Canada - Camelina & Multi-Species, Dr. Christina Eynck, AAFC-Saskatoon
- CPS Napus Herbicide Systems, Tim Ferguson / Daryl Rex - CPS, Saskatoon
- DL-Seed Napus Trials, Dr. Kevin McCallum - DL Seeds, MB
- PIONEER - Napus - early season trial, Jason Nordstrom, Pioneer Hi-Bred, Edmonton
- Syngenta-Peace-Learning Center - Napus Demos, Justin Bouvier - Syngenta Canada Inc.
- WCC/RRC Napus Co-ops, Raymond Gadoua - Canola Council
- Northern Flax Co-op, Michelle Beath, CPS, Saskatoon, SK
- Northern Flax CFET, Dr. Scott Duguid - MRC Morden
- Flax Northern Prelim, Dr. Scott Duguid - MRC Morden
- Flax - NorFlax-Project, Michelle Beath, CPS, Saskatoon, SK
- Oat Private Co-op, Dr. Jennifer Mitchell-Fetch - AAFC Winnipeg

- Oat Co-op (BOAT), Dr. Jennifer Mitchell-Fetch - AAFC Winnipeg
- Western Oat Co-op (WCORT), Dr. Jennifer Mitchell-Fetch - AAFC Winnipeg
- Oat Organic Co-op (BORG) - hand weeded, Dr. Jennifer Mitchell-Fetch - AAFC Winnipeg
- "Peace Field Pea Project" private pre-coops, Dr. Dengjin Bing - AAFC Lacombe
- Field Pea - Short-Season - Co-op "C", Don Beauchesne - AAFC Lacombe
- T-Y3A Triticale Grain Pre-Co-op, Dr. Mazen Aljarrah - AAFC Lacombe
- T-Y3B Triticale Grain Pre-Co-op, Dr. Mazen Aljarrah - AAFC Lacombe
- Triticale Registration Co-op Test, Dr. Harpinder Randhawa - AAFC - Lethbridge
- CPS® - CPS Wheat Performance Trial, Jim Anderson - CPS, Calgary
- CPS® - CWRS Wheat Performance Trial, Jim Anderson - CPS, Calgary
- Early Wheat Parkland Private A-level Co-ops, Dr. Gavin Humphreys - AAFC Winnipeg
- Early Wheat Private Pre-A Co-ops, Dr. Gavin Humphreys - AAFC Winnipeg
- Parkland 'C' Wheat Co-op, Alanna Olson - AAFC Beaverlodge
- Syngenta-Peace-Learning Center - Wheat Demos, Justin Bouvier - Syngenta Canada Inc.
- Early Wheat U of A Program Private Co-ops, Dr. Dean Spaner - U of A, Edmonton, AB Agronomy
- Bayer - Flea Beetle Control - Seed-Trt Studies, Scott Henry - Bayer CropScience, Calgary
- BASF - Flea Beetle Study - Seed Trt Studies, Ryan Nielson - BASF, Edmonton
- Cereal Rust Plots (individual plots), Tom Fetch - AAFC Winnipeg
- Spring Wheat Seeding Rate Study, BCGPA (Dr. O'Donovan input-AAFC Lacombe) 2011
- IPNI - Avail® in-furrow Fertilizer Trial, Tom Jensen - IPNI, Saskatoon, SK
- IPNI - Nutrisphere® deep-band Fert Trial, Tom Jensen - IPNI, Saskatoon, SK
- Oat - Advantage® - Private Co-op B-level, Jim Dyck- Advantage Seeds
- Hard White Spring Wheat Co-op, Dr. Ron DePauw - AAFC Swift Current

## 2. Lakeland College

Lakeland College has 2.4 FTE, a land base of 85 acres and some equipment- few pieces value \$16,000. Equipment includes: plot seeders, potato planters and harvesters.

Projects- The College is usually in a lead role in research and is developing its capacity.

- Management Intensity ROI : 5 year study assessing agronomics of input intensity including input stacking using canola/cereals/peas rotation

- Jerusalem artichoke 5 year study: agronomy and commercial growing practices

## 3. Olds College

Olds College has 1 FTE- and have 2.5 FTE professionals available on a part-time basis. The land base is 2000 acres, has some equipment- plot equipment and all field equipment. It can operate in both lead and support roles, and has capacity to do more work. About 10 students are involved annually in projects.

Staffing-



- Tanya McDonald, Associate Vice President Research, Biodiesel, Water quality, Agri-food, Manages \$1.1M external funding for research, approx. 50% may be related to agronomy
- Dr. Paul Tiede, Biodiesel, alternative feedstock trials, controlled pesticide trials (greenhouse, environ), phytotoxicity trials for industrial by-products, plant health sector greenhouse and field plot trials. Analytical capability: soil and plant tissue analysis, pesticide and residue (LC, GC), metals (ICP, CE). Research trials and demonstrations for new varieties, pesticide efficacy, fertilizers or plant health products, soil remediation strategies or new product validations.
- Dr. Ken Fry, Faculty Biological Control, Integrated Pest Management, Pest Diagnostics
- Dr. Dickson Atuke, Water quality, Constructed Wetlands, Remediation
- Jim Ross, Prairie Turfgrass Research
- Darrell Tompkins, Faculty, Plant ecology, plant physiology, agronomy, plant pathology

#### Projects-

- \$2.3 million NSERC Innovation Enhancement Grant Biodiesel Production, Alternative Feedstocks, and Commercial Adoption
- \$50,000- Industry sponsored Greenhouse, plot trials
- \$10,000 Dutch Elm Disease Alien Invasive Species Surveillance, Elm Bark Beetle Monitoring,
- \$3,000 Biological Control of Lily Beetle,
- \$2.3 million NSERC Innovation Enhancement Grant Sustainable Turfgrass Management,
- \$543,000 ACIDF Adoption of Integrated Pest Management in commercial greenhouses,
- \$360,000 ACIDF Improved Pest Surveillance and Pest Management for Fruit and Vegetable Crops in Alberta
- 799,000 Canadian Foundation for Innovation- Real Time Monitoring System for Water Quality
- \$19,800 Topsoil Construction

#### Equipment- Olds College Seeding/Spraying Equipment List

- 2014 Morris Contour 2 Air Drill, 51' Drill, 2" Row Spacing with 4" Paired Row Opener, Double Shoot, Triple Compartment Tank, Variable Rate Capability, No-Till Drill
- Fabro Cone Plot Seeder – Approx. 20-25 Years Old, 1m Drill, Six openers – Disc or Hoe Adjustable Row Spacing, Single Product
- Plot Sprayer, 20' 3pt Hitch Sprayer, 100 gallon Tank
- Conserva Pac Plot Drill – Approx. 25-30 Years Old, 12' Drill, 12" Row Spacing Side Band Twin Shank Opener, Double Shoot, Four Seed/Fertilizer Compartments, No-Till Drill
- Blumhardt Field Sprayer – Approx 20 Years Old, 60' 3pt Hitch Sprayer, 300 gallon Tank Air Induction Nozzles

#### Publications Specific to Agronomy (2011; 2012; 2013)

- Blackshaw, R. E., E. N. Johnson, Y. Gan, W. E. May, D. W. McAndrew, V. Barthelet, **T. McDonald**, and D. Wispinski. **2011**. Alternative oilseed crops for biodiesel feedstock on the Canadian Prairies, *Canadian Journal of Plant Science*, 91:889-896.
- Harker, K.N., J.T. O'Donovan, R.E. Blackshaw, L.M. Hall, C.J. Willenborg, H.R. Kutcher, Y. Gan, G.P. Lafond, W.E. May, C.A Grant, V. Barthelet, **T. McDonald**, D. Wispinski and M.

Hartman. **2013**. Effect of agronomic inputs and crop rotation on biodiesel quality and fatty acid profiles of direct-seeded canola. *Canadian Journal of Plant Science*, 93:577-588.

- **Miluch, C.**, L. Dossdall and M. Evenden. **2013**. The potential for pheromone-based monitoring to predict larval populations of diamondback moth, *Plutella xylostella* (L.), in canola (*Brassica napus* L.). *Crop Protection*, 45 (2013) 89-97.
- Steppuhn, H., **T. McDonald**, R. Dunn, M.A. Stumborg. **2010**. Biodiesel fuel quality of canola feedstock grown on saline land. *Biological Engineering*. 2(3):165-179.

#### 4. University of Alberta

The University of Alberta has an estimated 3 FTEs, a number of part-time scientists involved (9) and 900 acres in agronomy. No equipment list was submitted. Most projects are in a lead role.

##### Publications-

Dr. Linda Hall- Publications Specific to Agronomy (2011; 2012; 2013)

- Ward, S.M., R.D. Cousens, M.V. Bagavathiannan, J.N. Barney, H.J. Beckie, R. Busi, A.S. Davis, J.S. Dukes, F. Forcella, R.P. Freckleton, E.R. Gallandt, L.M. Hall, M. Jasieniuk, A. Lawton-Rauh, E.A. Lehnhoff, M. Liebman, B.D. Maxwell, M.B. Mesgaran, J.V. Murray, P. Neve, M.A. Nuñez, A. Pauchard, S.A. Queenborough, and B.L. Webber. Agricultural weed research: A critique and two proposals. *Weed Science* (submitted).
- Lupwayi, N.Z., K.N. Harker, J.T. O'Donovan, T.K. Turkington, R.E. Blackshaw, L.M. Hall, C.J. Willenborg, Y. Gan, G.P. Lafond, W.E. May and C.A Grant. Relating soil microbial characteristics to yields of no-till canola on the Canadian prairies. *Canadian Journal of Plant Science* (submitted).
- Mallory-Smith, C., L.M. Hall and N. Burgos. 2014. Research methods in weed science: Experimental methods to study gene flow. *Weed Science* (accepted).
- Walsh, K.D., D. Sanderson, L.M. Hall, S. Mugo and M.J. Hills. 2014. Allelopathic effects of camelina and canola on wild oat, flax and radish. *Allelopathy Journal* 33 (1): 83-96.
- Raatz, L.L., R.-C. Yang, F. Eudes, and L.M. Hall. Simulated GM triticale: Adventitious presence from volunteers in four cropping systems. *Crop Science* (accepted).
- Tidemann, B.D., L.M. Hall, E.N. Johnson, H.J. Beckie, K.L. Sapsford, and L.L. Raatz. 2014. Efficacy of fall- and spring-applied pyroxasulfone for herbicide-resistant weeds in field pea. *Weed Technology* (accepted).
- Beckie, H.J., A. Francis, and L.M. Hall. 2012. The biology of Canadian weeds. 27. *Avena fatua* L. (updated). *Canadian Journal of Plant Science* 92: 1329-1357.
- Raatz, L.L., R.-C. Yang, B. Beres and L.M. Hall. 2012. Persistence of triticale (*xTriticosecale* Wittmack) seed in the soil seed bank. *Crop Science*. 52:1868–1880.
- Hall, L.M., S.J. Smyth, and H.J. Beckie. 2011. Environmental impacts of herbicide-resistant crops in Canada (Changing pesticide use and risk scenarios with the introduction of GMO crops, 2) Environmental Fate and Safety Assessment). *Journal of Pesticide Science* 36 (1), 172.

- Kavanagh, V.B., M.J. Hills, F. Eudes, A.K. Topinka, R.-C. Yang and L.M. Hall. 2011. Pollen-mediated gene flow in triticale (*xTriticosecale* Wittmack). *Crop Sci.* doi: 10.2135/cropsci2011.08.0457; 2012. Volume 52, Number 5.
- Jhala, A.J., H. Bhatt, A.K. Topinka and L.M. Hall. 2011. Pollen mediated gene flow in flax: Can genetically engineered and organic flax co-exist? *Heredity*: 106: 557-566.
- Dexter, J.E., A.J. Jhala, R-C. Yang, M.J. Hills, R.J. Weselake and L.M. Hall. 2011. Harvest loss and seed bank longevity of flax (*Linum usitatissimum* L.): Implications for seed-mediated gene flow. *Weed Sci.* 59: 61-67.
- Raatz, L., M. Hills, R. McKenzie, R.-C. Yang, K. Topinka and L. Hall. 2011. Tolerance of spring triticale (*X Triticosecale* Wittmack) to four wheat herbicides. *Weed Tech.* 25: 84–89.
- Beckie, H.J., S.B. Dilk, R.M. Cole, K.N. Harker, L.M. Hall, F.A. Holm, R.H. Gulden, B.G. Murray and D.J. Kelner. 2011. Risk assessment of glyphosate resistance in Western Canada. *Weed Tech.* 25: 159–164.
- Beckie, H.J., S.I. Warwick, C.A. Sauder, L.M. Hall, K.N. Harker and C. Lozinski. 2011. Pollen-mediated gene flow in commercial fields of spring wheat in Western Canada. *Crop Sci.* 51(1): 306-313.

Dr. M. Dyck Agronomy Publications (2011 – present)

- Shahidi, B. M. R., M. Dyck and . S. S. Malhi. 2014. Short-term effects of tillage of long-term no-till on carbon dioxide emissions from two contrasting Canadian prairie soils. Submitted to *Soil and Tillage Research*.
- Giweta, M., M. F. Dyck, S. S. Malhi and D. Puurveen. 2013. Long-term S-fertilization increases carbon sequestration in a sulfur-deficient soil. *Canadian Journal of Soil Science*. In Press.

## 5. AAFC- Lacombe

Lacombe has a strong team in agronomy, totalling 6 PhD FTEs. The key scientists include: Integrated Crop Management & Agronomy – Dr. John O'Donovan; Weeds – Dr. Neil Harker; Pathology – Dr. Kelly Turkington; Forages – Dr. Vern Baron. The station has 2,886 acres for related crop research. Most cereal and oilseed research programs are long-term and are well established. In addition, other research areas include integrated crop management, weeds, pathology, forages and peas. They have both lead and support roles.

Equipment-

- JD 6620 Combine (Early 1980's), 2005
- Kincaid 8XP plot combine, 2012
- JD 5425 Tractor, 2008
- JD 6430, 2011
- JD 6125R, 2013
- Shulte Mower FX210, 2009
- Kubota 3080 Mower, 2011
- JD Gator XUV 4x4, 2010
- Can -Am Quad, 2011

- Soil Sampler #15 series, 2012
- Hardi Sprayer N-105, 2008
- Spray cabinet, 2002
- Applicator Dribbler, 2010
- 9" CPAK, 1995 UPGRADE 2010
- 12" CPAK, 1996 UPGRADE 2010
- RETSCH Soil grinder, 2011
- Wiley Mill, 2011
- Udy Cyclone, 2008
- Clipper, 2010
- Blower, 2009
- International 4000 Swather, 2011(Used)
- Gas air compressor, 2002

Projects include:

- Barley agronomy, some with wheat
- Weed sciences- canola, barley, wheat
- Pathology- barley.

Publications in agronomy are extensive. See the AAFC Input to WGRF Paper.

## **6. AAFC Lethbridge**

This centre has a strong research team and capacity for agronomic projects with 11 PhD FTEs. The centre has about 1,754 acres available and conducts work with many organizations. No equipment list was obtained.

Publications in agronomy are extensive. See the AAFC Input to WGRF Paper.

## **7. AA&RD Alberta Agriculture and Rural Development**

The Agriculture Department has about 37 FTEs in the agronomy area and a land base of about 1,025 acres for crop research. They have lead and support roles. Key scientists include: Donald Pauly, Dr. Kweis Ampong Kyarko, Dr. Manjurla Bandara, Mark Olson, Murray Hartman, Dr. Sheri Stryhorst in the Food & Bio-industrial Crops Branch. The Pest Surveillance Branch includes Chris Neeser, Dr. Shea-Fang Hwang, Dr. Jie Feng, Dr. Kan-Fa Chang, Dr. Michael Harding, Dr. Jim Broatch and Dr. Shelly Hoover. The Field Crops Branch has several researchers also. No equipment or publications were provided.

Agronomy work includes:

- Agronomy research in fertility, nutrients, fertilizers
- Special crops- Rhodiola, greenhouse
- Soybeans, drybeans, pulses
- Project wheat 150
- Entomology and plant pathology aspects.

## **8. AITF- Alberta Innovates Technology Futures**

AITF (Alberta Innovates Technology Futures) has the crop agronomy expertise in Vegreville and Edmonton. They have lead and support roles.

Equipment includes:

- POTATO DIGGER - MODEL SP100
- 2+ ROW VIBRO CULTIVATOR - MODE
- 3 ROW POTATO PLANTER - MODEL F3
- HEADROW PLOT SEEDER
- AIR SEEDER
- 4WD TRACTOR
- "8" X 51' GRAIN AUGER"
- GRAIN BIN
- 48 X 9 1/2 X 8 1/2 SEACAN
- 2800 BUSHEL GRAIN BIN
- ROTARY RAKE
- GPS MAPPING SYSTEM
- 1986 VERSATILE 4700 SWATHER
- BRILLION PULV-MULCHER
- GRAIN BOX ON FARM TRUCK
- IRRIGATION PIPING & PUMP
- SINGLE PLANT BELT THRESHER
- FRACTIONATING ASPIRATOR TESTER
- FIELD COMBINE
- SEA CAN STORAGE UNITS
- SEED DRILL SELF PROPELLED MDL
- HYDRAULIC SOIL AND CORING MACHINE
- SELF PROPELLED PRECISION PLOT
- FORD TRUCK MODEL F600
- TRAILER
- TRACTOR FORD FWA
- BOBCAT
- MODEL 737 SELF-PROPELLED PLOT
- MODEL CLARK 843 BOBCAT
- TRACTOR MASEY-FERGUSON 230
- MASSY FERGUSON 265 TRACTOR
- PLOT COMBINE ALMACO MODEL 1989
- FORAGE PLOT HARVESTER MDL SMW
- ZERO TILL SEEDER
- THRESHER PLOT MODEL LPT-MRB-E
- NURSERYMASTER ELITE PLOT COMBI
- KUBOTA TRACTOR BX 2350
- SHED 48FT X 100FT X 16FT

- MULTI-BOOM PESTICIDE SPRAYER
- SPRAY CHAMBER CUSTOM BUILT

Projects they have worked in include:

- Flax agronomy
- Hemp agronomy and production (industrial crop)
- Jerusalem artichoke
- Drought and cold resistance in canola and cereals
- Resistance to blackleg in canola (several projects)
- Production of disease inocula for breeding and agronomy research
- Crop diagnostics.

### **9. ARECA Capacity Survey- 2013**

ARECA completed an internal survey of members which can offer some insight to the overall capacity. However, not all members are at the same level of capacity or crop interests. The information helps to supplement the other information collected in this review. The survey indicated the members have access to people, land base of 1,263 acres and equipment.

Equipment Listed

- Peace Beef-half ton truck, flat deck, sickle mower, soil , hay forage test equipment
- SARDA- two tractors, four trucks -half to one ton, Fabro small plot cone seeder, Conservapak seeder, flat deck, fifth wheel, cargo, forage harvester, weigh wagon, crop bundler, flail mower, lawn mower, soil, moisture, pH, compaction test equipment
- Gateway- soil , forage/ hay test equipment
- BRRG- two tractors, four trucks, Fabro small plot seeder, retro fitted to no till and air, flat deck, fifth wheel, forage harvester, Winterstieger combine, sickle mower, flail mower, soil, hay/forage, compaction test equipment
- CARA- three tractors, five trucks, Henderson direct seeder, lawn tractor, Fabro double disk, flat deck, 2 fifth wheel, cargo, livestock, forage harvester, weigh wagon, crop bundler, thresher, Winterstieger combine, sickle mower, flail mower, lawn mower, soil, hay/forage, salinity test equipment
- NPARA- one tractor, two trucks, seed hawk, Fabro small plot, flat deck, weigh wagon, Winterstieger combine, sickle mower, flail mower, lawn mower, soil, hay/forage, moisture, compaction test equipment
- MARA- two tractors, two trucks and two quads, local seed drill, Conservapak, flat deck, weigh wagon, lawn mower, flail mower
- West Central Forages- one tractor, two trucks, one quad, Fabro plot seeder, two car haulers, forage harvester, sickle mower, lawn mower, soil, hay/forage, moisture, compaction test equipment
- Farming Smarter- two tractors, two trucks, custom small plot, one flat deck, Hege combine, sickle mower, flail mower, lawn mower, soil moisture test equipment
- LARA- three tractors, four trucks, Fabro small plot, Conservapak, two flat decks, forage harvester, thresher, Winterstieger combine, lawn mower, soil, hay/forage test equipment
- GRO- three tractors, one truck, cone small plot seeder, Fabro small plot, one fifth wheel,

forage harvester, Winterstieger combine, lawn mower

Budgets for ARECA members are noted as from (%):

- Alberta Opportunity Fund- 42%
- Provincial grants- 19%
- Local municipality- 14%
- Industry- 16%
- Federal grants- 3.3%
- Other-3.8%
- Memberships- balance- 2%.

## **10. West Central Forages**

West Central Forages has 3 FTEs, 16 acres of land base and some equipment- tractor, plot seeder, quads. No publications were noted.

## **11. CARA**

Chinook Applied Research Association has 3 FTEs and no other equipment or land information was provided. It offers a lead and support role.

Projects (on the website)-

- Wheat and Durum Variety Trial
- Triticale Variety Trial
- Barley Variety Trial
- Oat Variety Trial
- Winter Wheat Variety Trial
- Field Pea Variety Trial
- Lentil Variety Demonstration and Crop Walk
- Weed Management Options in Lentils
- Canola Demonstrations and Crop Walks
- Broadcast Urea Fertilizer Compared to Side-Banded Urea at Planting – Custom Project Work
- Viterra Variety Performance Trials

## **12. Gateway**

Gateway has 2 FTES and has 6 acres of land for research in the next 5 years. Equipment is anywhere from 2 years old (seed drill) to 30 + years old (forage harvester) and everything in between – everything is in a state of repair currently and we are spending a great deal of money yearly for upkeep and repairs. A new seed drill is worth about \$40,000. They lead their own projects.

## **13. NRAPA**

NPARA has 3 FTEs and 139 acres of land for demonstration and extension. They have some equipment- tractor, combine, plot seeder, air seeder, misc. pieces from 1999 to 2010 at a value of about \$119,000. They are a lead organization in these demonstration projects.

Projects- they have a number of demonstration projects (85) but no publications listed.

2011	Tillage Demo		
2012	Wheat variety	Barley variety	Oat Variety
	Field Pea	Flax	Lentils
	Perennial Forages	Bromegrass Variety	Camelina
	Pulse seeding rate	Fababean Demo	Fababean Field Scale
	Specialty Crop- Safflower	Winter Wheat Fungicide	Tillage
	Proprietary- 5	Inoculant Comparison- Pea	Primers
	Certified vs bin run wheat	Certified vs bin run barley	Agrotain
	Canola Diagnostic	Wheat Protein study	Bromegrass Replace
	Regional Silage Variety Trial-Barley	Canola Seed Treatment-Formulation	
	Faba Bean Variety Trial	Regional Silage Variety Trial-Oats	
	Lentil field scale variety trial	Brome Variety	Timothy Variety
	Biological Control of Canada Thistle		
	Tillage Radish Evaluation	Shelterbelt	Murdoch Lake
	Eco-buffer		
2013	Wheat variety	Barley variety	Oat Variety
	Field Pea RVT-YELLOW	Fababean VT	Lentil VT
	Flax VT	Perennial Forage Seed	Bromegrass Variety
	Pulse demo	Fababean Field Scale Demo	Winter Wheat Variety
	Tillage	Inoculant Comparison- Pea	Canola Varieties
	Agrotain	ACPC	
	Proprietary- 4	Silage RVT -Barley	Silage RVT-Oats
	Alfalfa Variety Trial	Perennial Forage Variety	
	Corn Variety- Forage and Grain		
	Hemp	Field Pea RVT-Green	Pea silage RVT
	Triticale Silage RVT	Cocktail cover crop	Bromegrass Replace
	Brome Variety	Timothy Variety	Thistle Bio Control
	Tillage Radish Evaluation	Tillage 2012 Demo	Tillage 2012 Evaluation
	Shelterbelt	Murdoch Lake	Eco-buffer
	Cocktail Cover Crop		

#### 14. Peace Beef/ Forages

Peace has 3 FTEs and a focus on forages and livestock related projects. Peace has some equipment- Sickle Mower, Green Seeker & Yuma Tablet, ATV Mounted Soil Sampler. This equipment was acquired in 2011 and is about \$16,000. They generally are a lead on the projects.

Projects

2011

- On-Farm Evaluation of Corn, Millet and Sorghum for Yield, Quality and Grazing, Akim Omokanye
- Sod Seeding of Perennial Forages, Akim Omokanye



- Sod Seeding of Annual Crops into Strips for Greenfeed, Akim Omokanye
- Evaluation of Warm Season Cereal Crops for Forage and Feed Value, Akim Omokanye
- GSR Ca and Compost Tea on Forage Yield and Quality, Akim Omokanye
- Forage Yield and Quality from Turnips, Oats and Turnips-Oats Intercrop, Akim Omokanye
- Legume Establishment, Akim Omokanye
- Forage Yield and Quality of Forage Oat Varieties Harvested at 2 Stages of Maturity, Akim Omokanye, Kabal Gill
- Perennial Forage Demonstrations, Akim Omokanye

2012

- Evaluation of Low Heat Unit Corn Hybrids Compared to Barley for Grazing, Akim Omokanye Bart Lardner, Carla Amonson, Anne Kirk, Al Foster, Jennifer Heyden
- Stage at Swathing Oats for Swath Grazing, Akim Omokanye
- Foliar Fertilizer for Pasture Rejuvenation and Grasshopper Control: Bix (Sugar) Content, Soil Nutrients, Forage Yield and Feed Value, Akim Omokanye
- Alternative Feeds: Forage Yield and Feed Value of Brassicas (Tillage Radish and Turnips) and Warm Season Cereals, Akim Omokanye
- Extending the Grazing with Corn: Corn Hybrids, Forage Yield and Feed Value, Akim Omokanye
- Corn for Grazing, Akim Omokanye
- Corn Response to Manure and Inorganic Fertilizer, Akim Omokanye
- Testing of Four Corn Hybrids for Extending the Grazing Season Akim Omokanye
- Testing of Corn Hybrids, Akim Omokanye
- Perennial Forage Demonstrations - Year 2, Akim Omokanye
- Livestock Seeding of Anik Alfalfa and Cicer Milvetch Mix, Akim Omokanye
- Whole Farm Nutrient Management Project (2012-2015), Akim Omokanye

2013

- Sainfoin/Alfalfa Mixture Trial Akim Omokanye, Surya Acharya, Carla Amonson Vicki Heidt
- Demonstration of Soil Amendments to Control Foxtail Barley, Akim Omokanye
- Production of Mineral Balanced Fertilizer from Compost, Akim Omokanye
- Forage Type Barley Varieties for Forage Yield and Quality, Akim Omokanye, Vicki Heidt, Dianne Westerlund, Michelle Holden, Meghan Elsen, Kabal Gill, Fito Zamudio, Tom Fromme

2013

- Pea-Cereal Mixtures for Forage Yield and Quality, Akim Omokanye, Vicki Heidt Dianne Westerlund, Michelle Holden, Meghan Elsen, Kabal Gill, Fito Zamudio, Tom Fromme
- A Comparison of Selected Forage Type Cereal Crops for Forage Yield and Quality, Akim Omokanye
- Evaluation of Forage Type Soybeans and Peas for Forage Yield and Quality, Akim Omokanye
- Triticale Varieties for Swath Grazing, Akim Omokanye
- Soil Rejuvenation vs Foliar Fertilizer on Oats, Akim Omokanye

- Evaluation of Low Heat Unit Corn Hybrids Compared to Barley for Grazing - Year 2, Akim Omokanye, Bart Lardner, Carla Amonson, Anne Kirk, Al Foster, Jennifer Heyden
- Forage Yield and Feed Quality for Four Corn Hybrids, Akim Omokanye
- Forage Yield & Feed Quality of Five Corn Hybrids, Akim Omokanye
- Corn for Silage Grazing and Silage Production, Akim Omokanye
- Perennial Forage Demonstrations - Year 3, Akim Omokanye
- Pasture Rejuvenation with Soil and Foliar Fertilizers, Akim Omokanye

## **15. LARA**

LARA has 2.5 FTEs and 20 acres for research projects. No publications were noted.

## **16. MARA**

MARA operates in the MD of McKenzie in northern Alberta. They have two contract PhD researchers, 410 acres (prior AAFC Fort Vermilion farm) and equipment. They have been re-establishing the program since prior managers vacated the organization. They are working in cereals, oilseeds, forages and in 2015 hemp will be added. They have had a good response to their new staff and last year grew \$90,000 of crops to help their budgets.

## **17. SARDA**

SARDA has 3 FTEs and active in some research and extension. No other information was received.

## **18. FarmingSmarter**

Farmingsmarter is an active applied research company in the Lethbridge area. They have 10 FTEs, 200 acres of land and have been expanding their work. They can lead and support projects.

Equipment- a number of pieces of equipment are used and are being upgraded this year. plot seeder, small tractor, plot combine, veris, em 38, pipettes, soil sampler, ruck trailer, large plot seeder, truck. The age is from 2004 to current year.

### **Projects**

FS has been active and expanding their project work. In 2011 they conducted 56 projects, in 2012, 72 projects and in 2013, another 70 projects. Projects include:

- WGRF fusarium, Dr. Brian Beres, Dr. Randy Kutcher etc
- fungicide application, Dr. Brian Beres, Dr. Randy Kutcher etc
- weed management, Dr. Brian Beres, Dr. Randy Kutcher etc
- barley stubble, Dr. Brian Beres, Dr. Randy Kutcher etc
- crop sequencing, Dr. Brian Beres, Dr. Randy Kutcher etc
- seed size etc, Dr. Brian Beres, Dr. Randy Kutcher etc

- rates and varieties, Dr. Guy Lafond, Dr. Brian Beres, Dr. Randy Kutcher
- foliar N, Dr. Guy Lafond, Dr. Brian Beres, Dr. Randy Kutcher etc
- Japanese Brome, Dr. Brian Beres, Dr. Randy Kutcher etc
- Downy Brome, Dr. Brian Beres, Dr. Randy Kutcher etc
- seeding dates, rates, varieties, Daryl Males
- product trial, Earl Greenhough, Neil Yelland
- BU peas - product efficacy, Piran Cargeeg
- BU lentils - product efficacy, Piran Cargeeg
- BU peas - product efficacy, Piran Cargeeg
- BU lentils - product efficacy, Piran Cargeeg
- Canola - product efficacy, Piran Cargeeg
- product trial, Dr. Jan Slaski, Dr. Martin Doki
- product trial, Edwin Pansert
- field scale trials, Ken Coles, Dr. Ty Fechner
- product trial, Ken Coles
- product trial - fall fert. Spring wheat/canola, Dr. Rory Degenhardt
- demo, Sonia J. Matichuck
- info on website, Ken Coles, Dr. Ty Fechner
- herbicide product registration trial, Eric Johnson
- variety/agronomy, Trent Whiting, Ken Coles
- field scale trials, Ken Coles, Dr. Ron Howard, Dr. Mike Harding, Dr. Kelly Turkington
- large scale small plot trial, Ken Coles
- leaf disease research Dr. Kelly Turkington, Dr. Mike Harding
- funding consortium project, Ken Coles, Dr. Ron Howard, Dr. Mike Harding, Dr. Kelly Turkington
- funding consortium project, Ken Coles, Dr. Kabal Gill, JP Pettyjohn, Meghan Elsen
- product trial, Dr. Gerhard Bester
- chickpeas, peas, lentils, durum, fababeans, soybeans, Alex Fedko
- seed trials, Dr. Bob Blackshaw
- product trial, CJ Ireland, Ken Coles
- variable N trial - field scale, Ken Coles
- winter pea agronomy, Ken Coles
- winter pea herbicide, Ken Coles
- winter lentil agronomy, Ken Coles
- winter lentil herbicide, Ken Coles
- wRVT winter peas, Ken Coles
- pea leaf weevil, Ken Coles, Dr. Hector Carcamo

## 19. Agritrend

Agritrend is involved in crop agronomy and has about 99 people including 8 PhD, 11 MSc and 80 other staff in Western Canada. They have no land and no equipment. They have an annual conference in Saskatoon, offer publications and conduct crop consulting and some proprietary research with farm clients.

## 20. University of Saskatchewan

The University is a strong research group in the crop agronomy area with about 20 FTEs and 2500 acres of land and equipment (includes CDC staff). Some of the recent equipment includes: field instruments, GC field instruments in the order of \$350,000.

Other equipment includes:

- 16 items; value ?; 1-20 years
- 10-20 items; value ?; widely variable in age
- 5 items; value \$200,000; 10-30 years
- Numerous items shared with pulse breeding program
- Numerous items shared with cereal breeding program
- 3 items; value \$350,000; 5-12 years.

Projects are quite varied. Some examples include:

2011-2013

- Agronomy/weed control
- Agronomy/weed biology
- Forage crop agronomy
- Pulse crop disease management
- Cereal and oilseed disease management
- Agronomy/crop physiology
- Nitrogen fix in fababeans
- Heat stress in pea cultivars (four years)
- Nitrogen fixation of hypernodulating
- Cooling canopy traits pea

## 21. ICDC

The Irrigation Centre has completed many projects in its time and has addressed many crops for production in this zone. The list of projects is over 200 projects. It has one FTE and collaborates with AAFC and the provincial Government and can lead or support projects. A summary of the projects is noted below (since start):

- |                                 |           |             |
|---------------------------------|-----------|-------------|
| • Agronomy/Demonstration Trials | Alternate | \$24,640    |
| • Agronomy/Demonstration Trials | Cereal    | \$22,786    |
| • Agronomy/Demonstration Trials | Crops     | \$60,000    |
| • Agronomy/Demonstration Trials | Forage    | \$196,800   |
| • Agronomy/Demonstration Trials | Fruit     | \$10,380    |
| • Agronomy/Demonstration Trials | Legume    | \$75        |
| • Agronomy/Demonstration Trials | Oil       | \$4,638     |
| • Agronomy/Demonstration Trials | Specialty | \$21,450    |
| • Agronomy/Demonstration Trials | Technical | \$1,222,600 |
| • Agronomy/Demonstration Trials | Variety 8 | \$6,329     |
| • Agronomy/Demonstration Trials | Vegetable | \$454,760   |

• Cereal Variety Evaluation	Cereal	\$360,777
• Forage Variety Evaluation	Forage	\$424,705
• Oilseed Variety Evaluation	Oil	\$44,795
• Pulse Variety Evaluation	Legume	\$321,209
• Total 1997-2014	599 projects	\$3,175,950

## 22. Parkland College

The College is starting to develop its applied research program. It has 104 acres and is developing its equipment list. It is partnering with ECRF for applied research projects under a joint agreement.

Some of the projects include (2013):

- Dutch Industries
- Monsanto variety trials
- Soybean germination temperature trials
- Forage demo trial.

## 23. Wheatland

Wheatland has one FTE, access to 480 acres and has some equipment. They have 8 research partners involved in the organization.

Projects include:

2012

Optimum Camelina Seeding Dates #20100214  
 Rates of Seed Placed ESN and Agrotain Treated Urea for Wheat  
 Fungicide Timing in Cereals Demonstration  
 Mustard and Brassica Carinata Agronomy  
 Increased Stubble Heights and Soil Moisture

2013

Durum Varieties Demonstration  
 Enhancing Efficiency of Phosphorus Uptake  
 Rates of Seed Placed ESN and Agrotain Treated Urea for Wheat  
 Fungicide Timing in Cereals Demonstration  
 Identification and Reclamation of Saline Soil Using Perennial Forages  
 Input Study for Canola and Flax  
 Input Study for Pea and Lentil  
 New and Novel Crops Demonstration  
 Salt Tolerance of Hybrid Canola Demonstration  
 Timing of Weed Control in Herbicide Tolerant Canola

2014

Varietal Differences in Shattering for Straight Cutting Canola  
 B. Carinata Agronomy

Response to Seed Treatments, Size, and Rate  
Fungicide Management to Prevent Resistance

## 24. NARF

NARF is co-located at Melfort and has 3.8 FTEs. The Northeast Agriculture Research Foundation (NARF) started in 1997 to co-ordinate and support crop production research activities in Northeastern Saskatchewan. It is a not-for-profit organization that consists of a farmer board with several advisors from the provincial and federal governments as well as from agribusiness. NARF is affiliated with the AAFC Research Farm at Melfort (of the Saskatoon station). They have 6 research themes: Cereal Crops, Oilseed and Pulse Crops , Forage Crops, Other Crops , Fertility and Fertilizers and Cropping Practices.

Many projects have been completed and include:

2011

- Inputs to Target Very High Canola Yield
- Canola Seeding Speeds Demonstration
- Direct Seeding of Annual Crops into Sod
- New and Novel Crops Demonstration
- Rates of Seed Placed ESN and Agrotain Treated Urea for Wheat
- Maximizing benefits from foliar fungicides on wheat and barley
- Variable Rate Fertilizers
- Regional Cereal Variety Trials
- Co-operative Canola Variety Trials
- Regional Oilseed and Pulse Crop Trials
- Harvesting Oats and Barley as Yellowfeed.
- Demonstration of Triticale for Annual Forage Production.
- Short Rotation Forages.
- New Mid-oleic and High-oleic Sunflower Hybrids for Saskatchewan.
- Feasibility of a New Granular Rapid Release Elemental S (RRES) Fertilizer
- Rock Phosphate and Other Amendments in Preventing P Deficiency in Crops
- Wheat Cultivars on a P-deficient Soil
- Alternate Sources of S in Preventing S Deficiency in Hybrid Canola
- Repeated Applications of Liquid Swine Manure
- Variable Rate Fertilizer N (10 field sites).

2012

- Canola Seeding Speed Demo
- Yield Busters: Farmer Directed Research Demonstrations.
- Responsiveness of Oat to Fertilizer and Fungicides
- Inoculant Products and Formulation Effect on Field Pea.
- Canaryseed N and Fungicides.
- Demonstration of Annual Forages for Greenfeed and Swath Grazing
- Harvesting Oats and Barley as Yellow Feed
- Seeding Rates for Precision Seeded Canola.
- Response of Canola to Low Plant Densities and Evaluation of Reseeding Options.

- Field Pea Input Study.
- KCI Fertilizer Requirements.
- Forage Variety Trial.
- Demonstration of Perennial Forage Crops
- Variable Rate Fertilizer Nitrogen
- Maximizing Benefits from Foliar Fungicides on Wheat and Barley
- Hog Manure
- Keyera Elemental S for Organic Grain
- Rapid Release Elemental S for Canola
- Rapid Release Elemental S for Cereals
- AMF Fungi
- Canola Co-op Trials
- Regional Variety Trials
- Forage Trials
- Flax Agronomy and Variety Trials
- Sunflower Co-op.
- U of S: Oat and Barley Nurseries.

2013

- Demonstrating Winter Wheat Production Practices.
- Optimal Seeding Rate for Spring Wheat.
- Fungicide application timing on leaf disease and fusarium head blight infection levels in wheat.
- Responsiveness of Oat to Fertilizer and Fungicides.
- Plant Growth Regulators on Cereals.
- Regional Cereal Variety Trials
- Fall 2, 4-D Preceding Canola, Flax and Pea.
- Straight Combining Canola small plot demonstration
- Demonstrating Foliar Fungicide Options for Canola
- Seeding Rates for Precision Seeded Canola.
- Shattering and pod drop losses of canola cultivars.
- Field Pea Input Study.
- Genetic tolerance and foliar fungicide on canola.
- Co-operative Canola Variety Trials
- Regional Oilseed and Pulse Crop Trials
- Seed Primers and fungicides
- Demonstration of Forage corn varieties.
- Harvesting Oats and Barley as Yellowfeed.
- Demonstration of Triticale for Annual Forage Production.
- Short Rotation Forages.
- Demonstration of Perennial Forage Crops.
- Seed Production with Cool Season Forage Grasses.
- Herbicide tolerance of Forage Grasses.
- Herbicide Tolerance of Forage Legumes.
- New Mid-oleic and High-oleic Sunflower Hybrids for Saskatchewan.

- Sunflower Seeding Rates
- Canaryseed N and Fungicides.
- High Rate Fertilizer P to Correct Very Low P Zones on Variable Rate Fields
- Sulfur Availability (2 sites)
- Feasibility of a New Granular Rapid Release Elemental S (RRES) Fertilizer
- Rock Phosphate and Other Amendments in Preventing P Deficiency in Crops
- Alternate Sources of S in Preventing S Deficiency in Hybrid Canola
- Repeated Applications of Liquid Swine Manure
- Copper fertilization of forages
- Variable Rate Fertilizer N (10 field sites).

## 25. SERF

South east research farm has 1.6 FTEs and a small land base of 120 acres. South East Research Farm (SERF) is located a few miles south east of Redvers. SERF is a non-profit corporation dedicated to bringing agriculture research closer to south eastern farmers. SERF owns which is for crop production and field crop trials. This quarter also serves as headquarters for their office, field and lab equipment. The main trials included variety trials for peas, durum wheat, oats, two and six row barley and flax. They also conducted larger scale Nexera canola trails and field scale demonstration trials that compared seeding rates with three wheat varieties as well as seeding and fertility rates for flax. SERF also works closely with the District #5 Agriculture, Development and Diversification Board to manage a research site near Fairlight and another off-site location sponsored by the Parrish and Heimbecker elevator at Moosomin.

They have some equipment including: Wintersteiger Combine, Seedmaster Plot Drill Fabro Cone Seeder, Clipper Office Cleaner at a value of \$65,000.

Projects (29) include:

- Soybean Regional Variety Trial- 2012
- 2 and 6 Row Barley Regional Variety Trial
- Durum Regional Variety Trial
- Viterra Juncea Canola N x Varieties
- Seeding Rates of Precision Seeded Canola
- Flax Regional Variety Trial
- Oat Regional Variety Trial
- Canaryseed Nitrogen Fertility and Fungicide Trial
- Soybean Regional Variety Trial- 2013
- Chickpea-Flax Intercropping
- Canaryseed Chloride Fertility Trial
- Wetlands Restoration Trial
- Seeding Rates of Precision Seeded Canola
- 2 and 6 Row Barley Regional Variety Trial
- Flax Regional Variety Trial
- Dry Bean Regional Variety Trial
- Oat Regional Variety Trial



- Wheat 1 & 2 Regional Variety Trials
- CIGI Wheat Gluten Trial
- Side banding ESN-urea blends to improve nitrogen efficiency in spring wheat
- Sunflower Seeding Rate Trial
- Sunflower Regional Variety Trial
- Soybean Granular Inoculant Trial
- Quarry Grain Halbrite Trial
- Quarry Grain Halbrite Variety Trial
- Northstar Variety Trial
- Wetlands Restoration Trial
- Canaryseed Nitrogen Fertility and Fungicide Trial
- Soybean Seeding Rate Trial.

### 30. **WARC**

WARC is a non-profit producer based organization that facilitates practical field research and demonstration. The producer group is co-located with Agriculture and AgriFood Canada (AAFC) at the Scott Research Farm. The mandate of WARC is:

- Transfer of technology from research to Saskatchewan producers
- Evaluating the economic implications of technology for Saskatchewan producers.

WARC is active in research projects (52) including:

2011

- Optimum camelina seeding dates
- Optimum camelina seeding depth

2012

- Managing herbicide resistance in Wild Oat
- Fungicide effects on canola yield
- Timing of weed control in herbicide tolerant canola
- Evaluating canola response to foliar fertilizer application
- Proper pre-harvest glyphosate timing in wheat
- Response to cereal fungicide applications in spring wheat
- Seed applied nutrient effects on spring wheat
- Intercropping for better profit
- Faba beans as green manure crop
- Inoculant product and formulation effect on field pea
- Development of a grain yield response curve for canaryseed to chloride fertilizer based on residual chloride levels in the soil
- Response of canola to application of phosphorus fertilizer and *Penicillium billai*

2011-2012

- Cleavers - understanding the biology and managing herbicide resistance
- Canola seeding speeds demonstration
- Inputs to target very high canola yield
- Rates of seed placed ESN and agrotain treated urea for wheat

- Maximizing benefits from foliar fungicides on wheat and barley
  - Micronutrient seed dressing effects on various crops
  - Response of canola to low plant populations and evaluation of reseeding options
  - Control of leafy spurge (*Euphorbia esula* L.) with aminocyclopyachlor in grassland
  - Evaluation of adaptability and ecological performance of brassica juncea in diverse growing conditions
  - Combinations of sulfentrazone (Authority) and saflufenacil (Heat) for an improved spectrum of broadleaf weed control in chickpea
  - Hybrid poplar and willow demo
- 2011-2013
- Intergrated Weed Management of Kochia Control in Lentils
  - Quantifying pod drop/shattering resistance amongst canola cultivars
  - Integrating cultural, chemical & mechanical weed management for controlling herbicide resistant broadleaf weeds in lentil
  - Reclamation of saline soil using perennial forages
  - Legume Crops to Improve Soil Fertility for Enhanced Canola Production Test 36
- 2012-2013
- Common or Yellow Toadflax Timing Trial
  - Mitigating blackleg disease of canola using fungicide strategies
  - Seeding rates for precision seeded canola
  - Optimal seeding rate for spring wheat
  - Field pea input study
  - Corn grazing study
  - Response of canary seed to N rates and fungicide
  - Precision inter - row seeding
  - Improving phosphorus efficiency
- 2013
- Managing herbicide resistance in Kochia
  - Fall 2,4-D preceding canola, lentil and pea
  - Optimum timing of weed control in field pea and lentil
  - Straight combining canola small plot demonstration
  - Effect of fungicide timing on leaf disease and fusarium head blight of spring wheat
  - Effect of fungicide on wheat quality
  - Demonstrating winter wheat production practices
  - Nitrogen fertilizer mgmt options for winter wheat
  - Fungicide and seeding rate on disease levels in field peas and lentils
  - Short season grain corn and soybean demo
  - Seed Size and Seeding Rate Effects on Canola Yield and Quality
  - Quality and yield response of malting barley varieties to increasing nitrogen rates
  - Canola Input Demo

### 31. IHARF- Indian Head

The organization has 320 acres it purchased for applied research projects. Incorporated in 1993,

*Toma & Bouma/ Western Canada Agronomic Research Capacity*

IHARF works in close harmony with Agriculture and Agri-Food Canada at the Indian Head Research Farm. It is a very active and well operated organization. They have about 40 research partners. They had a very well-known leader Dr. Guy LaFond who passed away in 2013 and established the quality of the research programs.

Projects include:

- 2004 - 2011 Field-Scale Fungicide Trials
- Durum- Alternating Agronomic Practices to Reduce the Effect of Fusarium
- Top-Dressing Durum with Nitrogen to Manage Protein
- Canaryseed- 2012 Canaryseed Agronomy Report. The Effect of Seeding Date, Rate and Applied Nitrogen on the Yield of Canaryseed
- Forage- Cool and Warm Season Annual Cereal Species for Winter Grazing in Saskatchewan
- Yellowfeed Production in Saskatchewan

Presentations include:

2013 IHARF Agronomy Research Update - Chris Holzapfel  
Canola Challenges & Opportunities - Warren Ward  
Enhancing Wheat & Oat Yield - Stu Brandt  
Natural Aeration Grain Drying - Ron Palmer  
Soybean Agronomy - Kristen Podolsky

2014 Agri-ARM Research Update  
Chickpea & Flax Intercropping - Lana Shaw  
Enhancing Wheat & Oat Yield - Stu Brandt  
Low Canola Plant Populations - Laryssa Grenkow  
Saskatchewan Soybean Production - Garry Hnatowich  
Soybeans & ECRF - Parkland College - Mike Hall  
Wheat Seed Treatments, Size & Rates - Bryan Nybo  
Winter Wheat Production - Chris Holzapfel

2013 IHARF Soil and Crop Management Seminar  
Oat Production - Bill May  
Natural Aeration Grain Drying – Dr. Ron Palmer  
Economic Considerations for Fungicide Applications - Brent Flaten

2012 IHARF Agronomy Research Update - Chris Holzapfel  
2012 AAFC Agronomy Research Update - Dr. Guy Lafond  
25 Year SK. Water Security Plan - Water Security Agency

2013 Agri-ARM Research Update  
Field Pea Input Optimization - Anne Kirk  
Irrigation Fertility - Gary Kruger  
Natural Aeration Grain Drying - Dr. Ron Palmer  
Precision Seeding - Stu Brandt  
Salt Tolerance of Hybrid Canola - Bryan Nybo

Straight-Combining Canola - Chris Holzapfel

2012 Indian Head Crop Management Field Day  
2012 Crop Disease Update - Faye Dokken-Bouchard  
2012 IHARF Soil and Crop Management Seminar

2012 AAFC Agronomy Update  
Crown Rust in Oats  
Economic Update for Agriculture  
Factors to Consider for Straight-Combining Canola  
Fertility Issues with Wet Acres  
New Insights into Natural Aeration Grain Drying  
Small-Holder Agriculture  
Yield-Busters: Farmer Directed Research of Products and Practices

### **32. AAFC-Saskatoon**

Saskatoon (AAFC) has 9 PhD FTEs and has 2,470 acres. It also has several sub-sites including: Melfort, Scott and Outlook. Collaborations are carried out with the province and producer associations. Lists of publications are noted in the AAFC Input to WGRF paper.

### **33. AAFC- SPARC**

Swift Current (AAFC) is very active and has about 6 PhD FTEs in crop agronomy. This is a very strong agronomy research program in the province. They have about 3,620 acres and a sub-site at Indian Head. Lists of publications are noted in the AAFC Input to WGRF paper.

Projects (21 in 2013) include:

- Understanding the extent of nitrate leaching beneath agricultural lands in the semi-arid Canadian Prairies and determining appropriate management measures.
- Conserving carbon and biological energy reserves in prairie soils: a century perspective
- Determination of Appropriate Species for Diverse Annual Plantings Based on their Contribution to Forage Yield & Soil Improvement
- Germination Response of Selected Grass & Legume Species Under Current & Predicted Temperature Increases
- Feed Production and Utilization and Environmental Sustainability
- Long-Term Sustainability of Soil and Crop Management Practices for Canadian Prairie Agriculture
- Understanding the extent of nitrate leaching beneath agricultural lands in the semi-arid Canadian Prairies and determining appropriate management measures.
- Impact of Land Use on Soil Functional Diversity and Nutrient Cycling in Prairie Ecosystems
- Improving phosphorus use efficiency under different Canadian agro-ecosystems
- Long-Term Sustainability of Soil and Crop Management Practices for Canadian Prairie Agriculture

- An Evaluation of Soil Water Use Efficiency for Different Seeding Row Spacings
- Further investigations into the impact of pesticide use on crop diseases, microbial populations, plant nutrition and long-term sustainability
- Optimizing the frequency and sequence of annual pulses in cropping systems and their impacts on crop performance, biotic and abiotic stresses, and soil quality attributes- Phase II
- Detection, surveillance and management of weeds, insects and plant diseases that threaten the environmental health of prairie agro-ecosystems and the security of the food supply
- Glyphosate/AMPA soil residues and their potential effect on crop productivity in western Canada
- A4: Production / Agronomy
- Legume crops to improve soil fertility for enhanced canola production.
- WGRF - Increased Crop Performance through Wheat-mycorrhizal Interactions
- Development of a Highly Reliable Biofertilizer for Pulse-Based Rotations
- Evaluating Forage Production & Stand Longevity of New Sainfoin Germplasm in Mixture with Alfalfa Under Grazing for Western Canada - 20120197
- Long-Term Sustainability of Soil and Crop Management Practices for Canadian Prairie Agriculture.

E&OE

November 10, 2014

# AAFC input

## Western Grains Research Foundation – Agronomy Research Capacity – for planning purposes



*Prepared by:*

George Clayton

Brian Beres

Sheila Torgunrud

16 July 2014

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## AAFC Strategic Objectives and agronomy research focus (crop or method or program)

From The AAFC Business Plan 2014-2017, Page 18-19:

The role of science and technology continues to be critically important in maintaining the profitability and competitiveness of Canada's agriculture, agri-food and agri-based products sector. At the same time, the sector's science requirements are growing in complexity, new technologies are emerging, the government policy and program landscape is changing, and the science capacity of other players in Canada's agri-innovation system – such as provincial governments, universities and the private sector – continues to evolve.

AAFC has a 127-year history of scientific achievement. The Department continues to modernize its delivery of science and technology, with an important part of our mission being to provide leadership in the growth and development of a competitive, innovative and sustainable Canadian agriculture, agri-food and agri-based products sector. As a result of these efforts, in 2012 the Department established the Science and Technology Branch (STB), in pursuit of improved tailoring of national priorities to regional needs; more complementary partnerships with industry; better integration of agronomic and environmental expertise; and a more coordinated interface with industry and other groups.

Through working with industry, STB has developed a strategic direction to focus the department's scientific activities in support of the sector, and to inform future investments and resource allocations. The emphasis has evolved from three pillars that described the *raison d'être* of the Branch to our common, cross-cutting strategic objectives that address the major scientific challenges facing the twenty-first century agri-based production systems.

These objectives include:

- **(P)** increasing agricultural productivity – at both an individual commodity level and from a systems perspective, such as crop rotations, and livestock and forage systems;
- **(E)** improving environmental sustainability – for example, improved nutrient utilization and recycling and mitigating greenhouse gas emissions;
- **(A)** improving attributes for food and non-food uses – such as nutritional attributes, use of crops and livestock in pharmaceuticals, bio-chemicals and bioenergy; and
- **(T)** addressing threats to the agriculture and agri-food value chain – such as catastrophic risks associated with weeds, insects and disease, and risks to food safety.

To better communicate with the sector, seven sector strategies have been developed, addressing each of the four common strategic objectives (PEAT) of the Branch. These sector strategies address: (1) Forages and Beef, (2) Cereals and Pulses, (3) Oilseeds, (4) Dairy, Pork, Poultry, and Other Livestock, (5) Agri-Food, (6) Horticulture, and (7) Bioproducts. Additionally, two horizontal strategies provide foundational research that supports the sector strategies. The Agroecosystem Productivity and Health strategy defines and studies systemic relationships between agriculture and the resource base, and the Biodiversity and Bioresource Collections strategy develops and maintains species level knowledge and genetic material.

The science-based sector strategies are evergreen, and will be adapted and updated as new challenges and opportunities arise. Internally, these strategies have been aided by sector strategy maps that take into account changes in science and technology capacity.

These strategies also communicate expectations to our stakeholders and lay the foundation for a stronger collaborative approach.

The AAFC Network of Sites functions within the Science and Technology Branch pillars (Annex C) and the Sector Strategies strategic objectives PEAT (Annex D) to deliver agronomic functions over space and

time and crops that are productive, sustainable and profitable. The agronomic areas listed in the table on Page 8 indicate where major activity and science capacity exists at a Centre. However, agronomic trials occur at most of the AAFC Network of Sites. For example, weed management studies are not only conducted at the AAFC Lead Centres as described in the table but are most likely also conducted at Beaverlodge, Melfort, Swift Current, Indian Head and Brandon.

Hence, the research focus is to answer agronomic questions in a timely manner, 2 to 3 years over space and time. Murray Hartman (Alberta Agriculture and Rural Development; personal communication) indicated he needs 20 site-years of agronomic data to confidently make a recommendation. Our network of sites as well as the potential to collaborate with Universities and other research providers develops confident recommendations in 2 to 4 years depending on the research question. Why? The AAFC Network of Sites can conduct the same trial at 8-10 sites in a growing season, providing 21 to 40 site-years of agronomic data in a 2 to 4 year period of time. Properly conducted, these agronomic trials can make inferences about soil type or geographic region.

The agronomy function at AAFC Centres develops integrated crop management strategies for sustainable cropping systems and conducts research in key areas of Agro-Ecosystem Productivity and Health, and Sustainable and Profitable Agri-Systems and includes:

Strategic Objective	Agronomy Function	AAFC Lead Centres and (sites)
(P) <b>increasing agricultural productivity</b> (E) <b>improving environmental sustainability</b> (A) <b>improving attributes for food and non-food uses</b>	Integrated Crop Management (ICM) and Animal Management including enhancing Agri-productivity-Nutrient cycling, sustainability of cropping systems, economic benefits for stakeholders.	Lacombe, Lethbridge, Saskatoon, Swift Current, Brandon (Scott)
(T) <b>addressing threats to the agriculture and agri-food value chain</b>	Insect Management and Ecology contributing to an ICM system	Lacombe, Lethbridge, Saskatoon (Beaverlodge)
(T) <b>addressing threats to the agriculture and agri-food value chain</b>	Disease Management and Ecology contributing to an ICM system	Lacombe, Saskatoon, Swift Current, Brandon, Morden
(T) <b>addressing threats to the agriculture and agri-food value chain</b>	Weed Management and Ecology contributing to an ICM system	Lacombe, Lethbridge, Saskatoon (Scott)
(P) <b>increasing agricultural productivity</b>	Improved agronomic practices for better crop adoption in northern growing areas	(Melfort, Beaverlodge)
(P) <b>increasing agricultural productivity</b>	Sustainable crop production agronomy for irrigated crops (field, horticultural and special crops) in Saskatchewan	(Outlook, Carberry, Portage la Prairie)
(P) <b>increasing agricultural productivity</b> (A) <b>improving attributes for food and non-food uses</b>	New crop agronomy	Swift Current (Scott, Indian Head)
(E) <b>improving environmental sustainability</b>	Understanding integrated cropping/animal systems, especially for pulse and forages, and developing best practices to enhance environmental performance and sustainability	Swift Current (Scott, Indian Head)
(E) <b>improving environmental sustainability</b>	Long-term-rotation field experimental plots at AAFC	More than 100 years at Lethbridge; 50 years (Indian Head); 40 years at Swift Current; other sites for more than 30 years (Scott).
(P) <b>increasing agricultural productivity</b> (E) <b>improving environmental sustainability</b>	Rangeland management	Lacombe: Grazing systems Swift Current: Beef systems
(T) <b>addressing threats to the agriculture and agri-food value chain</b>	Grain storage	(Winnipeg – co-located at the UofM)
(E) <b>improving environmental sustainability</b>	Soil Health and Soil Microbiology impacts on ecosystem health	Lethbridge, Swift Current
(P) <b>increasing agricultural productivity</b> (E) <b>improving environmental sustainability</b>	Economic evaluation and risk of ICM systems	Lethbridge, Brandon
(T) <b>addressing threats to the agriculture and agri-food value chain</b>	Assessment and monitoring of existing, new and potential threats to agricultural production	All Centres

## AAFC scientists or professionals involved in the AAFC Network of Sites

Network of AAFC Sites (Lacombe, Beaverlodge, Lethbridge, Saskatoon, Melfort, Scott, Outlook, Swift Current, Indian Head, Brandon, Morden)

### RESEARCH

Scientists involved in Integrated Crop Management (ICM) through a network of sites or working on their discipline that contributes to knowledge to be incorporated into ICM studies.

**Agronomy, CROPS** – Vice-Dr. Guy Lafond (deceased 2013) – Indian Head

**Agronomy, CROPS** – Dr. John O’Donovan – Lacombe, cropping system

**Agronomy, CROPS** – Dr. Brian Beres – Lethbridge, cropping systems

**Agronomy, CROPS** – Dr. Yantai Gan – Swift Current, pulse, cropping systems

**Agronomy, CROPS** – Bill May – Indian Head, annual crop agronomy

**Agronomy, CROPS** – Dr. Ramona Mohr – Brandon, annual crop agronomy

**Agronomy, CROPS** – Dr. Scott Duguid – Morden, cropping systems

**Agronomy, SOILS** – Dr. Cynthia Grant – Brandon, nutrient management

**Agronomy, SOILS** – Dr. Xiyang Hao – Lethbridge, nutrient management

**Agronomy, SOILS** – Dr. Reynald Lemke – Saskatoon, environmental cropping systems

**Agronomy, SOILS** – Dr. Alan Moulin – Brandon

**Agronomy, BEEF GRAZING** – Dr. Vern Baron – Lacombe, forage agronomy/swath grazing

**Agronomy, BEEF GRAZING** – Dr. Hushton Block – Lacombe, forage/grazing systems

**Agronomy, Range Management** – Dr. Michael Schellenberg – Swift Current

**Agrometeorology** – Dr. Herb Cutforth – Swift Current

**Agrometeorology** – Dr. Aaron Glenn – Brandon

**Weeds** – Dr. Neil Harker - Lacombe

**Weeds** – Dr. Robert Blackshaw – Lethbridge

**Weeds** – Eric Johnson - Scott

**Weeds** – Dr. Hugh Beckie - Saskatoon

**Pathology** – Dr. Kelly Turkington – Lacombe, Cereals

**Pathology** – Dr. Syama Chatterton – Lethbridge, Pulses

**Pathology** – Dr. Bruce Gossen – Saskatoon, Oilseeds

**Pathology** – Dr. Gary Peng – Saskatoon, Oilseeds

**Pathology** – Dr. Debbie McLaren – Brandon, Pulses, Oilseeds, Cereals

**Pathology** – Dr. Bob Conner – Morden, Pulses

**Pathology** – Dr. Khalid Rashid – Morden, Oilseeds/Cereals

**Pathology** – Dr. Myriam Fernandez – Swift Current, Cereals

**Entomology** – Jennifer Otani - Beaverlodge

**Entomology** – Dr. Hector Carcamo - Lethbridge

**Entomology** – Dr. Robert Elliott - Saskatoon

**Entomology** – Dr. Owen Olfert - Saskatoon

**Entomology** – Dr. Julie Soroka - Saskatoon

**Entomology** – Dr. Noel White - Winnipeg

**Entomology** – Dr. Paul Fields - Winnipeg

**Cropping System Microbiology** – Dr. Newton Lupwayi – Lethbridge

**Cropping System Microbiology** – Dr. Chantel Hamel – Swift Current

**Economist** – Dr. Elwin Smith – Lethbridge

**Economist** – Dr. Mohammad Khakbazan – Brandon

## RELATED AGRONOMY CAPACITY

**Environmental Soil Agronomy** – Dr. Henry Janzen – Lethbridge

**Environmental Soil Agronomy** – Dr. Ben Ellert – Lethbridge

**Remote Sensing** – Dr. Anne Smith – Lethbridge

## DEVELOPMENT/TECHNOLOGY TRANSFER

**Agronomy** – Cecil Vera – Melfort

**Agronomy** – Dr. Jazeem Wahab – Outlook

**Agronomy** – Laurie Tollefson – Outlook

**Agronomy** – Dr. Dale Tomasiewicz – Outlook

**Agronomy** – Curtis Cavers – Portage La Prairie (Carberry)

**Agronomy** – Dr. Allison Nelson – Winnipeg (Carberry)

**Agronomy** – Tricia Pollock – Indian Head

**Agronomy** – Laura Poppy – Indian Head

**Weeds** – Dr. Julie Leeson - Saskatoon

**Minor Use Program** – Dan Ulrich - Scott

## AAFC Research Capacity

Scientists involved in Integrated Crop Management (ICM) through a network of sites or working on their discipline that contributes to knowledge to be incorporated into ICM studies are relatively at near capacity considering the reductions in the Science and Technology Branch in 2012 and 2013.

In the Prairie/Boreal Plain Ecozone, agronomic capacity (number full-time equivalents; FTE) exists at Lacombe/ Beaverlodge (6 in total), Lethbridge (11), Saskatoon/Outlook/Melfort/Scott (9), Swift Current/Indian Head (6), Brandon (5) and Morden (2). The main areas include agronomy (crops, soils, beef grazing, and range management), agrometeorology, weeds, pathology, entomology, cropping system microbiology and of course, the economics of the research conducted under AAFC agronomy capacity.

In addition, since 2012, the Science and Technology Branch (STB) have professional positions that work on Development as well as Technology Transfer. These Development positions bring new capacity that complements and supplements the science activity. However, there is some carry-over from existing

projects from the former Agri-Environmental Services Branch. This activity will be integrated into the strategic objectives PEAT as new projects are developed.

### **In the next three years there is expected to be a number of scientists retire in AAFC:**

	<b>Number of scientists who will retire or leave the position</b>
<b>Agronomy – Beef Grazing</b>	1 of 2
<b>Agronomy – Crops</b>	3 of 7
<b>Agronomy – Soils</b>	1 of 4
<b>Agrometerology</b>	1 of 2
<b>Entomology</b>	5 of 8
<b>Pathology</b>	2 of 8
<b>Weeds</b>	3 of 4

Within the next three years, 16 AAFC scientists who contribute to agronomy research are expected to retire. The biggest impact to research capacity will be at Lacombe and Saskatoon; and yet retirements of these world-class scientists could result in a major gap at a Centre such as Brandon. In addition, the number of weed scientists in AAFC could be reduced to one in Western Canada. Of course some scientists have a bigger impact than others; at least 10 of the 14 are globally recognized and the pride of AAFC research. They are irreplaceable as one cannot hire experience, know-how, connections as well as the ability to interact equally effectively with world-class researchers and farmers. If replaced, new scientists will need time to become completely effective. Experienced researchers that remain can play a key role as mentors of newly hired HQP.

It is critical for AAFC to complete the Business Plan, cross-walk capacity with the science strategy, define the investment plan and ensure the HR Plan reflects the salary dollar envelope available in the Prairies.

## **Resources - field equipment, land and infrastructure**

In general, our basic needs to conduct agronomy are up to date in terms of equipment to complete field trials that producers can relate to in relation to their own situations. The network of sites has similar equipment for seeding and harvesting plots that are near state-of-the-art and reflect seeding systems in Western Canada. There is a complement of Conserva-Pak or Seed Hawk seeding systems located at Lacombe/Beaverlodge, Lethbridge, Melfort, Scott, Swift Current, Indian Head and Brandon which provide the opportunity to compare sites more accurately for most of the research questions developed by researchers or producers. In addition, this type of seeding system required makeshift combine capacity where researchers were modifying large, field-scale combines. Recently, and throughout GF Cluster and DIAP projects, AAFC utilized Vote 1 and some industry funds to purchase research combines designed for larger plot sizes. These combines are located at Beaverlodge, Lacombe, Lethbridge, Scott, Indian Head and Brandon. This equipment supports the Integrated Crop Management (ICM) capacity in AAFC that support multi-site agronomy trials in canola, pulse, barley and other crops.

There will be cases where individual research scientists or development professionals require equipment in the future for specific projects to align with other agronomy programs across the west.



There is opportunity in project funding to meet the needs of the program and project without compromising the delivery of the research.

A rating for current equipment generally by site is **excellent** (Lacombe, Scott), **very good** (Beaverlodge, Lethbridge, Indian Head, Saskatoon), **good** (Outlook, Melfort, Swift Current and Brandon), and **fair** (Morden, Portage la Prairie).

In all likelihood every site will require upgrades or new equipment but the degree to which it is required will be estimated at:

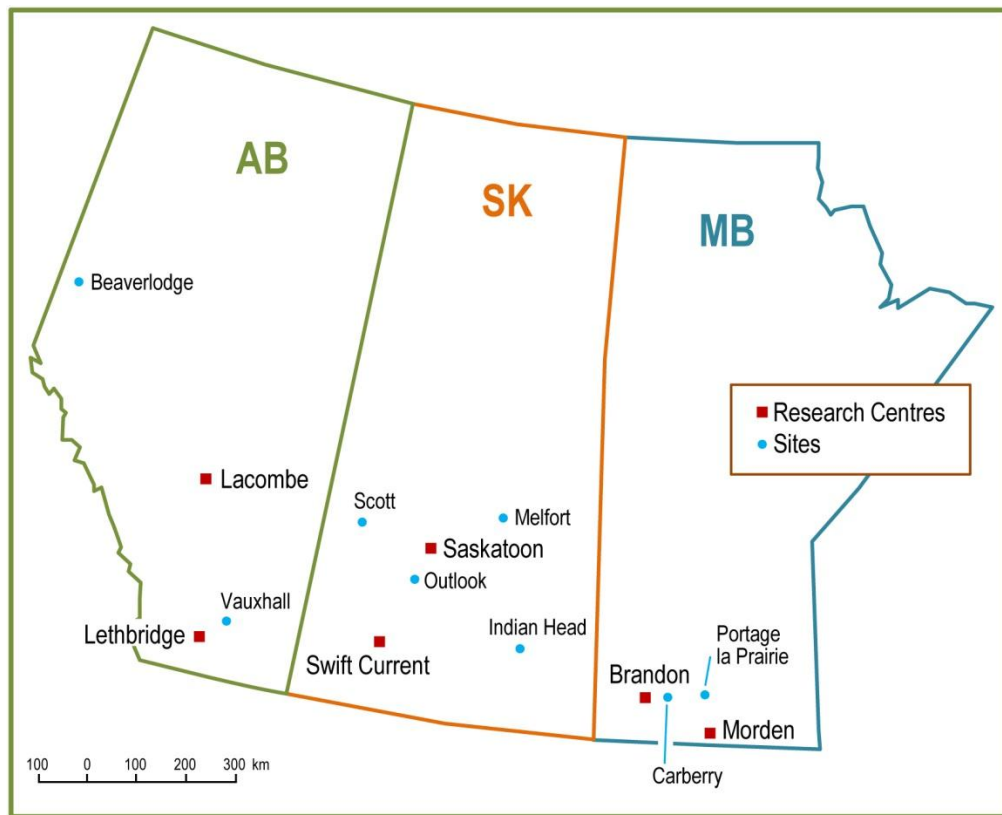
- Excellent           \$50K per year
- Very good         \$50K per year
- Good                \$800K one time investment, \$50K per year
- Fair                 \$600K one time investment, \$50K per year

**Initial equipment investment** – \$1.4M at Swift Current/Morden/Outlook/Portage la Prairie to bring equipment capacity to network with other AAFC sites. Morden has initiated a flax agronomy program as it transitions away from breeding. Consequently, there has been little invested in equipment to conduct agronomy trials at the site to facilitate the trading of trials where flax trials could be conducted at other AAFC sites in return for wheat, barley, canola and pulse trials conducted at Morden.

**Maintenance and upgrades** – \$600K per year all sites. This can be captured through GF2 funding, government sources, industry or some other mechanism as on-going costs (one suggestion was to host bingos).

**Land and infrastructure** – In addition, there is land and infrastructure that will need to be assessed and addressed, particularly after the Gap Analysis is complete linking our scientists and work to the sector strategies. This is an action item to be completed by AAFC in the near-term. On the surface, it appears our land-base is adequate but there are some short-comings in building infrastructure. Once the AAFC Centre Profiles are completed and approved by senior management, the landscape will become much clearer.

### Locations and land resources at AAFC Network of Sites, Prairies:



Centres and (Sites) in PBPE	# of hectares
<b>Alberta</b>	
Lacombe	808 total
- (Beaverlodge)	360 at 2 sites
Lethbridge	520
- (Vauxhall)	190
<b>Saskatchewan</b>	
Saskatoon	1,000 combined
- (Melfort)	
- (Outlook)	
- (Scott)	
Swift Current	930 (forage, pasture 575; native grass 140)
- (Indian Head)	535
Outlook: Canada-SK Irrigation Diversification Centre (CSIDC)	72 main station; 52 off-station
<b>Manitoba</b>	
Brandon	890 (plus 100 ha leased)
Morden	259
Canada-MB Crop Diversification Centre (CMDC):	
- Carberry (headquarters)	128 ha with 70 ha irrigated
- Portage la Prairie	65 ha

## Enhancing Capacity?

- 1) **AAFC Renewal Plan** – Capacity can be added in the future through a well-prepared Business Plan that includes a Strategic Plan, a Human Resource Plan and an Investment Plan. AAFC is currently building a HR plan and Investment Plan. The Strategic Plan has been completed and an exercise is currently underway to define projects under the Strategic objectives. A Gap Analysis will be completed by the fall to understand where AAFC has capacity, where others have capacity in strategic areas and where there are gaps.
- 2) **Training High Quality Personnel (HQP)** – Training of graduate students at AAFC locations is a collaborative effort between University researchers and AAFC researchers. This activity is underutilized because of a lack of a formal program; it is administratively difficult in some cases; and the distant proximity of some AAFC some Centres to Universities. Agronomy is not always enticing; if producers want to maintain this type of activity it is imperative that a formal program exists to train HQP under existing productive agronomy programs at AAFC, Universities or other research providers.
- 3) **GF2 Clusters/ASP and other funding opportunities** – In the context of Clusters and large Agri-Innovation Projects (ASP) under GF2 Fed-only program, industry sets their priorities and applies to the program. Industry can build the best science teams and leverage expertise outside of AAFC. Consequently there is opportunity to build bigger teams and pursue more ambitious goals. In this way, program delivery can be accelerated. In some instances there is opportunity to access the GF2 Fed/Prov cost-shared program that supports innovation and provides capacity outside of AAFC.

Provincial funding agencies and/or industry is interested in collaborating with AAFC scientists outside of matching programs. These funds can be utilized to build short-term capacity to complete research on specified projects. Science capacity is supplemented for targeted research projects through the hiring of Post-Doctoral Fellows (PDFs) and/or graduate students, summer students, casual labour in emergencies and occasionally term technicians.

- 4) **Partnership or Co-existence Agreements** – AAFC has unique collaborations at smaller Centres. These collaborations are critical in the maintenance and development of agronomic information in rural areas. Capacity can be leveraged from Federal, Provincial and Industry where a whole is better than the sum of their parts. Currently, Indian Head Agricultural Research Foundation (IHARF), Western Agricultural Research Commission (WARC), and Northern Agricultural Research Foundation (NARF) co-exist under agreements at Indian Head, Scott and Melfort, respectively, as well as the Canada-Saskatchewan Irrigation Diversification Centre (CSIDC) at Outlook and the Canada-Manitoba Crop Diversification Centre (CMDC) in Carberry and Portage la Prairie.

## Collaborations with Other Researchers

The development of Growing Forward and Growing Forward 2 have had a major impact on collaboration both between researchers and with industry. The Innovation programming under GF and GF2 has made it possible for Industry match funding under these programs to develop priorities and pick their best science teams to deliver on those priorities. Under GF, Clusters were formed in Canola, Beef, Horticulture, and Pulse to provide funding to AAFC (Vote 1) and to industry (Vote 10). Industry contracted with external research providers (i.e., Universities) to accomplish their priorities. The DIAP

program funded agronomy projects in barley, canola, wheat, pulses and other crops. Several collaborations between researchers were formed which saw a significant increase in the funding available to conduct agronomy type research. GF2 has carried on this activity with agronomy funding directed towards all the major crops and to AAFC researchers and external researchers supported by industry

In addition, scientist networking through meetings, site-exchange (AAFC network) of common work, interdisciplinary collaborations (AAFC, NRC, University, Industry) has led to increased collaboration. Collaborative research projects; formal agreements and through informal co-operation all contribute to collaboration by researchers. The common theme that builds collaboration is the access to funding. Sometimes the complexity of formal agreements, particularly between institutions and industry partners are a barrier to collaboration.

There are also exchanges of information. Some producer-run, applied research organizations request novel agronomic information to extend into their regions. This is a valuable activity to extend the reach of knowledge and to verify if the research results are applicable over a wider geographic area. Other collaborations include mentoring of organizations by experienced scientists.

## Communicating Results

AAFC is a science-based organization that requires scientists to conduct research under the scrutiny of the scientific community. This is similar to having a warranty on expensive equipment such as seeders or combines. To be a world-class research organization requires an obligation to publish results in peer-reviewed publications.

Our most prolific scientists who publish in scientific journals also happen to be prolific in technology transfer, contributing to scientific meetings, conferences, technology transfer through speaking engagements at producer meetings and workshops, technical reports and annual or regional meeting presentations for producer groups. Other activities include annual field days commodity group tours, factsheets, annual reports, and farm media publications.

Commodity organizations (canola, pulse, and beef) also communicate results from studies. The Canola Council of Canada has an elite group of agronomists and communication professionals that extend information from Cluster-developed projects. Producer-run applied research organizations e.g. WARC, IHARF, NARF also take results from AAFC or Universities and extend them to their members and non-members or introduce new research in their geographic areas.

Listed on the next several pages are the deliverables from research mostly funded by producer dollars or provincial organizations. Research publications (Annex A) and Technology Transfer activities (Annex B) developed between from 2011-2014 are listed for each scientist identified on Pages 9 and 10. There are duplicates of publications but since each scientist has contributed in some form or manner they are listed under their names. Removing the scientists and their scientific publication and technology transfer activities provides a measure of the impact or the loss if the scientist retires or leaves within the next three years.

The technology Transfer lists are incomplete as they were taken from our external AAFC website where scientists may or may not include all their activity. It is estimated that the Technology Transfer function is likely three times the list provided.

## Research and Technology Transfer Publications (2011-2014)

Agronomy Focus	Name - Location	Publications	
		Research	Technology Transfer
<b>Crops</b>	Dr. Guy Lafond (deceased) – Indian Head	26	3
	Dr. John O’Donovan – Lacombe	22	16
	Dr. Brian Beres – Lethbridge	29	7
	Dr. Yantai Gan – Swift Current	40	18
	Bill May – Indian Head	24	3
	Dr. Ramona Mohr – Brandon	9	3
	Dr. Scott Duguid – Morden	12	5
<b>Soils</b>	Dr. Cynthia Grant – Brandon	40	26
	Dr. Xiyang Hao – Lethbridge	43	25
	Dr. Reynald Lemke – Saskatoon	26	5
	Dr. Alan Moulin – Brandon	8	3
<b>Beef Grazing</b>	Dr. Vern Baron – Lacombe	21	30
	Dr. Hushton Block – Lacombe	7	11
<b>Agronomy, Range Management</b>	Dr. Michael Schellenberg – Swift Current	17	49
<b>Agrometeorology</b>	Dr. Herb Cutforth – Swift Current	10	3
	Dr. Aaron Glenn – Brandon	6	16
<b>Weeds</b>	Dr. Neil Harker - Lacombe	28	15
	Dr. Robert Blackshaw – Lethbridge	18	25
	Eric Johnson - Scott	21	41
	Dr. Hugh Beckie - Saskatoon	16	21
<b>Pathology</b>	Dr. Kelly Turkington - Lacombe	32	43
	Dr. Syama Chatterton - Lethbridge	1	4
	Dr. Bruce Gossen - Saskatoon	51	154
	Dr. Debbie McLaren - Brandon	16	37
	Dr. Bob Conner – Morden, pulses	22	29
	Dr. Khalid Rashid – Morden, oilseeds/cereals	4	16
	Dr. Myriam Fernandez – Swift Current	13	14
<b>Entomology</b>	Jennifer Otani - Beaverlodge	4	37
	Dr. Héctor Cárcamo - Lethbridge	25	17
	Dr. Robert Elliott - Saskatoon	5	18
	Dr. Owen Olfert - Saskatoon	14	32
	Dr. Julie Soroka - Saskatoon	11	27
	Dr. Gary Peng - Saskatoon	23	79
	Dr. Noel White - Winnipeg	28	2
	Dr. Paul Fields - Winnipeg	13	7
<b>Cropping System Microbiology</b>	Dr. Newton Lupwayi - Lethbridge	20	29
	Dr. Chantel Hamel – Swift Current	26	31
<b>Economist</b>	Dr. Elwin Smith - Lethbridge	14	15
	Dr. Mohammad Khakbazan - Brandon	9	7
<b>Environmental Soil Agronomy</b>	Dr. Henry Janzen – Lethbridge	19	25
	Dr. Ben Ellert – Lethbridge	11	3
<b>Remote Sensing</b>	Dr. Anne Smith	5	5
<b>Totals:</b>		789	956

## ANNEX A) LIST OF PUBLICATIONS - RESEARCH

### AGRONOMY

#### *Crops*

#### **Lafond, Guy (deceased 2013; Indian Head)**

Research Publications:

2014

- May, W.E., Fernandez, M.R., Selles, F., and Lafond, G.P. (2014 in press). "Agronomic practices to reduce leaf spotting and Fusarium kernel infections in durum wheat on the Canadian prairies.", *Canadian Journal of Plant Science*.

2013

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### **O'Donovan, John (Lacombe - cropping systems)**

Research Publications:

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2013

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productivity, quality, and foliar disease severity.", *Canadian Journal of Plant Science*, 92(3), pp. 577-588. doi : 10.4141/CJPS2011-216

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### **Beres, Brian (Lethbridge - cropping systems)**

Research Publications:

2014

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- Cárcamo, H.A. and Beres, B.L. (2013). "*Cephus cinctus* Norton, Wheat stem sawfly (Hymenoptera: Cephidae)", in Mason, P.G. and Gillespie, D.R. (eds.) - Biological Control Programmes in Canada 2001-2012, CABI Publishing, Chapter 15, pp. 112-119.
- Collier, G.R.S., Beres, B.L., Salmon, D.F., Nyachiro, J.M., Bork, E.W., and Spaner, D.M. (2013). "A sustainable management package for triticale in the western Canadian prairies.", *Agronomy Journal*, 105(2), pp. 546-554. doi : 10.2134/agronj2012.0314
- Graf, R.J., Beres, B.L., Laroche, A., Gaudet, D.A., Eudes, F., Pandeya, R.S., Badea, A., and Randhawa, H.S. (2013). "Emerson hard red winter wheat.", *Canadian Journal of Plant Science*, 93(4), pp. 741-748. doi : 10.4141/CJPS2012-262
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- Beres, B.L., Skovmand, B., Randhawa, H.S., Eudes, F., Graf, R.J., and McLeod, G.J. (2012). "Sunray spring triticale.", *Canadian Journal of Plant Science*, 92(2), pp. 363-367. doi : 10.4141/CJPS2011-138
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### Gan, Yantai (Swift Current - pulse, cropping systems)

Research Publications:

2014

- Bainard, L.D., Bainard, J.D., Hamel, C., and Gan, Y.T. (2014). "Spatial and temporal structuring of arbuscular mycorrhizal communities is differentially influenced by abiotic factors and host crop in a semiarid prairie agroecosystem.", *FEMS Microbiology Ecology*. doi : 10.1111/1574-6941.12300

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- Yang, C., Gan, Y.T., Harker, K.N., Kutcher, H.R., Gulden, R.H., Irvine, R.B., May, W.E., and O'Donovan, J.T. (2014). "Up to 32 % yield increase with uniform canola stands in western Canada.", *Agronomy for Sustainable Development* . doi : 0.1007/s13593-014-0218-5

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- Harker, K.N., O'Donovan, J.T., Blackshaw, R.E., Hall, L.M., Willenborg, C.J., Kutcher, H.R., Gan, Y.T., Lafond, G.P., May, W.E., Grant, C.A., Barthet, V., McDonald, T., Wispinski, D., and Hartman, M. (2013). "Effect of agronomic inputs and crop rotation on biodiesel quality and fatty acid profiles of direct-seeded canola.", *Canadian Journal of Plant Science*, 93(4), pp. 577-588. doi : 10.4141/cjps2012-277
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challenges in a semiarid agroecosystem.", *Field Crops Research*, 126(2), pp. 181-188. doi : 10.1016/j.fcr.2011.10.010

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- Gan, Y.T. and Yang, R.-C. (2011). "Advanced statistical tools and their applications to agricultural research: An introduction (Preface).", *Canadian Journal of Plant Science*, 91(4), pp. 599-601. doi : 10.4141/cjps11505
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- Gan, Y.T., Liang, C., Wang, X., and McConkey, B.G. (2011). "Lowering carbon footprint of durum wheat by diversifying cropping systems.", *Field Crops Research*, 122(3), pp. 199-206. doi : 10.1016/j.fcr.2011.03.020
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- Yang, C., Hamel, C., Vujanovic, V., and Gan, Y.T. (2011). "Fungicide: modes of action and possible impact on non-target microorganisms - Review Article", *ISRN Ecology*, 2011(Article ID 130289), pp. 8 pages. doi : 10.5402/2011/130289

**May, Bill (Indian Head)**

## Research Publications:

2014

- Yang, C., Gan, Y.T., Harker, K.N., Kutcher, H.R., Gulden, R.H., Irvine, R.B., May, W.E., and O'Donovan, J.T. (2014). "Up to 32 % yield increase with uniform canola stands in western Canada.", *Agronomy for Sustainable Development*. doi : 0.1007/s13593-014-0218-5

2013

- Harker, K.N., O'Donovan, J.T., Blackshaw, R.E., Hall, L.M., Willenborg, C.J., Kutcher, H.R., Gan, Y.T., Lafond, G.P., May, W.E., Grant, C.A., Barthet, V., McDonald, T., Wispinski, D., and Hartman, M. (2013). "Effect of agronomic inputs and crop rotation on biodiesel quality and fatty acid profiles of direct-seeded canola.", *Canadian Journal of Plant Science*, 93(4), pp. 577-588. doi : 10.4141/cjps2012-277
- Irvine, R.B., Lafond, G.P., May, W.E., Kutcher, H.R., Clayton, G.W., Harker, K.N., Turkington, T.K., and Beres, B.L. (2013). "Stubble options for winter wheat in the Black soil zone of western Canada.", *Canadian Journal of Plant Science*, 93(2), pp. 261-270. doi : 10.4141/CJPS2012-198
- Lafond, G.P., May, W.E., and Holzapfel, C.B. (2013). "Row spacing and nitrogen fertilizer effect on no-till oat production.", *Agronomy Journal*, 105(1), pp. 1-10. doi : 10.2134/agronj2012.0221
- May, W.E., Holzapfel, C.B., Lafond, G.P., and Schoenau, J.J. (2013). "Does the presence of the gene for glabrous hull in annual canarygrass affect the response to chloride Fertilizer?", *Canadian Journal of Plant Science*, 93(1), pp. 109-118. doi : 10.4141/cjps2012-068

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- Edney, M.J., O'Donovan, J.T., Turkington, T.K., Clayton, G.W., McKenzie, R.H., Juskiw, P.E., Lafond, G.P., Brandt, S.A., Grant, C.A., Harker, K.N., Johnson, E.N., and May, W.E. (2012). "Effects of seeding rate, nitrogen rate and cultivar on barley malt quality.", *Journal of the Science of Food and Agriculture*, 92(13), pp. 2672-2678. doi : 10.1002/jsfa.5687
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- Harker, K.N., O'Donovan, J.T., Blackshaw, R.E., Johnson, E.N., Lafond, G.P., and May, W.E. (2012). "Seeding depth and seeding speed effects on no-till canola emergence, maturity, yield and seed quality.", *Canadian Journal of Plant Science*, 92(4), pp. 795-802. doi : 10.4141/CJPS2011-189
- Harker, K.N., O'Donovan, J.T., Turkington, T.K., Blackshaw, R.E., Lupwayi, N.Z., Smith, E.G., Klein-Gebbinck, H.W., Dossdall, L.M., Hall, L.M., Willenborg, C.J., Kutcher, H.R., Malhi, S.S., Vera, C.L., Gan, Y.T., Lafond, G.P., May, W.E., Grant, C.A., and McLaren, D.L. (2012). "High-yield no-till canola production on the Canadian prairies.", *Canadian Journal of Plant Science*, 92(2), pp. 221-233. doi : 10.4141/CJPS2011-125
- Lafond, G.P., Campbell, C.A., Lemke, R.L., May, W.E., and Holzapfel, C.B. (2012). "Indian Head Long Term Crop Rotations: Indian Head Saskatchewan.", *Prairie Soils and Crops*, 5, pp. 42-50.
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- Blackshaw, R.E., Johnson, E.N., Gan, Y.T., May, W.E., McAndrew, D.W., Barthet, V., McDonald, T., and Wispinski, D. (2011). "Alternative oilseed crops for biodiesel feedstock on the Canadian prairies.", *Canadian Journal of Plant Science*, 91(5), pp. 889-896. doi : 10.4141/cjps2011-002
- Campbell, C.A., Lafond, G.P., VandenBygaart, A.J., Zentner, R.P., Lemke, R.L., May, W.E., and Holzapfel, C.B. (2011). "Effect of crop rotation, fertilizer and tillage management on spring wheat grain yield and N and P content in a thin Black Chernozem: A long-term study.", *Canadian Journal of Plant Science*, 91(3), pp. 467-483. doi : 10.4141/cjps10032
- Fernandez, M.R., May, W.E., and Lafond, G.P. (2011). "Effect of fungicide seed treatments on root pathogens of cereal crops under field conditions.", *Canadian Journal of Plant Science*, 90(6), pp. 905-917. doi : 10.4141/CJPS09172
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- Lafond, G.P., Walley, F.L., May, W.E., and Holzapfel, C.B. (2011). "Long term impact of no-till on soil properties and crop productivity on the Canadian prairies.", *Soil & Tillage Research*, 117, pp. 110-123. doi : 10.1016/j.still.2011.09.006
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- Turmel, M.S., Entz, M.H., Tenuta, M., May, W.E., and Lafond, G.P. (2011). "The influence of a long-term black medic (*Medicago lupulina* cv. George) cover crop on arbuscular mycorrhizal fungal colonization and nutrient uptake in flax (*Linum usitatissimum*) under zero-tillage

management.", *Canadian Journal of Plant Science*, 91(6), pp. 1071-1076. doi : 10.4141/cjps10115

### **Mohr, Ramona (Brandon)**

Research Publications:

2013

- Gao, X., Tenuta, M., Nelson, A.G., Sparling, B., Tomasiewicz, D.J., Mohr, R.M., and Bizimungu, B. (2013). "Effect of nitrogen fertilizer rate on nitrous oxide emission from irrigated potato on a clay loam soil in Manitoba, Canada.", *Canadian Journal of Soil Science*, 93(1), pp. 1-11. doi : 10.4141/cjss2012-057

2012

- Mohr, R.M. and Tomasiewicz, D.J. (2012). "Effect of rate and timing of potassium chloride application on the yield and quality of potato (*Solanum tuberosum* L. 'Russet Burbank').", *Canadian Journal of Plant Science*, 92(4), pp. 783-794. doi : 10.4141/CJPS2011-195
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- Buckley, K.E., Therrien, M.C., and Mohr, R.M. (2011). "Agronomic performance of barley cultivars in response to varying rates of swine slurry.", *Canadian Journal of Plant Science*, 91(1), pp. 69-79. doi : 10.4141/CJPS09032
- Gao, X., Mohr, R.M., McLaren, D.L., and Grant, C.A. (2011). "Grain cadmium and zinc concentrations in wheat as affected by genotypic variation and potassium chloride fertilization.", *Field Crops Research*, 122(2), pp. 95-103. doi : 10.1016/j.fcr.2011.03.005
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### **Duguid, Scott (Morden – flax)**

Research Publications:

2014

- Radovanovic, N., Thambugala, D., Duguid, S.D., Loewen, E., and Cloutier, S. (2014). "Heterologous expression of flax fatty acid desaturase isoforms shows functional diversity.", *Molecular Biotechnology*. doi : 10.1007/s12033-014-9737-1
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## Hao, Xiyang (Lethbridge)

### Research Publications:

2014

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**Lemke, Reynald (Saskatoon)**

## Research Publications:

2014

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2013

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2012

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### **Moulin, Alan (Brandon)**

#### Research Publications:

2014

- Moulin, A.P., Glenn, A.J., Tenuta, M., Lobb, D.A., Dunmola, A.S., and Yapa, P. (2014). "Alternative transformations of nitrous oxide soil flux data to normal distributions.", *Canadian Journal of Soil Science*, 94(1), pp. 105-108. doi : 10.4141/CJSS2013-008

2012

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- Li, S., MacMillan, R.A., Lobb, D.A., McConkey, B.G., Moulin, A.P., and Fraser, W. (2011). "Lidar DEM error analyses and topographic depression identification in a hummocky landscape in the prairie region of Canada.", *Geomorphology*, 129(3-4), pp. 263-275. doi : 10.1016/j.geomorph.2011.02.020
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- Moulin, A.P., Buckley, K.E., and Volkmar, K.M. (2011). "Soil quality as affected by amendments in bean-potato rotations.", *Canadian Journal of Soil Science*, 91(4), pp. 533-542. doi : 10.4141/cjss10011
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### **Beef Grazing**

**Baron, Vern (Lacombe - forage agronomy)**

## Research Publications:

2014

- Mapiye, C., Turner, T.D., Basarab, J.A., Baron, V.S., Aalhus, J.L., and Dugan, M.E.R (2014). "Subcutaneous fatty acid composition of steers finished as weanlings or yearlings with and without growth promotants.", *Journal of Animal Science*. doi : 10.1186/2049-1891-4-41

2013

- Basarab, J.A., Beauchemin, K.A., Baron, V.S., Ominski, K.H., Guan, L.L., Miller, S.P., and Crowley, J.J. (2013). "Reducing GHG emissions through genetic improvement for feed efficiency: effects on economically important traits and enteric methane production.", *Animal*, 7(S2), pp. 305-315. doi : 10.1017/S1751731113000888
- Gilmanov, T.G., Wylie, B.K., Tieszen, L.L., Meyers, T.P., Baron, V.S., Bernacchi, C.J., Billesbach, D.P., Burba, G.G., Fischer, M.L., Glenn, A.J., Hanan, N.P., Hatfield, J.L., Heuer, M.W., Hollinger, S.E., Howard, D.M., Matamala, R., Preuger, J.H., Tenuta, M., and Young, D.G. (2013). "CO<sub>2</sub> uptake and ecophysiological parameters of the grain crops of midcontinent North America: Estimates from flux tower measurements.", *Agriculture, Ecosystems and Environment*, 164, pp. 162-175. doi : 10.1016/j.agee.2012.09.017
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- Mapiye, C., Dugan, M.E.R, Turner, T.D., Rolland, D.C., Basarab, J.A., Baron, V.S., McAllister, T.A., Block, H.C., Uttaro, B., and Aalhus, J.L. (2013). "Erythrocytes assayed early ante mortem can predict adipose tissue and muscle *trans*-18:1 isomeric profiles of steers fed red clover silage supplemented with flaxseed.", *Canadian Journal of Animal Science*, 93(1), pp. 149-153. doi : 10.4141/CJAS2012-054
- Mapiye, C., Turner, T.D., Rolland, D., Basarab, J.A., Baron, V.S., McAllister, T.A., Block, H.C., Uttaro, B., Aalhus, J.L., and Dugan, M.E.R (2013). "Adipose tissue and muscle fatty acid profiles of steers fed red clover silage with and without flaxseed.", *Livestock Science*, 151(1), pp. 11-20. doi : 10.1016/j.livsci.2012.10.021

2012

- Baron, V.S., Aasen, A., Oba, M., Dick, A.C., Salmon, D.F., Basarab, J.A., and Stevenson, F.C. (2012). "Swath-Grazing Potential for Small-Grain Species with a Delayed Planting Date.", *Agronomy Journal*, 104(2), pp. 393-404. doi : 10.2134/agronj2011.0234
- Basarab, J.A., Baron, V.S., López-Campos, Ó., Aalhus, J.L., Haugen-Kozyra, K., and Okine, E.K. (2012). "Greenhouse gas emissions from calf- and yearling-fed beef production systems, with

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- López-Campos, Ó., Basarab, J.A., Baron, V.S., Aalhus, J.L., and Juárez, M. (2012). "Reduced age at slaughter in youthful beef cattle: effects on carcass merit traits.", *Canadian Journal of Animal Science*, 92(4), pp. 449-463. doi : 10.4141/CJAS2012-014
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2011

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## **Block, Hushton (Lacombe – forage/grazing systems)**

Research Publications:

2013

- Mapiye, C., Aalhus, J.L., Turner, T.D., Rolland, D.C., Basarab, J.A., McAllister, T.A., Block, H.C., Uttaro, B., López-Campos, Ó., Proctor, S.D., and Dugan, M.E.R (2013). "Effects of feeding flaxseed or sunflower-seed in high-forage diets on beef production, quality and fatty acid composition.", *Meat Science*, 95(1), pp. 98-109. doi : 10.1016/j.meatsci.2013.03.033

- Mapiye, C., Dugan, M.E.R, Turner, T.D., Rolland, D.C., Basarab, J.A., Baron, V.S., McAllister, T.A., Block, H.C., Uttaro, B., and Aalhus, J.L. (2013). "Erythrocytes assayed early ante mortem can predict adipose tissue and muscle *trans*-18:1 isomeric profiles of steers fed red clover silage supplemented with flaxseed.", *Canadian Journal of Animal Science*, 93(1), pp. 149-153. doi : 10.4141/CJAS2012-054
- Mapiye, C., Turner, T.D., Rolland, D., Basarab, J.A., Baron, V.S., McAllister, T.A., Block, H.C., Uttaro, B., Aalhus, J.L., and Dugan, M.E.R (2013). "Adipose tissue and muscle fatty acid profiles of steers fed red clover silage with and without flaxseed.", *Livestock Science*, 151(1), pp. 11-20. doi : 10.1016/j.livsci.2012.10.021
- Rosser, C.L., Górká, P., Beattie, A.D., Block, H.C., McKinnon, C.M., Lardner, H.A., and Penner, G.B. (2013). "Effect of Maturity at Harvest on Yield, Chemical Composition, and In Situ Degradability for Annual Cereals used for Swathgrazing.", *Journal of Animal Science*. doi : 10.2527/jas.2012-5677

2012

- Amat, S., Hendrick, S., McAllister, T.A., Block, H.C., and McKinnon, J.J. (2012). "Effects of distillers' dried grains with solubles from corn, wheat or a 50:50 corn:wheat blend on performance, carcass characteristics and serum sulphate levels of feedlot steers.", *Canadian Journal of Animal Science*, 92(3), pp. 343-351. doi : 10.4141/cjas2011-127
- Legesse, G., Small, J.A., Scott, S.L., Kebreab, E., Crow, G.H., Block, H.C., Robins, C.D., Khakbazan, M., and McCaughey, W.P. (2012). "Bioperformance evaluation of various summer pasture and winter feeding strategies for cow-calf production.", *Canadian Journal of Animal Science*, 92(1), pp. 89-102. doi : 10.4141/CJAS2011-082

2011

- Legesse, G., Small, J.A., Scott, S.L., Crow, G.H., Block, H.C., Alemu, A.W., Robins, C.D., and Kebreab, E. (2011). "Predictions of enteric methane emissions for various summer pasture and winter feeding strategies for cow calf production.", *Animal Feed Science and Technology*, 166-167, pp. 678-687. doi : 10.1016/j.anifeedsci.2011.04.082

## **Range Management**

### **Schellenberg, Michael (Swift Current)**

Research Publications:

2014

- Klabi, R., Hamel, C., Schellenberg, M.P., Iwaasa, A.D., Raies, A., and St-Amaud, M. (2014). "Interaction between legume and arbuscular mycorrhizal fungi identity alters the competitive ability of warm-season grass species in a grassland community.", *Soil Biology & Biochemistry*, 70, pp. 176-182. doi : 10.1016/j.soilbio.2013.12.019

2013

- Biligetu, B. and Schellenberg, M.P. (2013). "Forage quality variation among accessions of warm-season grasses of North America during summer of semiarid Western Canada.", The future of Rangeland Fire in a Changing World, SRM-AGM, Oklahoma City, Oklahoma, USA, February 2-8, 2013.



- Biligetü, B., Schellenberg, M.P., and Fu, Y.B. (2013). "Genetic diversity of side-oats grama [*Bouteloua curtipendula* (Michx.) Torr.] populations as revealed by AFLP markers.", *Canadian Journal of Plant Science*, 93, pp. 1105-1114.
- Jin, L., Wang, Y., Iwaasa, A.D., Xu, Z., Schellenberg, M.P., Zhang, Y.G., and McAllister, T.A. (2013). "Effect of condensed tannin on *in vitro* ruminal fermentation of purple prairie clover (*Dalea purpurea* Vent)-cool season grass mixture.", *Canadian Journal of Animal Science*, 93(1), pp. 155-158. doi : 10.4141/CJAS2012-109
- Mischkolz, J.M., Schellenberg, M.P., and Lamb, E.G. (2013). "Early productivity and crude protein content of establishing forage swards composed of combinations of native grass and legume species in mixed-grassland ecoregions.", *Canadian Journal of Plant Science*, 93(3), pp. 445-454. doi : 10.4141/CJPS2012-261
- Schellenberg, M.P. and Biligetü, B. (2013). "What should be in a recommended reseeding mixture?", The future of Rangeland Fire in a Changing World, SRM-AGM, Oklahoma City, Oklahoma, USA, February 2-8, 2013, Abstract and Poster B5.
- Schellenberg, M.P., Biligetü, B., Lamb, E.G., and Mischkolz, J.M. (2013). "World interest in diverse native plants.", 22nd International Grasslands Congress 2013, Sydney, New South Wales, Australia, September 15-19, 2013, pp. 355-358.
- Schellenberg, M.P., Biligetü, B., and Picasso, V. (2013). "Mixed species seeding: A means to increase production in temperate pastures.", 22nd International Grasslands Congress 2013, Sydney, New South Wales, Australia, September 15-19, 2013, pp. 483-484.
- Schellenberg, M.P., Biligetü, B., and Wei, Y. (2013). "Predicting seed germination of slender wheatgrass [*Elymus trachycaulus* (link) Gould subsp. *Trachycaulus*] using thermal and hydro time models.", *Canadian Journal of Plant Science*, 93(5), pp. 793-798. doi : 10.4141/CJPS2013-028

## 2012

- Iwaasa, A.D., Schellenberg, M.P., and McConkey, B.G. (2012). "Re-establishment of Native Mixed Grassland Species into Annual Cropping Land.", *Prairie Soils and Crops*, 5, pp. 85-95.
- Jin, L., Wang, Y., Iwaasa, A.D., Xu, Z.J., Schellenberg, M.P., Zhang, Y.G., Liu, X.-L., and McAllister, T.A. (2012). "Effect of condensed tannins on ruminal degradability of purple prairie clover (*Dalea purpurea* Vent.) harvested at two growth stages.", *Animal Feed Science and Technology*, 176(1-4), pp. 17-25. doi : 10.1016/j.anifeedsci.2012.07.003
- Schellenberg, M.P., Biligetü, B., McLeod, G.J., and Wang, Z. (2012). "Phenotypic variation of side-oats grama grass (*Bouteloua curtipendula* (Michx.) Torr.) collections from the Canadian prairie.", *Canadian Journal of Plant Science*, 92(6), pp. 1043-1048. doi : 10.4141/cjps2011-142
- Schellenberg, M.P., Biligetü, B., and Iwaasa, A.D. (2012). "Species dynamic, forage yield, and nutritive value of seeded native plant mixtures following grazing.", *Canadian Journal of Plant Science*, 92(4), pp. 699-706. doi : 10.4141/CJPS2011-273
- Wang, Z. and Schellenberg, M.P. (2012). "Drought and N addition in a greenhouse experiment: blue grama and western wheatgrass.", *Journal of Agricultural Science and Technology B*, 2(1B), pp. 29-37.
- Wang, Z., Schellenberg, M.P., Biligetü, B., Zhao, M.G., and Han, G.D. (2012). "Forage mixture responses to water stress in semi-arid prairie grassland: A pot experiment.", *Canadian Journal of Plant Science*, 92(7), pp. 1259-1261. doi : 10.4141/cjps2011-283

## 2011

- Biligetü, B., Schellenberg, M.P., and McLeod, G.J. (2011). "The effect of temperature and water potential on seed germination of poly-cross side-oats grama (*Bouteloua curtipendula* (Michx.) Torr.) population of Canadian prairie.", *Seed Science and Technology*, 39(1), pp. 74-81.
- Tadevosyan, A.H., Mayrapetyan, S.K., Schellenberg, M.P., Ghalachyan, L.M., Hovsepyan, A.H., and Mayrapetyan, K.S. (2011). "Migration and Accumulation of Artificial Radionuclides in the System Water-Soil-Plants Depending on Polymers Applying.", *World Academy of Science, Engineering and Technology*, 78(54), pp. 79-82.

## CROPPING MICROMETEOROLOGY

### Cutforth, Herb (Swift Current)

Research Publications:

2013

- Cutforth, H.W. (2013). "Agricultural meteorology and crop production on the Canadian Prairie: solar radiation, temperature and water.", *Prairie Soils and Crops*, 6, pp. 78-86.
- Cutforth, H.W. (2013). "Yield of spring wheat and field pea seeded into standing and cultivated canola stubble on the semiarid Canadian prairie.", *Canadian Journal of Plant Science*, 93(2), pp. 287-289. doi : 10.4141/cjps2012-049
- Cutforth, H.W., Angadi, S.V., McConkey, B.G., Miller, P.R., Ulrich, D.J., Gulden, R.H., Volkmar, K.M., Entz, M.H., and Brandt, S.A. (2013). "Comparing rooting characteristics and soil water withdrawal patterns of wheat with alternative oilseed and pulse crops grown in the semiarid Canadian prairie.", *Canadian Journal of Soil Science*, 93(2), pp. 147-160. doi : 10.4141/cjss2012-081
- Fouli, Y., Cade-Menun, B.J., and Cutforth, H.W. (2013). "Freeze thaw cycles and soil water content effects on infiltration rate and bulk density of three Saskatchewan soils.", *Canadian Journal of Soil Science*, 93(4), pp. 485-496. doi : 10.4141/cjss2012-060

2012

- Cutforth, H.W. and Judiesch, D. (2012). "Temperature trends in southwestern Saskatchewan revisited.", *Canadian Journal of Soil Science*, 92(5), pp. 803-806. doi : 10.4141/CJSS2012-015
- He, Y., Wang, H., Qian, B., McConkey, B.G., Cutforth, H.W., Lemke, R.L., DePauw, R.M., Brandt, K., Hu, K.L., and Hoogenboom, G. (2012). "Effects of climate change on killing frost in the Canadian prairies.", *Climate Research*, 54(3), pp. 221-231. doi : 10.3354/cr01114
- Wang, H., He, Y., Qian, B., McConkey, B.G., Cutforth, H.W., McCaig, T.N., McLeod, G.J., Zentner, R.P., DePauw, R.M., Lemke, R.L., Brandt, K., Liu, T.T., Qin, X., White, J., Hunt, T., and Hoogenboom, G. (2012). "Climate change and biofuel wheat: A case study of southern Saskatchewan.", *Canadian Journal of Plant Science*, 92(3), pp. 421-425. doi : 10.4141/CJPS2011-192

2011

- Cutforth, H.W., McConkey, B.G., Angadi, S.V., and Judiesch, D. (2011). "Extra-tall stubble can increase crop yield in the semiarid Canadian prairie.", *Canadian Journal of Plant Science*, 91(4), pp. 783-785. doi : 10.4141/cjps10168

- Gan, Y.T., Liang, C., Hamel, C., Cutforth, H.W., and Wang, H. (2011). "Strategies for reducing the carbon footprint of field crops for semiarid areas. A review.", *Agronomy for Sustainable Development*, 31(4), pp. 643-656. doi : 10.1007/s13593-011-0011-7
- Gan, Y.T., Liu, L., Cutforth, H.W., Wang, X-Y., and Ford, G. (2011). "Vertical distribution profiles and temporal growth patterns of roots in selected oilseeds, pulses and spring wheat.", *Crop & Pasture Science*, 62(6), pp. 457-466. doi : 10.1071/CP10406

## Glenn, Aaron (Brandon)

### Research Publications:

2014

- Gilmanov, T.G., Baker, J., Bernacchi, C.J., Billesbach, D.P., Burba, G.G., Castro, S., Chen, J., Eugster, W., Fischer, M.L., Gamon, J.A., Gebremedhin, M.T., Glenn, A.J., Griffis, T.J., Hatfield, J.L., Heuer, M.W., Howard, D.M., Leclerc, M.Y., Loescher, H.W., Marloie, O., Meyers, T.P., Oliso, A., Phillips, R.L., Prueger, J.H., Skinner, R.H., Suyker, A.E., Tenuta, M., and Wylie, B.K. (2014). "Productivity and carbon dioxide exchange of the leguminous crops: Estimates from flux tower measurements.", *Agronomy Journal*, 106(2), pp. 545-559. doi : 10.2134/agronj2013.0270
- Moulin, A.P., Glenn, A.J., Tenuta, M., Lobb, D.A., Dunmola, A.S., and Yapa, P. (2014). "Alternative transformations of nitrous oxide soil flux data to normal distributions.", *Canadian Journal of Soil Science*, 94(1), pp. 105-108. doi : 10.4141/CJSS2013-008

2013

- Gilmanov, T.G., Wylie, B.K., Tieszen, L.L., Meyers, T.P., Baron, V.S., Bernacchi, C.J., Billesbach, D.P., Burba, G.G., Fischer, M.L., Glenn, A.J., Hanan, N.P., Hatfield, J.L., Heuer, M.W., Hollinger, S.E., Howard, D.M., Matamala, R., Preuger, J.H., Tenuta, M., and Young, D.G. (2013). "CO<sub>2</sub> uptake and ecophysiological parameters of the grain crops of midcontinent North America: Estimates from flux tower measurements.", *Agriculture, Ecosystems and Environment*, 164, pp. 162-175. doi : 10.1016/j.agee.2012.09.017
- Maas, S.E., Glenn, A.J., Tenuta, M., and Amiro, B.D. (2013). "Net CO<sub>2</sub> and N<sub>2</sub>O exchange during perennial forage establishment in an annual crop rotation in the Red River Valley, Manitoba.", *Canadian Journal of Soil Science*, 93(5), pp. 639-652. doi : 10.4141/CJSS2013-025

2012

- Glenn, A.J., Tenuta, M., Amiro, B.D., Maas, S.E., and Wagner-Riddle, C. (2012). "Nitrous oxide emissions from an annual crop rotation on poorly drained soil on the Canadian Prairies.", *Agricultural and Forest Meteorology*, 166-167, pp. 41-49. doi : 10.1016/j.agrformet.2012.06.015

2011

- Glenn, A.J., Amiro, B.D., Tenuta, M., Wagner-Riddle, C., Drewitt, G.B., and Warland, J.S. (2011). "Contribution of crop residue carbon to soil respiration at a northern Prairie site using stable isotope flux measurements.", *Agricultural and Forest Meteorology*, 151(8), pp. 1045-1054. doi : 10.1016/j.agrformet.2011.03.008

## WEEDS

### Harker, K. Neil (Lacombe)

#### Research Publications:

## 2014

- Yang, C., Gan, Y.T., Harker, K.N., Kutcher, H.R., Gulden, R.H., Irvine, R.B., May, W.E., and O'Donovan, J.T. (2014). "Up to 32 % yield increase with uniform canola stands in western Canada.", *Agronomy for Sustainable Development*. doi : 0.1007/s13593-014-0218-5

## 2013

- Harker, K.N. (2013). "Slowing weed evolution with integrated weed management.", *Canadian Journal of Plant Science*, 93(5), pp. 759-764. doi : 10.4141/cjps2013-049
- Harker, K.N. and O'Donovan, J.T. (2013). "Recent weed control, weed management, and integrated weed management.", *Weed Technology*, 27(1), pp. 1-11. doi : 10.1614/wt-d-12-00109.1
- Harker, K.N., O'Donovan, J.T., Blackshaw, R.E., Hall, L.M., Willenborg, C.J., Kutcher, H.R., Gan, Y.T., Lafond, G.P., May, W.E., Grant, C.A., Barthet, V., McDonald, T., Wispinski, D., and Hartman, M. (2013). "Effect of agronomic inputs and crop rotation on biodiesel quality and fatty acid profiles of direct-seeded canola.", *Canadian Journal of Plant Science*, 93(4), pp. 577-588. doi : 10.4141/cjps2012-277
- Harker, K.N., O'Donovan, J.T., Turkington, T.K., Blackshaw, R.E., Johnson, E.N., Brandt, S.A., Kutcher, H.R., and Clayton, G.W. (2013). "Weed interference impacts and yield recovery after four years of variable crop inputs in no-till barley and canola.", *Weed Technology*, 27(2), pp. 281-290. doi : 10.1614/WT-D-12-00115.1
- Irvine, R.B., Lafond, G.P., May, W.E., Kutcher, H.R., Clayton, G.W., Harker, K.N., Turkington, T.K., and Beres, B.L. (2013). "Stubble options for winter wheat in the Black soil zone of western Canada.", *Canadian Journal of Plant Science*, 93(2), pp. 261-270. doi : 10.4141/CJPS2012-198
- Khakbazan, M., Grant, C.A., Finlay, G., Wu, R.G., Malhi, S.S., Selles, F., Clayton, G.W., Lupwayi, N.Z., Soon, Y.K., and Harker, K.N. (2013). "An economic study of controlled release urea and split applications of nitrogen as compared with non-coated urea under conventional and reduced tillage management.", *Canadian Journal of Plant Science*, 93(3), pp. 523-534. doi : 10.4141/CJPS2012-107
- Kutcher, H.R., Turkington, T.K., Clayton, G.W., and Harker, K.N. (2013). "Response of herbicide-tolerant canola (*Brassica napus* L.) cultivars to four row spacings and three seeding rates in a no-till production system.", *Canadian Journal of Plant Science*, 93(6), pp. 1229-1236. doi : 10.4141/cjps2013-173
- O'Donovan, J.T., Harker, K.N., Turkington, T.K., and Clayton, G.W. (2013). "Combining cultural practices with herbicides reduces wild oat (*Avena fatua*) seed in the soil seed bank and improves barley yield.", *Weed Science*, 61(2), pp. 328-333. doi : 10.1614/WS-D-12-00168.1
- St. Luce, M., Ziadi, N., Zebarth, B.J., Whalen, J.K., Grant, C.A., Gregorich, E.G., Lafond, G.P., Blackshaw, R.E., Johnson, E.N., O'Donovan, J.T., and Harker, K.N. (2013). "Particulate organic matter and soil mineral nitrogen concentrations are good predictors of the soil nitrogen supply to canola following legume and non-legume crops in western Canada.", *Canadian Journal of Soil Science*, 93(5), pp. 607-620. doi : 10.4141/cjss2013-005

## 2012

- Dosdall, L.M., Harker, K.N., O'Donovan, J.T., Blackshaw, R.E., Kutcher, H.R., Gan, Y.T., and Johnson, E.N. (2012). "Crop Sequence Effects on Root Maggot (Diptera: Anthomyiidae: *Delia* spp.) Infestations in Canola.", *Journal of Economic Entomology*, 105(4), pp. 1261-1267. doi : 10.1603/EC11440

- Edney, M.J., O'Donovan, J.T., Turkington, T.K., Clayton, G.W., McKenzie, R.H., Juskiw, P.E., Lafond, G.P., Brandt, S.A., Grant, C.A., Harker, K.N., Johnson, E.N., and May, W.E. (2012). "Effects of seeding rate, nitrogen rate and cultivar on barley malt quality.", *Journal of the Science of Food and Agriculture*, 92(13), pp. 2672-2678. doi : 10.1002/jsfa.5687
- Grant, C.A., Wu, R.G., Selles, F., Harker, K.N., Clayton, G.W., Bittman, S., Zebarth, B.J., and Lupwayi, N.Z. (2012). "Crop yield and nitrogen concentration with controlled release urea and split applications of nitrogen as compared to non-coated urea applied at seeding", *Field Crops Research*, 127(27), pp. 170-180. doi : 10.1016/j.fcr.2011.11.002
- Harker, K.N., O'Donovan, J.T., Blackshaw, R.E., Beckie, H.J., Mallory-Smith, C., and Maxwell, B.D. (2012). "Our view.", *Weed Science*, 60(2), pp. 143-144. doi : 10.1614/WS-D-11-00177.1
- Harker, K.N., O'Donovan, J.T., Blackshaw, R.E., Johnson, E.N., Lafond, G.P., and May, W.E. (2012). "Seeding depth and seeding speed effects on no-till canola emergence, maturity, yield and seed quality.", *Canadian Journal of Plant Science*, 92(4), pp. 795-802. doi : 10.4141/CJPS2011-189
- Harker, K.N., O'Donovan, J.T., Turkington, T.K., Blackshaw, R.E., Lupwayi, N.Z., Smith, E.G., Klein-Gebbinck, H.W., Dosedall, L.M., Hall, L.M., Willenborg, C.J., Kutcher, H.R., Malhi, S.S., Vera, C.L., Gan, Y.T., Lafond, G.P., May, W.E., Grant, C.A., and McLaren, D.L. (2012). "High-yield no-till canola production on the Canadian prairies.", *Canadian Journal of Plant Science*, 92(2), pp. 221-233. doi : 10.4141/CJPS2011-125
- Hummel, J.D., Dosedall, L.M., Clayton, G.W., Harker, K.N., and O'Donovan, J.T. (2012). "Ground Beetle (Coleoptera: Carabidae) Diversity, Activity Density, and Community Structure in a Diversified Agroecosystem.", *Environmental Entomology*, 41(1), pp. 72-80. doi : 10.1603/EN11072
- Li, C.L., Hao, X., Blackshaw, R.E., O'Donovan, J.T., Harker, K.N., and Clayton, G.W. (2012). "Nitrous oxide emissions in response to ESN and urea, herbicide management and canola cultivar in a no-till cropping system.", *Soil & Tillage Research*, 118, pp. 97-106. doi : 10.1016/j.still.2011.10.017
- O'Donovan, J.T., Turkington, T.K., Edney, M.J., Juskiw, P.E., McKenzie, R.H., Harker, K.N., Clayton, G.W., Lafond, G.P., Grant, C.A., Brandt, S.A., Johnson, E.N., May, W.E., and Smith, E.G. (2012). "Effect of seeding date and seeding rate on malting barley production in western Canada.", *Canadian Journal of Plant Science*, 92(2), pp. 321-330. doi : 10.4141/cjps2011-130
- Smith, E.G., O'Donovan, J.T., Henderson, W.J., Turkington, T.K., McKenzie, R.H., Harker, K.N., Clayton, G.W., Juskiw, P.E., Lafond, G.P., Brandt, S.A., Edney, M.J., Johnson, E.N., and May, W.E. (2012). "Net return risk for malting barley production in Western Canada as influenced by production strategies.", *Agronomy Journal*, 104(5), pp. 1374-1382. doi : 10.2134/agronj2011.0416
- Turkington, T.K., O'Donovan, J.T., Edney, M.J., Juskiw, P.E., McKenzie, R.H., Harker, K.N., Clayton, G.W., Xi, K., Lafond, G.P., Irvine, R.B., Brandt, S.A., Johnson, E.N., May, W.E., and Smith, E.G. (2012). "Effect of crop residue, nitrogen rate and fungicide application on malting barley productivity, quality, and foliar disease severity.", *Canadian Journal of Plant Science*, 92(3), pp. 577-588. doi : 10.4141/CJPS2011-216

## 2011

- Beckie, H.J., Harker, K.N., Hall, L.M., Holm, F.A., and Gulden, R.H. (2011). "Risk assessment of glyphosate resistance in western Canada.", *Weed Technology*, 25(1), pp. 159-164. doi : 10.1614/wt-d-10-00080.1

- Beckie, H.J., Warwick, S.I., Sauder, I.C.A., Hall, L.M., Harker, K.N., and Lozinski, C. (2011). "Pollen-mediated gene flow in commercial fields of spring wheat in Western Canada.", *Crop Science*, 51(1), pp. 306-313. doi : 10.2135/cropsci2010.03.0176
- Blackshaw, R.E., Hao, X., Brandt, R.N., Clayton, G.W., Harker, K.N., O'Donovan, J.T., Johnson, E.N., and Vera, C.L. (2011). "Canola response to ESN and urea in a four-year no-till cropping system.", *Agronomy Journal*, 103(1), pp. 92-99. doi : 10.2134/agronj2010.0299
- Blackshaw, R.E., Hao, X., Harker, K.N., O'Donovan, J.T., Johnson, E.N., and Vera, C.L. (2011). "Barley productivity response to polymer-coated urea in a no-till production system.", *Agronomy Journal*, 103(4), pp. 1100-1105. doi : 10.2134/agronj2010.0494
- Harker, K.N., O'Donovan, J.T., Blackshaw, R.E., Johnson, E.N., Holm, F.A., and Clayton, G.W. (2011). "Environmental effects on the relative competitive ability of canola and small-grain cereals in a direct-seeded system.", *Weed Science*, 59(3), pp. 404-415. doi : 10.1614/WS-D-10-00121.1
- Kosinski, S.M., King, J.R., Harker, K.N., Turkington, T.K., and Spaner, D.M. (2011). "Barley and triticale underseeded with a kura clover living mulch: Effects on weed pressure, disease incidence, silage yield, and forage quality.", *Canadian Journal of Plant Science*, 91(4), pp. 667-687. doi : 10.4141/CJPS10138
- O'Donovan, J.T., Turkington, T.K., Edney, M.J., Clayton, G.W., McKenzie, R.H., Juskiw, P.E., Lafond, G.P., Grant, C.A., Brandt, S.A., Harker, K.N., Johnson, E.N., and May, W.E. (2011). "Seeding Rate, Nitrogen Rate, and Cultivar Effects on Malting Barley Production.", *Agronomy Journal*, 103(3), pp. 709-716. doi : 10.2134/agronj2010.0490

## **Blackshaw, Robert (Lethbridge)**

### **Research Publications:**

2013

- Beckie, H.J., Blackshaw, R.E., Low, R., Hall, L.M., Sauder, I.C.A., Martin, S.L., Brandt, R.N., and Shirriff, S. (2013). "Glyphosate- and acetolactate synthase inhibitor-resistant kochia (*Kochia scoparia*) in Western Canada.", *Weed Science*, 61(2), pp. 310-318. doi : 10.1614/WS-D-12-00140.1
- Benerfer, C.M., van Herk, W.G., Ellis, J.S., Blackshaw, R.E., Vernon, R.S., and Knight, M.E. (2013). "The molecular identification and genetic diversity of economically important wireworm species (Coleoptera: Elateridae) in Canada.", *Journal of Pest Science*, 86(1), pp. 19-27. doi : 10.1007/s10340-012-0454-x
- Harker, K.N., O'Donovan, J.T., Blackshaw, R.E., Hall, L.M., Willenborg, C.J., Kutcher, H.R., Gan, Y.T., Lafond, G.P., May, W.E., Grant, C.A., Barthet, V., McDonald, T., Wispinski, D., and Hartman, M. (2013). "Effect of agronomic inputs and crop rotation on biodiesel quality and fatty acid profiles of direct-seeded canola.", *Canadian Journal of Plant Science*, 93(4), pp. 577-588. doi : 10.4141/cjps2012-277
- Harker, K.N., O'Donovan, J.T., Turkington, T.K., Blackshaw, R.E., Johnson, E.N., Brandt, S.A., Kutcher, H.R., and Clayton, G.W. (2013). "Weed interference impacts and yield recovery after four years of variable crop inputs in no-till barley and canola.", *Weed Technology*, 27(2), pp. 281-290. doi : 10.1614/WT-D-12-00115.1
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- Li, C.L., Hao, X., Blackshaw, R.E., O'Donovan, J.T., Harker, K.N., and Clayton, G.W. (2012). "Nitrous oxide emissions in response to ESN and urea, herbicide management and canola cultivar in a no-till cropping system.", *Soil & Tillage Research*, 118, pp. 97-106. doi : 10.1016/j.still.2011.10.017
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- Blackshaw, R.E., Hao, X., Harker, K.N., O'Donovan, J.T., Johnson, E.N., and Vera, C.L. (2011). "Barley productivity response to polymer-coated urea in a no-till production system.", *Agronomy Journal*, 103(4), pp. 1100-1105. doi : 10.2134/agronj2010.0494
- Blackshaw, R.E., Johnson, E.N., Gan, Y.T., May, W.E., McAndrew, D.W., Barthet, V., McDonald, T., and Wispinski, D. (2011). "Alternative oilseed crops for biodiesel feedstock on the Canadian prairies.", *Canadian Journal of Plant Science*, 91(5), pp. 889-896. doi : 10.4141/cjps2011-002
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and Health, Part B: Pesticides, Food Contaminants, and Agricultural Wastes, 46(7), pp. 590-599.  
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## Johnson, Eric (Scott)

Research Publications:

2013

- Harker, K.N., O'Donovan, J.T., Turkington, T.K., Blackshaw, R.E., Johnson, E.N., Brandt, S.A., Kutcher, H.R., and Clayton, G.W. (2013). "Weed interference impacts and yield recovery after four years of variable crop inputs in no-till barley and canola.", *Weed Technology*, 27(2), pp. 281-290. doi : 10.1614/WT-D-12-00115.1
- Légère, A., Stevenson, F.C., Beckie, H.J., Warwick, S.I., Johnson, E.N., Hrynewich, B.L., and Lozinski, C. (2013). "Growth characterization of kochia (*Kochia scoparia*) with substitutions at Pro<sub>197</sub> or Trp<sub>574</sub> conferring resistance to acetolactate synthase-inhibiting herbicides.", *Weed Science*, 61(2), pp. 267-276. doi : 10.1614/WS-D-12-00116.1
- Séguin-Swartz, G.T., Beckie, H.J., Warwick, S.I., Roslinsky, V., Nettleton, J.A., Johnson, E.N., and Falk, K.C. (2013). "Pollen-mediated gene flow between glyphosate-resistant *Brassica napus* canola and *B. juncea* and *B. carinata* mustard crops under large-scale field conditions in Saskatchewan.", *Canadian Journal of Plant Science*, 93(6), pp. 1083-1087. doi : 10.4141/cjps2013-129
- St. Luce, M., Ziadi, N., Zebarth, B.J., Whalen, J.K., Grant, C.A., Gregorich, E.G., Lafond, G.P., Blackshaw, R.E., Johnson, E.N., O'Donovan, J.T., and Harker, K.N. (2013). "Particulate organic matter and soil mineral nitrogen concentrations are good predictors of the soil nitrogen supply to canola following legume and non-legume crops in western Canada.", *Canadian Journal of Soil Science*, 93(5), pp. 607-620. doi : 10.4141/cjss2013-005

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- Dosedall, L.M., Harker, K.N., O'Donovan, J.T., Blackshaw, R.E., Kutcher, H.R., Gan, Y.T., and Johnson, E.N. (2012). "Crop Sequence Effects on Root Maggot (Diptera: Anthomyiidae: *Delia* spp.) Infestations in Canola.", *Journal of Economic Entomology*, 105(4), pp. 1261-1267. doi : 10.1603/EC11440
- Edney, M.J., O'Donovan, J.T., Turkington, T.K., Clayton, G.W., McKenzie, R.H., Juskiw, P.E., Lafond, G.P., Brandt, S.A., Grant, C.A., Harker, K.N., Johnson, E.N., and May, W.E. (2012). "Effects of seeding rate, nitrogen rate and cultivar on barley malt quality.", *Journal of the Science of Food and Agriculture*, 92(13), pp. 2672-2678. doi : 10.1002/jsfa.5687
- Harker, K.N., O'Donovan, J.T., Blackshaw, R.E., Johnson, E.N., Lafond, G.P., and May, W.E. (2012). "Seeding depth and seeding speed effects on no-till canola emergence, maturity, yield and seed quality.", *Canadian Journal of Plant Science*, 92(4), pp. 795-802. doi : 10.4141/CJPS2011-189
- Lemke, R.L., Malhi, S.S., Johnson, E.N., Brandt, S.A., Zentner, R.P., and Olfert, O.O. (2012). "Alternative Cropping Systems Study - Scott, Saskatchewan.", *Prairie Soils and Crops*, 5, pp. 74-84.



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- Szmigielski, A.M., Schoenau, J.J., Johnson, E.N., Holm, F.A., Sapsford, K.L., and Liu, J. (2012). "Effects of Soil Factors on Phytotoxicity and Dissipation of Sulfentrazone in Canadian Prairie Soils.", *Communications in Soil Science and Plant Analysis*, 43(6), pp. 896-904. doi : 10.1080/00103624.2012.653025
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- Turkington, T.K., O'Donovan, J.T., Edney, M.J., Juskiw, P.E., McKenzie, R.H., Harker, K.N., Clayton, G.W., Xi, K., Lafond, G.P., Irvine, R.B., Brandt, S.A., Johnson, E.N., May, W.E., and Smith, E.G. (2012). "Effect of crop residue, nitrogen rate and fungicide application on malting barley productivity, quality, and foliar disease severity.", *Canadian Journal of Plant Science*, 92(3), pp. 577-588. doi : 10.4141/CJPS2011-216

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- Blackshaw, R.E., Hao, X., Brandt, R.N., Clayton, G.W., Harker, K.N., O'Donovan, J.T., Johnson, E.N., and Vera, C.L. (2011). "Canola response to ESN and urea in a four-year no-till cropping system.", *Agronomy Journal*, 103(1), pp. 92-99. doi : 10.2134/agronj2010.0299
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- Fedoruk, L.K., Johnson, E.N., and Shirliffe, S.J. (2011). "The critical period of weed control for lentil in Western Canada.", *Weed Science*, 59(4), pp. 517-526. doi : 10.1614/WS-D-11-00051.1
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- O'Donovan, J.T., Turkington, T.K., Edney, M.J., Clayton, G.W., McKenzie, R.H., Juskiw, P.E., Lafond, G.P., Grant, C.A., Brandt, S.A., Harker, K.N., Johnson, E.N., and May, W.E. (2011). "Seeding Rate, Nitrogen Rate, and Cultivar Effects on Malting Barley Production.", *Agronomy Journal*, 103(3), pp. 709-716. doi : 10.2134/agronj2010.0490

**Beckie, Hugh (Saskatoon)**

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2013

- Beckie, H.J., Blackshaw, R.E., Low, R., Hall, L.M., Sauder, I.C.A., Martin, S.L., Brandt, R.N., and Shirriff, S. (2013). "Glyphosate- and acetolactate synthase inhibitor-resistant kochia (*Kochia scoparia*) in Western Canada.", *Weed Science*, 61(2), pp. 310-318. doi : 10.1614/WS-D-12-00140.1
- Beckie, H.J., Lozinski, C., Shirriff, S., and Brenzil, C.A. (2013). "Herbicide-resistant weeds in the canadian prairies: 2007 to 2011.", *Weed Technology*, 27(1), pp. 171-183. doi : 10.1614/wt-d-12-00095.1
- Légère, A., Stevenson, F.C., Beckie, H.J., Warwick, S.I., Johnson, E.N., Hrynewich, B.L., and Lozinski, C. (2013). "Growth characterization of kochia (*Kochia scoparia*) with substitutions at Pro<sub>197</sub> or Trp<sub>574</sub> conferring resistance to acetolactate synthase-inhibiting herbicides.", *Weed Science*, 61(2), pp. 267-276. doi : 10.1614/WS-D-12-00116.1
- Séguin-Swartz, G.T., Beckie, H.J., Warwick, S.I., Roslinsky, V., Nettleton, J.A., Johnson, E.N., and Falk, K.C. (2013). "Pollen-mediated gene flow between glyphosate-resistant *Brassica napus* canola and *B. juncea* and *B. carinata* mustard crops under large-scale field conditions in Saskatchewan.", *Canadian Journal of Plant Science*, 93(6), pp. 1083-1087. doi : 10.4141/cjps2013-129

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- Beckie, H.J. and Shirriff, S. (2012). "Site-specific wild oat (*Avena fatua* L.) management.", *Canadian Journal of Plant Science*, 92(5), pp. 923-931. doi : 10.4141/cjps2012-007
- Beckie, H.J. and Tardif, F.J. (2012). "Herbicide cross resistance in weeds.", *Crop Protection*, 35, pp. 15-28. doi : 10.1016/j.cropro.2011.12.018
- Beckie, H.J., Francis, A., and Hall, L.M. (2012). "The Biology of Canadian Weeds. 27. *Avena fatua* L. (updated).", *Canadian Journal of Plant Science*, 92(7), pp. 1329-1357. doi : 10.4141/cjps2012-005
- Beckie, H.J., Johnson, E.N., and Légère, A. (2012). "Negative cross-resistance of acetolactate synthase inhibitor-resistant kochia (*Kochia scoparia*) to protoporphyrinogen oxidase and hydroxyphenylpyruvate dioxygenase-inhibiting herbicides.", *Weed Technology*, 26(3), pp. 570-574. doi : 10.1614/WT-D-12-00020.1
- Beckie, H.J., Warwick, S.I., Sauder, I.C.A., Kelln, G.M., and Lozinski, C. (2012). "Acetolactate Synthase Inhibitor-Resistant False Cleavers (*Galium spurium*) in Western Canada.", *Weed Technology*, 26(1), pp. 151-155. doi : 10.1614/WT-D-11-00075.1
- Beckie, H.J., Warwick, S.I., and Sauder, I.C.A. (2012). "Acetolactate Synthase (ALS) Inhibitor-Resistant Wild Buckwheat (*Polygonum convolvulus*) in Alberta.", *Weed Technology*, 26(1), pp. 156-160. doi : 10.1614/WT-D-11-00096.1
- Beckie, H.J., Warwick, S.I., and Sauder, I.C.A. (2012). "Basis for Herbicide Resistance in Canadian Populations of Wild Oat (*Avena fatua*).", *Weed Science*, 60(1), pp. 10-18. doi : 10.1614/WS-D-11-00110.1
- Harker, K.N., O'Donovan, J.T., Blackshaw, R.E., Beckie, H.J., Mallory-Smith, C., and Maxwell, B.D. (2012). "Our view.", *Weed Science*, 60(2), pp. 143-144. doi : 10.1614/WS-D-11-00177.1

2011

- Beckie, H.J. (2011). "Herbicide-resistant weed management: focus on glyphosate.", *Pest Management Science*, 67(9), pp. 1037-1048. doi : 10.1002/ps.2195
- Beckie, H.J., Harker, K.N., Hall, L.M., Holm, F.A., and Gulden, R.H. (2011). "Risk assessment of glyphosate resistance in western Canada.", *Weed Technology*, 25(1), pp. 159-164. doi : 10.1614/wt-d-10-00080.1
- Beckie, H.J., Warwick, S.I., Sauder, I.C.A., Hall, L.M., Harker, K.N., and Lozinski, C. (2011). "Pollen-mediated gene flow in commercial fields of spring wheat in Western Canada.", *Crop Science*, 51(1), pp. 306-313. doi : 10.2135/cropsci2010.03.0176
- Beckie, H.J., Warwick, S.I., Sauder, I.C.A., Lozinski, C., and Shirriff, S. (2011). "Occurrence and molecular characterization of acetolactate synthase (ALS) inhibitor-resistant kochia (*Kochia scoparia*) in western Canada.", *Weed Technology*, 25(1), pp. 170-175. doi : 10.1614/wt-d-10-00067.1

## PATHOLOGY

### Turkington, Kelly (Lacombe)

Research Publications:

2014

- Legge, W.G., Tucker, J.R., Fetch Jr., T.G., Haber, S.M., Menzies, J.G., Tekauz, A., Turkington, T.K., and Savard, M.E. (2014). "AAC Synergy barley.", *Canadian Journal of Plant Science*, 94. doi : 10.4141/cjps2013-307

2013

- Aboukhaddour, R., Turkington, T.K., and Strelkov, S.E. (2013). "Race structure of *Pyrenophora tritici-repentis* (tan spot of wheat) in Alberta, Canada.", *Canadian Journal of Plant Pathology*, 35(2), pp. 256-268. doi : 10.1080/07060661.2013.782470
- Harker, K.N., O'Donovan, J.T., Turkington, T.K., Blackshaw, R.E., Johnson, E.N., Brandt, S.A., Kutcher, H.R., and Clayton, G.W. (2013). "Weed interference impacts and yield recovery after four years of variable crop inputs in no-till barley and canola.", *Weed Technology*, 27(2), pp. 281-290. doi : 10.1614/WT-D-12-00115.1
- Irvine, R.B., Lafond, G.P., May, W.E., Kutcher, H.R., Clayton, G.W., Harker, K.N., Turkington, T.K., and Beres, B.L. (2013). "Stubble options for winter wheat in the Black soil zone of western Canada.", *Canadian Journal of Plant Science*, 93(2), pp. 261-270. doi : 10.4141/CJPS2012-198
- Kutcher, H.R., Turkington, T.K., Clayton, G.W., and Harker, K.N. (2013). "Response of herbicide-tolerant canola (*Brassica napus* L.) cultivars to four row spacings and three seeding rates in a no-till production system.", *Canadian Journal of Plant Science*, 93(6), pp. 1229-1236. doi : 10.4141/cjps2013-173
- Legge, W.G., Tucker, J.R., Bizimungu, B., Fetch Jr., T.G., Haber, S.M., Menzies, J.G., Noll, J.S., Tekauz, A., Turkington, T.K., Savard, M.E., and Choo, T.-M. (2013). "Cerveza barley.", *Canadian Journal of Plant Science*, 93(3), pp. 557-564. doi : 10.4141/cjps2012-299
- Legge, W.G., Tucker, J.R., Bizimungu, B., Tekauz, A., Fetch Jr., T.G., Haber, S.M., Menzies, J.G., Noll, J.S., Turkington, T.K., Martin, R.A., Choo, T.-M., Vigier, B.J., Blackwell, B.A., and Savard, M.E. (2013). "Taylor barley.", *Canadian Journal of Plant Science*, 93(5), pp. 969-977. doi : 10.4141/cjps2013-126

- Legge, W.G., Tucker, J.R., Fetch Jr., T.G., Haber, S.M., Menzies, J.G., Noll, J.S., Tekauz, A., Turkington, T.K., and Savard, M.E. (2013). "Major barley.", *Canadian Journal of Plant Science*, 93(2), pp. 291-297. doi : 10.4141/cjps2012-248
- O'Donovan, J.T., Harker, K.N., Turkington, T.K., and Clayton, G.W. (2013). "Combining cultural practices with herbicides reduces wild oat (*Avena fatua*) seed in the soil seed bank and improves barley yield.", *Weed Science*, 61(2), pp. 328-333. doi : 10.1614/WS-D-12-00168.1
- Peng, G., Pageau, D., Hwang, S.F., Lahlali, R.L., Hynes, R.K., Anderson, K., Strelkov, S.E., McDonald, M.R., Gossen, B.D., Turkington, T.K., Yu, F.Q., Falk, K.C., Boyetchko, S.M., and McGregor, L. (2013). "Assessment of crop rotation in combination with cultivar resistance or a biofungicide seed treatment for control of clubroot on canola.", 10th International Congress of Plant Pathology, Beijing International Convention Center, Beijing, China, August 25-30, 2013.
- Peng, G., Pageau, D., Strelkov, S.E., Lahlali, R.L., Hwang, S.F., Hynes, R.K., Anderson, K., McDonald, M.R., Gossen, B.D., Turkington, T.K., Falk, K.C., Yu, F.Q., McGregor, L., Hupka, D., and Geissler, H.J. (2013). "Assessment of crop rotation, cultivar resistance and *Bacillus subtilis* biofungicide for control of clubroot on canola.", 6th International Symposium on Brassica and 18th Crucifer Genetics Workshop, Catania, Sicily, Italy, November 12-16, 2012, Published on Acta Hort. 1005: 591–598.
- Xi, K., Chen, X.M., Capettini, F., Falconi, E., Yang, R.-C., Helm, J.H., Holtz, M.D., Juskiw, P.E., Kumar, K., Nyachiro, J.M., and Turkington, T.K. (2013). "Multivariate analysis of stripe rust assessment and reactions of barley in multi-location nurseries.", *Canadian Journal of Plant Science*, 93(2), pp. 209-219. doi : 10.4141/CJPS2012-051

## 2012

- Edney, M.J., O'Donovan, J.T., Turkington, T.K., Clayton, G.W., McKenzie, R.H., Juskiw, P.E., Lafond, G.P., Brandt, S.A., Grant, C.A., Harker, K.N., Johnson, E.N., and May, W.E. (2012). "Effects of seeding rate, nitrogen rate and cultivar on barley malt quality.", *Journal of the Science of Food and Agriculture*, 92(13), pp. 2672-2678. doi : 10.1002/jsfa.5687
- Harker, K.N., O'Donovan, J.T., Turkington, T.K., Blackshaw, R.E., Lupwayi, N.Z., Smith, E.G., Klein-Gebbinck, H.W., Dossall, L.M., Hall, L.M., Willenborg, C.J., Kutcher, H.R., Malhi, S.S., Vera, C.L., Gan, Y.T., Lafond, G.P., May, W.E., Grant, C.A., and McLaren, D.L. (2012). "High-yield no-till canola production on the Canadian prairies.", *Canadian Journal of Plant Science*, 92(2), pp. 221-233. doi : 10.4141/CJPS2011-125
- LeBoldus, J.M., Manolii, V.P., Turkington, T.K., and Strelkov, S.E. (2012). "Adaptation to *Brassica* Host Genotypes by a Single-Spore Isolate and Population of *Plasmodiophora brassicae* (Clubroot).", *Plant Disease*, 96(6), pp. 833-838. doi : 10.1094/PDIS-09-11-0807
- McLean, M.S., Howlett, B.J., Turkington, T.K., Platz, G.J., and Hollaway, G.J. (2012). "Spot Form of Net Blotch Resistance in a Diverse Set of Barley Lines in Australia and Canada.", *Plant Disease*, 96(4), pp. 569-576. doi : 10.1094/PDIS-06-11-0477
- O'Donovan, J.T., Turkington, T.K., Edney, M.J., Juskiw, P.E., McKenzie, R.H., Harker, K.N., Clayton, G.W., Lafond, G.P., Grant, C.A., Brandt, S.A., Johnson, E.N., May, W.E., and Smith, E.G. (2012). "Effect of seeding date and seeding rate on malting barley production in western Canada.", *Canadian Journal of Plant Science*, 92(2), pp. 321-330. doi : 10.4141/cjps2011-130
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### Gossen, Bruce (Saskatoon)

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2014

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### McLaren, Debbie (Brandon)

#### Research Publications:

2014

- Chang, K.F., Conner, R.L., Hwang, S.F., Ahmed, H.U., McLaren, D.L., Gossen, B.D., and Turnbull, G.D. (2014). "Effects of seed treatments and inoculum density of *Fusarium avenaceum* and *Rhizoctonia solani* on seedling blight and root rot of in faba bean." *Canadian Journal of Plant Science*, 94(4), pp. 693-700. doi : 10.4141/cjps2013-339

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- Turkington, T.K., Kutcher, H.R., McLaren, D.L., and Rashid, K.Y. (2011). "Managing Sclerotinia in Oilseed and Pulse Crops.", *Prairie Soils and Crops*, 4, pp. 105-113.

### Conner, Robert (Morden – pulses)

Research Publications:

2014

- Chang, K.F., Conner, R.L., Hwang, S.F., Ahmed, H.U., McLaren, D.L., Gossen, B.D., and Turnbull, G.D. (2014). "Effects of seed treatments and inoculum density of *Fusarium avenaceum* and *Rhizoctonia solani* on seedling blight and root rot of in faba bean.", *Canadian Journal of Plant Science*, 94(4), pp. 693-700. doi : 10.4141/cjps2013-339

2013

- Boersma, J.G., Conner, R.L., Balasubramanian, P.M., Yu, K., and Hou, A. (2013). "Marker-assisted dissection of anthracnose resistance in the dry bean cultivar 'Morden003'", *Canadian Journal of Plant Science*, 93(6), pp. 1115-1123. doi : 10.4141/CJPS2013-085
- Chang, K.F., Hwang, S.F., Ahmed, H.U., Strelkov, S.E., Conner, R.L., Gossen, B.D., Bing, D.-J., and Turnbull, G.D. (2013). "Yield loss and management of downy mildew on field pea in Alberta, Canada.", *Crop Protection*, 46, pp. 23-28. doi : 10.1016/j.cropro.2012.12.001
- Conner, R.L., Chang, K.F., Hwang, S.F., Warkentin, T.D., and McRae, K.B. (2013). "Assessment of tolerance for reducing yield losses in field pea caused by *Aphanomyces* root rot.", *Canadian Journal of Plant Science*, 93(3), pp. 473-482. doi : 10.4141/cjps2012-183

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- Chen, Y.-Y., Conner, R.L., Gillard, C.L., McLaren, D.L., Boland, G.J., Balasubramanian, P.M., Stasolla, C., Zhou, Q.-X., Hwang, S.F., Chang, K.F., and Babcock, C. (2012). "A quantitative real-time PCR assay for detection of *Colletotrichum lindemuthianum* in navy bean seeds.", *Plant Pathology*. doi : 10.1111/j.1365-3059.2012.02692.x
- Conner, R.L., Gossen, B.D., Hwang, S.F., Chang, K.F., McRae, K.B., and Penner, W.C. (2012). "Field assessment of partial resistance to mycosphaerella blight in *Pisum* subspecies accessions.", *Canadian Journal of Plant Science*, 92(2), pp. 289-296. doi : 10.4141/CJPS2011-152
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- Gillard, C.L., Ranatunga, N.K., and Conner, R.L. (2012). "The control of dry bean anthracnose through seed treatment and the correct application timing of foliar fungicides.", *Crop Protection*, 37, pp. 81-90. doi : 10.1016/j.cropro.2012.02.009
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- Li, H.J., Cui, L., Li, H.-L., Wang, X.-M., Murray, T.D., Conner, R.L., Wang, L.J., Gao, X., Sun, Y., Sun, S.C., and Tang, W.H. (2012). "Effective Resources in Wheat and Wheat-*Thinopyrum* Derivatives for Resistance to *Heterodera filipjevi* in China.", *Crop Science*, 52(3), pp. 1209-1217. doi : 10.2135/cropsci2011.11.0591
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- Shaikh, R., Diederichsen, A., Harrington, M., Adam, J., Conner, R.L., and Buchwaldt, L. (2012). "New sources of resistance to *Colletotrichum truncatum* race Ct0 and Ct1 in *Lens culinaris* subsp. *culinaris* obtained by single plant selection in germplasm accessions.", *Genetic Resources and Crop Evolution*, 60(1), pp. 193-201. doi : 10.1007/s10722-012-9825-7

- Thomas, J.B., Conner, R.L., and Graf, R.J. (2012). "Radiant hard red winter wheat.", *Canadian Journal of Plant Science*, 92(1), pp. 169-175. doi : 10.4141/CJPS2011-082

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- Balasubramanian, P.M., Hou, A., Conner, R.L., Kiehn, F.A., and Mündel, H.-H. (2011). "Carman Black dry bean.", *Canadian Journal of Plant Science*, 91(3), pp. 519-521. doi : 10.4141/cjps2010-005
- Conner, R.L. and Fernandez, M.R. (2011). "Root and Crown Rot of Wheat.", *Prairie Soils and Crops*, 4, pp. 151-157.
- Feng, J., Hwang, R., Chang, K.F., Conner, R.L., Hwang, S.F., Strelkov, S.E., Gossen, B.D., McLaren, D.L., and Xue, A.G. (2011). "Identification of microsatellite markers linked to quantitative trait loci controlling resistance to fusarium root rot in field pea.", *Canadian Journal of Plant Science*, 91(1), pp. 199-204. doi : 10.4141/CJPS09176
- Fernandez, M.R. and Conner, R.L. (2011). "Black Point and Smudge in Wheat.", *Prairie Soils and Crops*, 4, pp. 158-164.
- Fernandez, M.R., Sissons, M.J., Conner, R.L., Wang, H., and Clarke, J.M. (2011). "Influence of biotic and abiotic factors on dark discoloration of durum wheat kernels.", *Crop Science*, 51(3), pp. 1205-1214. doi : 10.2135/cropsci2010.07.0433
- Gossen, B.D., Hwang, S.F., Conner, R.L., and Chang, K.F. (2011). "Managing the ascochyta blight complex on field pea in western Canada.", *Prairie Soils and Crops*, 4, pp. 135-141.
- Hou, A., Balasubramanian, P.M., Conner, R.L., Park, S.J., Yu, K., Kiehn, F.A., and Navabi, A. (2011). "Portage common bean.", *Canadian Journal of Plant Science*, 91(3), pp. 523-525. doi : 10.4141/cjps2010-015

### Rashid, Khalid (Morden)

Research Publications:

2013

- Asgarinia, P., Cloutier, S., Duguid, S.D., Rashid, K.Y., Mirlohi, A.F., Banik, M., and Saeidi, G. (2013). "Mapping QTL for powdery mildew resistance in flax (*Linum usitatissimum* L.).", *Crop Science*, 53(6), pp. 2462-2472. doi : 10.2135/cropsci2013.05.0298

2012

- Vera, C.L., Duguid, S.D., Fox, S.L., Rashid, K.Y., Dribnenki, J.C.P., and Clarke, F.R. (2012). "Comparative effect of lodging on seed yield of flax and wheat.", *Canadian Journal of Plant Science*, 92(1), pp. 39-43. doi : 10.4141/CJPS2011-031

2011

- Fetch Jr., T.G., McCallum, B.D., Menzies, J.G., Rashid, K.Y., and Tenuta, A.U. (2011). "Rust diseases in Canada.", *Prairie Soils and Crops*, 4, pp. 87-96.
- Turkington, T.K., Kutcher, H.R., McLaren, D.L., and Rashid, K.Y. (2011). "Managing Sclerotinia in Oilseed and Pulse Crops.", *Prairie Soils and Crops*, 4, pp. 105-113.

### Fernandez, Myriam (Swift Current)

Research Publications:

2013

- Fox, S.L., Humphreys, D.G., Brown, P.D., McCallum, B.D., Fetch Jr., T.G., Menzies, J.G., Gilbert, J., Fernandez, M.R., Despina, T., and Niziol, D. (2013). "Cardale hard red spring wheat.", *Canadian Journal of Plant Science*, 93(2), pp. 307-313. doi : 10.4141/cjps2012-236
- Fox, S.L., Wise, I.L., Smith, M.A.H., Humphreys, D.G., Brown, P.D., McCallum, B.D., Fetch Jr., T.G., Menzies, J.G., Gilbert, J., Fernandez, M.R., Despina, T., Lukow, O.M., and Niziol, D. (2013). "Shaw hard red spring wheat.", *Canadian Journal of Plant Science*, 93(2), pp. 299-305. doi : 10.4141/cjps2012-137

## 2012

- Fox, S.L., Lamb, R.J., McKenzie, R.I.H., Wise, I.L., Smith, M.A.H., Humphreys, D.G., Brown, P.D., Townley-Smith, T.F., McCallum, B.D., Fetch Jr., T.G., Menzies, J.G., Gilbert, J., Fernandez, M.R., Despina, T., Lukow, O.M., and Niziol, D. (2012). "Registration of 'Fieldstar' Hard Red Spring Wheat.", *Journal of Plant Registrations*, 6(2), pp. 161-168. doi : 10.3198/jpr2011.06.0329crc
- Sheng, M., Hamel, C., and Fernandez, M.R. (2012). "Cropping practices modulate the impact of glyphosate on arbuscular mycorrhizal fungi and rhizosphere bacteria in agroecosystems of the semiarid prairie.", *Canadian Journal of Microbiology*, 58(8), pp. 990-1001. doi : 10.1139/W2012-080
- Singh, A.K., Clarke, J.M., Knox, R.E., DePauw, R.M., McCaig, T.N., Fernandez, M.R., and Clarke, F.R. (2012). "Transcend Durum wheat.", *Canadian Journal of Plant Science*, 92(4), pp. 809-813. doi : 10.4141/cjps2011-255

## 2011

- Conner, R.L. and Fernandez, M.R. (2011). "Root and Crown Rot of Wheat.", *Prairie Soils and Crops*, 4, pp. 151-157.
- Fernandez, M.R. and Conner, R.L. (2011). "Black Point and Smudge in Wheat.", *Prairie Soils and Crops*, 4, pp. 158-164.
- Fernandez, M.R. and Vujanovic, V. (2011). "Improvement of emergence and performance of plants derived from red-smudged durum wheat seed by fungicide seed treatments.", *Canadian Journal of Plant Pathology*, 33(1), pp. 19-25. doi : 10.1080/07060661.2011.536647
- Fernandez, M.R., May, W.E., and Lafond, G.P. (2011). "Effect of fungicide seed treatments on root pathogens of cereal crops under field conditions.", *Canadian Journal of Plant Science*, 90(6), pp. 905-917. doi : 10.4141/CJPS09172
- Fernandez, M.R., Sissons, M.J., Conner, R.L., Wang, H., and Clarke, J.M. (2011). "Influence of biotic and abiotic factors on dark discoloration of durum wheat kernels.", *Crop Science*, 51(3), pp. 1205-1214. doi : 10.2135/cropsci2010.07.0433
- Fernandez, M.R., Ulrich, D.J., Brandt, K., Zentner, R.P., Wang, H., Thomas, A.G., and Olfert, O.O. (2011). "Crop management effects on root and crown rot of wheat in West-Central Saskatchewan, Canada.", *Agronomy Journal*, 103(3), pp. 756-765. doi : 10.2134/agronj2010.0190
- Zentner, R.P., Basnyat, P., Brandt, S.A., Thomas, A.G., Ulrich, D.J., Campbell, C.A., Nagy, C.N., Frick, B.L., Lemke, R.L., Malhi, S.S., Olfert, O.O., and Fernandez, M.R. (2011). "Effects of input management and crop diversity on economic returns and riskiness of cropping systems in the semi-arid Canadian Prairie.", *Renewable Agriculture and Food Systems*, 26(3), pp. 208-223. doi : 10.1017/s1742170510000591
- Zentner, R.P., Basnyat, P., Brandt, S.A., Thomas, A.G., Ulrich, D.J., Campbell, C.A., Nagy, C.N., Frick, B.L., Lemke, R.L., Malhi, S.S., and Fernandez, M.R. (2011). "Effects of input management

and crop diversity on non-renewable energy use efficiency of cropping systems in the Canadian Prairie.", *European Journal of Agronomy*, 34(2), pp. 113-123. doi : 10.1016/j.eja.2010.11.004

## ENTOMOLOGY

### Otani, Jennifer (Beaverlodge)

#### Research Publications:

2014

- Mori, B.A., Yoder, C., Otani, J.K., and Evenden, M.L. (2014). "Relationships among male *Coleophora deauratella* (Lepidoptera: Coleophoridae) pheromone-baited trap capture, larval abundance, damage and flight phenology.", *Agricultural and Forest Entomology*. doi : 10.1111/afe.12050

2013

- Otani, J.K. (2013). "Insect pests and beneficials within forage seed systems.", Peace Forage Agronomy Update, Rycroft, AB, Canada, April 9, 2013. (Presentation)

2011

- Otani, J.K. and Cárcamo, H.A. (2011). "Biology and management of *Lygus* in canola.", *Prairie Soils and Crops*, 4, pp. 42-53.
- Soroka, J.J. and Otani, J.K. (2011). "Arthropods of Legume Forage Crops.", in Floate, K.D. (ed.) - Arthropods of Canadian Grasslands. Vol. 2: Inhabitants of a Changing Landscape, Biological Survey of Canada (BSC), Chapter 10, pp. 239-264.

### Cárcamo, Héctor (Lethbridge)

#### Research Publications:

2013

- Beres, B.L., Cárcamo, H.A., Byers, J.R., Clarke, F.R., Pozniak, C.J., Basu, S.K., and DePauw, R.M. (2013). "Host plant interactions between wheat germplasm source and wheat stem sawfly *Cephus cinctus* Norton (Hymenoptera: Cephidae) II. Other germplasm.", *Canadian Journal of Plant Science*, 93(6), pp. 1169-1177. doi : 10.4141/CJPS2013-035
- Beres, B.L., Cárcamo, H.A., Byers, J.R., Clarke, F.R., Pozniak, C.J., Basu, S.K., and DePauw, R.M. (2013). "Host plant interactions between wheat germplasm source and wheat stem sawfly *Cephus cinctus* Norton (Hymenoptera: Cephidae) I. Commercial cultivars.", *Canadian Journal of Plant Science*, 93, pp. 607-617. doi : 10.4141/CJPS2012-088
- Cárcamo, H.A. and Beres, B.L. (2013). "*Cephus cinctus* Norton, Wheat stem sawfly (Hymenoptera: Cephidae)", in Mason, P.G. and Gillespie, D.R. (eds.) - Biological Control Programmes in Canada 2001-2012, CABI Publishing, Chapter 15, pp. 112-119.
- Kher, S.V., Dodsall, L.M., Cárcamo, H.A., and El-Bouhssini, M. (2013). "Antibiosis resistance to cereal leaf beetle, *Oulema melanopus* (L.) (Coleoptera: Chrysomelidae), in Central Asian wheat germplasm.", *Journal of Applied Entomology*. doi : 10.1111/jen.12074
- Wu, X., Cárcamo, H.A., Beres, B.L., Clarke, F.R., DePauw, R.M., and Pang, B. (2013). "Effects of novel wheat genotype on *Cephus cinctus* Norton (Hymenoptera: Cephidae) and its parasitoid *Bracon cephi* (Hymenoptera: Braconidae).", *Cereal Research Communications*, 41, pp. 647-660.

## 2012

- Beres, B.L., McKenzie, R.H., Cárcamo, H.A., Dosdall, L.M., Evenden, M.L., Yang, R.-C., and Spaner, D.M. (2012). "Influence of Seeding Rate, Nitrogen Management, and Micronutrient Blend Applications on Pith Expression in Solid-Stemmed Spring Wheat.", *Crop Science*, 52(3), pp. 1316-1329. doi : 10.2135/cropsci2011.05.0239
- Cárcamo, H.A., Herle, C.E., and Hervet, V.A.D. (2012). "Greenhouse studies of thiamethoxam effects on pea leaf weevil, *itona lineatus*.", *Journal of Insect Science*, 12(Article No. 151). doi : 10.1673/031.012.15101
- Cárcamo, H.A., Weaver, D.K., Meers, S., Beres, B.L., and Mauduit, A.L. (2012). "First record of *Bracon lissogaster* (Hymenoptera: Braconidae) in Canada - a potentially important parasitoid of *Cephus cinctus* (Hymenoptera: Cephidae) in the prairies.", *Biocontrol Science and Technology*, 22(3), pp. 367-369. doi : 10.1080/09583157.2012.658355
- Olfert, O.O., Weiss, R.M., Cárcamo, H.A., and Meers, S. (2012). "The Influence of Abiotic Factors on an Invasive Pest of Pulse Crops, *Sitona lineatus* (L.) (Coleoptera: Curculionidae), in North America.", *Psyche*, 2012(Article ID 746342). doi : 10.1155/2012/746342

## 2011

- Beres, B.L., Cárcamo, H.A., Dosdall, L.M., Yang, R.-C., Evenden, M.L., and Spaner, D.M. (2011). "Do Interactions between Residue Management and Direct Seeding System Affect Wheat Stem Sawfly and Grain Yield?.", *Agronomy Journal*, 103(6), pp. 1-10. doi : 10.2134/agronj2011.0055
- Beres, B.L., Cárcamo, H.A., Weaver, D.K., Dosdall, L.M., Evenden, M.L., Hill, B.D., Yang, R.-C., McKenzie, R.H., and Spaner, D.M. (2011). "Integrating the building blocks of agronomy and biocontrol into an IPM strategy for wheat stem sawfly.", *Prairie Soils and Crops*, 4, pp. 54-65.
- Beres, B.L., Cárcamo, H.A., Yang, R.-C., and Spaner, D.M. (2011). "Integrating Spring Wheat Sowing Density with Variety Selection to Manage Wheat Stem Sawfly.", *Agronomy Journal*, 103(6), pp. 1755-1764. doi : 10.2134/agronj2011.0187
- Beres, B.L., Dosdall, L.M., Weaver, D.K., Cárcamo, H.A., and Spaner, D.M. (2011). "Biology and integrated management of wheat stem sawfly and the need for continuing research."
- Cárcamo, H.A. and Vankosky, M.A. (2011). "Managing the Pea Leaf Weevil in Field Peas.", *Prairie Soils and Crops*, 4, pp. 77-85.
- Cárcamo, H.A., Beres, B.L., Herle, C.E., McLean, H., and McGinn, S.M. (2011). "Solid-stemmed wheat does not affect overwintering mortality of the wheat stem sawfly, *Cephus cinctus*.", *Journal of Insect Science*, 11(129), pp. 1-12. doi : 10.1673/031.011.12901
- De Clerck-Floate, R.A. and Cárcamo, H.A. (2011). "Biocontrol arthropods: new denizens of Canada's grassland agroecosystems.", in Floate, K.D. (ed.) - *Arthropods of Canadian Grasslands*. Vol. 2: Inhabitants of a Changing Landscape, Biological Survey of Canada (BSC), Chapter 12, pp. 291-321.
- Dosdall, L.M. and Cárcamo, H.A. (2011). "Biology and Integrated Management of the Cabbage Seedpod Weevil in Prairie Canola Crops.", *Prairie Soils and Crops*, 4, pp. 14-23.
- Dosdall, L.M., Cárcamo, H.A., Olfert, O.O., Meers, S., Hartley, S., and Gavloski, J.E. (2011). "Insect invasions of agroecosystems in the western Canadian prairies: case histories, patterns, and implications for ecosystem function.", *Biological Invasions*, 13(5), pp. 1135-1149. doi : 10.1007/s10530-011-9951-8



- Gavloski, J.E., Cárcamo, H.A., and Dosdall, L.M. (2011). "Insects of Canola, Mustard, and Flax in Canadian Grasslands.", in Floate, K.D. (ed.) - Arthropods of Canadian Grasslands. Vol. 2: Inhabitants of a Changing Landscape, Biological Survey of Canada (BSC), Chapter 8, pp. 181-214.
- Kher, S.V., Dosdall, L.M., and Cárcamo, H.A. (2011). "The Cereal Leaf Beetle: Biology, Distribution and Prospects for Control.", *Prairie Soils and Crops*, 4, pp. 32-41.
- Otani, J.K. and Cárcamo, H.A. (2011). "Biology and management of *Lygus* in canola.", *Prairie Soils and Crops*, 4, pp. 42-53.
- Vankosky, M.A., Cárcamo, H.A., McKenzie, R.H., and Dosdall, L.M. (2011). "Integrated management of *Sitona lineatus* with Nitrogen fertilizer, *Rhizobium*, and thiamethoxam insecticide.", *Agronomy Journal*, 103(3), pp. 565-572. doi : 10.2134/agronj2010.0314
- Vankosky, M.A., Cárcamo, H.A., and Dosdall, L.M. (2011). "Identification of potential natural enemies of the pea leaf weevil, *Sitona lineatus* L. in western Canada.", *Journal of Applied Entomology*, 135(4), pp. 293-301. doi : 10.1111/j.1439-0418.2010.01542.x
- Vankosky, M.A., Cárcamo, H.A., and Dosdall, L.M. (2011). "Response of *pisum sativum* (Fabales: Fabaceae) to *Sitona lineatus* (Coleoptera: Curculionidae) infestation: Effect of adult weevil density on damage, larval population, and yield loss.", *Journal of Economic Entomology*, 104(5), pp. 1550-1560. doi : 10.1603/EC10392
- Wu, X., Cárcamo, H.A., Beres, B.L., and Pang, B. (2011). "Parasitoid (*Bracon cephi*) effects on grain yield of selected genotypes of wheat infested by *Cephus cinctus*.", *Australian Journal of Crop Science*, 5(9), pp. 1102-1107.

### **Elliott, Robert (Saskatoon)**

#### Research Publications:

2014

- Olivier, C.Y., Elliott, R.H., Man, L., and Nordin, D. (2014). "Development of a rating scale for Aster yellow in canola.", *Canadian Plant Disease Survey*, 94, pp. 162-176.

2011

- Elliott, R.H., Mann, L.W., and Olfert, O.O. (2011). "Calendar and degree-day requirements for emergence of adult *Macroglenes penetrans* (Kirby), an egg-larval parasitoid of wheat midge, *Sitodiplosis mosellana* (Géhin).", *Crop Protection*, 30(4), pp. 405-411. doi : 10.1016/j.cropro.2010.12.007
- Elliott, R.H., Olfert, O.O., and Hartley, S. (2011). "Management practices for wheat midge, *Sitodiplosis mosellana* (Géhin).", *Prairie Soils and Crops*, 4, pp. 8-13.
- Onyilagha, J.C., Elliott, R.H., Buckner, E., Okiror, S.O., and Raney, J.P. (2011). "Seed chlorophyll influences vigor in oilseed rape (*Brassica napus* L. var *AC Excel*).", *Journal of Agricultural Science*, 3(2), pp. 73-79. doi : 10.5539/jas.v3n2p73
- Soroka, J.J. and Elliott, R.H. (2011). "Innovative Methods for Managing Flea Beetles in Canola.", *Prairie Soils and Crops*, 4, pp. 1-7.

### **Olfert, Owen (Saskatoon)**

#### Research Publications:

2013

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## Soroko, Julie (Saskatoon)

### Research Publications:

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## Peng, Gary (Saskatoon)

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#### 2014

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## White, Noel (Winnipeg)

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2014

- Jian, F., Chelladurai, V., Jayas, D.S., Demianyk, C.J., and White, N.D.G. (2014). "Interstitial concentrations of carbon dioxide and oxygen in stored canola, soybean, and wheat seeds under various conditions.", *Journal of Stored Products Research*, 54, pp. 63-72. doi : 10.1016/j.jspr.2013.12.002
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- Jian, F., Jayas, D.S., and White, N.D.G. (2013). "Specific thermal diffusivity and bulk density of genetically modified canola with high oil content at different moisture contents, temperatures, and storage times.", *Transactions of the American Society of Agricultural Engineers (ASAE)*, 56, pp. 1077-1083.
- Jian, F., Subramanyam, B.H., Jayas, D.S., and White, N.D.G. (2013). "Models to predict mortality of *Tribolium castaneum* (Coleoptera: Tenebrionidae) exposed to elevated temperatures during structural heat treatments.", *Journal of Economic Entomology*, 106(5), pp. 2247-2258. doi : 10.1603/EC12278
- Kaliramesh, S., Chelladurai, V., Jayas, D.S., Alagusundaram, K., White, N.D.G., and Fields, P.G. (2013). "Detection of infestation by *Callosobruchus maculatus* in mung bean using near-infrared hyperspectral imaging.", *Journal of Stored Products Research*, 52, pp. 107-111. doi : 10.1016/j.jspr.2012.12.005
- Purohit, P., Jayas, D.S., Yadav, B.K., Chelladurai, V., Fields, P.G., and White, N.D.G. (2013). "Microwaves to control *Callosobruchus maculatus* in stored mung bean (*Vigna radiata*).", *Journal of Stored Products Research*, 53, pp. 19-22. doi : 10.1016/j.jspr.2013.01.002
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- Sravanthi, B., Jayas, D.S., Alagusundaram, K., Chelladurai, V., and White, N.D.G. (2013). "Effect of storage conditions on red lentils.", *Journal of Stored Products Research*, 53, pp. 48-53. doi : 10.1016/j.jspr.2013.01.004
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### Fields, Paul (Winnipeg)

#### Research Publications:

#### 2013

- Clark, E.L., Isitt, R., Plettner, E., Fields, P.G., and Huber, D. (2013). "An Inexpensive Feeding Bioassay Technique for Stored-Product Insects.", *Journal of Economic Entomology*, 107(1), pp. 455-461. doi : 10.1603/EC13283
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## AGROMETEROLOGY

### Lupwayi, Newton (Lethbridge)

Research Publications:

2014

- Akter, Z., Pageni, B.B., Lupwayi, N.Z., and Balasubramanian, P.M. (2014). "Biological nitrogen fixation and *nifH* gene expression in dry beans (*Phaseolus vulgaris* L.).", *Canadian Journal of Plant Science*, 94. doi : 10.4141/cjps2013-200
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## 2013

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- Benke, M.B., Goh, T.B., Karamanos, R.E., Lupwayi, N.Z., and Hao, X. (2012). "Retention and nitrification of injected anhydrous NH<sub>3</sub> as affected by soil pH.", *Canadian Journal of Soil Science*, 92(4), pp. 589-598. doi : 10.4141/CJSS2011-108
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### Hamel, Chantel (Swift Current)

Research Publications:

2014

- Bainard, L.D., Bainard, J.D., Hamel, C., and Gan, Y.T. (2014). "Spatial and temporal structuring of arbuscular mycorrhizal communities is differentially influenced by abiotic factors and host crop in a semiarid prairie agroecosystem.", *FEMS Microbiology Ecology*. doi : 10.1111/1574-6941.12300
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- Yang, C., Hamel, C., Vujanovic, V., and Gan, Y.T. (2011). "Fungicide: modes of action and possible impact on non-target microorganisms - Review Article", *ISRN Ecology*, 2011(Article ID 130289), pp. 8 pages. doi : 10.5402/2011/130289

## ECONOMIST

### Smith, Elwin (Lethbridge)

Research Publications:

2014

- Smith, E.G., Hao, X., and Miller, J.J. (2014). "Economics of Utilizing Biodigested Beef Feedlot Manure to Manage Nutrient Application to Cropland.", *International Journal of Renewable Energy & Biofuels*, 2014(Article ID 371507). doi : 10.5171/2014.371507

2013

- Kutcher, H.R., Brandt, K., Smith, E.G., Ulrich, D.J., and Malhi, S.S. (2013). "Blackleg disease of canola mitigated by resistant cultivars and four-year crop rotations in western Canada.", *Canadian Journal of Plant Pathology*. doi : 10.1080/07060661.2013.775600
- Smith, E.G., Brandt, S.A., Kutcher, H.R., and Malhi, S.S. (2013). "Economic evaluation of canola and pea interval in rotations.", *Canadian Journal of Plant Science*, 93(5), pp. 933-940.

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- Carew, R., Florkowski, W.J., and Smith, E.G. (2012). "Hedonic Analysis of Apple Attributes in Metropolitan Markets of Western Canada.", *Agribusiness: An International Journal*, 28(3), pp. 293-309. doi : 10.1002/agr.21302
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- Smith, E.G., Ellert, B.H., Janzen, H.H., and Nakonechny, E.M. (2012). "Rotation ABC – Lethbridge, Alberta.", *Prairie Soils and Crops*, 5, pp. 147-154.
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- Smith, E.G., Larney, F.J., Nakonechny, D.J., Barbieri, J.M., and Lindwall, C.W. (2012). "Productivity of Long-Term No-Till Plots - Lethbridge Alberta.", *Prairie Soils and Crops*, 5, pp. 123-131.
- Smith, E.G., O'Donovan, J.T., Henderson, W.J., Turkington, T.K., McKenzie, R.H., Harker, K.N., Clayton, G.W., Juskiw, P.E., Lafond, G.P., Brandt, S.A., Edney, M.J., Johnson, E.N., and May, W.E. (2012). "Net return risk for malting barley production in Western Canada as influenced by production strategies.", *Agronomy Journal*, 104(5), pp. 1374-1382. doi : 10.2134/agronj2011.0416
- Toor, I.A., Smith, E.G., Whalen, J.K., and Naseem, A. (2012). "Tree-Based Intercropping in Southern Ontario, Canada.", *Canadian Journal of Agricultural Economics*, 60(2), pp. 141-154. doi : 10.1111/j.1744-7976.2012.01245.x
- Turkington, T.K., O'Donovan, J.T., Edney, M.J., Juskiw, P.E., McKenzie, R.H., Harker, K.N., Clayton, G.W., Xi, K., Lafond, G.P., Irvine, R.B., Brandt, S.A., Johnson, E.N., May, W.E., and Smith, E.G. (2012). "Effect of crop residue, nitrogen rate and fungicide application on malting barley productivity, quality, and foliar disease severity.", *Canadian Journal of Plant Science*, 92(3), pp. 577-588. doi : 10.4141/CJPS2011-216

2011

- Kellman, L.M. and Smith, E.G. (2011). "Examination of nitrate concentration, loading and isotope dynamics in subsurface drainage under standard agricultural cropping in Atlantic Canada.", *Journal of Environmental Management*, 92(11), pp. 2892-2899. doi : 10.1016/j.jenvman.2011.06.043

### **Khakbazan, Mohammad (Brandon)**

Research Publications:

2013

- Khakbazan, M., Grant, C.A., Finlay, G., Wu, R.G., Malhi, S.S., Selles, F., Clayton, G.W., Lupwayi, N.Z., Soon, Y.K., and Harker, K.N. (2013). "An economic study of controlled release urea and split applications of nitrogen as compared with non-coated urea under conventional and reduced tillage management.", *Canadian Journal of Plant Science*, 93(3), pp. 523-534. doi : 10.4141/CJPS2012-107
- Khakbazan, M., Hamilton, C., Elliott, J.A., and Yarotski, J.B. (2013). "Economic analysis of agricultural nutrient management practices in the South Tobacco Creek Watershed in Manitoba, Canada.", *Journal of Soil and Water Conservation*, 68(4), pp. 257-269. doi : 10.2489/jswc.68.4.257
- Khakbazan, M., Hamilton, C., and Yarotski, J.B. (2013). "The effect of land management changes and nutrient runoff capture on water quality and farm and watershed economics.", published in Online AgEcon Search Journal, Research in Agriculture and Applied Economics, 18.

## 2012

- Khakbazan, M. and Hamilton, C. (2012). "Economic evaluation of tillage management practices at the watershed scale in southern Manitoba.", *Soil & Tillage Research*, 118, pp. 40-51. doi : 10.1016/j.still.2011.10.009
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- Mohr, R.M., Irvine, R.B., Khakbazan, M., McLaren, D.L., Monreal, M.A., Moulin, A.P., Tomasiewicz, D.J., Volkmar, K.M., and Derksen, D.A. (2012). "Potato Rotation Study - Carberry, Manitoba (1997-2010).", *Prairie Soils and Crops*, 5, pp. 36-41.

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- Khakbazan, M., Hamilton, C., Mohr, R.M., and Grant, C.A. (2011). "Water and nutrient crop sufficiency models for potato, wheat, canola, oats, alfalfa, and corn.", *The Americas Journal of Plant Science and Biotechnology*, 5(Spec. Issue 2), pp. 45-60.
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- Monreal, M.A., Grant, C.A., Irvine, R.B., Mohr, R.M., McLaren, D.L., and Khakbazan, M. (2011). "Crop management effect on arbuscular mycorrhizae and root growth of flax.", *Canadian Journal of Plant Science*, 91(2), pp. 315-324. doi : 10.4141/cjps10136

## RELATED AGRONOMY CAPACITY

### *Environmental Soil Agronomy*

#### **Janzen, H. Henry (Lethbridge)**

Research Publications:

2014

- Helgason, B.L., Gregorich, E.G., Janzen, H.H., Ellert, B.H., Lorenz, N., and Dick, R.P. (2014). "Long-term microbial retention of residue C is site-specific and depends on residue placement.", *Soil Biology & Biochemistry*, 68, pp. 231-240. doi : 10.1016/j.soilbio.2013.10.002

## 2013

- Greenfield, L.G., Gregorich, E.G., Van Kessel, C., Baldock, J.A., Beare, M.H., Billings, S.A., Clinton, P., Condon, L.M., Hill, S., Hopkins, D.W., and Janzen, H.H. (2013). "Acid hydrolysis to define a biologically-resistant pool is compromised by carbon loss and transformation. Short communication.", *Soil Biology & Biochemistry*, 64, pp. 122-126. doi : 10.1016/j.soilbio.2013.04.009
- Kröbel, R., Janzen, H.H., Beauchemin, K.A., Bonesmo, H., Little, S.M., and McAllister, T.A. (2013). "A proposed approach to estimate and reduce the environmental impact from whole farms.", *Acta Agriculturae Scandinavica, Section A - Animal Science*, 62(4), pp. 225-232. doi : 10.1080/09064702.2013.770912
- Whalen, J.K., Gul, S., Poirier, V., Yanni, S.F., Simpson, M.J., Clemente, J.S., Feng, X.-J., Grayston, S.J., Barker, J., Ishimaru, K., Gregorich, E.G., Angers, D.A., Rochette, P., and Janzen, H.H. (2013). "Transforming plant carbon into soil carbon: process-level controls on carbon sequestration.", *Canadian Journal of Plant Science*. doi : 10.4141/CJPS2013-145

## 2012

- Bonesmo, H., Skjelvåg, A.O., Janzen, H.H., Klakegg, O., and Tveito, O.E. (2012). "Greenhouse gas emission intensities and economic efficiency in crop production: A systems analysis of 95 farms.", *Agricultural Systems*, 110, pp. 142-151. doi : 10.1016/j.agsy.2012.04.001
- Campbell, C.A., Juma, N.G., Zentner, R.P., Smith, E.G., Izaurrealde, R.C., Robertson, J.A., Dyck, M.F., and Janzen, H.H. (2012). "A Bibliography of Scientific Publications Based on Long-Term Crop Rotation Studies in the Canadian Prairies.", *Prairie Soils and Crops*, 5, pp. 7-29.
- Dai, M., Hamel, C., St. Arnaud, M., He, Y., Grant, C.A., Lupwayi, N.Z., Janzen, H.H., Malhi, S.S., Yang, X., and Zhou, Z. (2012). "Arbuscular mycorrhizal fungi assemblages in Chernozem great groups revealed by massively parallel pyrosequencing.", *Canadian Journal of Microbiology*, 58(1), pp. 81-92. doi : 10.1139/W11-111
- Janzen, H.H., Olson, B.M., Zvomuya, F., Larney, F.J., and Ellert, B.H. (2012). "Long-term Field Bioassay of Soil Quality.", *Prairie Soils and Crops*, 5, pp. 165-168.
- Larney, F.J. and Janzen, H.H. (2012). "Long-Term Erosion-Productivity Relationships: The Lethbridge Soil Scalping Studies.", *Prairie Soils and Crops*, 5, pp. 139-146.
- McGeough, E.J., Little, S.M., Janzen, H.H., McAllister, T.A., McGinn, S.M., and Beauchemin, K.A. (2012). "Life-cycle assessment of greenhouse gas emissions from dairy production in eastern Canada: A case study.", *Journal of Dairy Science (JDS)*, 95(9), pp. 5164-5175. doi : 10.3168/jds.2011-5229
- Smith, E.G., Ellert, B.H., Janzen, H.H., and Nakonechny, E.M. (2012). "Rotation ABC – Lethbridge, Alberta.", *Prairie Soils and Crops*, 5, pp. 147-154.
- Smith, E.G., Janzen, H.H., Ellert, B.H., and Nakonechny, D.J. (2012). "Rotation 120 – Lethbridge Alberta.", *Prairie Soils and Crops*, 5, pp. 155-164.

## 2011

- Beauchemin, K.A., Janzen, H.H., McAllister, T.A., and McGinn, S.M. (2011). "Mitigation of greenhouse gas emissions from beef production in western Canada - Evaluation using farm-



based life cycle assessment.", *Animal Feed Science and Technology*, 166-167, pp. 663-677. doi : 10.1016/j.anifeedsci.2011.04.047

- Bremer, E., Janzen, H.H., Ellert, B.H., and McKenzie, R.H. (2011). "Carbon, nitrogen, and greenhouse gas balances in an 18-year cropping system study on the northern Great Plains.", *Soil Science Society of America Journal*, 75(4), pp. 1493-1502. doi : 10.2136/sssaj2010.0326
- Janzen, H.H. (2011). "What place for livestock on a re-greening earth?.", *Animal Feed Science and Technology*, 166-167, pp. 783-796. doi : 10.1016/j.anifeedsci.2011.04.055
- Janzen, H.H., Fixen, P.E., Franzluebbers, A.J., Hattey, J., Izaurrealde, R.C., Ketterings, Q.M., Lobb, D.A., and Schlesinger, W.H. (2011). "Global Prospects Rooted in Soil Science.", *Soil Science Society of America Journal*, 75(1), pp. 1-8. doi : 10.2136/sssaj2009.0216
- Larney, F.J., Janzen, H.H., and Olson, A.F. (2011). "Residual effects of one-time manure, crop residue and fertilizer amendments on a desurfaced soil.", *Canadian Journal of Soil Science*, 91(6), pp. 1029-1043. doi : 10.4141/CJSS10065
- Richter, D.D.B., Bacon, A.R., Mobley, M.L., Richardson, C.J., Andrews, S.S., West, L., Wills, S., Billings, S.A., Cambardella, C.A., Cavallaro, N., DeMeester, J.E., Franzluebbers, A.J., Grandy, A.S., Grunwald, S., Gruver, J., Hartshorn, A.S., Janzen, H.H., Kramer, M.G., Ladha, J.K., Lajtha, K., Liles, G.C., Markewitz, D., Megonigal, P.J., Mermut, A.R., Rasmussen, C., Robinson, D.A., Smith, P., Stiles, C.A., Tate III, R.L., Thompson, A., Tugel, A.J., van Es, H., Yaalon, D., and Zobeck, T.M. (2011). "Human-soil relations are changing rapidly: Proposals from SSSA's cross-divisional soil change working group.", *Soil Science Society of America Journal*, 75(6), pp. 2079-2084. doi : 10.2136/sssaj2011.0124
- VandenBygaart, A.J., Bremer, E., McConkey, B.G., Ellert, B.H., and Janzen, H.H. (2011). "Impact of sampling depth on differences in soil carbon stocks in long-term agroecosystem experiments.", *Soil Science Society of America Journal*, 75(1), pp. 226-234. doi : 10.2136/sssaj2010.0099

### Ellert, Ben (Lethbridge)

#### Research Publications:

2014

- Gillespie, A.W., Sanei, H., Diochon, A., Ellert, B.H., Regier, T.Z., Chevrier, D., Dynes, J.J., Tarnocai, C., and Gregorich, E.G. (2014). "Perennially and annually frozen soil carbon differ in their susceptibility to decomposition: analysis of Subarctic earth hummocks by bioassay, XANES and pyrolysis.", *Soil Biology & Biochemistry*, 68, pp. 106-116. doi : 10.1016/j.soilbio.2013.09.021
- Helgason, B.L., Gregorich, E.G., Janzen, H.H., Ellert, B.H., Lorenz, N., and Dick, R.P. (2014). "Long-term microbial retention of residue C is site-specific and depends on residue placement.", *Soil Biology & Biochemistry*, 68, pp. 231-240. doi : 10.1016/j.soilbio.2013.10.002
- Phillips, A.J.L., Newlands, N.K., Liang, S.H.L., and Ellert, B.H. (2014). "Integrated sensing of soil moisture at the field-scale: sampling, modelling and sharing for improved agricultural decision-support.", *Computers and Electronics in Agriculture*.

2012

- Janzen, H.H., Olson, B.M., Zvomuya, F., Larney, F.J., and Ellert, B.H. (2012). "Long-term Field Bioassay of Soil Quality.", *Prairie Soils and Crops*, 5, pp. 165-168.

- Li, C.L.Hao, X., Ellert, B.H., Willms, W.D., Zhao, M.G., and Han, G.D. (2012). "Changes in soil C, N, and P with long-term (58 years) cattle grazing on rough fescue grassland.", *Journal of Plant Nutrition and Soil Science*, 175(3), pp. 339-344. doi : 10.1002/jpln.201100212
- Smith, E.G., Ellert, B.H., Janzen, H.H., and Nakonechny, E.M. (2012). "Rotation ABC – Lethbridge, Alberta.", *Prairie Soils and Crops*, 5, pp. 147-154.
- Smith, E.G., Janzen, H.H., Ellert, B.H., and Nakonechny, D.J. (2012). "Rotation 120 – Lethbridge Alberta.", *Prairie Soils and Crops*, 5, pp. 155-164.
- Tang, X., Ellert, B.H., Hao, X., Ma, Y., Nakonechny, E.M., and Li, J. (2012). "Temporal changes in soil organic carbon contents and  $\delta^{13}\text{C}$  values under long-term maize-wheat rotation systems with various soil and climate conditions.", *Geoderma*, 183-184, pp. 67-73. doi : 10.1016/j.geoderma.2012.03.003

2011

- Bremer, E., Janzen, H.H., Ellert, B.H., and McKenzie, R.H. (2011). "Carbon, nitrogen, and greenhouse gas balances in an 18-year cropping system study on the northern Great Plains.", *Soil Science Society of America Journal*, 75(4), pp. 1493-1502. doi : 10.2136/sssaj2010.0326
- Rock, L., Ellert, B.H., and Mayer, B. (2011). "Tracing sources of soil nitrate using the dual isotopic composition of nitrate in 2 M KCl-extracts.", *Soil Biology & Biochemistry*, 43(12), pp. 2397-2405. doi : 10.1016/j.soilbio.2011.08.016
- VandenBygaart, A.J., Bremer, E., McConkey, B.G., Ellert, B.H., and Janzen, H.H. (2011). "Impact of sampling depth on differences in soil carbon stocks in long-term agroecosystem experiments.", *Soil Science Society of America Journal*, 75(1), pp. 226-234. doi : 10.2136/sssaj2010.0099

## **Remote Sensing**

### **Smith, Anne (Lethbridge)**

Research Publications:

2012

- Smith, A.M. (2012). "Spatial and temporal variation in vulnerability of crop production to drought in southern Alberta.", *Canadian Geographer*, 56(4), pp. 474-491. doi : 10.1111/j.1541-0064.2012.00440.x

2011

- Buckley, J.R. and Smith, A.M. (2011). "Comparing RADARSAT 2 and TerraSAR-X quad-pol SAR imagery of grasslands.", *International Geoscience and Remote Sensing Symposium (IGARSS), 2011*(Article No. 6050022), pp. 3676-3679. doi : 10.1109/IGARSS.2011.6050022
- Smith, A.M. and Buckley, J.R. (2011). "Investigating RADARSAT-2 as a tool for monitoring grassland in western Canada.", *Canadian Journal of Remote Sensing*, 37(1), pp. 93-102.
- Teillet, P.M., Ren, X., and Smith, A.M. (2011). "Suitability of rangeland terrain for satellite remote sensing calibration.", *Canadian Journal of Remote Sensing*, 36(5), pp. 451-463. doi : 10.5589/m10-074
- Zhang, K., Wang, J.-G, and Pattey, E., Smith, A.M. (2011). "Improving the Retrieval of the Biophysical Parameters of Vegetation Canopies by using the Contribution Index.", *Canadian Journal of Remote Sensing*, 37(6), pp. 643-652. doi : 10.5589/m12-006.

## DEVELOPMENT

### Vera, Cecil (Melfort)

#### Research Publications:

2013

- Bing, D.-J., Beauchesne, D., McLaren, D.L., Vera, C.L., and Gehl, D.T. (2013). "AAC Peace River field pea.", *Canadian Journal of Plant Science*, 93(2), pp. 337-339. doi : 10.4141/cjps2012-173
- Malhi, S.S., Vera, C.L., and Brandt, S.A. (2013). "Relative effectiveness of organic and inorganic nutrient sources in improving yield, seed quality and nutrient uptake of canola.", *Agricultural Sciences*, 4(12A), pp. 1-18. doi : 10.4236/as.2013.412A001
- Vera, C.L., Fox, S.L., DePauw, R.M., Smith, M.A.H., Wise, I.L., Clarke, F.R., Procnier, J.D., and Lukow, O.M. (2013). "Relative performance of resistant wheat varietal blends and susceptible wheat cultivars exposed to wheat midge, *Sitodiplosis mosellana* (Géhin).", *Canadian Journal of Plant Science*, 93(1), pp. 59-66. doi : 10.4141/cjps2012-019

2012

- Harker, K.N., O'Donovan, J.T., Turkington, T.K., Blackshaw, R.E., Lupwayi, N.Z., Smith, E.G., Klein-Gebbinck, H.W., Dossdall, L.M., Hall, L.M., Willenborg, C.J., Kutcher, H.R., Malhi, S.S., Vera, C.L., Gan, Y.T., Lafond, G.P., May, W.E., Grant, C.A., and McLaren, D.L. (2012). "High-yield no-till canola production on the Canadian prairies.", *Canadian Journal of Plant Science*, 92(2), pp. 221-233. doi : 10.4141/CJPS2011-125
- Prashar, S., Wolfe, D., King, M.C., Vera, C.L., Fox, S.L., DePauw, R.M., Chen, G., Smith, M.A.H., Wise, I.L., Clarke, F.R., Lukow, O.M., and Procnier, J.D. (2012). "Stability of midge tolerant varietal blends over 3-4 successive generations: High-speed / high-throughput, SNP-DNA fingerprinting in grain seeds.", *Journal of Plant Biochemistry and Biotechnology*, 3(2), pp. 1-10.
- Vera, C.L., Duguid, S.D., Fox, S.L., Rashid, K.Y., Dribnenki, J.C.P., and Clarke, F.R. (2012). "Comparative effect of lodging on seed yield of flax and wheat.", *Canadian Journal of Plant Science*, 92(1), pp. 39-43. doi : 10.4141/CJPS2011-031

2011

- Bing, D.-J., Beauchesne, D., Sloan, A., McLaren, D.L., and Vera, C.L. (2011). "Earlstar field pea.", *Canadian Journal of Plant Science*, 91(6), pp. 1115-1116. doi : 10.4141/CJPS2011-076
- Blackshaw, R.E., Hao, X., Brandt, R.N., Clayton, G.W., Harker, K.N., O'Donovan, J.T., Johnson, E.N., and Vera, C.L. (2011). "Canola response to ESN and urea in a four-year no-till cropping system.", *Agronomy Journal*, 103(1), pp. 92-99. doi : 10.2134/agronj2010.0299
- Blackshaw, R.E., Hao, X., Harker, K.N., O'Donovan, J.T., Johnson, E.N., and Vera, C.L. (2011). "Barley productivity response to polymer-coated urea in a no-till production system.", *Agronomy Journal*, 103(4), pp. 1100-1105. doi : 10.2134/agronj2010.0494
- Wang, Y., Xie, Z., Malhi, S.S., Vera, C.L., Zhang, Y., and Guo, Z. (2011). "Effects of gravel-sand mulch, plastic mulch and ridge and furrow rainfall harvesting system combinations on water use efficiency, soil temperature and watermelon yield in a semi-arid Loess Plateau of northwestern China.", *Agricultural Water Management*, 101(1), pp. 88-92. doi : 10.1016/j.agwat.2011.09.006

## ANNEX B) LIST OF PUBLICATIONS – TECHNOLOGY TRANSFER

Network of AAFC Sites (Alberta: Lacombe, Beaverlodge, Lethbridge; Saskatchewan: Saskatoon, Melfort, Scott, Outlook, Swift Current, Indian Head; Manitoba: Brandon, Morden)

### AGRONOMY

#### *Crops*

#### **Lafond, Guy (deceased 2013; Indian Head)**

Technology Transfer Publications:

2013

- Grant, B.B., Smith, W.N., Campbell, C.A., Desjardins, R.L., Lemke, R.L., Kröbel, R., McConkey, B.G., Smith, E.G., and Lafond, G.P. (2013 submitted). "Comparison of DayCent and DNDC models: Case studies using data from long-term experiments on the Canadian prairies.", - Synthesis and Modeling of Greenhouse Gas Emissions and Carbon Storage in Agricultural and Forest Systems to Guide Mitigation and Adaptation, ASA, CSSA, and SSSA, Madison, WI, USA.
- Bassendowski, K.A., Lafond, G.P., May, W.E., Holzapfel, C.B., and Gossen, B.D. (2013). "Frequent cropping to field pea increases the severity of root and foliar diseases.", Canadian Journal of Plant Pathology, 35, pp. 518. (Abstract)

2011

- O'Donovan, J.T., Blackshaw, R.E., Grant, C.A., Harker, K.N., Lafond, G.P., Johnson, E.N., Gan, Y.T., May, W.E., Turkington, T.K., and Lupwayi, N.Z. (2011). "Legume Crops to Improve Soil Fertility for Enhanced Canola Production.", 2011 ASA-CSSA-SSSA International Annual Meeting: Fundamental for life: soil, crop and environmental sciences, San Antonio, TX, USA, October 16-19, 2011. (Poster)

#### **O'Donovan, John (Lacombe - cropping systems)**

Technology Transfer Publications:

2014

- Lupwayi, N.Z., Harker, K.N., Larney, F.J., Blackshaw, R.E., and O'Donovan, J.T. (2014). "Correlating soil microbial properties with crop yields in the Canadian prairies: two case studies.", Soil's Role in Restoring Ecosystem Services Conference, Sacramento, CA, USA, March 6-9, 2014. (Abstract)

2013

- Otani, J.K., O'Donovan, J.T., Yoder, C., Azooz, R.H., and Burton, S.L. (2013). Competitive contract production of forage seed in western Canada (DIAP# PRO-05147/AGR-05846). AAFC's Developing Innovative Agri-Products Initiative. Final Report 2010-2013, April 19, 2013. (Report)

2012

- Beaudoin, N., Sansoulet, J.B., Pattey, E., Grant, C.A., Blackshaw, R.E., Harker, K.N., Johnson, E.N., O'Donovan, J.T., and Gervois, S. (2012). "Adaptation de STICS à la culture de canola au Canada à partir du module colza en vue de simuler les émissions de N<sub>2</sub>O par ModuloSTICS.", IXe Séminaire du modèle de culture STICS, Sainte-Montaine, France, October 16-19, 2012. (Poster)

- Harker, K.N. and O'Donovan, J.T. (2012). "Canola after pulse crops.", Agronomy Update Conference 2012, Red Deer, AB, Canada, January 17-18, 2012, pp. 9.
- Smith, E.G., O'Donovan, J.T., Henderson, W.J., Turkington, T.K., and Clayton, G.W. (2012). "Malting Barley Production: Profitability and Risk.", 2012 Annual Meeting of the Canadian Agricultural Economics Society (CAES), Niagara Falls, ON, Canada, June 17-19, 2012.

## 2011

- Blackshaw, R.E., Hao, X., Clayton, G.W., Harker, K.N., O'Donovan, J.T., Johnson, E.N., and Vera, C.L. (2011). "Canola response to polymer-coated urea versus urea in a four-year zero-tillage cropping system on the Canadian prairies.", 13th International Rapeseed Congress, Prague, Czech Republic, June 5-9, 2011, pp. 61-64.
- Blackshaw, R.E., Harker, K.N., and O'Donovan, J.T. (2011). "Polymer-coated urea compared with urea reduces N uptake by weeds.", Canadian Weed Science Society 65th Annual Meeting, Marriott Gateway on the Falls, Niagara Falls, ON, Canada, November 21-24, 2011, pp. 65. (Poster)
- Grant, C.A., Zebarth, B.J., Malhi, S.S., Soon, Y.K., Selles, F., Lupwayi, N.Z., O'Donovan, J.T., Harker, K.N., and Clayton, G.W. (2011). "Changes in soil ammonium and nitrate concentration over the growing season in western Canada as affected by urea or controlled release urea application.", 12th International Symposium on Soil and Plant Analysis, Mediterranean Agronomic Institute of Chania, Crete, Greece, June 6-10, 2011.
- Harker, K.N., Brandt, S.A., O'Donovan, J.T., Blackshaw, R.E., Johnson, E.N., and Kutcher, H.R. (2011). "The Impact of Two Years of Wild Oat Management After Four Years of Low Crop Inputs in Barley and Canola.", 51st Meeting Weed Science Society of America, Hilton Portland & Executive Tower Hotel, Portland, OR, USA, February 7-10, 2011, pp. 62. (Presentation)
- Harker, K.N., Turkington, T.K., O'Donovan, J.T., Kutcher, H.R., and Johnson, E.N. (2011). "Barley Herbicide and Fungicide Tank-Mixtures?", Canadian Weed Science Society 65th Annual Meeting, Marriott Gateway on the Falls, Niagara Falls, ON, Canada, November 21-24, 2011, pp. 46. (Abstract)
- Harker, K.N., Turkington, T.K., O'Donovan, J.T., Kutcher, H.R., and Johnson, E.N. (2011). "Barley Herbicide and Fungicide Tank-Mixtures?", Canadian Weed Science Society 65th Annual Meeting, Marriott Gateway on the Falls, Niagara Falls, ON, Canada, November 24, 2011. (Presentation)
- O'Donovan, J.T. and Turkington, T.K. (2011). "Effect of farming practices on malting grade barley and brewhouse performance.", Western Barley Growers Association & Master Brewers Association of the Americas Joint Conference, Deerfoot Inn & Casino, Calgary, AB, Canada, February 16-18, 2011.
- O'Donovan, J.T., Blackshaw, R.E., Grant, C.A., Harker, K.N., Lafond, G.P., Johnson, E.N., Gan, Y.T., May, W.E., Turkington, T.K., and Lupwayi, N.Z. (2011). "Legume Crops to Improve Soil Fertility for Enhanced Canola Production.", 2011 ASA-CSSA-SSSA International Annual Meeting: Fundamental for life: soil, crop and environmental sciences, San Antonio, TX, USA, October 16-19, 2011. (Poster)
- O'Donovan, J.T., Harker, K.N., and Blackshaw, R.E. (2011). "Implications of sub-economic threshold wild oat densities in a cereal/field pea rotation under no-till.", Canadian Weed Science Society 65th Annual Meeting, Marriott Gateway on the Falls, Niagara Falls, ON, Canada, November 21-24, 2011, pp. 46. (Abstract)
- Turkington, T.K. and O'Donovan, J.T. (2011). "Malt Barley Research Update: The impact of harvest management and seed source", Alberta Barley Commission, Rahr Malting, Inc. and

Canadian Wheat Board meeting, Alberta Barley Commission Office, Calgary, AB, Canada, April 19, 2011. (Presentation)

- Turkington, T.K., Kutcher, H.R., Xi, K., Harker, K.N., O'Donovan, J.T., and Johnson, E.N. (2011). "The impact of fungicide and herbicide timing on barley leaf disease severity, weed management and crop productivity.", *Phytopathology*, 101(6), pp. S180. (Abstract)

### **Beres, Brian (Lethbridge - cropping systems)**

Technology Transfer Publications:

2013

- Randhawa, H.S., Eudes, F., Beres, B.L., Graf, R.J., Fedak, G., Comeau, A., Langevin, F., Dion, Y., and Pozniak, C.J. (2013). "Integrated approaches for triticale breeding.", The 8th International Triticale Symposium, Ghent, Belgium, June 10-14, 2013, (Presentation).

2012

- Beres, B.L. (2012). "Manipulating agronomic factors for sustainable control of the wheat stem sawfly.", Entomological Society of Canada 62nd and Entomological Society of Alberta 60th joint Annual Meeting, Coast Edmonton Plaza Hotel, Edmonton, AB, Canada, November 4-7, 2012, #10. (Abstract)
- Beres, B.L., Cárcamo, H.A., Weaver, D.K., Dosdall, L.M., Evenden, M.L., Hill, B.D., McKenzie, R.H., Yang, R.-C., and Spaner, D.M. (2012). "Integrating the building blocks of agronomy and biocontrol into an IPM strategy for wheat stem sawfly (*Cephus cinctus*).", Entomological Society of America (ESA) 60th Annual Meeting, Knoxville Convention Centre, Knoxville, TN, USA, November 11-14, 2012, D0471. (Poster)

2011

- Beres, B.L. (2011). "Collaborative winter wheat stand establishment and overwintering trials (Ducks Unlimited Winter Wheat DIAP Project).", Ducks Unlimited and the Alberta Winter Wheat Producers Commission Speaker Event, Lethbridge, AB, Canada, July 22, 2011. (Presentation)
- Beres, B.L. (2011). "Integrated nutrient management of winter wheat: activities and results.", Agrotain LLC Global Annual Business Meeting, St. Louis, MO, USA, July 12, 2011. (Presentation)
- Grant, C.A., Beres, B.L., Malhi, S.S., Pageau, D., Lafond, J., Schoenau, J.J., Walley, F.L., Heard, J., Flaten, D.N., Hellegards, B., and Sahota, T.S. (2011). "New developments in nutrition research for canola.", Canola Research Summit meeting, Winnipeg, MB, Canada, April 12-13, 2011.
- Isidro, J., Singh, A.K., Wang, H., DePauw, R.M., Pozniak, C.J., Knox, R.E., Cuthbert, R.D., Beres, B.L., and Johnson, E.N. (2011). "Effects of plant density on durum crop production.", 1st Canadian Wheat Symposium, Winnipeg, MB, Canada, November 30-December 2, 2011.

### **Gan, Yantai (Swift Current - pulse, cropping systems)**

Technology Transfer Publications:

2012

- Gan, Y.T. (2012). "Lowering Carbon Footprint by Diversifying Cropping Systems.", 24th Annual Conference of the Saskatchewan Soil Conservation Association (SSCA), Saskatoon Inn, Saskatoon, SK, Canada, January 11, 2012.
- Liu, C., Fernando, W.G.D., Gan, Y.T., Kutcher, H.R., and Peng, G. (2012). "Baseline sensitivity of *Leptosphaeria maculans* to strobilurin fungicides.", Canadian Phytopathological Society (CPS)

83rd Annual Meeting and International PPV Meeting, Marriott Gateway On The Falls, Niagara Falls, ON, Canada, June 24-27, 2012. (Poster)

- Pageni, B.B., Lupwayi, N.Z., Larney, F.J., Kawchuk, L.M., Pearson, D.C., Blackshaw, R.E., and Gan, Y.T. (2012). "Characterization of bacterial endophytes associated with *Solanum tuberosum* in irrigated cropping systems.", 112th General Meeting of American Society for Microbiology, San Francisco, CA, USA, June 15-19, 2012. (Abstract)
- Pageni, B.B., Lupwayi, N.Z., Larney, F.J., Kawchuk, L.M., Pearson, D.C., Blackshaw, R.E., and Gan, Y.T. (2012). "Preceding crop, rotation length and soil management effects on bacterial endophytes.", 49th Annual Alberta Soil Science Workshop, Ramada Inn, Edmonton, AB, Canada, February 14-16, 2012. (Abstract)

2011

- Bazghaleh, N., Hamel, C., Knight, J.D., Gan, Y.T., Ishii, T., and Cruz, A.F. (2011). "Chickpea root antifungal activity and mycorrhization.", Pulse Science Cluster Scientific Meeting 2011, Radisson Hotel, Saskatoon, SK, Canada, November 17-18, 2011, pp. 17.
- DePauw, R.M., Malhi, S.S., Bullock, P.R., Gan, Y.T., McKenzie, R.H., Larney, F.J., Janzen, H.H., Cutforth, H.W., and Wang, H. (2011). "Wheat Production in Northern High Latitudes – Canadian example.", in Bonjean, A., Angus, W., and Van Ginkel, M. (eds.) - The World Wheat Book A History of Wheat Breeding. Vol. 2, Lavoisier Tech et Doc, Paris, France, pp. 607-651.
- Ellouze, W., St-Arnaud, M., Hamel, C., Gan, Y.T., Cruz, A.F., and Ishii, T. (2011). "Phytochemicals and spore germination: at the root of AMF host preference?", Soils Ecology Society Meeting 2011, University of British Columbia - Okanagan, Kelowna, BC, Canada, May 24-27, 2011, pp. 64.
- Gan, Y.T. (2011). "Science behind rotation agronomy.", Agronomy Update, University of Saskatchewan, Saskatoon, SK, Canada, December 8, 2011. (Presentation)
- Hamel, C., Yang, C., Taheri, A.E., Bazghaleh, N., Navarro-Borrell, A., Cruz, A.F., Ishii, T., Vujanovic, V., Knight, J.D., Germida, J.J., and Gan, Y.T. (2011). "Microbial pipeline to next generation pulses.", Pulse Science Cluster Scientific Meeting 2011, Radisson Hotel, Saskatoon, SK, Canada, November 17-18, 2011, pp. 5.
- Knight, J.D., Chao, T., Bazghaleh, N., Navarro, A., Taheri, A.E., Hamel, C., and Gan, Y.T. (2011). "Crop Rotation Effects on Soil Biology.", Agronomy Update Conference 2011, Lethbridge, AB, Canada, January 18-19, 2011.
- Navarro-Borrell, A., Hamel, C., Germida, J.J., and Gan, Y.T. (2011). "Arbuscular mycorrhiza fungi and dark septate endophytes colonization patterns are related with nutrient content in pulse and wheat Brown in the semiarid Canadian Prairie.", Pulse Science Cluster Scientific Meeting 2011, Radisson Hotel, Saskatoon, SK, Canada, November 17-18, 2011, pp. 18.
- Navarro-Borrell, A., Hamel, C., Germida, J.J., and Gan, Y.T. (2011). "Dark septate endophytes and arbuscular mycorrhiza fungi colonization patterns related with plant nutrient content in pulse and wheat.", Pulse Science Cluster Scientific Meeting 2011, Radisson Hotel, Saskatoon, SK, Canada, November 17-18, 2011, pp. 4.
- Navarro-Borrell, A., Hamel, C., Germida, J.J., and Gan, Y.T. (2011). "Elucidating the tripartite association plant-Arbuscular mycorrhizal fungi-dark septate endophytes [CD-Rom].", Soils and Crops Workshop 2011, Prairieland Park, Saskatoon, SK, Canada, March 15-16, 2011.
- Navarro-Borrell, A., Hamel, C., Hanson, K.G., McDonald, C.L., Germida, J.J., and Gan, Y.T. (2011). "Pulse and wheat crops' influence on soil dehydrogenase activity, soil nutrient content and microbial community.", Soils Ecology Society Meeting 2011, University of British Columbia - Okanagan, Kelowna, BC, Canada, May 24-27, 2011, pp. 67.

- O'Donovan, J.T., Blackshaw, R.E., Grant, C.A., Harker, K.N., Lafond, G.P., Johnson, E.N., Gan, Y.T., May, W.E., Turkington, T.K., and Lupwayi, N.Z. (2011). "Legume Crops to Improve Soil Fertility for Enhanced Canola Production.", 2011 ASA-CSSA-SSSA International Annual Meeting: Fundamental for life: soil, crop and environmental sciences, San Antonio, TX, USA, October 16-19, 2011. (Poster)
- Pageni, B.B., Lupwayi, N.Z., Larney, F.J., Kawchuk, L.M., Pearson, D.C., Blackshaw, R.E., and Gan, Y.T. (2011). "Preceding crop, rotation length and soil management effects on bacterial endophytes.", Pulse Science Cluster Scientific Meeting 2011, Radisson Hotel, Saskatoon, SK, Canada, November 17-18, 2011. (Abstract)
- Wang, X. and Gan, Y.T. (2011). "Biological nitrogen fixation and nodulation characterization of various pulse species, market classes and varieties in semiarid northern latitudes.", Canadian Society of Plant Physiologists Eastern Regional Meeting & Plant Development Workshop / Congrès de la Société Canadienne de Physiologie Végétale & Congrès de Développement Végétale (Congrès Régional de l'Est), Carleton University, Ottawa, ON, Canada, December 2-3, 2011, P38, pp. 48. (Poster)
- Yang, C., Hamel, C., Gan, Y.T., and Vujanovic, V. (2011). "Isolation of hydrogen-oxidizing bacteria with positive effects on plant growth from chickpea field.", Pulse Science Cluster Scientific Meeting 2011, Radisson Hotel, Saskatoon, SK, Canada, November 17-18, 2011.

### May, Bill (Indian Head)

Technology Transfer Publications:

2013

- Bassendowski, K.A., Lafond, G.P., May, W.E., Holzapfel, C.B., and Gossen, B.D. (2013). "Frequent cropping to field pea increases the severity of root and foliar diseases.", *Canadian Journal of Plant Pathology*, 35, pp. 518. (Abstract)

2011

- Fernandez, M.R., May, W.E., Chalmers, S., Savard, M.E., and Singh, A.K. (2011). "Effectiveness of fungicide applications at various growth stages on head/kernel diseases, and productivity of durum wheat in southern Saskatchewan.", 7th Canadian Workshop on Fusarium Head Blight (CWFHB) / Colloque canadien sur la fusariose, Delta Winnipeg Hotel, Winnipeg, MB, Canada, November 27-30, 2011, pp. 87.
- O'Donovan, J.T., Blackshaw, R.E., Grant, C.A., Harker, K.N., Lafond, G.P., Johnson, E.N., Gan, Y.T., May, W.E., Turkington, T.K., and Lupwayi, N.Z. (2011). "Legume Crops to Improve Soil Fertility for Enhanced Canola Production.", 2011 ASA-CSSA-SSSA International Annual Meeting: Fundamental for life: soil, crop and environmental sciences, San Antonio, TX, USA, October 16-19, 2011. (Poster)

### Mohr, Ramona (Brandon)

Technology Transfer Publications:

2011

- Buckley, K.E., Mohr, R.M., Coulter, V., Phillips, K., and Westwood, R. (2011). "Nutrient status of potatoes grown on compost amended soils as determined by sap nitrate levels.", 21st Annual National Compost Conference, Charlottetown, PEI, Canada, September 19-21, 2011. (Presentation)



- Gao, X., Mohr, R.M., McLaren, D.L., and Grant, C.A. (2011). "Variation in Cadmium, Iron and Zinc Concentrations in Grain of 13 Bread Wheat Cultivars Grown on Canadian Prairies.", 11th International Conference of Biogeochemistry of Trace Elements, Florence, Italy, July 3-7, 2011. (Abstract)
- Mohr, R.M. (2011). "Enhancing Nitrogen Management in Irrigated Potato.", 125th Anniversary of the Brandon Research Centre, Brandon, MB, Canada, August 11, 2011. (Poster)

### **Duguid, Scott (Morden – flax)**

#### Technology Transfer Publications:

2013

- Rashid, K.Y., Desjardins, M., and Duguid, S.D. (2013). "Diseases of flax in Manitoba and Saskatchewan in 2012.", *Canadian Plant Disease Survey*, 93, pp. 161-162.

2012

- Cloutier, S., Banik, M., You, F.M., Radovanovic, N., Miranda, D.E., Reimer, E., Ward, K., Walichnowski, A.Z., Rowland, G.G., and Duguid, S.D. (2012). "High Density SSR- and SNP-based Genetic Maps of Flax.", Plant & Animal Genome XX Conference, Town & Country Convention Center, San Diego, CA, USA, January 14-18, 2012. (Poster)
- Rashid, K.Y., Desjardins, M.L., Duguid, S.D., and Northover, P.R. (2012). "Diseases of flax in Manitoba and Saskatchewan in 2011.", *Canadian Plant Disease Survey*, 92, pp. 134-135.

2011

- Rashid, K.Y., Desjardins, M.L., and Duguid, S.D. (2011). "Diseases of flax in Manitoba and Saskatchewan in 2010.", *Canadian Plant Disease Survey*, 91, pp. 128-129.
- Vera, C.L., Irvine, R.B., Duguid, S.D., and Rashid, K.Y. (2011). "Effect of fungicide and N application on lodging and disease in flax.", Soils and Crops Workshop 2011, Prairieland Park, Saskatoon, SK, Canada, March 15-16, 2011. (Poster)

### **Grant, Cynthia (Brandon – fertility)**

#### Technology Transfer Publications:

2013

- Ziadi, N., Bélanger, G., Grant, C.A., Cade-Menun, B.J., Lalande, R., Hamel, C., Lafond, J., Lajeunesse, J., Pageau, D., Tremblay, G.F., and Zhang, T.Q. (2013). Soil and plant phosphorus assessment and modeling in Canadian agro-ecosystems. Final report SAGES#1475. (Report)

2012

- Beaudoin, N., Sansoulet, J.B., Pattey, E., Grant, C.A., Blackshaw, R.E., Harker, K.N., Johnson, E.N., O'Donovan, J.T., and Gervois, S. (2012). "Adaptation de STICS à la culture de canola au Canada à partir du module colza en vue de simuler les émissions de N<sub>2</sub>O par ModuloSTICS.", IXe Séminaire du modèle de culture STICS, Sainte-Montaine, France, October 16-19, 2012. (Poster)
- Grant, C.A. (2012). "Managing phosphorus for high canola yields.", Ontario Canola Growers, Alliston, ON, Canada, January 26, 2012.
- Grant, C.A. (2012). "Sulphur – It's not just for Canola anymore.", Advanced Crop Advisors Workshop, Fargo, ND, USA, February 8, 2012.
- Grant, C.A. and Bruulsema, T.W. (2012). "Protein, Oil and Carbohydrate Composition of Food.", in Bruulsema, T.W., Heffer, P., Welch, R.M., Cakmak, I. and Moran, K. (eds.) - Fertilizing Crops to

Improve Human health: A Scientific Review. Vol. 1. Food and Nutritional Security, International Plant Nutrition Institute (IPNI), Norcross, GA and International Fertilizer Industry Association, Paris, France, Chapter 6, pp. 143-175.

- Grant, C.A., Cubadda, F., Carcea, M., Pogna, N.E., and Gassa, L. (2012). "Vitamins, Minerals and Nutritional Value of Durum Wheat.", in Sisson, M., Abecassis, J., Marchylo, B. and Carcea, M. (eds.) - Durum Wheat: Chemistry and Technology. 2nd Edition, American Association of Cereal Chemists (AACC), Chapter 7.
- Grant, C.A., Di Fonzo, N., and Pisante, M. (2012). "Agronomy of Wheat Production.", in Sisson, M., Abecassis, J., Marchylo, B. and Carcea, M. (eds.) - Durum Wheat: Chemistry and Technology. 2nd Edition, American Association of Cereal Chemists (AACC), Chapter 3, pp. 37-55.
- Nyiraneza, J., Zebarth, B.J., Ziadi, N., Sharifi, M., Burton, D.L., Drury, C.F., Bittman, S., and Grant, C.A. (2012). "The ability of soil chemical and biological N availability indices to predict soil nitrogen supply of contrasting soils under corn.", Canadian Society of Soil Science (CSSS) and Association Québécoise de Spécialistes en Sciences du Sol (AQSSS) Joint Meeting, Manoir St-Castin, Lac Beauport, QC, Canada, June 3-8, 2012. (Poster)

## 2011

- Akinremi, W., Grant, C.A., Ige, D.V., Gao, X., Flaten, D.N., Tenuta, M., and Malhi, S.S. (2011). "Changes in soil test phosphorus following seven consecutive applications of high rates of phosphate fertilizer.", 2011 ASA-CSSA-SSSA International Annual Meeting: Fundamental for life: soil, crop and environmental sciences, San Antonio, TX, USA, October 16-19, 2011. (Abstract)
- Cambouris, A.N., Zebarth, B.J., Ziadi, N., Grant, C.A., Hu, Z., Gagnon, B., Drury, C.F. (2011). "Agri-environmental effect of N fertilizer on potato production.", 2011 ASA-CSSA-SSSA International Annual Meeting: Fundamental for life: soil, crop and environmental sciences, San Antonio, TX, USA, October 16-19, 2011.
- Cambouris, A.N., Zebarth, B.J., Ziadi, N., Grant, C.A., and Drury, C.F. (2011). "Impacts agro-environnementaux de divers fertilisants azotés sur la production de pomme de terre. Association québécoise de spécialistes en sciences du sol.", 25ème congrès annuel de l'AQSSS, Wendake, QC, Canada, May 25-27, 2011.
- Dai, M., Hamel, C., St. Arnaud, M., Grant, C.A., Lupwayi, N.Z., Janzen, H.H., Yang, X.Q., and Zhou, Z. (2011). "Composition and diversity of arbuscular mycorrhizal fungi in cropping system associated with different soil zones using pyrosequencing.", Soils Ecology Society Meeting 2011, University of British Columbia - Okanagan, Kelowna, BC, Canada, May 24-27, 2011, pp. 43.
- Drury, C.F., Reynolds, W.D., Yang, X.M., Welacky, T.W., McLaughlin, N.B., Calder, W., and Grant, C.A. (2011). "Tillage and N source effects on nitrous oxide emissions from soils.", 2011 ASA-CSSA-SSSA International Annual Meeting: Fundamental for life: soil, crop and environmental sciences, San Antonio, TX, USA, October 16-19, 2011.
- Fatteicher, C., Qian, P.Y., Urton, R., Kin, T., Schoenau, J.J., and Grant, C.A. (2011). "Effect of Seed-Placed Sulfate and Phosphate On the Emergence of Brassicae Crops.", 2011 ASA-CSSA-SSSA International Annual Meeting: Fundamental for life: soil, crop and environmental sciences, San Antonio, TX, USA, October 16-19, 2011. (Abstract)
- Gao, X., Mohr, R.M., McLaren, D.L., and Grant, C.A. (2011). "Variation in Cadmium, Iron and Zinc Concentrations in Grain of 13 Bread Wheat Cultivars Grown on Canadian Prairies.", 11th International Conference of Biogeochemistry of Trace Elements, Florence, Italy, July 3-7, 2011. (Abstract)

- Grant, C.A. (2011). "Management practices to minimize cadmium concentration in crops.", Oral presentation to Chinese Academy of Agricultural Sciences, Beijing, China, November 23, 2011. (Presentation)
- Grant, C.A. (2011). "Sulphur Fertilization – What has Changed?", Manitoba Agronomists 2011 Conference, Winnipeg, MB, Canada, December 13-14, 2011, 8 pages.
- Grant, C.A. (2011). "Supplying nutrients for canola – whatever the weather.", Saskatchewan Canola Workshop, Yorkton, SK, Canada, November 2, 2011. (Presentation)
- Grant, C.A., Beres, B.L., Malhi, S.S., Pageau, D., Lafond, J., Schoenau, J.J., Walley, F.L., Heard, J., Flaten, D.N., Hellegards, B., and Sahota, T.S. (2011). "New developments in nutrition research for canola.", Canola Research Summit meeting, Winnipeg, MB, Canada, April 12-13, 2011.
- Grant, C.A., Gao, X., Flaten, D.N., Tenuta, M., Malhi, S.S., and Akinremi, W. (2011). "Impact of long-term application of cadmium in phosphate fertilizer on extractable cadmium as affected by soil characteristics.", 2011 ASA-CSSA-SSSA International Annual Meeting: Fundamental for life: soil, crop and environmental sciences, San Antonio, TX, USA, October 16-19, 2011. (Abstract)
- Grant, C.A., Gao, X., Flaten, D.N., Tenuta, M., and Malhi, S.S. (2011). "Impact of Long-term Application of Cadmium in Phosphate Fertilizer on Extractable Cadmium as Affected by Soil Characteristics.", 11th International Conference of Biogeochemistry of Trace Elements, Florence, Italy, July 3-7, 2011.
- Grant, C.A., Zebarth, B.J., Malhi, S.S., Soon, Y.K., Selles, F., Lupwayi, N.Z., O'Donovan, J.T., Harker, K.N., and Clayton, G.W. (2011). "Changes in soil ammonium and nitrate concentration over the growing season in western Canada as affected by urea or controlled release urea application.", 12th International Symposium on Soil and Plant Analysis, Mediterranean Agronomic Institute of Chania, Crete, Greece, June 6-10, 2011.
- Karamanos, R.E., Grant, C.A., and Malhi, S.S. (2011). "Sulfur Management in the Northern Great Plains.", 2011 ASA-CSSA-SSSA International Annual Meeting: Fundamental for life: soil, crop and environmental sciences, San Antonio, TX, USA, October 16-19, 2011. (Abstract)
- O'Donovan, J.T., Blackshaw, R.E., Grant, C.A., Harker, K.N., Lafond, G.P., Johnson, E.N., Gan, Y.T., May, W.E., Turkington, T.K., and Lupwayi, N.Z. (2011). "Legume Crops to Improve Soil Fertility for Enhanced Canola Production.", 2011 ASA-CSSA-SSSA International Annual Meeting: Fundamental for life: soil, crop and environmental sciences, San Antonio, TX, USA, October 16-19, 2011. (Poster)
- Urton, R., Qian, P., Schoenau, J.J., King, T., and Grant, C.A. (2011). "Effect of Seed-Placed Phosphorus and Ammonium Sulfate on Germination and Emergence of Canola.", Soils and Crops Workshop 2011, Prairieland Park, Saskatoon, SK, Canada, March 15-16, 2011, [CD-ROM].
- Zebarth, B.J., Dessureault-Rompré, J., Burton, D.L., Georgallas, A., Sharifi, M., Porter, G.A., Moreau, G., Leclerc, Y., Arsenault, W.J., Chow, T.L., and Grant, C.A. (2011). "Predicting Soil Nitrogen Supply in Potato Fields Using a Simple Kinetic Model.", 19th Annual Northeast Potato Technology Forum, Crowne Plaza Fredericton Lord Beaverbrook Hotel, Fredericton, NB, Canada, March 16-17, 2011.

### Hao, Xiyang (Lethbridge)

Technology Transfer Publications:

2014

- Hao, X., Hill, B.D., Caffyn, P.R., Travis, G.R., Olson, A.F., Larney, F.J., McAllister, T.A., and Alexander, T.W. (2014). "Co-composting of beef cattle feedlot manure with housing construction waste for value-added organic fertilizer.", 51st Annual Alberta Soil Science Workshop, Calgary, AB, Canada, February 12-14, 2014, pp. 30. (Abstract)
- Miller, J.J., Beasley, B.W., Hao, X., Larney, F.J., and Drury, C.F. (2014). "Transport of chemicals through intact soil cores amended with composted or stockpiled feedlot manure with wood-chip or straw bedding.", 51st Annual Alberta Soil Science Workshop, Calgary, AB, Canada, February 12-14, 2014, pp. 31. (Abstract)

## 2013

- Agomoh, I., Hao, X., Li, C., Yang, G., Schoenau, J.J., and McAllister, T.A. (2013). "Greenhouse gas emission from soil amended with DDGS manure and compost: a laboratory study.", 50th Annual Alberta Soil Science Workshop, Lethbridge, AB, Canada, February 19-21, 2013.
- Hao, X. (2013). "GHG emissions and barley response to digestate applications.", Tri-Provincial Manure Management Workshop, Lethbridge, AB, Canada, March 20-21, 2013.
- Hao, X., Hill, B.D., Caffyn, P.R., Nelson, V., and Li, X. (2013). "Improving barley utilization of N and P nutrients from soil amended with bio-digested cattle manure.", 50th Annual Alberta Soil Science Workshop, Lethbridge, AB, Canada, February 19-21, 2013.
- Hao, X., Hill, B.D., Caffyn, P.R., Travis, G.R., Nelson, V., and Li, X. (2013). "Yield, Nitrogen, Phosphorus, Copper and Zinc Uptake by Barley Forage Amended with Anaerobically Digested Cattle Feedlot Manure (ADM).", *E3S Web of Conferences*, 1(04002).

## 2012

- Hao, X. (2012). "Greenhouse gas emission from stockpiling cattle feedlot manure. ASA-CSSA-SSSA 2012 International Annual Meeting", 2012 ASA-CSSA-SSSA International Annual Meeting, Cincinnati, OH, USA, October 21-24, 2012, Electronic Abs. Computer CD.
- Hao, X. (2012). "Nitrous oxide emission from soil amended with bio-digested materials.", 49th Annual Alberta Soil Science Workshop, Ramada Inn, Edmonton, AB, Canada, February 14-16, 2012, pp. 29.
- Hao, X., Hill, B.D., Caffyn, P.R., Travis, G.R., Nelson, V., and Li, X. (2012). "Yield, Nitrogen, Phosphorus, Copper and Zinc Uptake by Barley Forage Amended with Anaerobically Digested Cattle Feedlot Manure (ADM).", 16th International Conference on Heavy Metals in the Environment, Rome, Italy, September 23-27, 2012.
- Hao, X., Larney, F.J., and McAllister, T.A. (2012). "Effect of dried distillers' grains with solubles (DDGS) in cattle diets and windrow turning frequency on greenhouse gas emissions during feedlot manure composting.", 2012 World Congress on Advances in Civil, Environmental and Materials Research (ACEM'12), Seoul, South Korea, August 26-30, 2012, pp. 76.
- Schoenau, J.J., Alotaibi, K., Stefankiw, J., Benke, M.B., and Hao, X. (2012). "Plant and soil responses to manure from cattle fed dried distillers grain.", Tri-Provincial Manure Management Council, Saskatoon, SK, Canada, February 7-8, 2012.
- Yang, L., Li, C., and Hao, X. (2012). "Effect of compost source and soil type on canola and pea under controlled greenhouse conditions.", Plant Canada 2012 (joint meeting of the Canadian Society of Agronomy (CSA), Canadian Society for Horticultural Science (CSHS), Certified Crop Advisors (CCA), North American Fruit Explorers (NAFEX)): Adapting Crops to Change, University of Saskatchewan, Saskatoon, SK, Canada, July 16-19, 2012.

## 2011

- Blackshaw, R.E., Hao, X., Clayton, G.W., Harker, K.N., O'Donovan, J.T., Johnson, E.N., and Vera, C.L. (2011). "Canola response to polymer-coated urea versus urea in a four-year zero-tillage cropping system on the Canadian prairies.", 13th International Rapeseed Congress, Prague, Czech Republic, June 5-9, 2011, pp. 61-64.
- Chiyoka, W.L., Zvomuya, F., and Hao, X. (2011). "Nitrogen uptake by barley grown in Chernozemic soils amended with anaerobically digested manure.", 54th Annual Manitoba Soil Science Society Meeting, Winnipeg, MB, Canada, February 3-4, 2011, pp. 12.
- Gilroyed, B.H., Li, C.L., McAllister, T.A., and Hao, X. (2011). "Anaerotic fermentative hydrogen production using manure from cattle fed on a modified distiller's grain diet.", 48th Annual Alberta Soil Science Workshop, Calgary, AB, Canada, February 15-17, 2011, pp. 19. (Workshop)
- Hao, X. (2011). "Impact of dietary DDGS on nutrient composition and management of cattle feedlot manure.", Insights into Use of DDGS in Western Canadian Feedlot Diets, Lethbridge Lodge Hotel, Lethbridge, AB, Canada, June 9, 2011.
- Hao, X. (2011). "Managing cattle manure nutrient for sustainable agriculture production.", Saskatchewan Agronomy Update, Saskatoon, SK, Canada, December 7-8, 2011. (Presentation)
- Hao, X. and Larney, F.J. (2011). "Manure management practices: effective use of nutrients from feedlot cattle in Alberta.", 2011 ASA-CSSA-SSSA International Annual Meeting: Fundamental for life: soil, crop and environmental sciences, San Antonio, TX, USA, October 16-19, 2011, Electronic Abs. CD-ROM.
- Hao, X. and Larney, F.J. (2011). "Reducing greenhouse gas emissions from livestock manure: From diet manipulation to composting.", Manure Management Update 2011, Lethbridge, AB, Canada, January 17, 2011, pp. 37-45.
- Hao, X., Hill, B.D., Nelson, V., and Li, X. (2011). "Nitrous oxide emissions and barley yields from soil receiving anaerobically digested manure by-product applications.", 2011 ASA-CSSA-SSSA International Annual Meeting: Fundamental for life: soil, crop and environmental sciences, San Antonio, TX, USA, October 16-19, 2011, Electronic Abs. CD-ROM.
- Hao, X., Li, C.L., and McAllister, T.A. (2011). "Greenhouse gas emission from stockpiling cattle feedlot manure.", 48th Annual Alberta Soil Science Workshop, Calgary, AB, Canada, February 15-17, 2011, pp. 24. (Workshop)
- Larney, F.J., Cessna, A.J., Kuchta, S.L., Hao, X., Entz, T., Topp, E., and McAllister, T.A. (2011). "Composting effects on antibiotics in feedlot manure.", Manure Management Update 2011, Lethbridge, AB, Canada, January 17, 2011, pp. 46-54.
- Li, C.L., Hao, X., Yang, G., Schoenau, J.J., and McAllister, T.A. (2011). "Greenhouse Gas Emissions from Soil Amended with Cattle Manure and Compost - The Effect of Condensed Tannin Co-applications.", 48th Annual Alberta Soil Science Workshop, Calgary, AB, Canada, February 15-17, 2011.
- Li, C.L., Hao, X., Yang, G., Schoenau, J.J., and McAllister, T.A. (2011). "Greenhouse gas emission from soil amended with DDGS cattle manure nad compost: The effect of condensed tannin co-application.", 48th Annual Alberta Soil Science Workshop, Calgary, AB, Canada, February 15-17, 2011, pp. 23. (Workshop)
- Stefankiw, J., Schoenau, J.J., Farrell, R.E., and Hao, X. (2011). "Composted versus fresh distillers grain and solubles derived manure as nutrient source for canola.", Soils and Crops Workshop 2011, Prairieland Park, Saskatoon, SK, Canada, March 15-16, 2011, Electronic Abs. Computer CD.

**Lemke, Reynald (Saskatoon)**

## Technology Transfer Publications:

2012

- Lemke, R.L. (2012). "Longterm Crop Rotations.", 24th Annual Conference of the Saskatchewan Soil Conservation Association (SSCA), Saskatoon Inn, Saskatoon, SK, Canada, January 11, 2012.

2011

- Baron, V.S., Lemke, R.L., Basarab, J.A., and Iwaasa, A.D. (2011). "Root, residue and removal-C and -N pools compared to above ground production for forage-based management practices.", 2011 ASA-CSSA-SSSA International Annual Meeting: Fundamental for life: soil, crop and environmental sciences, San Antonio, TX, USA, October 16-19, 2011, Abstract 67442. (Abstract)
- Kröbel, R., Lemke, R.L., Campbell, C.A., Zentner, R.P., and Brandt, K. (2011). "Nitrogen and Phosphorus effect on water use- and nutrient use- efficiency in the Canadian semi-arid prairie.", Soils and Crops Workshop 2011, Prairieland Park, Saskatoon, SK, Canada, March 15-16, 2011, [CD-ROM]. (Workshop)
- Lemke, R.L., Iwaasa, A.D., Baron, V.S., Farrell, R.E., and Schoenau, J.J. (2011). "Quantifying nitrous oxide emissions resulting from beef cattle urine and dung on semiarid pasture.", 2011 ASA-CSSA-SSSA International Annual Meeting: Fundamental for life: soil, crop and environmental sciences, San Antonio, TX, USA, October 16-19, 2011.
- Wang, H., He, Y., Qian, B., McConkey, B.G., Cutforth, H.W., McCaig, T.N., McLeod, G.J., Zentner, R.P., Campbell, C.A., DePauw, R.M., Lemke, R.L., Brandt, K., Liu, T.T., Qin, X., Hoogenboom, G., White, J., and Hunt, T. (2011). "Impact of Climate Change on Dual-Purpose Wheat Production in Western Canada.", World Renewable Energy Congress, Linköping, Sweden, May 8-13, 2011.

**Moulin, Alan (Brandon)**

## Technology Transfer Publications:

2014

- Glenn, A.J. and Moulin, A.P. (2014). "Nitrous oxide flux from a clay loam under mature no-till and variable rate N fertilizer management in western Manitoba.", 57th Annual Manitoba Soil Science Society Conference, Winnipeg, Manitoba, Canada, February 6-7, 2014. (Poster)

2013

- Moulin, A.P., Glenn, A.J., Tenuta, M., Lobb, D.A., Dunmola, A.S., and Yapa, P. (2013). "Alternative statistical distributions and transformation of nitrous oxide soil flux data.", ASA/CSSA/SSSA International annual meeting, Tampa, Florida, USA, November 3-6, 2013, Presentation.
- Moulin, A.P., Glenn, A.J., Tenuta, M., Lobb, D.A., Dunmola, A.S., and Yapa, P. (2013). "Alternative statistical distributions and transformation of nitrous oxide soil flux data.", Joint meeting of the Canadian Society of Soil Science, Manitoba Soil Science Society, and Canadian Society of Agricultural and Forest Meteorology, Winnipeg, Manitoba, Canada, July 22-25, 2013.

***Beef Grazing*****Baron, Vern (Lacombe - forage agronomy)**

## Technology Transfer Publications:

2013

- Baron, V.S. (2013). "Reduce winter feeding costs through swath grazing and use of new varieties.", Lacombe AAFC-ARD Field day, June 25, 2013. (Presentation)
- Baron, V.S. (2013). Extended grazing research at Lacombe research Centre. August 21, 2013. (Report)
- Baron, V.S., Doce, R.R., Swift, M.-L., Aljarrah, M., Juskiw, P.E., and Basarab, J.A. (2013). "Use of triticale as an annual forage source.", Saskatchewan Beef Industry Conference, Saskatoon, SK, Saskatchewan, Canada, January 23, 2013. (Presentation)
- Doce, R.R., Baron, V.S., Basarab, J.A., Juskiw, P.E., and Swift, M.-L. (2013). "The validity of field-scale estimated carrying capacity from plot-scale data for swath grazing systems.", CFGA Annual meeting, Olds, AB, Canada, December 8-11, 2013. (Poster)
- Furber, D. and Baron, V.S. (2013). "Tighten up with triticale.", *Canadian Cattlemen*, 2013(April), pp. 22-25.
- Juskiw, P.E., Swift, M.-L., Baron, V.S., Doce, R.R., and Nyachiro, J.M. (2013). "New tools for breeding forage barley.", ASA/CSSA/SSSA International annual meeting, Tampa, Florida, USA, November 3-6, 2013, *Canadian Soc. Agron*: 177-178. (Poster)
- Kielen, A. and Baron, V.S. (2013). "Researchers eye new varieties to boost the savings from swath grazing.", *Alberta Farmer Express*, 10(17), pp. 11.
- Mapiye, C., Turner, T.D., Basarab, J.A., Baron, V.S., Aalhus, J.L., and Dugan, M.E.R (2013). "Subcutaneous fatty acid composition of calf- and yearling-fed steers with and without growth promotants.", World Conference on Animal Product, Beijing, China, October 2013. (Abstract)
- Mapiye, C., Turner, T.D., Rolland, D.C., Basarab, J.A., Baron, V.S., McAllister, T.A., Block, H.C., Uttaro, B., Aalhus, J.L., and Dugan, M.E.R (2013). "Beef production and quality of yearling steers fed high-forage diets with flaxseed or sunflower-seed.", CSAS-CMSA Joint Annual Meeting, Banff Park Lodge Resort Hotel and Conference Centre, Banff, AB, Canada, June 18-20, 2013, P29, pp. 37. (Poster)
- Mapiye, C., Turner, T.D., Rolland, D.C., Basarab, J.A., Baron, V.S., McAllister, T.A., Block, H.C., Uttaro, B., Aalhus, J.L., and Dugan, M.E.R (2013). "Composition of biohydrogenation intermediates in intramuscular fat of yearling steers fed forage-based diets with supplemental flaxseed or sunflower-seed.", CSAS-CMSA Joint Annual Meeting, Banff Park Lodge Resort Hotel and Conference Centre, Banff, AB, Canada, June 18-20, 2013, P28, pp. 36. (Poster)
- Mapiye, C., Turner, T.D., Rolland, D.C., Basarab, J.A., Baron, V.S., McAllister, T.A., Block, H.C., Uttaro, B., Aalhus, J.L., and Dugan, M.E.R (2013). "Effects of feeding flaxseed and sunflower seed diets in high forage diets on biohydrogenation intermediates in adipose tissues of yearling steers.", ADSA-ASAS Joint Annual Meeting, Indianapolis, USA, July 2013. (Abstract)
- Mapiye, C., Turner, T.D., Rolland, D.C., Basarab, J.A., Baron, V.S., McAllister, T.A., Block, H.C., Uttaro, B., Aalhus, J.L., and Dugan, M.E.R (2013). "Effects of feeding flaxseed or sunflower-seed in high forage diets on biohydrogenation intermediates in adipose tissues of yearling steers.", ADSA-ASAS Joint Annual Meeting, Indianapolis, USA, July 2013. (Abstract)
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growing beef bulls fed forage and grainbased diets.", CSAS-CMSA Joint Annual Meeting, Banff Park Lodge Resort Hotel and Conference Centre, Banff, AB, Canada, June 18-20, 2013, P13, pp. 29. (Poster)

- Turner, T.D., Aalhus, J.L., Mapiye, C., Rolland, D.C., Larsen, I.L., Basarab, J.A., Baron, V.S., McAllister, T.A., Block, H.C., Uttaro, B., and Dugan, M.E.R (2013). "Enriching hamburger with PUFA biohydrogenation products by supplementing steers fed high forage diets with either flaxseed or sunflower seed: Effects of adipose tissue source on palatability and fatty acid composition.", CSAS-CMSA Joint Annual Meeting, Banff Park Lodge Resort Hotel and Conference Centre, Banff, AB, Canada, June 18-20, 2013, P20, pp. 32. (Poster)
- Turner, T.D., Mapiye, C., Rolland, D.C., Basarab, J.A., Baron, V.S., McAllister, T.A., Block, H.C., Uttaro, B., Lopez-Campos, O., Aalhus, J.L., and Dugan, F.M. (2013). "Inclusion of perirenal fat to enhance the bioactive fatty acid content of hamburger.", 2013, Banff, Alberta, Canada, June 18-20, 2013.
- Ullenboom, T.R., Crow, G.H., Basarab, J.A., Wittenberg, K.M., Baron, V.S., and Ominski, K.H. (2013). "Residual feed intake, enteric methane and carbon dioxide emissions in growing beef bulls.", CSAS-CMSA Joint Annual Meeting, Banff Park Lodge Resort Hotel and Conference Centre, Banff, AB, Canada, June 18-20, 2013, O21-GS, pp. 11.

## 2012

- Baron, V.S. (2012). "Review of Environmental Issues facing the beef industry in Alberta.", Lacombe, AB, Canada, May 17, 2012. (Presentation)
- López-Campos, Ó., Juárez, M., Baron, V.S., Aalhus, J.L., Okine, E.K., Haugen-Kozyra, K., and Basarab, J.A. (2012). "Reducing age at harvest: toward maximizing efficiency in beef production.", 58th International Congress of Meat Science and Technology (ICoMST), Hilton Montréal Bonaventure, Montréal, QC, Canada, August 12-17, 2012, Paper 326.
- Mapiye, C., Dugan, M.E.R, Juárez, M., Basarab, J.A., Baron, V.S., Turner, T.D., Yang, X.Q., Aldai, N., and Aalhus, J.L. (2012). "Effect of vitamin E inclusion on trans-18:1 isomers in subcutaneous fat of steers fed a high-barley grain diet.", ADSA-AMPA-ASAS-CSAS-WSASAS 2012 Joint Annual Meeting, Hyatt Regency, Phoenix, AZ, USA, July 15-19, 2012.
- Mapiye, C., Dugan, M.E.R, Turner, T.D., Basarab, J.A., Baron, V.S., McAllister, T.A., Block, H.C., and Aalhus, J.L. (2012). "Relationships of trans-18:1 isomers between red blood cells and beef tissues in steers fed red clover silage with/without flaxseed.", 58th International Congress of Meat Science and Technology, Montreal, Canada, August 12-17, 2012.

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- Baron, V.S. (2011). "What about yield?", Alberta Forage Industry Network (AFIN) Annual General Meeting, Lacombe, AB, Canada, March 15, 2011. (Presentation)
- Baron, V.S., Basarab, J.A., and Aalhus, J.L. (2011). Forage-Beef Research and Extension Vision. Document requested by John Knapp, Deputy Minister, AARD, Alberta, Agriculture and Agri-Food Canada (AAFC)/Agriculture et Agroalimentaire Canada (AAC).
- Baron, V.S., Lemke, R.L., Basarab, J.A., and Iwaasa, A.D. (2011). "Root, residue and removal-C and -N pools compared to above ground production for forage-based management practices.", 2011 ASA-CSSA-SSSA International Annual Meeting: Fundamental for life: soil, crop and environmental sciences, San Antonio, TX, USA, October 16-19, 2011, Abstract 67442. (Abstract)
- Basarab, J.A., Baron, V.S., López-Campos, Ó., Aalhus, J.L., Haugen-Kozyra, K., and Okine, E.K. (2011). Greenhouse gas emissions from calf- and yearling-fed beef production systems, with and



without the use of growth promotants. Full Report for Alberta Livestock and Meat Agency (ALMA) Ltd., Edmonton, AB. (Report)

- Juárez, M., Basarab, J.A., Baron, V.S., López-Campos, Ó., Valera, M., and Aalhus, J.L. (2011). "Ante- and post-mortem factors affecting Canadian beef: Relative contribution of carcass and meat quality.", Livestock Gentec's 2nd Annual Conference: Addressing the Gap Between Discovery and Profitable Adoption, Edmonton, AB, Canada, October 19-20, 2011.
- Juárez, M., Basarab, J.A., Baron, V.S., López-Campos, Ó., Valera, M., and Aalhus, J.L. (2011). "Relative contribution of ante- and post-mortem factors to Canadian beef carcass and meat quality.", 57th International Congress of Meat Science and Technology (ICoMST), Ghent, Belgium, August 7-12, 2011, P 318.
- López-Campos, Ó., Robertson, W.M., Aalhus, J.L., Larsen, I.L., Baron, V.S., Juárez, M., Uttaro, B., Okine, E.K., and Basarab, J.A. (2011). "Effect of production system and implant strategies on steer performance and carcass traits.", Canadian Meat Science Association Annual Meeting, Halifax, NS, Canada, May 4-6, 2011, published in 2011 Annual Meeting Poster Session Abstracts, pp. 17. (Poster)
- Lemke, R.L., Iwaasa, A.D., Baron, V.S., Farrell, R.E., and Schoenau, J.J. (2011). "Quantifying nitrous oxide emissions resulting from beef cattle urine and dung on semiarid pasture.", 2011 ASA-CSSA-SSSA International Annual Meeting: Fundamental for life: soil, crop and environmental sciences, San Antonio, TX, USA, October 16-19, 2011.
- Nassu, R.T., Dugan, M.E.R, Juárez, M., Basarab, J.A., Baron, V.S., and Aalhus, J.L. (2011). "Beef quality of animals fed different levels of vitamin E.", 57th International Congress of Meat Science and Technology (ICoMST), Ghent, Belgium, August 7-12, 2011.

### **Block, Hushton (Lacombe – forage/grazing systems)**

Technology Transfer Publications:

2013

- Block, H.C., Durunna, O.N., Robins, C.D., Entz, M.H., Khakbazan, M., and Scott, S.L. (2013). "Effect of rested grazing and alfalfa inclusion in bromegrass pastures on cow-calf productivity.", CSAS-CMSA Joint Annual Meeting, Banff Park Lodge Resort Hotel and Conference Centre, Banff, AB, Canada, June 18-20, 2013, O36, pp. 17.
- Block, H.C., Rosser, C.L., Beattie, A.D., McKinnon, J.J., Lardner, H.A., and Penner, G.B. (2013). "Effect of harvest maturity and crop on forage yield and the productivity weaned beef calves strip-grazing annual swaths.", CSAS-CMSA Joint Annual Meeting, Banff Park Lodge Resort Hotel and Conference Centre, Banff, AB, Canada, June 18-20, 2013, O37, pp. 18.
- Mapiye, C., Turner, T.D., Rolland, D.C., Basarab, J.A., Baron, V.S., McAllister, T.A., Block, H.C., Uttaro, B., Aalhus, J.L., and Dugan, M.E.R (2013). "Beef production and quality of yearling steers fed high-forage diets with flaxseed or sunflower-seed.", CSAS-CMSA Joint Annual Meeting, Banff Park Lodge Resort Hotel and Conference Centre, Banff, AB, Canada, June 18-20, 2013, P29, pp. 37. (Poster)
- Mapiye, C., Turner, T.D., Rolland, D.C., Basarab, J.A., Baron, V.S., McAllister, T.A., Block, H.C., Uttaro, B., Aalhus, J.L., and Dugan, M.E.R (2013). "Composition of biohydrogenation intermediates in intramuscular fat of yearling steers fed forage-based diets with supplemental flaxseed or sunflower-seed.", CSAS-CMSA Joint Annual Meeting, Banff Park Lodge Resort Hotel and Conference Centre, Banff, AB, Canada, June 18-20, 2013, P28, pp. 36. (Poster)

- Mapiye, C., Turner, T.D., Rolland, D.C., Basarab, J.A., Baron, V.S., McAllister, T.A., Block, H.C., Uttaro, B., Aalhus, J.L., and Dugan, M.E.R (2013). "Effects of feeding flaxseed and sunflower seed diets in high forage diets on biohydrogenation intermediates in adipose tissues of yearling steers.", ADSA-ASAS Joint Annual Meeting, Indianapolis, USA, July 2013. (Abstract)
- Mapiye, C., Turner, T.D., Rolland, D.C., Basarab, J.A., Baron, V.S., McAllister, T.A., Block, H.C., Uttaro, B., Aalhus, J.L., and Dugan, M.E.R (2013). "Effects of feeding flaxseed or sunflower seed in high forage diets on biohydrogenation intermediates in adipose tissues of yearling steers.", ADSA-ASAS Joint Annual Meeting, Indianapolis, USA, July 2013. (Abstract)
- Rosser, C.L., Beattie, A.D., Block, H.C., McKinnon, J.J., Lardner, H.A., and Penner, G.B. (2013). "Effect of Harvest Maturity of Whole-Crop Oat (*Avena* spp.) on Forage Intake, Rumen Fermentation and Total Tract Digestibility.", CSAS-CMSA Joint Annual Meeting, Banff Park Lodge Resort Hotel and Conference Centre, Banff, AB, Canada, June 18-20, 2013, O03-GS, pp. 4.
- Straathof, C., Paradis, F., Block, H.C., Colazo, M.G., Yaremci, B., Li, C., Bruce, H.L., and Fitzsimmons, C.J. (2013). "Investigating RFI and diet interactions on ADG, body weight, rib and back fat thickness in pregnant Angus heifers.", CSAS-CMSA Joint Annual Meeting, Banff Park Lodge Resort Hotel and Conference Centre, Banff, AB, Canada, June 18-20, 2013, P25, pp. 35. (Poster)
- Turner, T.D., Aalhus, J.L., Mapiye, C., Rolland, D.C., Larsen, I.L., Basarab, J.A., Baron, V.S., McAllister, T.A., Block, H.C., Uttaro, B., and Dugan, M.E.R (2013). "Enriching hamburger with PUFA biohydrogenation products by supplementing steers fed high forage diets with either flaxseed or sunflower seed: Effects of adipose tissue source on palatability and fatty acid composition.", CSAS-CMSA Joint Annual Meeting, Banff Park Lodge Resort Hotel and Conference Centre, Banff, AB, Canada, June 18-20, 2013, P20, pp. 32. (Poster)
- Turner, T.D., Mapiye, C., Rolland, D.C., Basarab, J.A., Baron, V.S., McAllister, T.A., Block, H.C., Uttaro, B., Lopez-Campos, O., Aalhus, J.L., and Dugan, F.M. (2013). "Inclusion of perirenal fat to enhance the bioactive fatty acid content of hamburger.", 2013, Banff, Alberta, Canada, June 18-20, 2013.

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- Mapiye, C., Dugan, M.E.R, Turner, T.D., Basarab, J.A., Baron, V.S., McAllister, T.A., Block, H.C., and Aalhus, J.L. (2012). "Relationships of trans-18:1 isomers between red blood cells and beef tissues in steers fed red clover silage with/without flaxseed.", 58th International Congress of Meat Science and Technology, Montreal, Canada, August 12-17, 2012.

## ***Range Management***

### **Schellenberg, Michael (Swift Current)**

Technology Transfer Publications:

2013

- Biliget, B. and Schellenberg, M.P. (2013). "Dormant seeding of perennial forages.", Agri-Mart Express.Com, September 23-October 4, 2013, pp. C3.
- Biliget, B. and Schellenberg, M.P. (2013). "Forage quality variation among accessions of warm-season grasses of North America during summer of semiarid Western Canada.", The future of Rangeland Fire in a Changing World, SRM-AGM, Oklahoma City, Oklahoma, USA, February 2-8, 2013. (Abstract)
- Cote, J. and Schellenberg, M.P. (2013). Foraging into the Future (Media Pitch).

- Cote, J. and Schellenberg, M.P. (2013). Polycultures – a Cocktail Mix for the Semiarid Prairies (Media Pitch).
- Fleury, D. and Schellenberg, M.P. (2013). "Polycultures for the Canadian Prairies.", *Top Crop Manager (Western edition)*, 2013(September), pp. 10.
- Gao, F., Schellenberg, M.P., and Kehler, M. (2013). "Comparative germination of Cicer Milkvetch and Purple Prairie Clover under varying temperature and osmotic pressure.", Soil and Crops Workshop, Saskatoon, SK, Canada, March 4-5, 2013. (Presentation)
- Schellenberg, M.P. (2013). "Diversification of forage stands: Improving yields by adding two legumes.", *Prairie Post - Bull Breeders*, 2013(February), pp. A8.
- Schellenberg, M.P. (2013). "Greenhouse tour of native plant material.", Horticultural Society, Swift Current, Canada, April 25, 2013. (Presentation)
- Schellenberg, M.P. (2013). "Health food for cattle: Prairie clovers packed with health benefits.", *Farming for Tomorrow (Saskatchewan Edition)*, 2013(April/May), pp. 18.
- Schellenberg, M.P. (2013). "Plant ecology Program.", Oral Communication with Visiting Tibetan Researcher, Swift Current., Canada, April 25, 2013. (Presentation)
- Schellenberg, M.P. (2013). "Polyculture research highlight.", *Saskatchewan Hay and Pasture Report*, 14(3).
- Schellenberg, M.P. (2013). "The benefit of partnerships.", CFGA Annual General Meeting and Conference, Olds, AB, Canada, December 8-11, 2013.
- Schellenberg, M.P. (2013). Annual Report ADF 20110069 Genetic improvement of white prairie clover. (Report)
- Schellenberg, M.P. (2013). Beef Science Cluster project Foraging into Future (GX90 Yorkton Radio Interview with Rod MacDonald).
- Schellenberg, M.P. (2013). Final Report Beef Cluster proposal FRG.07.13 2009-2013. (Report)
- Schellenberg, M.P. (2013). Final Report FRG.07.13 Beef Science Cluster. (Report)
- Schellenberg, M.P. (2013). Potential of Polycultures (Radio interview with CJWW).
- Schellenberg, M.P. and Biliget, B. (2013). "What should be in a recommended reseeding mixture?", The future of Rangeland Fire in a Changing World, SRM-AGM, Oklahoma City, Oklahoma, USA, February 2-8, 2013, Abstract and Poster B5. (Abstract)
- Schellenberg, M.P. and Piche, I. (2013). "First year results of 12 annual species polyculture.", Soil and Crops Workshop, Saskatoon, SK, Canada, March 4-5, 2013. (Presentation)
- Schellenberg, M.P., Biliget, B., and Picasso, V. (2013). "Mixed species seeding: A means to increase production in temperate pastures.", 22nd International Grasslands Congress 2013, Sydney, New South Wales, Australia, September 15-19, 2013.
- Wilson, G. and Schellenberg, M.P. (2013). "Foraging into the Future.", *Canadian Cattlemen*.

## 2012

- Biliget, B., Schellenberg, M.P., and Fu, Y.B. (2012). "AFLP variation in native populations of side-oats grama (*Bouteloua curtipendula* (Michx.) Torr.) and its corresponding selected and multiple-site composite populations", Plant Canada 2012 (joint meeting of the Canadian Society of Agronomy (CSA), Canadian Society for Horticultural Science (CSHS), Certified Crop Advisors (CCA), North American Fruit Explorers (NAFEX)): Adapting Crops to Change, University of Saskatchewan, Saskatoon, SK, Canada, July 16-19, 2012. (Poster)

- Iwaasa, A.D. and Schellenberg, M.P. (2012). "AAFC-SPARC long term grazing and forage production on re-established native grasslands in Southern Saskatchewan.", 2012 Native Prairie Restoration/Reclamation Workshop, TCU Place, Saskatoon, SK, Canada, February 8-9, 2012.
- Iwaasa, A.D., Li, Y., Muri, R., Jin, Y., Schellenberg, M.P., and Biliget, B. (2012). "Evaluation of the forage and seed characteristics of purple prairie clover (*Dalea purpurea* Vent.) and white prairie clover (*Dalea candida* Michx. Ex. Willd.).", 2012 Native Prairie Restoration/Reclamation Workshop, TCU Place, Saskatoon, SK, Canada, February 8-9, 2012. (Poster)
- Iwaasa, A.D., McLeod, G.J., Schellenberg, M.P., Muri, R., and Biliget, B. (2012). "Opportunities await for native and tame forage research at the Semiarid Prairie Agricultural Research Centre (SPARC) - Agriculture and Agri-Food Canada (AAFC).", 2012 Native Prairie Restoration/Reclamation Workshop, TCU Place, Saskatoon, SK, Canada, February 8-9, 2012. (Poster)
- Jin, L., Xu, Z., Iwaasa, A.D., Zhang, Y.G., Schellenberg, M.P., and Wang, Y. (2012). "Mixing purple prairie clover with alfalfa reduced alfalfa N transforming to ammonia-N.", ADSA-AMPA-ASAS-CSAS-WSASAS 2012 Joint Annual Meeting, Hyatt Regency, Phoenix, AZ, USA, July 15-19, 2012, W118. (Abstract)
- Jin, L., Xu, Z.J., Iwaasa, A.D., Zhang, Y.G., Schellenberg, M.P., McAllister, T.A., and Wang, Y. (2012). "Mixing purple prairie clover with alfalfa reduced alfalfa N transforming to ammonia-N.", Joint Annual Meeting, American Dairy Science Association, Poultry Science Association, American Milk Producers Association, Canadian Society of Animal Science, and American Society of Animal Science, Phoenix, Arizona, USA, July 15-19, 2012.
- Schellenberg, M.P. and Biliget, B. (2012). "Multiple species grass-legume mixture in semiarid Saskatchewan.", Plant Canada 2012 (joint meeting of the Canadian Society of Agronomy (CSA), Canadian Society for Horticultural Science (CSHS), Certified Crop Advisors (CCA), North American Fruit Explorers (NAFEX)): Adapting Crops to Change, University of Saskatchewan, Saskatoon, SK, Canada, July 16-19, 2012. (Poster)
- Schellenberg, M.P., Biliget, B., Piche, I., Kehler, M., and Ruest, I. (2012). "Realizing the benefits for an ever changing environment.", Foraging Into the Future 7: Times are good....let's make it count!, Sky Centre, Living Sky Casino, Swift Current, SK, Canada, December 12-13, 2012. (Abstract)

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- Biliget, B. and Schellenberg, M.P. (2011). "Germination of two native wheatgrass (*Agropyron*) species under different temperature and water potential regimes.", Soils and Crops Workshop 2011, Prairieland Park, Saskatoon, SK, Canada, March 15-16, 2011. (Workshop)
- Biliget, B., Schellenberg, M.P., and McLeod, G.J. (2011). "Relationship of Morphological traits and seed yield of plain rough fescue grass (*Festuca hallii* (Vasey) Piper) with different origins.", Soils and Crops Workshop 2011, Prairieland Park, Saskatoon, SK, Canada, March 15-16, 2011. (Workshop)
- Iwaasa, A.D., Steppuhn, H., Schellenberg, M.P., Acharya, S.N., and Wang, Y. (2011). "A forage and grazing research update.", SWFA Annual General Meeting, Swift Current, SK, Canada, March 1, 2011.
- Jin, L., Xu, Z.J., Iwaasa, A.D., Schellenberg, M.P., Zhang, Y.G., McAllister, T.A., and Wang, Y. (2011). "Nutrient and tannin contents of purple prairie clover (*Petalostemon purpureum*) harvested at different growth stages.", *Journal of Animal Science*, 89(E-Suppl. 1), pp. 48. (Abstract)

- Jin, L., Xu, Z.J., Iwaasa, A.D., Zhang, Y.G., Schellenberg, M.P., McAllister, T.A., and Wang, Y. (2011). "Effect of tannins on *in vitro* ruminal degradability of purple prairie clover (*Petalostemon purpureum*) harvested at two growth stages in the DaisyII Fermentation System.", *Journal of Animal Science*, 89(E-Suppl. 1), pp. 387. (Abstract)
- Jin, L., Xu, Z.J., Iwaasa, A.D., Zhang, Y.G., Schellenberg, M.P., McAllister, T.A., and Wang, Y. (2011). "Effect of tannins on *in vitro* ruminal degradability of purple prairie clover (*Petalostemon purpureum*) harvested at two growth stages in the DaisyII Fermentation System.", ADSA-PSA-AMPA-CSAS-ASAS 2011 Joint Annual Meeting, New Orleans, LA, USA, July 11-14, 2011, T356. (Poster)
- Jin, L., Xu, Z.J., Iwaasa, A.D., Zhang, Y.G., Schellenberg, M.P., McAllister, T.A., and Wang, Y. (2011). "Nutrient and tannin contents of purple prairie clover (*Petalostemon purpureum*) harvested at different growth stages.", ADSA-PSA-AMPA-CSAS-ASAS 2011 Joint Annual Meeting, New Orleans, LA, USA, July 11-14, 2011, M#127. (Poster)
- Jin, L., Zhang, Y.G., Iwaasa, A.D., Schellenberg, M.P., Xu, Z.J., McAllister, T.A., and Wang, Y. (2011). "Effect of incorporation of purple prairie clover (*Petalostemon purpureum*) into cool season grasses mixture on *in vitro* ruminal fermentation.", 60th Annual Meeting of the Canadian Society of Animal Science (CSAS), Atlantica Hotel, Halifax, NS, Canada, May 4-5, 2011, FPE-3. (Poster)
- Jin, L., Zhang, Y.G., Iwaasa, A.D., Schellenberg, M.P., Xu, Z.J., McAllister, T.A., and Wang, Y. (2011). "Effect of incorporation of purple prairie clover (*Petalostemon purpureum*) into cool season grasses mixture on *in vitro* ruminal fermentation.", *Canadian Journal of Animal Science*, 91(3), pp. 476. (Abstract)
- Jin, L., Zhang, Y.G., Iwaasa, A.D., Schellenberg, M.P., Xu, Z.J., McAllister, T.A., and Wang, Y. (2011). "Fecal shedding of *Escherichia coli* of cattle grazing pastures with and without purple prairie clover (*Petalostemon purpureum*).", 60th Annual Meeting of the Canadian Society of Animal Science (CSAS), Atlantica Hotel, Halifax, NS, Canada, May 4-5, 2011, TDC-2. (Poster)
- Jin, L., Zhang, Y.G., Iwaasa, A.D., Schellenberg, M.P., Xu, Z.J., McAllister, T.A., and Wang, Y. (2011). "Fecal shedding of *Escherichia coli* of cattle grazing pastures with and without purple prairie clover (*Petalostemon purpureum*).", *Canadian Journal of Animal Science*, 91(3), pp. 503. (Abstract)
- Schellenberg, M.P. (2011). "The Diversification of Crested Wheatgrass.", 64th Annual Meeting of the Society For Range Management and Workshop of the Rangeland Technology and Equipment Council (RTEC): Crested Wheatgrass Diversification, Billings, MT, USA, February 6, 2011, published in Rangeland technology and equipment workshop: diversification of crested wheatgrass stands, SRM-AGM, Transcending Borders: Landscapes and Legends. (Presentation)
- Schellenberg, M.P. (2011). "Using plant biodiversity to help decrease production risk during drought.", 2 pages. (Factsheet)
- Schellenberg, M.P., Biliget, B., and Iwaasa, A.D. (2011). "Botanical composition of seeded simple and complex native forage mixtures following grazing.", IX International Rangeland Congress - IRC2011: Diverse Rangelands for a Sustainable Society, Rosario, Argentina, April 2-8, 2011, pp. 393.
- Schellenberg, M.P., Biliget, B., and Iwaasa, A.D. (2011). "Effects of grazing disturbance on re-established native forage stands for a semiarid climate.", IX International Rangeland Congress - IRC2011: Diverse Rangelands for a Sustainable Society, Rosario, Argentina, April 2-8, 2011, pp. 179.

- Schellenberg, M.P., Biliget, B., and McLeod, G.J. (2011). "Phenotypic variation of side-oats grama grass collections from Canadian prairie.", Plant Canada 2011, Saint Mary's University, Halifax, NS, Canada, July 17-21, 2011, pp. 272.
- Schellenberg, M.P., Biliget, B., and Wang, Z. (2011). "What is new on the SPARC Range: Plant ecology research program update.", SPARC Seminar series, February 17, 2011. (Presentation)
- Tadevosyan, A.H., Mayrapetyan, S.K., Schellenberg, M.P., Ghalachyan, L.M., Hovsepyan, A.H., and Mayrapetyan, K.S. (2011). "Migration and Accumulation of Artificial Radionuclides.", ICABBBE 2011: International Conference on Agricultural, Biosystems, Biotechnology and Biological Engineering: The System Water-Soil-Plants Depending on Polymers Applying, Amsterdam, The Netherlands, July 13-15, 2011.
- Tadevosyan, A.H., Mayrapetyan, S.K., Schellenberg, M.P., Ghalachyan, L.M., Tavakalyan, N.B., Hovsepyan, A.H., and Mayrapetyan, K.S. (2011). "Influence of polymers applying on migration and accumulation of artificial radionuclides in sweet basil.", 14th International Congress of Radiation Research, Warsaw, Poland, August 28-September 1, 2011, pp. 170.
- Wang, Z., Schellenberg, M.P., Zhao, M., and Guodong, H. (2011). "Investigation of responses of plant mixture to different water stress regimes in a pot experiment.", Soils and Crops Workshop 2011, Prairieland Park, Saskatoon, SK, Canada, March 15-16, 2011. (Workshop)

## CROPPING MICROMETEOROLOGY

### Cutforth, Herb (Swift Current)

Technology Transfer Publications:

2012

- Fouli, Y., Cade-Menun, B.J., and Cutforth, H.W. (2012). "Freeze-thaw cycles and water content effects on infiltration rate and bulk density of three Saskatchewan soils.", 2012 Soils and Crops Workshop, University of Saskatchewan, Saskatoon, SK, Canada, March 13-14, 2012. (Presentation)

2011

- DePauw, R.M., Malhi, S.S., Bullock, P.R., Gan, Y.T., McKenzie, R.H., Larney, F.J., Janzen, H.H., Cutforth, H.W., and Wang, H. (2011). "Wheat Production in Northern High Latitudes – Canadian example.", in Bonjean, A., Angus, W., and Van Ginkel, M. (eds.) - The World Wheat Book A History of Wheat Breeding. Vol. 2, Lavoisier Tech et Doc, Paris, France, pp. 607-651.
- Wang, H., He, Y., Qian, B., McConkey, B.G., Cutforth, H.W., McCaig, T.N., McLeod, G.J., Zentner, R.P., Campbell, C.A., DePauw, R.M., Lemke, R.L., Brandt, K., Liu, T.T., Qin, X., Hoogenboom, G., White, J., and Hunt, T. (2011). "Impact of Climate Change on Dual-Purpose Wheat Production in Western Canada.", World Renewable Energy Congress, Linköping, Sweden, May 8-13, 2011.

### Glenn, Aaron (Brandon)

Technology Transfer Publications:

2014

- Glenn, A.J. and Moulin, A.P. (2014). "Nitrous oxide flux from a clay loam under mature no-till and variable rate N fertilizer management in western Manitoba.", 57th Annual Manitoba Soil Science Society Conference, Winnipeg, Manitoba, Canada, February 6-7, 2014. (Poster)

## 2013

- Glenn, A.J. (2013). "Impact of climate change on integrated agricultural production in the Aspen Parkland. Presentation.", Canadian Association of Agri-Retailers, Crop Management Forum, Brandon, Manitoba, Canada, November 19, 2013. (Presentation)
- Glenn, A.J. and Wilson, H.F. (2013). "Carbon balance of an organic cropland in southwestern Manitoba.", Joint meeting of the Canadian Society of Soil Science, Manitoba Soil Science Society, and Canadian Society of Agricultural and Forest Meteorology, Winnipeg, Manitoba, Canada, July 22-25, 2013.
- Hanis, K., Tenuta, M., Amiro, B.D., Glenn, A.J., Maas, S.E., and Gervais, M. (2013). "Can inclusion of 4 years of perennial forage in an annual crop rotation within the Red River Valley of the Canadian Prairies increase soil carbon storage and reduce nitrous oxide emissions?", Joint meeting of the Canadian Society of Soil Science, Manitoba Soil Science Society, and Canadian Society of Agricultural and Forest Meteorology, Winnipeg, Manitoba, Canada, July 22-25, 2013, Presentation.
- Hanis, K., Tenuta, M., Amiro, B.D., Glenn, A.J., Maas, S.E., and Gervais, M. (2013). "Harvest removals negate the benefit of perennial forage in reducing greenhouse gas emissions in an annual crop rotation within the Red River Valley, Manitoba.", ASA/CSSA/SSSA International annual meeting, Tampa, Florida, USA, November 3-6, 2013, Presentation.
- Moulin, A.P., Glenn, A.J., Tenuta, M., Lobb, D.A., Dunmola, A.S., and Yapa, P. (2013). "Alternative statistical distributions and transformation of nitrous oxide soil flux data.", ASA/CSSA/SSSA International annual meeting, Tampa, Florida, USA, November 3-6, 2013, Presentation.
- Moulin, A.P., Glenn, A.J., Tenuta, M., Lobb, D.A., Dunmola, A.S., and Yapa, P. (2013). "Alternative statistical distributions and transformation of nitrous oxide soil flux data.", Joint meeting of the Canadian Society of Soil Science, Manitoba Soil Science Society, and Canadian Society of Agricultural and Forest Meteorology, Winnipeg, Manitoba, Canada, July 22-25, 2013.

## 2012

- Cardillo, M., Gulden, R.H., Bullock, P.R., and Glenn, A.J. (2012). "Stubble Height Effects on Canola Performance.", Manitoba Agronomists Conference, Winnipeg, Manitoba, Canada, December 12-13, 2012. (Poster)
- Glenn, A.J. (2012). "Diurnal and Seasonal Relationships Between Incoming Solar Radiation and the Photosynthetically-Active Photon Flux Density in Southwestern Manitoba.", 55th Annual Manitoba Soil Science Society Meeting, Winnipeg, MB, Canada, February 2-3, 2012. (Poster)
- Glenn, A.J. and Wilson, H.F. (2012). "Water, carbon, and nitrogen balance components of a no-till crop rotation in southwestern Manitoba.", Manitoba Zero-Tillage Research Association Annual General Meeting 2012, Brandon, MB, Canada, March 20, 2012. (Presentation)
- Glenn, A.J., Tenuta, M., Amiro, B.D., Maas, S.E., and Wagner-Riddle, C. (2012). "Nitrous oxide emissions from an annual crop rotation in the Red River Valley, Manitoba.", Canadian Society of Soil Science (CSSS) and Association Québécoise de Spécialistes en Sciences du Sol (AQSSS) Joint Meeting, Lac Beauport, QC, Canada, June 6, 2012. (Presentation)
- Sapkota, T., Tenuta, M., Amiro, B.D., Glenn, A.J., and Stewart, S.E. (2012). "Greenhouse Gas Emissions from Annual-alone and Annual-Perennial Cropping Systems in the Red River Valley, Manitoba. Presentation.", 55th Annual Manitoba Soil Science Society Meeting, Winnipeg, MB, Canada, February 2-3, 2012.
- Tenuta, M., Sapkota, T., Amiro, B.D., Glenn, A.J., and Maas, S.E. (2012). "Greenhouse Gas Emissions from Annual-alone and Annual-Perennial Cropping Systems in the Red River Valley,

Manitoba.", 30th Conference on Agricultural and Forest Meteorology and 1st Conference on Atmospheric Biogeosciences, Boston, MA, USA, May 28-June 1, 2012.

2011

- Glenn, A.J., Amiro, B.D., Tenuta, M., Wagner-Riddle, C., Drewitt, G.B., and Warland, J.S. (2011). "Using stable carbon isotope flux measurements to estimate the contribution of crop residue carbon to soil respiration during the non-growing season in an annual agroecosystem in the Red River Valley.", Joint Annual Meeting of the Canadian Geophysical Union and the Canadian Society of Agricultural and Forest Meteorologists, Banff Park Lodge, Banff, AB, Canada, May 15-18, 2011. (Presentation)
- Sapkota, T., Tenuta, M., Amiro, B.D., Glenn, A.J., and Stewart, S.E. (2011). "Greenhouse gas emission benefit of including perennial forage in a Canadian Prairie cropping system.", Manitoba Agronomists 2009 Conference, Winnipeg, MB, Canada, December 15-16, 2009. (Poster)

## WEEDS

### Harker, K. Neil (Lacombe)

Technology Transfer Publications:

2014

- Lupwayi, N.Z., Harker, K.N., Larney, F.J., Blackshaw, R.E., and O'Donovan, J.T. (2014). "Correlating soil microbial properties with crop yields in the Canadian prairies: two case studies.", Soil's Role in Restoring Ecosystem Services Conference, Sacramento, CA, USA, March 6-9, 2014. (Abstract)

2012

- Beaudoin, N., Sansoulet, J.B., Pattey, E., Grant, C.A., Blackshaw, R.E., Harker, K.N., Johnson, E.N., O'Donovan, J.T., and Gervois, S. (2012). "Adaptation de STICS à la culture de canola au Canada à partir du module colza en vue de simuler les émissions de N<sub>2</sub>O par ModuloSTICS.", IXe Séminaire du modèle de culture STICS, Sainte-Montaine, France, October 16-19, 2012. (Poster)
- Harker, K.N. and O'Donovan, J.T. (2012). "Canola after pulse crops.", Agronomy Update Conference 2012, Red Deer, AB, Canada, January 17-18, 2012, pp. 9.
- Harker, K.N., Willenborg, C.J., Gulden, R.H., Shirliffe, S.J., and Hall, L.M. (2012). "Harvest losses in canola.", 52nd Annual Meeting of the Weed Science Society of America (WSSA), Waikoloa, HI, USA, February 6-9, 2012.

2011

- Beckie, H.J., Harker, K.N., Hall, L.M., Holm, F.A., and Gulden, R.H. (2011). "Risk Assessment of Glyphosate Resistance in Western Canada.", 51st Meeting Weed Science Society of America, Hilton Portland & Executive Tower Hotel, Portland, OR, USA, February 7-10, 2011, pp. 64. (Presentation)
- Blackshaw, R.E., Hao, X., Clayton, G.W., Harker, K.N., O'Donovan, J.T., Johnson, E.N., and Vera, C.L. (2011). "Canola response to polymer-coated urea versus urea in a four-year zero-tillage cropping system on the Canadian prairies.", 13th International Rapeseed Congress, Prague, Czech Republic, June 5-9, 2011, pp. 61-64.
- Blackshaw, R.E., Harker, K.N., and O'Donovan, J.T. (2011). "Polymer-coated urea compared with urea reduces N uptake by weeds.", Canadian Weed Science Society 65th Annual Meeting,



Marriott Gateway on the Falls, Niagara Falls, ON, Canada, November 21-24, 2011, pp. 65. (Poster)

- Grant, C.A., Zebarth, B.J., Malhi, S.S., Soon, Y.K., Selles, F., Lupwayi, N.Z., O'Donovan, J.T., Harker, K.N., and Clayton, G.W. (2011). "Changes in soil ammonium and nitrate concentration over the growing season in western Canada as affected by urea or controlled release urea application.", 12th International Symposium on Soil and Plant Analysis, Mediterranean Agronomic Institute of Chania, Crete, Greece, June 6-10, 2011.
- Harker, K.N., Brandt, S.A., O'Donovan, J.T., Blackshaw, R.E., Johnson, E.N., and Kutcher, H.R. (2011). "The Impact of Two Years of Wild Oat Management After Four Years of Low Crop Inputs in Barley and Canola.", 51st Meeting Weed Science Society of America, Hilton Portland & Executive Tower Hotel, Portland, OR, USA, February 7-10, 2011, pp. 62. (Presentation)
- Harker, K.N., Turkington, T.K., O'Donovan, J.T., Kutcher, H.R., and Johnson, E.N. (2011). "Barley Herbicide and Fungicide Tank-Mixtures?", Canadian Weed Science Society 65th Annual Meeting, Marriott Gateway on the Falls, Niagara Falls, ON, Canada, November 21-24, 2011, pp. 46. (Abstract)
- Harker, K.N., Turkington, T.K., O'Donovan, J.T., Kutcher, H.R., and Johnson, E.N. (2011). "Barley Herbicide and Fungicide Tank-Mixtures?", Canadian Weed Science Society 65th Annual Meeting, Marriott Gateway on the Falls, Niagara Falls, ON, Canada, November 24, 2011. (Presentation)
- Hugh, J.B., Harker, K.N., Légère, A., Morrison, M.J., Séguin-Swartz, G.T., and Falk, K.C. (2011). "GM Canola: The Canadian Experience.", *Farm Policy Journal*, 8(1), pp. 43-49.
- O'Donovan, J.T., Blackshaw, R.E., Grant, C.A., Harker, K.N., Lafond, G.P., Johnson, E.N., Gan, Y.T., May, W.E., Turkington, T.K., and Lupwayi, N.Z. (2011). "Legume Crops to Improve Soil Fertility for Enhanced Canola Production.", 2011 ASA-CSSA-SSSA International Annual Meeting: Fundamental for life: soil, crop and environmental sciences, San Antonio, TX, USA, October 16-19, 2011. (Poster)
- O'Donovan, J.T., Harker, K.N., and Blackshaw, R.E. (2011). "Implications of sub-economic threshold wild oat densities in a cereal/field pea rotation under no-till.", Canadian Weed Science Society 65th Annual Meeting, Marriott Gateway on the Falls, Niagara Falls, ON, Canada, November 21-24, 2011, pp. 46. (Abstract)
- Turkington, T.K., Kutcher, H.R., Xi, K., Harker, K.N., O'Donovan, J.T., and Johnson, E.N. (2011). "The impact of fungicide and herbicide timing on barley leaf disease severity, weed management and crop productivity.", *Phytopathology*, 101(6), pp. S180. (Abstract)

### **Blackshaw, Robert (Lethbridge)**

Technology Transfer Publications:

2014

- Larney, F.J., Li, L., Lupwayi, N.Z., Angers, D.A., Pearson, D.C., and Blackshaw, R.E. (2014). "Irrigated crop rotations: soil quality.", Irrigated Crop Production Update, Lethbridge, AB, Canada, January 21-22, 2014.
- Lupwayi, N.Z., Harker, K.N., Larney, F.J., Blackshaw, R.E., and O'Donovan, J.T. (2014). "Correlating soil microbial properties with crop yields in the Canadian prairies: two case studies.", Soil's Role in Restoring Ecosystem Services Conference, Sacramento, CA, USA, March 6-9, 2014. (Abstract)

- Lupwayi, N.Z., Larney, F.J., Pearson, D.C., Kanashiro, D.A., and Blackshaw, R.E. (2014). "Shifts in soil microbial community structure after 12 years of conservation management on irrigated crop rotations.", 51st Annual Alberta Soil Science Workshop, Calgary, AB, Canada, February 12-14, 2014, pp. 37. (Abstract)

## 2013

- Pearson, D.C., Larney, F.J., Blackshaw, R.E., and Lupwayi, N.Z. (2013). "Soil carbon changes over 12 years on the Vauxhall irrigated rotation study.", 50th Annual Alberta Soil Science Workshop, Lethbridge, AB, Canada, February 19-21, 2013. (Abstract)

## 2012

- Beaudoin, N., Sansoulet, J.B., Pattey, E., Grant, C.A., Blackshaw, R.E., Harker, K.N., Johnson, E.N., O'Donovan, J.T., and Gervois, S. (2012). "Adaptation de STICS à la culture de canola au Canada à partir du module colza en vue de simuler les émissions de N<sub>2</sub>O par ModuloSTICS.", IXe Séminaire du modèle de culture STICS, Sainte-Montaine, France, October 16-19, 2012. (Poster)
- Larney, F.J., Pearson, D.C., Blackshaw, R.E., Lupwayi, N.Z., Regitnig, P.J., and Balasubramanian, P.M. (2012). "Irrigated crop rotation research: Findings from the Vauxhall rotation study over 12 years (2000-11).", 2012 Irrigated Crop Production Update Conference, Lethbridge, AB, Canada, January 31-February 1, 2012. (Abstract)
- Larney, F.J., Pearson, D.C., Blackshaw, R.E., Lupwayi, N.Z., and Balasubramanian, P.M. (2012). "Irrigated dry bean response to cropping history and soil management practices in southern Alberta.", 9th Canadian Pulse Research Workshop, Niagara Falls Marriott Gateway, Niagara Falls, ON, Canada, November 6-12, 2012. (Abstract)
- Larney, F.J., Pearson, D.C., Blackshaw, R.E., Lupwayi, N.Z., and Regitnig, P.J. (2012). "Building soil quality on irrigated rotations in southern Alberta.", 49th Annual Alberta Soil Science Workshop, Ramada Inn, Edmonton, AB, Canada, February 14-16, 2012. (Abstract)
- Larney, F.J., Pearson, D.C., Blackshaw, R.E., Lupwayi, N.Z., and Regitnig, P.J. (2012). "What have we learned about potatoes in the 12 yr Vauxhall irrigated rotation study.", Potato Growers of Alberta Annual Meeting, Red Deer, AB, Canada, November 13-15, 2012. (Poster)
- Pageni, B.B., Lupwayi, N.Z., Larney, F.J., Kawchuk, L.M., Pearson, D.C., Blackshaw, R.E., and Gan, Y.T. (2012). "Characterization of bacterial endophytes associated with *Solanum tuberosum* in irrigated cropping systems.", 112th General Meeting of American Society for Microbiology, San Francisco, CA, USA, June 15-19, 2012. (Abstract)
- Pageni, B.B., Lupwayi, N.Z., Larney, F.J., Kawchuk, L.M., Pearson, D.C., Blackshaw, R.E., and Gan, Y.T. (2012). "Preceding crop, rotation length and soil management effects on bacterial endophytes.", 49th Annual Alberta Soil Science Workshop, Ramada Inn, Edmonton, AB, Canada, February 14-16, 2012. (Abstract)

## 2011

- Blackshaw, R.E. (2011). "Including cover crops in prairie no-till systems.", 23rd Annual Conference of the Saskatchewan Soil Conservation Association (SSCA), Saskatoon Inn, Saskatoon, SK, Canada, January 13, 2011, pp. 3.
- Blackshaw, R.E. (2011). "Integrated Cropping Practices Reduce the Risk of Resistance Development.", 51st Meeting Weed Science Society of America, Hilton Portland & Executive Tower Hotel, Portland, OR, USA, February 7-10, 2011. (Presentation)
- Blackshaw, R.E., Hao, X., Clayton, G.W., Harker, K.N., O'Donovan, J.T., Johnson, E.N., and Vera, C.L. (2011). "Canola response to polymer-coated urea versus urea in a four-year zero-tillage

cropping system on the Canadian prairies.", 13th International Rapeseed Congress, Prague, Czech Republic, June 5-9, 2011, pp. 61-64.

- Blackshaw, R.E., Harker, K.N., and O'Donovan, J.T. (2011). "Polymer-coated urea compared with urea reduces N uptake by weeds.", Canadian Weed Science Society 65th Annual Meeting, Marriott Gateway on the Falls, Niagara Falls, ON, Canada, November 21-24, 2011, pp. 65. (Poster)
- Blackshaw, R.E., Molnar, L.J., and Moyer, J.R. (2011). "Weed Suppression and Soil Nitrogen Benefits Associated with Legume Cover Crop-Winter Wheat Intercrops.", 51st Meeting Weed Science Society of America, Hilton Portland & Executive Tower Hotel, Portland, OR, USA, February 7-10, 2011. (Presentation)
- Harker, K.N., Brandt, S.A., O'Donovan, J.T., Blackshaw, R.E., Johnson, E.N., and Kutcher, H.R. (2011). "The Impact of Two Years of Wild Oat Management After Four Years of Low Crop Inputs in Barley and Canola.", 51st Meeting Weed Science Society of America, Hilton Portland & Executive Tower Hotel, Portland, OR, USA, February 7-10, 2011, pp. 62. (Presentation)
- Larney, F.J., Pearson, D.C., Blackshaw, R.E., Lupwayi, N.Z., Regitnig, P.J., and Balasubramanian, P.M. (2011). "Dry bean performance in the Vauxhall irrigated rotation study over 12 growing seasons (2000-11).", Pulse Science Cluster Scientific Meeting 2011, Radisson Hotel, Saskatoon, SK, Canada, November 17-18, 2011. (Abstract)
- Larney, F.J., Pearson, D.C., Blackshaw, R.E., Lupwayi, N.Z., and Regitnig, P.J. (2011). "A soil conservation package for irrigated rotations in southern Alberta.", 2011 ASA-CSSA-SSSA International Annual Meeting: Fundamental for life: soil, crop and environmental sciences, San Antonio, TX, USA, October 16-19, 2011. (Abstract)
- Larney, F.J., Pearson, D.C., Blackshaw, R.E., Lupwayi, N.Z., and Regitnig, P.J. (2011). "Potato performance in the Vauxhall irrigated rotation study over 12 growing seasons (2000-11).", 2011 Annual Meeting of Potato Growers of Alberta, Calgary, AB, Canada, November 15-18, 2011. (Abstract)
- Lovell, A. and Blackshaw, R.E. (2011). "Slow release N a good fit in wet areas.", *Grain News*, 37(2), pp. 6.
- O'Donovan, J.T., Blackshaw, R.E., Grant, C.A., Harker, K.N., Lafond, G.P., Johnson, E.N., Gan, Y.T., May, W.E., Turkington, T.K., and Lupwayi, N.Z. (2011). "Legume Crops to Improve Soil Fertility for Enhanced Canola Production.", 2011 ASA-CSSA-SSSA International Annual Meeting: Fundamental for life: soil, crop and environmental sciences, San Antonio, TX, USA, October 16-19, 2011. (Poster)
- O'Donovan, J.T., Harker, K.N., and Blackshaw, R.E. (2011). "Implications of sub-economic threshold wild oat densities in a cereal/field pea rotation under no-till.", Canadian Weed Science Society 65th Annual Meeting, Marriott Gateway on the Falls, Niagara Falls, ON, Canada, November 21-24, 2011, pp. 46. (Abstract)
- Pageni, B.B., Lupwayi, N.Z., Larney, F.J., Kawchuk, L.M., Pearson, D.C., Blackshaw, R.E., and Gan, Y.T. (2011). "Preceding crop, rotation length and soil management effects on bacterial endophytes.", Pulse Science Cluster Scientific Meeting 2011, Radisson Hotel, Saskatoon, SK, Canada, November 17-18, 2011. (Abstract)
- Pageni, B.B., Lupwayi, N.Z., Larney, F.J., Pearson, D.C., and Blackshaw, R.E. (2011). "Soil microbial biomass and diversity in irrigated crop systems.", Soil Ecology Society Meeting, Kelowna, BC, Canada, May 24-27, 2011. (Abstract)

**Johnson, Eric (Scott)**

## Technology Transfer Publications:

## 2013

- Johnson, E.N. (2013). "Carinata agronomy and production research in Saskatchewan.", Carinata Day Producer Meeting, Swift Current, SK, Canada, March 26, 2013. (Presentation)
- Johnson, E.N. (2013). "Mustard weed control: Are we making progress?", Saskatchewan Mustard Development Commission Annual Meeting, Saskatoon, SK, Canada, January 9, 2013. (Presentation)
- Johnson, E.N. (2013). "Weed management.", published in Carinata: A Guide to Best Management Practices., 14 pages.
- McAllister, T.A., He, M.L., McKinnon, J.J., Nair, J., Johnson, E.N., and Cheng, B.F. (2013). "*Canola juncea* - new meal in town.", Saskatchewan Beef and Forage Symposium, Saskatoon, SK, Canada, January 24, 2013. (Presentation)
- Szmigielski, A.M., Schoenau, J.J., and Johnson, E.N. (2013). "Bioactivity and dissipation of pyroxasulfone herbicide in Saskatchewan soils.", 66th Annual Meeting of the Western Society of Weed Science, Catamaran Resort, San Diego, CA, USA, March 11-14, 2013. (Poster)

## 2012

- Beaudoin, N., Sansoulet, J.B., Pattey, E., Grant, C.A., Blackshaw, R.E., Harker, K.N., Johnson, E.N., O'Donovan, J.T., and Gervois, S. (2012). "Adaptation de STICS à la culture de canola au Canada à partir du module colza en vue de simuler les émissions de N<sub>2</sub>O par ModuloSTICS.", IXe Séminaire du modèle de culture STICS, Sainte-Montaine, France, October 16-19, 2012. (Poster)
- Johnson, E.N. (2012). "Efficacy of fall and spring applications of pyroxasulfone.", 9th Canadian Pulse Research Workshop, Niagara Falls Marriott Gateway, Niagara Falls, ON, Canada, November 6-12, 2012, pp. 57. (Poster)
- Johnson, E.N. (Ed.) (2012). "Managing Herbicide-Resistant Weeds in Pulses.", *PulsePoint*, 12(1), pp. 8-9.
- Johnson, E.N., Beckie, H.J., Hall, L.M., Lturnus, B.D., Willenborg, C.J., Sapsford, K.L., Schoenau, G.J., and Szmigielski, A.M. (2012). "The potential for Group 15 herbicides in managing herbicide resistant weeds in pulses.", 9th Canadian Pulse Research Workshop, Niagara Falls Marriott Gateway, Niagara Falls, ON, Canada, November 6-12, 2012, pp. 30.
- Johnson, E.N., Beckie, H.J., Hall, L.M., Schoenau, J.J., Willenborg, C.J., Sapsford, K.L., and Vandenberg, A. (2012). "Minor Use and New Herbicides.", FarmTech 2012, Edmonton, AB, Canada, January 24-26, 2012. (Presentation)
- Johnson, E.N., Beckie, H.J., Hall, L.M., Schoenau, J.J., Willenborg, C.J., Sapsford, K.L., and Vandenberg, A. (2012). "Progress in Managing Herbicide Resistant Weeds in Pulse Crops.", Pulse Days 2012, Saskatoon, SK, Canada, January 10, 2012. (Presentation)
- Johnson, E.N., Beckie, H.J., Hall, L.M., Schoenau, J.J., Willenborg, C.J., Sapsford, K.L., and Vandenberg, A. (2012). "Progress in managing herbicide resistant weeds in pulses.", Pulse Science Cluster Scientific Meeting 2011, Radisson Hotel, Saskatoon, SK, Canada, November 17-18, 2011. (Abstract)
- Johnson, E.N., Beckie, H.J., Willenborg, C.J., Sapsford, K.L., Vandenberg, A., Schoenau, J.J., Hall, L.M., and Lturnus, B.D. (2012). "Progress in managing herbicide resistance in pulse crops.", Pulse Science Cluster Scientific Meeting 2012, Niagara Falls Marriott Gateway, Niagara Falls, ON, Canada, November 5, 2012. (Presentation)

- Johnson, E.N., Beckie, H.J., Willenborg, C.J., and Sapsford, K.L. (2012). "Progress in managing herbicide resistant weed in lentil.", 65th Annual Meeting of the Western Society of Weed Science, Peppermill Resort, Reno, NV, USA, March 12-15, 2012. (Abstract)
- Johnson, E.N., Falk, K.C., and Cote, J. (2012). "Opportunities for Ethiopian Mustard.", Western Canadian Crop Production Show 2012, Saskatoon, SK, Canada, January 9, 2012. (Poster)
- Johnson, E.N., Hall, L.M., Laternus, B.D., Beckie, H.J., Sapsford, K.L., and Willenborg, C.J. (2012). "Pyroxasulfone application timing and efficacy on cleavers (*Galium aparine*) and wild oats (*Avena fatua*).", Canadian Weed Science Society 66th Annual Meeting, Fairmont Hotel, Winnipeg, MB, Canada, November 12-15, 2012, pp. 18. (Abstract)
- Johnson, E.N., Sapsford, K.L., Willenborg, C.J., Hall, L.M., Topinka, A.K., Juras, L.T., Degenhardt, R.F., Hamman, W.M., and Nybo, B.X. (2012). "Broadleaf herbicide tolerance in Brassica carinata.", 2012 Western Society of Weed Science Annual Meeting, Reno, NV, USA, March 12-14, 2012. (Poster)
- Laternus, B.D., Hall, L.M., Johnson, E.N., Beckie, H.J., Sapsford, K.L., Willenborg, C.J., and Raatz, L.L. (2012). "Pyroxasulfone and sulfentrazone efficacy on cleavers (*Galium aparine*) and wild oats (*Avena fatua*).", Pulse Science Cluster Scientific Meeting 2012, Niagara Falls Marriott Gateway, Niagara Falls, ON, Canada, November 5, 2012. (Presentation)
- Pajic, V., Holm, F.A., Sapsford, K.L., Johnson, E.N., and Vandenberg, A. (2012). "Developing sulfentrazone and fluthiacet-methyl tolerance in lentil.", 9th Canadian Pulse Research Workshop, Niagara Falls Marriott Gateway, Niagara Falls, ON, Canada, November 6-12, 2012, pp. 41. (Poster)
- Peng, G., Fernando, W.G.D., Kirkham, C.L., Lange, R., Kutcher, H.R., McLaren, D.L., Johnson, E.N., and Turkington, T.K. (2012). "Mitigating the risk of blackleg disease of canola using fungicide strategies.", Soils and Crops Workshop 2012, University of Saskatchewan, Saskatoon, SK, Canada, March 13-14, 2012, [CD], 7 pages.
- Sapsford, K.L., Johnson, E.N., and Vandenberg, A. (2012). "Searching for improved lentil tolerance to ppo inhibitor herbicides.", 2012 Western Society of Weed Science Annual Meeting, Reno, NV, USA, March 12-14, 2012. (Abstract)
- Sapsford, K.L., Willenborg, C.J., Johnson, E.N., and Beckie, H.J. (2012). "Group 2 (ALS) resistant cleavers (*Galium aparine* / *Galium spurium*) control in field peas (*Pisum* sp.).", 9th Canadian Pulse Research Workshop, Niagara Falls Marriott Gateway, Niagara Falls, ON, Canada, November 6-12, 2012, pp. 57. (Poster)

## 2011

- Beckie, H.J., Warwick, S.I., Johnson, E.N., and Falk, K.C. (2011). "Gene flow between canola and mustard in Saskatchewan, Canada.", Canadian Weed Science Society 65th Annual Meeting, Marriott Gateway on the Falls, Niagara Falls, ON, Canada, November 21-24, 2011, pp. 58. (Poster)
- Blackshaw, R.E., Hao, X., Clayton, G.W., Harker, K.N., O'Donovan, J.T., Johnson, E.N., and Vera, C.L. (2011). "Canola response to polymer-coated urea versus urea in a four-year zero-tillage cropping system on the Canadian prairies.", 13th International Rapeseed Congress, Prague, Czech Republic, June 5-9, 2011, pp. 61-64.
- Fedoruk, L.K., Shirliffe, S.J., and Johnson, E.N. (2011). "Utilizing the Critical Period of Weed Control Concept to Optimize Herbicide Timing in Lentil.", 51st Meeting Weed Science Society of America, Hilton Portland & Executive Tower Hotel, Portland, OR, USA, February 7-10, 2011. (Presentation)

- Harker, K.N., Brandt, S.A., O'Donovan, J.T., Blackshaw, R.E., Johnson, E.N., and Kutcher, H.R. (2011). "The Impact of Two Years of Wild Oat Management After Four Years of Low Crop Inputs in Barley and Canola.", 51st Meeting Weed Science Society of America, Hilton Portland & Executive Tower Hotel, Portland, OR, USA, February 7-10, 2011, pp. 62. (Presentation)
- Harker, K.N., Turkington, T.K., O'Donovan, J.T., Kutcher, H.R., and Johnson, E.N. (2011). "Barley Herbicide and Fungicide Tank-Mixtures?", Canadian Weed Science Society 65th Annual Meeting, Marriott Gateway on the Falls, Niagara Falls, ON, Canada, November 21-24, 2011, pp. 46. (Abstract)
- Harker, K.N., Turkington, T.K., O'Donovan, J.T., Kutcher, H.R., and Johnson, E.N. (2011). "Barley Herbicide and Fungicide Tank-Mixtures?", Canadian Weed Science Society 65th Annual Meeting, Marriott Gateway on the Falls, Niagara Falls, ON, Canada, November 24, 2011. (Presentation)
- Isidro, J., Singh, A.K., Wang, H., DePauw, R.M., Pozniak, C.J., Knox, R.E., Cuthbert, R.D., Beres, B.L., and Johnson, E.N. (2011). "Effects of plant density on durum crop production.", 1st Canadian Wheat Symposium, Winnipeg, MB, Canada, November 30-December 2, 2011.
- Johnson, E.N. (2011). "Breeders excited with performance of new mustard.", *Western Producer*(Sept. 15).
- Johnson, E.N. (2011). "Breeders excited with performance of new mustard.", SaskMustard, Mustard Field Day, Swift Current, SK, Canada, July 12, 2011. (Presentation)
- Johnson, E.N. (2011). "Controlling Weeds in Pulses in 2011.", *PulsePoint*, 11(1), pp. 3-4.
- Johnson, E.N., Beckie, H.J., Hall, L.M., Schoenau, J.J., Willenborg, C.J., Sapsford, K.L., and Vandenberg, A. (2011). "Progress in managing herbicide resistant weeds in pulses.", Canadian Weed Science Society 65th Annual Meeting, Marriott Gateway on the Falls, Niagara Falls, ON, Canada, November 21-24, 2011.
- Johnson, E.N., Beckie, H.J., Hall, L.M., Schoenau, J.J., Willenborg, C.J., and Sapsford, K.L. (2011). "Progress in Managing Herbicide Resistant Weeds in Pulse Crops.", Canadian Weed Science Society 65th Annual Meeting, Marriott Gateway on the Falls, Niagara Falls, ON, Canada, November 21-24, 2011, pp. 48-49. (Abstract)
- Johnson, E.N., Beckie, H.J., Holm, F.A., Sapsford, K.L., and Vandenberg, A. (2011). "Weed control challenges in pulses in 2011.", Pulse Days 2011, Saskatoon, SK, Canada, January 11, 2011. (Presentation)
- Johnson, E.N., Brandt, S.A., Hall, L.M., and Smith, E.G. (2011). "Agronomic challenges and opportunities for second generation crops with novel traits and new crops.", in Beckie, H.J. and Hall, L.M. (eds.) - Topics in Canadian Weed Science, Vol. 8. New Crops and Crops with Second-Generation Traits: Weed Management Challenges, Canadian Weed Science Society – Société canadienne de malherbologie, Pinawa, MB, pp. 31-48.
- Johnson, E.N., Falk, K.C., and Ramsey, S. (2011). "Oilseeds of the future.", Crop Production Show, Saskatoon, SK, Canada, January 10, 2011. (Poster)
- Légère, A., Beckie, H.J., Hrynewich, B.L., Lozinski, C., Johnson, E.N., Warwick, S.I., and Stevenson, C. (2011). "Kochia with ALS (AHAS) Mutations: More on the Manitoba Conundrum.", 51st Meeting Weed Science Society of America, Hilton Portland & Executive Tower Hotel, Portland, OR, USA, February 7-10, 2011. (Presentation)
- O'Donovan, J.T., Blackshaw, R.E., Grant, C.A., Harker, K.N., Lafond, G.P., Johnson, E.N., Gan, Y.T., May, W.E., Turkington, T.K., and Lupwayi, N.Z. (2011). "Legume Crops to Improve Soil Fertility for Enhanced Canola Production.", 2011 ASA-CSSA-SSSA International Annual Meeting:

Fundamental for life: soil, crop and environmental sciences, San Antonio, TX, USA, October 16-19, 2011. (Poster)

- Sapsford, K.L., Johnson, E.N., and Vandenberg, A. (2011). "Searching for improved lentil tolerance to PPO Inhibitor (Group 14) herbicides.", Canadian Weed Science Society 65th Annual Meeting, Marriott Gateway on the Falls, Niagara Falls, ON, Canada, November 21-24, 2011, pp. 48. (Abstract)
- Turkington, T.K., Kutcher, H.R., Xi, K., Harker, K.N., O'Donovan, J.T., and Johnson, E.N. (2011). "The impact of fungicide and herbicide timing on barley leaf disease severity, weed management and crop productivity.", *Phytopathology*, 101(6), pp. S180. (Abstract)

### Beckie, Hugh (Saskatoon)

Technology Transfer Publications:

2012

- Beckie, H.J. (2012). "Glyphosate Resistant Weeds.", 24th Annual Conference of the Saskatchewan Soil Conservation Association (SSCA), Saskatoon Inn, Saskatoon, SK, Canada, January 11, 2012.
- Beckie, H.J., Weiss, R.M., Olfert, O.O., and Leeson, J.Y. (2012). "Range Expansion of Kochia (*Kochia scoparia*) in North America under a Changing Climate.", *Topics in Canadian Weed Science*, 8, pp. 33-46.
- Johnson, E.N., Beckie, H.J., Hall, L.M., Laternus, B.D., Willenborg, C.J., Sapsford, K.L., Schoenau, G.J., and Smizigielski, A.M. (2012). "The potential for Group 15 herbicides in managing herbicide resistant weeds in pulses.", 9th Canadian Pulse Research Workshop, Niagara Falls Marriott Gateway, Niagara Falls, ON, Canada, November 6-12, 2012, pp. 30.
- Johnson, E.N., Beckie, H.J., Hall, L.M., Schoenau, J.J., Willenborg, C.J., Sapsford, K.L., and Vandenberg, A. (2012). "Minor Use and New Herbicides.", FarmTech 2012, Edmonton, AB, Canada, January 24-26, 2012. (Presentation)
- Johnson, E.N., Beckie, H.J., Hall, L.M., Schoenau, J.J., Willenborg, C.J., Sapsford, K.L., and Vandenberg, A. (2012). "Progress in Managing Herbicide Resistant Weeds in Pulse Crops.", Pulse Days 2012, Saskatoon, SK, Canada, January 10, 2012. (Presentation)
- Johnson, E.N., Beckie, H.J., Hall, L.M., Schoenau, J.J., Willenborg, C.J., Sapsford, K.L., and Vandenberg, A. (2012). "Progress in managing herbicide resistant weeds in pulses.", Pulse Science Cluster Scientific Meeting 2011, Radisson Hotel, Saskatoon, SK, Canada, November 17-18, 2011. (Abstract)
- Johnson, E.N., Beckie, H.J., Willenborg, C.J., Sapsford, K.L., Vandenberg, A., Schoenau, J.J., Hall, L.M., and Laternus, B.D. (2012). "Progress in managing herbicide resistance in pulse crops.", Pulse Science Cluster Scientific Meeting 2012, Niagara Falls Marriott Gateway, Niagara Falls, ON, Canada, November 5, 2012. (Presentation)
- Johnson, E.N., Beckie, H.J., Willenborg, C.J., and Sapsford, K.L. (2012). "Progress in managing herbicide resistant weed in lentil.", 65th Annual Meeting of the Western Society of Weed Science, Peppermill Resort, Reno, NV, USA, March 12-15, 2012. (Abstract)
- Johnson, E.N., Hall, L.M., Laternus, B.D., Beckie, H.J., Sapsford, K.L., and Willenborg, C.J. (2012). "Pyroxasulfone application timing and efficacy on cleavers (*Galium aparine*) and wild oats (*Avena fatua*).", Canadian Weed Science Society 66th Annual Meeting, Fairmont Hotel, Winnipeg, MB, Canada, November 12-15, 2012, pp. 18. (Abstract)

- Laturnus, B.D., Hall, L.M., Johnson, E.N., Beckie, H.J., Sapsford, K.L., Willenborg, C.J., and Raatz, L.L. (2012). "Pyroxasulfone and sulfentrazone efficacy on cleavers (*Galium aparine*) and wild oats (*Avena fatua*).", Pulse Science Cluster Scientific Meeting 2012, Niagara Falls Marriott Gateway, Niagara Falls, ON, Canada, November 5, 2012. (Presentation)
- Olfert, O.O., Weiss, R.M., Turkington, T.K., Beckie, H.J., and Kriticos, D.J. (2012). "Bioclimatic approach to assessing the potential impact of climate change on representative crop pests in North America.", *Topics in Canadian Weed Science*, 8, pp. 47-70.
- Sapsford, K.L., Willenborg, C.J., Johnson, E.N., and Beckie, H.J. (2012). "Group 2 (ALS) resistant cleavers (*Galium aparine* / *Galium spurium*) control in field peas (*Pisum* sp.).", 9th Canadian Pulse Research Workshop, Niagara Falls Marriott Gateway, Niagara Falls, ON, Canada, November 6-12, 2012, pp. 57. (Poster)

## 2011

- Beckie, H.J., Harker, K.N., Hall, L.M., Holm, F.A., and Gulden, R.H. (2011). "Risk Assessment of Glyphosate Resistance in Western Canada.", 51st Meeting Weed Science Society of America, Hilton Portland & Executive Tower Hotel, Portland, OR, USA, February 7-10, 2011, pp. 64. (Presentation)
- Beckie, H.J., Lozinski, C., and Shirriff, S. (2011). "Susceptible Wild Oat (*Avena fatua*) Endangered in Manitoba.", 51st Annual Meeting of the Weed Science Society of America (WSSA), Hilton Portland & Executive Tower Hotel, Portland, OR, USA, February 7-10, 2011. (Poster)
- Beckie, H.J., Warwick, S.I., Johnson, E.N., and Falk, K.C. (2011). "Gene flow between canola and mustard in Saskatchewan, Canada.", Canadian Weed Science Society 65th Annual Meeting, Marriott Gateway on the Falls, Niagara Falls, ON, Canada, November 21-24, 2011, pp. 58. (Poster)
- Beckie, H.J., Warwick, S.I., Sauder, I.C.A., Kelln, G.M., and Lozinski, C. (2011). "Acetolactate synthase (ALS) inhibitor-resistant false cleavers (*Galium spurium*) in western Canada.", Canadian Weed Science Society 65th Annual Meeting, Marriott Gateway on the Falls, Niagara Falls, ON, Canada, November 21-24, 2011, pp. 47. (Abstract)
- Beckie, H.J., Warwick, S.I., Sauder, I.C.A., Kelln, G.M., and Lozinski, C. (2011). "Acetolactate synthase (ALS) inhibitor-resistant false cleavers (*Galium spurium*) in western Canada.", Canadian Weed Science Society 65th Annual Meeting, Marriott Gateway on the Falls, Niagara Falls, ON, Canada, November 21-24, 2011, pp. 59. (Poster)
- Johnson, E.N., Beckie, H.J., Hall, L.M., Schoenau, J.J., Willenborg, C.J., Sapsford, K.L., and Vandenberg, A. (2011). "Progress in managing herbicide resistant weeds in pulses.", Canadian Weed Science Society 65th Annual Meeting, Marriott Gateway on the Falls, Niagara Falls, ON, Canada, November 21-24, 2011.
- Johnson, E.N., Beckie, H.J., Hall, L.M., Schoenau, J.J., Willenborg, C.J., and Sapsford, K.L. (2011). "Progress in Managing Herbicide Resistant Weeds in Pulse Crops.", Canadian Weed Science Society 65th Annual Meeting, Marriott Gateway on the Falls, Niagara Falls, ON, Canada, November 21-24, 2011, pp. 48-49. (Abstract)
- Johnson, E.N., Beckie, H.J., Holm, F.A., Sapsford, K.L., and Vandenberg, A. (2011). "Weed control challenges in pulses in 2011.", Pulse Days 2011, Saskatoon, SK, Canada, January 11, 2011. (Presentation)
- Légère, A., Beckie, H.J., Hrynewich, B.L., Lozinski, C., Johnson, E.N., Warwick, S.I., and Stevenson, C. (2011). "Kochia with ALS (AHAS) Mutations: More on the Manitoba Conundrum.", 51st



Meeting Weed Science Society of America, Hilton Portland & Executive Tower Hotel, Portland, OR, USA, February 7-10, 2011. (Presentation)

## PATHOLOGY

### Turkington, Kelly (Lacombe)

Technology Transfer Publications:

2014

- Chen, W., Lewis, C.T., Lévesque, C.A., Zhang, N., Turkington, T.K., Bamforth, J., Gaba, D., Tittlemier, S.A., MacLeod, A., and Gräfenhan, T. (2014). "454 Pyrosequencing revealed geographical distribution and ecological diversification of fungal communities on barley and malt from western Canada.", XVIth International Congress of Virology - International Union of Microbiological Societies (IUMS 2014), July 27 - August 1, 2014, Montréal, Québec, Canada.

2013

- Akhavan, A., Turkington, T.K., Kebede, B., Strelkov, I.S., Xi, K., Kumar, K., Tekauz, A., Kutcher, H.R., Tucker, J.R., Kirkham, C., Dunfield, K.E., and Strelkov, S.E. (2013). "Etiology of *Pyrenophora teres* forms causing intermediate symptoms of net blotch in barley fields on the Prairies.", 84th Annual Meeting of the Canadian Phytopathological Society, Edmonton, AB, Canada, June 16-19, 2013, Received 2013 Canadian Phytopathological Society Best Student Poster Presentation Award. (Poster)
- Akhavan, A., Turkington, T.K., Kebede, B., Tekauz, A., Xi, K., Kutcher, H.R., Tucker, J.R., Kirkham, C., Kumar, K., Rennie, D.C., and Strelkov, S.E. (2013). "Assessing the nature and variability of the barley net blotch pathogen on the Canadian Prairies and the ability to adapt to host resistance and fungicides.", 2nd Annual General Meeting of the Alberta Barley Commission, Banff, AB, Canada, December 4-6, 2013, Received 2013 Alberta Barley Commission 2nd Place Student Poster Competition. (Poster)
- Akhavan, A., Turkington, T.K., Kebede, B., Tekauz, A., Xi, K., Kutcher, H.R., Tucker, J.R., Kirkham, C., Kumar, K., Rennie, D.C., and Strelkov, S.E. (2013). "Genetic diversity of the spot form of the net blotch pathogen of barley (*Pyrenophora teres* f. *maculata*) on the Canadian Prairies as revealed by simple sequence repeats analysis.", 34th Annual Meeting of the Plant Pathology Society of Alberta, Brooks, AB, Canada, November 4-6, 2013, Received 2013 Plant Pathology Society of Alberta Best Student Poster Presentation Award. (Poster)
- Akhavan, A., Turkington, T.K., Kebede, B., Tekauz, A., Xi, K., Kutcher, H.R., Tucker, J.R., Kirkham, C., Kumar, K., Rennie, D.C., and Strelkov, S.E. (2013). "Genetic structure of *Pyrenophora teres* f. *teres* (net form net blotch of barley) populations from the Canadian Prairies as revealed by simple sequence repeats analysis.", 34th Annual Meeting of the Plant Pathology Society of Alberta, Brooks, AB, Canada, November 4-6, 2013, oral presentation.
- Akhavan, A., Turkington, T.K., Strelkov, I.S., Xi, K., Kumar, K., Tekauz, A., Kutcher, H.R., Tucker, J.R., Kirkham, C., Dunfield, K.E., and Strelkov, S.E. (2013). "Occurrence of forms and mating type idiomorphs in western Canadian *Pyrenophora teres* (net blotch of barley) populations.", 84th Annual Meeting of the Canadian Phytopathological Society, Edmonton, AB, Canada, June 16-19, 2013, Received 2013 Canadian Phytopathological Society Graduate Student Travel Award.
- Peng, G., Lahlali, R.L., Pageau, D., Hwang, S.F., Hynes, R.K., Anderson, K., McDonald, M.R., Gossen, B.D., Strelkov, S.E., Turkington, T.K., Yu, F.Q., Falk, K.C., Boyetchko, S.M., McGregor, L.,

Hupka, D., and Geissler, H.J. (2013). "Assessment of crop rotation, resistance and *Bacillus subtilis* for management of clubroot on canola.", *Canadian Journal of Plant Pathology*, 35, pp. 112. (Abstract)

- Peng, G., Pageau, D., Strelkov, S.E., Lahlali, R.L., Gossen, B.D., Anderson, K., Hwang, S.F., McDonald, M.R., Yu, F.Q., Falk, K.C., Turkington, T.K., Hynes, R.K., Boyetchko, S.M., and McGregor, L. (2013). "Management of clubroot disease on canola with crop rotation combined with host resistance or biofungicide seed dressing.", *Canadian Journal of Plant Pathology*, 35, pp. 519. (Abstract)

## 2012

- Kutcher, H.R., Eynck, C., Gossen, B.D., Turkington, T.K., Brandt, S.A., and Xi, K. (2012). "Disease implications of canola-intensive crop rotations.", in Beckie, H.J. and Hall, L.M. (eds.) - Topics in Canadian Weed Science. Vol. 9. New Crops and Crops with Second-Generation Traits, Canadian Weed Science Society – Société canadienne de malherbologie, Pinawa, MB, pp. 49-66.
- Kutcher, H.R., Turkington, T.K., Gaudet, D.A., Randhawa, H.S., Puchalski, B., Wogsberg, S., and Graf, R.J. (2012). "Managing cereal and canola diseases.", Crop Talk, Prince Albert Exhibition Centre, Saskatoon, SK, Canada, March 7, 2012, (Presentation).
- Olfert, O.O., Weiss, R.M., Turkington, T.K., Beckie, H.J., and Kriticos, D.J. (2012). "Bioclimatic approach to assessing the potential impact of climate change on representative crop pests in North America.", *Topics in Canadian Weed Science*, 8, pp. 47-70.
- Peng, G., Fernando, W.G.D., Kirkham, C.L., Lange, R., Kutcher, H.R., McLaren, D.L., Johnson, E.N., and Turkington, T.K. (2012). "Mitigating the risk of blackleg disease of canola using fungicide strategies.", Soils and Crops Workshop 2012, University of Saskatchewan, Saskatoon, SK, Canada, March 13-14, 2012, [CD], 7 pages.
- Peng, G., Lahlali, R.L., Pageau, D., Hwang, S.F., Hynes, R.K., Anderson, K., McDonald, M.R., Gossen, B.D., Strelkov, S.E., Turkington, T.K., Yu, F.Q., Falk, K.C., Boyetchko, S.M., McGregor, L., Hupka, D., and Geissler, H.J. (2012). "Assessment of crop rotation, resistance and *Bacillus subtilis* for management of clubroot on canola.", Canadian Phytopathological Society (CPS) 83rd Annual Meeting and International PPV Meeting, Marriott Gateway On The Falls, Niagara Falls, ON, Canada, June 24-27, 2012, Published in: *Can. J. Plant Pathol.* (2013) 35(1), pp. 112.
- Peng, G., Lahlali, R.L., Pageau, D., Hwang, S.F., Hynes, R.K., Anderson, K., McDonald, M.R., Gossen, B.D., Strelkov, S.E., Turkington, T.K., Yu, F.Q., Falk, K.C., Boyetchko, S.M., McGregor, L., Hupka, D., and Geissler, H.J. (2012). "Crop rotation, cultivar resistance, and biofungicide seed dressing for clubroot control on canola.", 6th International Symposium on Brassica and 18th Crucifer Genetics Workshop, Catania, Sicily, Italy, November 12-16, 2012.
- Peng, G., Lahlali, R.L., Pageau, D., McDonald, M.R., Gossen, B.D., Strelkov, S.E., Turkington, T.K., Yu, F.Q., Falk, K.C., Boyetchko, S.M., McGregor, L., Hupka, D., and Geissler, H.J. (2012). "Assessment of crop rotation and host resistance in combination with *Bacillus subtilis* for management of clubroot on canola.", Canadian Phytopathological Society (CPS) 83rd Annual Meeting and International PPV Meeting, Marriott Gateway On The Falls, Niagara Falls, ON, Canada, June 24-27, 2012, Published in: *Canadian Journal of Plant Pathology*, 35(1), pp.122.
- Smith, E.G., O'Donovan, J.T., Henderson, W.J., Turkington, T.K., and Clayton, G.W. (2012). "Malting Barley Production: Profitability and Risk.", 2012 Annual Meeting of the Canadian Agricultural Economics Society (CAES), Niagara Falls, ON, Canada, June 17-19, 2012.
- Strelkov, S.E., Hwang, S.F., Howard, R.J., Rahman, H., Kutcher, H.R., Turkington, T.K., Gossen, B.D., Peng, G., McLaren, D.L., LeBoldus, J.M., Feng, J., Cao, T., and Manolii, V.P. (2012). "Clubroot

Risk Mitigation Initiative: Pathology Pillar.", Clubroot Summit 2012, Edmonton, AB, Canada, March 6, 2012, Invited presentation.

- Turkington, T.K., Kutcher, H.R., Jurke, C., Buchwaldt, L., and McLaren, D.L. (2012). "Managing sclerotinia stem rot of canola.", Webinar, Canola Council of Canada and canola grower's associations (ACPC/SC/MCGA), Canada, June 28, 2012. (Presentation)
- Xi, K., Zantinge, J.L., Meadus, W.J., Nyachiro, J.M., and Turkington, T.K. (2012). "Barley cultivar resistance in relation to *Rynchosporium secalis* virulence in Alberta.", 7th Canadian Barley Symposium, Calgary, AB, Canada, July 8-10, 2012.

## 2011

- Harker, K.N., Turkington, T.K., O'Donovan, J.T., Kutcher, H.R., and Johnson, E.N. (2011). "Barley Herbicide and Fungicide Tank-Mixtures?", Canadian Weed Science Society 65th Annual Meeting, Marriott Gateway on the Falls, Niagara Falls, ON, Canada, November 21-24, 2011, pp. 46. (Abstract)
- Harker, K.N., Turkington, T.K., O'Donovan, J.T., Kutcher, H.R., and Johnson, E.N. (2011). "Barley Herbicide and Fungicide Tank-Mixtures?", Canadian Weed Science Society 65th Annual Meeting, Marriott Gateway on the Falls, Niagara Falls, ON, Canada, November 24, 2011. (Presentation)
- Klein-Gebbinck, H.W., Turkington, T.K., Olfert, O.O., Weiss, R.M., Kriticos, D.J., Kutcher, H.R., Falk, K.C., and Strelkov, S.E. (2011). "Projected distribution and severity of clubroot of canola in the Canadian prairies under incremental temperature and precipitation, and potential climate change scenarios.", *Climate Change and the Implications for Plant Science: The science, the impacts, and the options*, University of Guelph, Guelph, ON, Canada, June 7-9, 2011.
- Kutcher, H.R., Dokken-Bouchard, F.L., Turkington, T.K., Fernando, W.G.D., Boyetchko, S.M., Buchwaldt, L., Hegedus, D.D., and Parkin, I.A.P. (2011). "Managing sclerotinia stem rot in canola.", Canola Research Summit meeting, Winnipeg, MB, Canada, April 12-13, 2011.
- Kutcher, H.R., Turkington, T.K., Brandt, S.A., Gossen, B.D., McLaren, D.L., Dokken-Bouchard, F.L., and Strelkov, S.E. (2011). "Canola Disease Management.", Annual Indian Head Crop Management Field Day 2011, Indian Head, SK, Canada, July 19, 2011.
- Kutcher, H.R., Turkington, T.K., Gossen, B.D., Brandt, S.A., Dokken-Bouchard, F.L., and Strelkov, S.E. (2011). "Canola Disease Resistance Management.", Crop Talk 2011 Meeting (Ministry of Agriculture and Pineland Coop), Prince Albert Exhibition Centre, Prince Albert, SK, Canada, March 8, 2011, Invited Presentation.
- Kutcher, H.R., Turkington, T.K., Gossen, B.D., Brandt, S.A., Dokken-Bouchard, F.L., and Strelkov, S.E. (2011). "Canola Disease and Fungicide Strategies Based on Crop Rotation.", Strategies for Successful Farming Meeting, Travelodge Hotel, Regina, SK, Canada, March 2, 2011, Invited Presentation and Report Abstract.
- Kutcher, H.R., Turkington, T.K., Gossen, B.D., Brandt, S.A., Dokken-Bouchard, F.L., and Strelkov, S.E. (2011). "Canola Disease and Fungicide Strategies Based on Crop Rotation.", Strategies for Successful Farming Meeting, Travelodge Hotel, Saskatoon, SK, Canada, March 1, 2011, Invited Presentation and Report Abstract.
- Lange, R.M., Platford, R.G., Kutcher, H.R., Hwang, S.F., Howard, R.J., Klein-Gebbinck, H.W., Strelkov, S.E., and Turkington, T.K. (2011). "Survey of blackleg and other canola diseases in Alberta, 2010.", *Canadian Plant Disease Survey*, 91, pp. 112-119.
- O'Donovan, J.T. and Turkington, T.K. (2011). "Effect of farming practices on malting grade barley and brewhouse performance.", Western Barley Growers Association & Master Brewers

Association of the Americas Joint Conference, Deerfoot Inn & Casino, Calgary, AB, Canada, February 16-18, 2011.

- O'Donovan, J.T., Blackshaw, R.E., Grant, C.A., Harker, K.N., Lafond, G.P., Johnson, E.N., Gan, Y.T., May, W.E., Turkington, T.K., and Lupwayi, N.Z. (2011). "Legume Crops to Improve Soil Fertility for Enhanced Canola Production.", 2011 ASA-CSSA-SSSA International Annual Meeting: Fundamental for life: soil, crop and environmental sciences, San Antonio, TX, USA, October 16-19, 2011. (Poster)
- Rauhala, N.E. and Turkington, T.K. (2011). "2010 Barley disease survey in Central Alberta.", *Canadian Plant Disease Survey*, 91, pp. 58-59.
- Rauhala, N.E. and Turkington, T.K. (2011). "2011 Barley disease survey in Central Alberta.", *Canadian Plant Disease Survey*, 92, pp. 63-64.
- Rioux, S., Pouleur, S., Randall, P., Turkington, T.K., Vanasse, A., and Dion, Y. (2011). "La vapeur d'acide acétique et la chaleur sèche comme traitements de semences chez les céréales.", La Journée: Grandes cultures biologiques, Centre communautaire de Saint-Rémi, Saint-Rémi, QC, Canada, December 6, 2011, pp. 17.
- Strelkov, S.E., Hwang, S.F., Howard, R.J., Rahman, H., Kutcher, H.R., Turkington, T.K., Gossen, B.D., Peng, G., McLaren, D.L., LeBoldus, J.M., Feng, J., Cao, T., and Manolii, V.P. (2011). "Clubroot Risk Mitigation Initiative: Pathology Pillar.", Clubroot Summit 2011, Saskatoon, SK, Canada, March 9, 2011, Invited presentation.
- Tucker, J.R., Turkington, T.K., and Legge, W.G. (2011). "Barley genotype interaction with three virulent scald (*Rhynchosporium secalis*) pathotypes from western Canada.", 4th International Workshop on Barley Leaf Blights (IWBLB), West Park Conference Centre, Dundee, Scotland, UK, June 27-29, 2011.
- Turkington, T.K. (2011). "Blackleg of canola strategy.", University of Alberta, Edmonton, AB, Canada, November 9, 2011. (Presentation)
- Turkington, T.K. (2011). "Canola disease research update.", Alberta Canola Industry Update 2011, Edmonton, AB, Canada, April 6, 2011.
- Turkington, T.K. (2011). "Disease forecasting.", Integrated Crop Management (PL SC 495), AFNS Program, University of Alberta, Edmonton, AB, Canada, January 25 and 27, 2011. (Presentation)
- Turkington, T.K. (2011). "Disease forecasting.", PL SC 495: Integrated Crop Management, AFNS, University of Alberta, Edmonton, AB, Canada, January 25 and 27, 2011. (Presentation)
- Turkington, T.K. (2011). "The disease management messaging for blackleg and clubroot of canola.", Crop Production Issues Team (CPIT), Edmonton, AB, Canada, November 10, 2011. (Presentation)
- Turkington, T.K. and O'Donovan, J.T. (2011). "Malt Barley Research Update: The impact of harvest management and seed source", Alberta Barley Commission, Rahr Malting, Inc. and Canadian Wheat Board meeting, Alberta Barley Commission Office, Calgary, AB, Canada, April 19, 2011. (Presentation)
- Turkington, T.K., Klein-Gebbinck, H.W., Olfert, O.O., Weiss, L.M., Kriticos, D.J., Kutcher, H.R., Falk, K.C., and Strelkov, S.E. (2011). "Projected distribution and severity of clubroot of canola in the Canadian prairies.", *Phytopathology*, 101(6), pp. S179. (Abstract)
- Turkington, T.K., Kutcher, H.R., Xi, K., Harker, K.N., O'Donovan, J.T., and Johnson, E.N. (2011). "The impact of fungicide and herbicide timing on barley leaf disease severity, weed management and crop productivity.", *Phytopathology*, 101(6), pp. S180. (Abstract)

**Chatterton, Syama (Lethbridge)**

## Technology Transfer Publications:

2012

- Balasubramanian, P.M., Chatterton, S., Hou, A., Conner, R.L., McLaren, D.L., Navabi, A., Pauls, K.P., and Bett, K.E. (2012). "Dry bean improvement on the prairies for high yield, disease resistance and seed quality.", Pulse Science Cluster Scientific Meeting 2012, Niagara Falls Marriott Gateway, Niagara Falls, ON, Canada, November 5-6, 2012.
- Balasubramanian, P.M., Conner, R.L., McLaren, D.L., Chatterton, S., and Hou, A. (2012). "Development of dry bean cultivars with resistance to white mold. Oral presentation.", 9th Canadian Pulse Research Workshop, Niagara Falls Marriott Gateway, Niagara Falls, ON, Canada, November 6-12, 2012, Oral presentation.
- Erickson, R.S. and Chatterton, S. (2012). "Survey of diseases of dry bean in Southern Alberta in 2011.", *Canadian Plant Disease Survey*, 92, pp. 118-119.

2011

- Howard, R.J., Burke, D.A., Chatterton, S., Erickson, R.S., Lisowski, S.L.I., and Pugh, C. (2011). "Dry bean disease survey in Alberta and Manitoba in 2011.", 2011 Alberta Pulse Growers Zone 1 Annual Meeting, Taber, AB, Canada, December 14, 2011. (Presentation)

**Gossen, Bruce (Saskatoon)**

## Technology Transfer Publications:

2014

- Cranmer, T., Gossen, B.D., Deora, A.D., and McDonald, M.R. (2014). "Vertical profile of *Plasmodiophora brassicae* resting spores in mineral and muck soils.", *Phytopathology*. (Abstract)
- Cranmer, T., Gossen, B.D., and McDonald, M.R. (2014). "Reaction of Tillage Radish (*Raphanus sativus* var. *longipinnatus*) to clubroot.", *Canadian Journal of Plant Pathology*, 36, pp. 126. (Abstract)
- Deora, A.D., Gossen, B.D., Amirsadeghi, S., and McDonald, M.R. (2014). "A TaqMan multiplexed qPCR assay for quantification of *Plasmodiophora brassicae* in soil.", *Phytopathology*. (Abstract)
- Deora, A.D., Gossen, B.D., Dalton, J., and McDonald, M.R. (2014). "Efficacy of saponins against on clubroot (*Plasmodiophora brassicae*) in canola and Shanghai pak choy.", *Phytopathology*. (Abstract)
- Fleury, D. and Gossen, B.D. (2014). "Fungicide resistance to FHB – a real concern?", published in Top Crop Manager (West), Bayer Special Edition (Jan. 2014, pp. 8 11). Article based in part on interview with Dr. Gossen. (Technology transfer)
- Gossen, B.D. (2014). "Fungicide resistance in western Canadian field crop pathogens: Risks and solutions.", *Canadian Journal of Plant Pathology*. (Abstract)
- Gossen, B.D., Hwang, S.F., and McDonald, M.R. (2014). "Need for a soil fumigant for management of clubroot (*Plasmodiophora brassicae*) on canola in Canada.", *Acta Horticulturae (ISHS)*. (Abstract)
- Gossen, B.D., Hwang, S.F., and McDonald, M.R. (2014). "Potential for metam sodium to eradicate *Plasmodiophora brassicae* in field soils.", *Phytopathology*. (Abstract)

- Gossen, B.D., Peng, G., Deora, A.D., and McDonald, M.R. (2014). "Clubroot resistance: Expression, durability, and metabolic cost.", Invited seminar, Department of Plant Agriculture, University of Guelph, Guelph, ON, Canada, March 5, 2014. (Presentation)
- Gossen, B.D., Sharma, K., Deora, A.D., and McDonald, M.R. (2014). "Longevity and ploidy of secondary zoospores of *Plasmodiophora brassicae*.", *Canadian Journal of Plant Pathology*, 36, pp. 127. (Abstract)
- Gossen, B.D., Strelkov, S.E., and McDonald, M.R. (2014). "Mechanisms of spread of clubroot of canola on the Canadian prairies.", *Canadian Journal of Plant Pathology*, 36, pp. 127-128. (Abstract)
- Lahlali, R.L., McGregor, L., Song, T., Gossen, B.D., Narisawa, K., and Peng, G. (2014). "*Heteroconium chaetospora* suppresses clubroot by inducing host resistance via ethylene, jasmonic acid and auxin pathway signaling.", *PLoS ONE*, 9(4: e94144), pp. 1-9. doi : 10.1371/journal.pone.0094144
- Song, T., Lahlali, R.L., Yu, F.Q., Gossen, B.D., and Peng, G. (2014). "Transcriptome analysis of the clubroot-resistant gene *Rpb1* using high-throughput RNA sequencing.", *Canadian Journal of Plant Pathology*. (Abstract)
- Tesfaendias, M.T., Trueman, C.L., Gossen, B.D., McKeown, A.W., and McDonald, M.R. (2014). "The influence of nitrogen and calcium fertilizers on septoria late blight and yield of celery.", *Phytopathology*. (Abstract)

## 2013

- Bassendowski, K.A. and Gossen, B.D. (2013). Efficacy of biocontrol seed treatments on root rot on canola and pulses in Saskatchewan, 2013. Final Report to Bayer CropScience for contract field studies on pulses and canola in 2013. 7 pp. (Report)
- Bassendowski, K.A. and Gossen, B.D. (2013). Efficacy of penthiopyrad and picoxystrobin fungicides on foliar diseases of lentil in Saskatchewan, 2013. Final Report to DuPont for contract field studies on lentil in 2013. 3 pp. (Report)
- Bassendowski, K.A. and Gossen, B.D. (2013). Efficacy of penthiopyrad and picoxystrobin fungicides on foliar diseases of lentil in Saskatchewan, 2013. Final Report to DuPont for contract field studies on lentil in 2013. 3 pp. (Report)
- Bassendowski, K.A. and Gossen, B.D. (2013). Impact of soil temperature on efficacy of fungicide seed treatments against root rot of canola and lentil under controlled conditions, 2013. Final Report to Bayer CropScience for contract laboratory studies on pulses and canola in 2013. 4 pp. (Report)
- Bassendowski, K.A., Lafond, G.P., May, W.E., Holzapfel, C.B., and Gossen, B.D. (2013). "Frequent cropping to field pea increases the severity of root and foliar diseases.", *Canadian Journal of Plant Pathology*, 35, pp. 518. (Abstract)
- Deora, A.D., Gossen, B.D., and McDonald, M.R. (2013). "Changes in canola root anatomy following infection by *Plasmodiophora brassicae*.", *Canadian Journal of Plant Pathology*, 35, pp. 106-107. (Abstract)
- Deora, A.D., Gossen, B.D., and McDonald, M.R. (2013). "Effect of host resistance on infection by *Plasmodiophora brassicae* in canola.", *Canadian Journal of Plant Pathology*, 34(2), pp. 329-330. (Abstract)
- Deora, A.D., Gossen, B.D., and McDonald, M.R. (2013). "Expression of resistance to *Plasmodiophora brassicae* in four resistant canola cultivars.", *Canadian Journal of Plant Pathology*, 35, pp. 106. (Abstract)

- Deora, A.D., Gossen, B.D., and McDonald, M.R. (2013). "Pathotype reaction in clubroot-resistant canola cultivars in Canada.", 10th International Congress of Plant Pathology, Beijing International Convention Center, Beijing, China, August 25-30, 2013.
- Feng, J., Chang, K.F., Hwang, S.F., Strelkov, S.E., Conner, R.L., Gossen, B.D., and McLaren, D.L. (2013). "Analysis of expressed sequence tags derived from a compatible pea-*Peronospora viciae* interaction.", *Canadian Journal of Plant Pathology*, 35, pp. 109. (Abstract)
- Gludovacz, T.V., Gossen, B.D., and McDonald, M.R. (2013). "Evidence for tolerance to *Plasmodiophora brassicae* in a cabbage cultivar.", *Canadian Journal of Plant Pathology*, 35(1), pp. 111. (Abstract)
- Gludovacz, T.V., Gossen, B.D., and McDonald, M.R. (2013). "Limitations of qPCR to quantify gDNA of *Plasmodiophora brassicae* in young seedlings.", International Clubroot Workshop, Edmonton, AB, Canada, June 2013.
- Gludovacz, T.V., Gossen, B.D., and McDonald, M.R. (2013). "Potential for degree day modeling of clubroot on canola.", International Clubroot Workshop, Edmonton, AB, Canada, June 2013.
- Gludovacz, T.V., Gossen, B.D., and McDonald, M.R. (2013). "Effect of fluctuating temperature on the development of *Plasmodiophora brassicae*.", *Canadian Journal of Plant Pathology*, 35(1), pp. 111. (Abstract)
- Gossen, B.D. (2013). "Clubroot: Managing Risk. Invited Presentation At The Crops Farm Update 2013.", Crops Farm Update 2013, Weyburn, SK, Canada, March 12, 2013, Invited presentation.
- Gossen, B.D. and McDonald, M.R. (2013). "Future plans for environment and clubroot risk.", Planning Meeting, Clubroot in GF2, Edmonton, Canada, December 6, 2013. (Presentation)
- Gossen, B.D., Deora, A.D., Peng, G., and McDonald, M.R. (2013). "Environmental parameters that affect clubroot risk on the Canadian prairies.", International Clubroot Workshop, Edmonton, AB, Canada, June 2013, Oral presentations, pp. 8.
- Gossen, B.D., Deora, A.D., Peng, G., and McDonald, M.R. (2013). "Update on environment and clubroot risk.", Planning Meeting, Clubroot in GF2, Edmonton, Canada, December 5, 2013. (Presentation)
- Gossen, B.D., Kasinathan, H., Strelkov, S.E., Manolii, V.P., Hwang, S.F., Peng, G., Cao, T., and McDonald, M.R. (2013). "Risk potential of clubroot on the Canadian prairies, based on soil type and pH.", *Canadian Journal of Plant Pathology*, 35(1), pp. 112. (Abstract)
- Gossen, B.D., McDonald, M.R., Sharma, K., Deora, A.D., and Peng, G. (2013). "Cost of resistance to *Plasmodiophora brassicae* when inoculum pressure is high.", International Clubroot Workshop, Edmonton, AB, Canada, June 2013, also International Congress of Plant Pathology, Beijing, China, August 2013. Also, *Can. J. Plant Pathol.* 36: xxx-xxx (in press), pp. 3.
- Gossen, B.D., Strelkov, S.E., and McDonald, M.R. (2013). "Rapid spread of clubroot (*Plasmodiophora brassicae*) of canola on the Canadian prairies.", 10th International Epidemiology Workshop, Beijing, China, August, 2013. (Workshop)
- Hwang, S.F., Ahmed, H.U., Zhou, Q-X., Strelkov, S.E., Gossen, B.D., Peng, G., and Turnbull, G.D. (2013). "Efficacy of Vapam to control clubroot (*Plasmodiophora brassicae*) in canola.", International Congress of Plant Pathology, Beijing, China, August 25 - 28, 2013.
- Hwang, S.F., Howard, R.J., Strelkov, S.E., Gossen, B.D., and Peng, G. (2013). "Management of clubroot on canola in western Canada.", International Clubroot Workshop, Edmonton, AB, Canada, June 2013, pp. 7. (Workshop)

- Hwang, S.F., Strelkov, S.E., Howard, R.J., Gossen, B.D., and Peng, G. (2013). "Management of clubroot on canola in western Canada.", Planning Meeting, Clubroot in GF2, Edmonton, Canada, December 5, 2013. (Presentation)
- Lahlali, R.L., Peng, G., McGregor, L., McDonald, M.R., Gossen, B.D., Hwang, S.F., Hynes, R.K., Boyetchko, S.M., and Geissler, H.J. (2013). "Induced host defense responses are involved in suppressing clubroot on canola with *Bacillus subtilis*, *Clonostachys rosea* and *Heteroconium chaetospora*.", Canadian Phytopathological Society (CPS) 83rd Annual Meeting and International PPV Meeting, Marriott Gateway On The Falls, Niagara Falls, ON, Canada, June 24-27, 2012, Published in: *Canadian Journal of Plant Pathology*, 35(1), pp.117 (Abstract).
- Li, W.J., Feng, J.-W., Chang, K.F., Conner, R.L., Hwang, S.F., Strelkov, S.E., Gossen, B.D., and McLaren, D.L. (2013). "Microsatellite DNA markers indicate quantitative trait loci controlling resistance to pea root rot caused by *Fusarium avenaceum*.", *Canadian Journal of Plant Pathology*, 35, pp. 107. (Abstract)
- McDonald, M.R., Sharma, K., Gossen, B.D., Feng, J., Deora, A.D., and Hwang, S.F. (2013). "Reaction of canola to inoculation with primary and secondary zoospores of *Plasmodiophora brassicae*.", International Clubroot Workshop, Edmonton, AB, Canada, June 2013, Also International Congress of Plant Pathology, Beijing, China. August 2013. Also in: *Can. J. Plant Pathol.* 36: xxx–xxx (in press).
- Peng, G. and Gossen, B.D. (2013). "Clubroot - A threat to canola production in western Canada.", AAFC – STB booth at the Crop Production Show, Saskatoon, SK, Canada, January 7-11, 2013. (Presentation)
- Peng, G., Gossen, B.D., Strelkov, S.E., Hwang, S.F., and McDonald, M.R. (2013). "Clubroot.", published by Agriculture and Agri-Food Canada (AAFC)/Agriculture et Agroalimentaire Canada (AAC), #4065141. (Factsheet)
- Peng, G., Hynes, R.K., Hwang, S.F., and Gossen, B.D. (2013). Synergy of biofungicides with cultivar resistance for control of clubroot on canola. Final report on ADF Project 20090359. 59 pp. (Report)
- Peng, G., Lahlali, R.L., Hwang, S.F., Pageau, D., Hynes, R.K., McDonald, M.R., Gossen, B.D., and Strelkov, S.E. (2013). "Integrated management of clubroot on canola with crop rotation, cultivar resistance, and fungicides/biofungicides.", International Clubroot Workshop, Edmonton, AB, Canada, June 2013, Oral presentation, pp. 7. (Workshop)
- Peng, G., Lahlali, R.L., Hynes, R.K., Boyetchko, S.M., Gossen, B.D., Hwang, S.F., Pageau, D., McDonald, M.R., and Strelkov, S.E. (2013). "*Plasmodiophora brassicae* Woronin, Clubroot of Crucifers (Plasmodiophoraceae).", in Mason, P.G. and Gillespie, D.R. (eds.) - Biological Control Programmes in Canada 2001-2012, CABI Publishing, Wallingford, UK, Chapter 65.
- Peng, G., Lahlali, R.L., Pageau, D., Hwang, S.F., Hynes, R.K., Anderson, K., McDonald, M.R., Gossen, B.D., Strelkov, S.E., Turkington, T.K., Yu, F.Q., Falk, K.C., Boyetchko, S.M., McGregor, L., Hupka, D., and Geissler, H.J. (2013). "Assessment of crop rotation, resistance and *Bacillus subtilis* for management of clubroot on canola.", *Canadian Journal of Plant Pathology*, 35, pp. 112. (Abstract)
- Peng, G., Pageau, D., Strelkov, S.E., Lahlali, R.L., Gossen, B.D., Anderson, K., Hwang, S.F., McDonald, M.R., Yu, F.Q., Falk, K.C., Turkington, T.K., Hynes, R.K., Boyetchko, S.M., and McGregor, L. (2013). "Management of clubroot disease on canola with crop rotation combined with host resistance or biofungicide seed dressing.", *Canadian Journal of Plant Pathology*, 35, pp. 519. (Abstract)



- Peng, G., Yu, F.Q., and Gossen, B.D. (2013). "Clubroot on canola -Disease development & Management.", Seminar at Zhejiang University, Hangzhou, China, April 1, 2013. (Presentation)
- Sharma, K., Gossen, B.D., Gludovacz, T.V., Deora, A.D., and McDonald, M.R. (2013). "Effect of *Plasmodiophora brassicae* (clubroot) on shoot and root weight in Brassica crops.", Canadian Phytopathological Society (CPS) 83rd Annual Meeting and International PPV Meeting, Marriott Gateway On The Falls, Niagara Falls, ON, Canada, June 24-27, 2012, Published in: Can. J. Plant Pathol. (2013), 35(1), pp. 124.

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- Ahmed, H.U., Hwang, S.F., Turnbull, G.D., Zhou, Q.-X., Strelkov, S.E., and Gossen, B.D. (2012). "Crop residues influence *Rhizoctonia solani* population dynamics and reduce canola seedling blight.", *Canadian Journal of Plant Pathology*, 34, pp. 463. (Abstract)
- Bassendowski, K.A. and Gossen, B.D. (2012). "Ascochyta blight on chickpea in Saskatchewan, 2011.", *Canadian Plant Disease Survey*, 92, pp. 133.
- Bassendowski, K.A. and Gossen, B.D. (2012). "Ascochyta blight on chickpea in Saskatchewan, 2012.", *Canadian Plant Disease Survey*, 93, pp. 160.
- Bassendowski, K.A., Soroka, J.J., and Gossen, B.D. (2012). "Foliar disease severity on alfalfa in Saskatchewan, 2012.", *Canadian Plant Disease Survey*, 93, pp. 142.
- Bowness, R.T., Chang, K.F., Gossen, B.D., Goswami, R.S., Hwang, S.F., Willenborg, C.J., and Strelkov, S.E. (2012). "Insensitivity to pyraclostrobin fungicide in *Mycosphaerella pinodes* on the Northern Great Plains.", 9th Canadian Pulse Research Workshop, Niagara Falls Marriott Gateway, Niagara Falls, ON, Canada, November 6-12, 2012.
- Bowness, R.T., Gossen, B.D., Conner, R.L., Wolf, T.M., Chang, K.F., Willenborg, C.J., and Strelkov, S.E. (2012). "Effect of nozzle type and orientation on fungicide efficacy against *mycosphaerella* blight in field pea.", *Canadian Journal of Plant Pathology*, 34, pp. 326-327. (Abstract)
- Chang, K.F., Conner, R.L., Hwang, S.F., Gossen, B.D., McLaren, D.L., and Turnbull, G.D. (2012). "Methods of inoculating pea plants with *Peronospora viciae* f. sp. *pisi*.", Canadian Phytopathological Society (CPS) 82nd Annual Meeting (with Plant Canada 2011), Halifax, NS, Canada, July 17-21, 2011, Published in: Can. J. Plant Pathol. (2011), 34(2), pp.328.
- Chang, K.F., Hwang, S.F., Ahmed, H.U., Fu, H., Gossen, B.D., and Turnbull, G.D. (2012). "Prevalence of pathogens associated with the *mycosphaerella* blight complex of field pea in Alberta.", 9th Canadian Pulse Research Workshop, Niagara Falls Marriott Gateway, Niagara Falls, ON, Canada, November 6-12, 2012, pp. 53.
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- Deora, A.D., Gossen, B.D., Riches, L., and McDonald, M.R. (2012). "Comparison of canola species and cultivars for susceptibility to *Plasmodiophora brassicae* pathotype 6, 2011.", *Muck Vegetable Cultivar Trial and Research Report*, 61, pp. 104-105.
- Deora, A.D., Gossen, B.D., and McDonald, C.L. (2012). "Changes in ROS and lignin associated with progression of *Plasmodiophora brassicae* (clubroot) from cortical to stele cells of canola (*Brassica napus* L.).", *Phytopathology*, 102(Suppl.No.4), pp. 29. (Abstract)
- Deora, A.D., Gossen, B.D., and McDonald, M.R. (2012). "Effect of host resistance on infection by *Plasmodiophora brassicae* in canola.", *Canadian Journal of Plant Pathology*, 34, pp. 329-330. (Abstract)

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- Feng, J., Li, W., Hwang, S.F., Gossen, B.D., and Strelkov, S.E. (2012). "Enhanced gene replacement frequency in KU70 disruption strain of *Stagonospora nodorum*.", *Canadian Journal of Plant Pathology*, 34, pp. 332. (Abstract)
- Gludovacz, T.V., Gossen, B.D., and McDonald, M.R. (2012). "Comparison of cabbage cultivars for resistance and susceptibility to clubroot, 2011.", *Muck Vegetable Cultivar Trial and Research Report*, 61, pp. 50-51.
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- Gossen, B.D. (2012). "Diagnostic Workshop: Clubroot Biology And Management.", 4th Joint Saskatchewan-Alberta Plant Pathology Conference: Plant Disease Diagnostic Workshop, Lloydminster, SK, Canada, November 5-7, 2012, Invited Presentation.
- Gossen, B.D. and McDonald, M.R. (2012). "Biology Pillar, CRMI.", Clubroot Summit 2012, Edmonton, AB, Canada, March 6, 2012, Invited Presentation.
- Gossen, B.D. and McDonald, M.R. (2012). "Clubroot Development and Management: Canola vs Vegetables.", CRMI Planning Meeting, Edmonton, AB, Canada, December 6, 2012, Invited Presentation.
- Gossen, B.D., Kasinathan, H., McDonald, M.R., and Peng, G. (2012). "Effect of soil type and compaction on severity of clubroot (*Plasmodiophora brassicae*).", *Phytopathology*, 102(Suppl. No.4), pp. 46. (Abstract)
- Gossen, B.D., Kasinathan, H., Peng, G., and McDonald, M.R. (2012). "Effect of soil type on assessment of biofungicide efficacy against clubroot under controlled conditions.", *Canadian Journal of Plant Pathology*, 34(3), pp. 464. (Abstract)
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- Gossen, B.D., Sharma, K., and McDonald, M.R. (2012). "Crop(S) and Differentials.", Clubroot Summit 2012, Edmonton, AB, Canada, March 6, 2012, Model Invited Presentation.
- Hwang, S.F., Cao, T., Xiao, Q., Ahmed, H.U., Manolii, V.P., Turnbull, G.D., Strelkov, S.E., Gossen, B.D., and Peng, G. (2012). "Efficacy of fungicide, seeding date, and seedling age on seedling emergence, clubroot severity, and yield of canola.", *Canadian Journal of Plant Pathology*, 34, pp. 335-336. (Abstract)
- Hwang, S.F., Strelkov, S.E., Gossen, B.D., Peng, G., and Howard, R.J. (2012). "Progress in canola clubroot management in Alberta, Canada.", CRMI Planning Meeting, Edmonton, AB, Canada, December 6, 2012. (Presentation)

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- Kasinathan, H., Gossen, B.D., Peng, G., and McDonald, M.R. (2012). "Efficacy of Serenade and Prestop against clubroot is affected by soil type.", *Canadian Journal of Plant Pathology*, 34, pp. 336-337. (Abstract)
- Kasinathan, H., Gossen, B.D., and McDonald, M.R. (2012). "Efficacy of biofungicides and fungicides for the reduction of clubroot incidence and severity in napa cabbage, 2011.", *Muck Vegetable Cultivar Trial and Research Report*, 61, pp. 54-55.
- Kasinathan, H., Gossen, B.D., and McDonald, M.R. (2012). "Evaluation of biofungicides and fungicides on incidence and clubroot symptom development in canola run 1, 2011.", *Muck Vegetable Cultivar Trial and Research Report*, 61, pp. 114-115.
- Kasinathan, H., Gossen, B.D., and McDonald, M.R. (2012). "Evaluation of fungicides for control of sclerotinia drop on inoculated lettuce, 2011.", *Muck Vegetable Cultivar Trial and Research Report*, 61, pp. 118-119.
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- McDonald, M.R. and Gossen, B.D. (2012). "Clubroot of Brassica Vegetables and Canola.", CRMI Planning Meeting, Edmonton, AB, Canada, December 6, 2012, Invited Presentation.
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**McLaren, Debbie (Brandon)**



## Technology Transfer Publications:

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- Balasubramanian, P.M., Conner, R.L., McLaren, D.L., Chatterton, S., and Hou, A. (2012). "Development of dry bean cultivars with resistance to white mold. Oral presentation.", 9th Canadian Pulse Research Workshop, Niagara Falls Marriott Gateway, Niagara Falls, ON, Canada, November 6-12, 2012, Oral presentation.
- Chang, K.F., Conner, R.L., Hwang, S.F., Gossen, B.D., McLaren, D.L., and Turnbull, G.D. (2012). "Methods of inoculating pea plants with *Peronospora viciae* f. sp. *pisi*.", Canadian Phytopathological Society (CPS) 82nd Annual Meeting (with Plant Canada 2011), Halifax, NS, Canada, July 17-21, 2011, Published in: *Can. J. Plant Pathol.* (2011), 34(2), pp.328.
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- Henriquez, M.A., McLaren, D.L., Conner, R.L., Penner, W.C., and Kerley, T.J. (2012). "Diseases of field bean in Manitoba in 2011.", *Canadian Plant Disease Survey*, 92, pp. 120-121.
- McLaren, D.L., Hausermann, D.J., Henriquez, M.A., Kerley, T.J., and Chang, K.F. (2012). "Field pea diseases in Manitoba in 2011.", *Canadian Plant Disease Survey*, 92, pp. 150-151.
- McLaren, D.L., Platford, R.G., Kubinec, A.M., Kutcher, H.R., Bisht, V., Derksen, H., Kristjanson, I., Phillips, K., Henderson, T.L., Hausermann, D.J., Jack, B., Picard, R., Jersak, S., Johnson, H., Stornowski, D., Neurenberg, E., Farooq, A., and McCracken, M. (2012). "Survey of canola diseases in Manitoba in 2011.", *Canadian Plant Disease Survey*, 92, pp. 130-132.
- Peng, G., Fernando, W.G.D., Kirkham, C.L., Lange, R., Kutcher, H.R., McLaren, D.L., Johnson, E.N., and Turkington, T.K. (2012). "Mitigating the risk of blackleg disease of canola using fungicide strategies.", Soils and Crops Workshop 2012, University of Saskatchewan, Saskatoon, SK, Canada, March 13-14, 2012, [CD], 7 pages.
- Peng, G., Fernando, W.G.D., Kutcher, H.R., Cross, D.J., Liban, S.H., Yu, F.Q., Kirkham, C., Dokken-Bouchard, F.L., McLaren, D.L., and Kubinec, A.M. (2012). "Recent occurrence of blackleg on canola and the profile of *Leptosphaeria maculans* races on the Canadian prairies.", 4th Joint Saskatchewan-Alberta Plant Pathology Conference: Mapping and cloning of clubroot resistance genes in Brassica species, Lloydminster, SK, Canada, November 5-7, 2012.
- Strelkov, S.E., Hwang, S.F., Howard, R.J., Rahman, H., Kutcher, H.R., Turkington, T.K., Gossen, B.D., Peng, G., McLaren, D.L., LeBoldus, J.M., Feng, J., Cao, T., and Manolii, V.P. (2012). "Clubroot Risk Mitigation Initiative: Pathology Pillar.", Clubroot Summit 2012, Edmonton, AB, Canada, March 6, 2012, Invited presentation.
- Turkington, T.K., Kutcher, H.R., Jurke, C., Buchwaldt, L., and McLaren, D.L. (2012). "Managing sclerotinia stem rot of canola.", Webinar, Canola Council of Canada and canola grower's associations (ACPC/SC/MCGA), Canada, June 28, 2012. (Presentation)

2011

- Balasubramanian, P.M., Hou, A., Conner, R.L., McLaren, D.L., Navabi, A., and Pauls, K.P. (2011). "Improvement of dry bean on the prairies for high yield, disease resistance and seed quality.",

Pulse Science Cluster Scientific Meeting 2011, Radisson Hotel, Saskatoon, SK, Canada, November 17-18, 2011.

- Chang, K.F., Conner, R.L., Hwang, S.F., Gossen, B.D., McLaren, D.L., Strelkov, S.E., and Turnbull, G.D. (2011). "Occurrence, impact and management of root rot on faba bean in Alberta.", *Canadian Journal of Plant Pathology*, 33, pp. 272. (Abstract)
- Chang, K.F., Hwang, S.F., Conner, R.L., Gossen, B.D., Strelkov, S.E., McLaren, D.L., and Turnbull, G.D. (2011). "Fungicide seed treatments to manage seedling blight of faba bean in Alberta, Canada, 2010.", American Phytopathological Society (APS) 2011 Joint Annual Meeting & International Association for the Plant Protection Sciences (IPPC), Honolulu, HI, USA, August 6-10, 2011, Published in: *Phytopathology* (2011), 101(6S), pp. S30.
- Conner, R.L., McLaren, D.L., Penner, W.C., and Kerley, T.J. (2011). "Diseases of dry bean in Manitoba in 2010.", *Canadian Plant Disease Survey*, 91, pp. 107-108.
- Feng, J., Chang, K.F., Hwang, S.F., Gossen, B.D., Conner, R.L., and McLaren, D.L. (2011). "Production of non-specific esterase by conidia of *Peronospora viciae* f.sp. *psii*.", *Canadian Journal of Plant Pathology*, 33, pp. 259. (Abstract)
- Gao, X., Mohr, R.M., McLaren, D.L., and Grant, C.A. (2011). "Variation in Cadmium, Iron and Zinc Concentrations in Grain of 13 Bread Wheat Cultivars Grown on Canadian Prairies.", 11th International Conference of Biogeochemistry of Trace Elements, Florence, Italy, July 3-7, 2011. (Abstract)
- Kutcher, H.R., Turkington, T.K., Brandt, S.A., Gossen, B.D., McLaren, D.L., Dokken-Bouchard, F.L., and Strelkov, S.E. (2011). "Canola Disease Management.", Annual Indian Head Crop Management Field Day 2011, Indian Head, SK, Canada, July 19, 2011.
- McLaren, D.L. (2011). "Diseases of canola: what to look for in 2011.", Webinar Presentation, July 22, 2011. (Presentation)
- McLaren, D.L., Hausermann, D.J., Henderson, T.L., and Kerley, T.J. (2011). "Field pea diseases in Manitoba in 2010.", *Canadian Plant Disease Survey*, 91, pp. 140-141.
- McLaren, D.L., Henriquez, M.A., and Conner, R.L. (2011). "Field pea and dry bean research at the Brandon Research Centre.", *Pulse Beat*, 64(Fall/Winter), pp. 32.
- McLaren, D.L., Kubinec, A.M., Derksen, H., and Bisht, V. (2011). "What's lurking in your canola field?", Manitoba Agronomists 2011 Conference, Winnipeg, MB, Canada, December 13-14, 2011.
- McLaren, D.L., Platford, R.G., Kutcher, H.R., Bisht, V., Kubinec, A.M., Kristjanson, I., Hammond, D., Henderson, T.L., Hausermann, D.J., Kaskiw, L., Williamson, K., Jersak, S., Johnson, H., Souque, J., Heshka, J., and Farooq, A. (2011). "Survey of canola diseases in Manitoba in 2010.", *Canadian Plant Disease Survey*, 91, pp. 124-126.
- Strelkov, S.E., Hwang, S.F., Howard, R.J., Rahman, H., Kutcher, H.R., Turkington, T.K., Gossen, B.D., Peng, G., McLaren, D.L., LeBoldus, J.M., Feng, J., Cao, T., and Manolii, V.P. (2011). "Clubroot Risk Mitigation Initiative: Pathology Pillar.", Clubroot Summit 2011, Saskatoon, SK, Canada, March 9, 2011, Invited presentation.

### Conner, Robert (Morden – pulses)

Technology Transfer Publications:

2013

- Feng, J., Chang, K.F., Hwang, S.F., Strelkov, S.E., Conner, R.L., Gossen, B.D., and McLaren, D.L. (2013). "Analysis of expressed sequence tags derived from a compatible pea-*Peronospora viciae* interaction.", *Canadian Journal of Plant Pathology*, 35, pp. 109. (Abstract)
- Hou, A., Conner, R.L., Balasubramanian, P.M., and Boersma, J.G. (2013). "Black bean (*Phaseolus vulgaris* L.) germplasm rich in anthracnose resistance.", Bean Improvement Cooperatives, Portland, OR, USA, October 28-30, 2013. (Poster)
- Hou, A., Marsolais, F., Pajak, A., and Conner, R.L. (2013). "Genetic improvement of protein quality in edible beans with adaptation to Manitoba. Poster presentation.", Bean Improvement Cooperatives, Portland, OR, USA, October 28-30, 2013. (Poster)
- Li, W.J., Feng, J.-W., Chang, K.F., Conner, R.L., Hwang, S.F., Strelkov, S.E., Gossen, B.D., and McLaren, D.L. (2013). "Microsatellite DNA markers indicate quantitative trait loci controlling resistance to pea root rot caused by *Fusarium avenaceum*.", *Canadian Journal of Plant Pathology*, 35, pp. 107. (Abstract)
- McLaren, D.L., Henriquez, M.A., Conner, R.L., Balasubramanian, P.M., and Chang, K.F. (2013). "Root rot of pulses in Manitoba.", Manitoba Special Crops 7th Symposium, Victoria Inn and Convention Centre, Winnipeg, MB, Canada, February 6-7, 2013.
- McLaren, D.L., Henriquez, M.A., Conner, R.L., and Chang, K.F. (2013). "2012 Field pea, dry bean and soybean research at the Brandon Research Centre.", *Pulse Beat*, 68(Spring), pp. 35-36.

## 2012

- Balasubramanian, P.M., Chatterton, S., Hou, A., Conner, R.L., McLaren, D.L., Navabi, A., Pauls, K.P., and Bett, K.E. (2012). "Dry bean improvement on the prairies for high yield, disease resistance and seed quality.", Pulse Science Cluster Scientific Meeting 2012, Niagara Falls Marriott Gateway, Niagara Falls, ON, Canada, November 5-6, 2012.
- Balasubramanian, P.M., Conner, R.L., McLaren, D.L., Chatterton, S., and Hou, A. (2012). "Development of dry bean cultivars with resistance to white mold. Oral presentation.", 9th Canadian Pulse Research Workshop, Niagara Falls Marriott Gateway, Niagara Falls, ON, Canada, November 6-12, 2012, Oral presentation.
- Boersma, J.G., Conner, R.L., Balasubramanian, P.M., Navabi, A., Yu, K., and Hou, A. (2012). "Pyramiding resistance to common bacterial blight, anthracnose and bean common mosaic virus in dry bean.", 9th Canadian Pulse Research Workshop, Niagara Falls Marriott Gateway, Niagara Falls, ON, Canada, November 6-12, 2012, Poster.
- Boersma, J.G., Conner, R.L., Balasubramanian, P.M., Yu, K., and Hou, A. (2012). "Molecular marker-assisted dissection of anthracnose resistance in the common dry bean cultivar, 'morden003'.", 9th Canadian Pulse Research Workshop, Niagara Falls Marriott Gateway, Niagara Falls, ON, Canada, November 6-12, 2012, Poster.
- Bowness, R.T., Gossen, B.D., Conner, R.L., Wolf, T.M., Chang, K.F., Willenborg, C.J., and Strelkov, S.E. (2012). "Effect of nozzle type and orientation on fungicide efficacy against mycosphaerella blight in field pea.", *Canadian Journal of Plant Pathology*, 34, pp. 326-327. (Abstract)
- Chang, K.F., Conner, R.L., Hwang, S.F., Gossen, B.D., McLaren, D.L., and Turnbull, G.D. (2012). "Methods of inoculating pea plants with *Peronospora viciae* f. sp. *pisi*.", Canadian Phytopathological Society (CPS) 82nd Annual Meeting (with Plant Canada 2011), Halifax, NS, Canada, July 17-21, 2011, Published in: *Can. J. Plant Pathol.* (2011), 34(2), pp.328.
- Conner, R.L., Chang, K.F., Hwang, S.F., McLaren, D.L., and Gossen, B.D. (2012). "Impact and control of fusarium root rot in faba bean.", *Pulse Beat*, 65, pp. 26-27.

- Conner, R.L., Chang, K.F., Hwang, S.F., Warkentin, T.D., and McRae, K.B. (2012). "Effectiveness of tolerance to *Aphanomyces* root rot for reducing yield losses in field pea.", 9th Canadian Pulse Research Workshop, Niagara Falls Marriott Gateway, Niagara Falls, ON, Canada, November 6-12, 2012, P67.
- Conner, R.L., Chang, K.F., McLaren, D.L., and Hwang, S.F. (2012). "Partial resistance to *Mycosphaerella* blight in field pea.", *Pulse Beat*, 65, pp. 32.
- Feng, J., Chang, K.F., Hwang, S.F., Strelkov, S.E., Conner, R.L., Gossen, B.D., and McLaren, D.L. (2012). "Identification of genes from the pea-downy mildew pathosystem.", 9th Canadian Pulse Research Workshop, Niagara Falls Marriott Gateway, Niagara Falls, ON, Canada, November 6-12, 2012, pp. 36.
- Henriquez, M.A., McLaren, D.L., Conner, R.L., Balasubramanian, P.M., and Chang, K.F. (2012). "*Fusarium* species from dry bean and field pea in Manitoba.", 9th Canadian Pulse Research Workshop, Niagara Falls Marriott Gateway, Niagara Falls, ON, Canada, November 6-12, 2012, pp. 6.
- Henriquez, M.A., McLaren, D.L., Conner, R.L., Balasubramanian, P.M., and Chang, K.F. (2012). "Root rot pathogens in dry bean and field pea fields in Manitoba.", Canadian Phytopathological Society (CPS) Manitoba Regional 2012 Meeting, Brandon, MB, Canada, November 29, 2012, Published in: *Can. J. Plant Pathol.* (2013), 35(2), pp. 270.
- Henriquez, M.A., McLaren, D.L., Conner, R.L., Penner, W.C., and Kerley, T.J. (2012). "Diseases of field bean in Manitoba in 2011.", *Canadian Plant Disease Survey*, 92, pp. 120-121.
- Hou, A., Marsolais, F., Pajak, A., and Conner, R.L. (2012). "Genetic improvement of protein quality in edible beans with adaptation to Manitoba.", 9th Canadian Pulse Research Workshop, Niagara Falls Marriott Gateway, Niagara Falls, ON, Canada, November 6-12, 2012, Poster.

## 2011

- Balasubramanian, P.M., Hou, A., Conner, R.L., McLaren, D.L., Navabi, A., and Pauls, K.P. (2011). "Improvement of dry bean on the prairies for high yield, disease resistance and seed quality.", Pulse Science Cluster Scientific Meeting 2011, Radisson Hotel, Saskatoon, SK, Canada, November 17-18, 2011.
- Boersma, J.G., Conner, R.L., Balasubramanian, P.M., Gillard, C.L., and Hou, A. (2011). "Evaluation of dry bean lines for resistance to common bacterial blight.", Plant Canada 2011, Saint Mary's University, Halifax, NS, Canada, July 17-21, 2011.
- Bowness, R.T., Gossen, B.D., Conner, R.L., Wolf, T.M., Chang, K.F., Willenborg, C.J., and Strelkov, S.E. (2011). "Effect of nozzle type and orientation on fungicide efficacy against *mycosphaerella* blight in field pea.", Canadian Phytopathological Society (CPS) 82nd Annual Meeting (with Plant Canada 2011), Halifax, NS, Canada, July 17-21, 2011, Published in: *Can. J. Plant Pathol.* (2012), 34 (2), pp. 326-327.
- Chang, K.F., Conner, R.L., Hwang, S.F., Gossen, B.D., McLaren, D.L., Strelkov, S.E., and Turnbull, G.D. (2011). "Occurrence, impact and management of root rot on faba bean in Alberta.", *Canadian Journal of Plant Pathology*, 33, pp. 272. (Abstract)
- Chang, K.F., Hwang, S.F., Conner, R.L., Gossen, B.D., Strelkov, S.E., McLaren, D.L., and Turnbull, G.D. (2011). "Fungicide seed treatments to manage seedling blight of faba bean in Alberta, Canada, 2010.", American Phytopathological Society (APS) 2011 Joint Annual Meeting & International Association for the Plant Protection Sciences (IPPC), Honolulu, HI, USA, August 6-10, 2011, Published in: *Phytopathology* (2011), 101(6S), pp. S30.

- Conner, R.L., McLaren, D.L., Penner, W.C., and Kerley, T.J. (2011). "Diseases of dry bean in Manitoba in 2010.", *Canadian Plant Disease Survey*, 91, pp. 107-108.
- Feng, J., Chang, K.F., Hwang, S.F., Gossen, B.D., Conner, R.L., and McLaren, D.L. (2011). "Production of non-specific esterase by conidia of *Peronospora viciae* f.sp. *psi*.", *Canadian Journal of Plant Pathology*, 33, pp. 259. (Abstract)
- Hou, A., Conner, R.L., and Balasubramanian, P.M. (2011). "Dry bean breeding research.", *Pulse Beat*, 2011(64), pp. 38.
- McLaren, D.L., Henriquez, M.A., and Conner, R.L. (2011). "Field pea and dry bean research at the Brandon Research Centre.", *Pulse Beat*, 64(Fall/Winter), pp. 32.

### Rashid, Khalid (Morden)

#### Technology Transfer Publications:

##### 2013

- Rashid, K.Y. and Desjardins, M. (2013). "Diseases of sunflower in Manitoba in 2012.", *Canadian Plant Disease Survey*, 93, pp. 174-176.
- Rashid, K.Y., Desjardins, M., and Duguid, S.D. (2013). "Diseases of flax in Manitoba and Saskatchewan in 2012.", *Canadian Plant Disease Survey*, 93, pp. 161-162.

##### 2012

- Rashid, K.Y. (2012). "Promising resistance to pasmo in flax genotypes and update on fungicides to reduce yield and quality loss.", 64th Flax Institute of the United States, Doublewood Inn, Fargo, ND, USA, March 29-30, 2012.
- Rashid, K.Y. (2012). "Updates on fungicide treatment to reduce powdery mildew and yield losses in flax.", 64th Flax Institute of the United States, Doublewood Inn, Fargo, ND, USA, March 29-30, 2012.
- Rashid, K.Y. and Desjardins, M.L. (2012). "Diseases of sunflower in Manitoba in 2011.", *Canadian Plant Disease Survey*, 92, pp. 152-153.
- Rashid, K.Y., Desjardins, M.L., Duguid, S.D., and Northover, P.R. (2012). "Diseases of flax in Manitoba and Saskatchewan in 2011.", *Canadian Plant Disease Survey*, 92, pp. 134-135.

##### 2011

- Fetch Jr., T.G., Zegeye, T., Singh, D., Wanyera, R., Penner, M., and Rashid, K.Y. (2011). "Virulence of Ug99 (race TTKSK) and race TRTTF on Canadian wheat cultivars.", *Canadian Journal of Plant Science*, 92(3), pp. 602. (Abstract)
- Rashid, K.Y. (2011). "Interaction between flax genotypes and *Septoria linicola* isolates from western Canada.", Canadian Phytopathological Society Saskatchewan Regional (CPS-SK) 2010 Meeting, Saskatoon, SK, Canada, December 9, 2010, published in *Canadian Journal of Plant Pathology / Revue canadienne de phytopathologie*, 33(2), pp. 290. (Presentation)
- Rashid, K.Y. (2011). "Report on the flax and sunflower disease situation in 2010.", Canadian Phytopathological Society (CPS) Manitoba Regional 2011 Meeting, Winnipeg, MB, Canada, December 8, 2011.
- Rashid, K.Y. (2011). "Seminar on Major diseases of flax.", 2nd year Agriculture Diploma Students, University of Manitoba, Winnipeg, MB, Canada, November 2, 2011. (Presentation)

- Rashid, K.Y. (2011). "Seminar on epidemiology and management of flax diseases.", 3rd year students, Faculty of Agriculture, University of Manitoba, Winnipeg, MB, Canada, November 2, 2011. (Presentation)
- Rashid, K.Y. (2011). Diseases of oilseed crops. Chapter 4. In: Guidelines of plant disease control, Western Committee of Plant Disease, Western Forum on Pest Management., Western Committee on Plant Diseases, Canada.
- Rashid, K.Y. and Desjardins, M.L. (2011). "Diseases of sunflower in Manitoba in 2010.", *Canadian Plant Disease Survey*, 91, pp. 142-144.
- Rashid, K.Y., Desjardins, M.L., and Duguid, S.D. (2011). "Diseases of flax in Manitoba and Saskatchewan in 2010.", *Canadian Plant Disease Survey*, 91, pp. 128-129.
- Vera, C.L. and Rashid, K.Y. (2011). "Lodging in association with disease in flax breeding plots.", Soils and Crops Workshop 2011, Prairieland Park, Saskatoon, SK, Canada, March 15-16, 2011. (Poster)
- Vera, C.L., Irvine, R.B., Duguid, S.D., and Rashid, K.Y. (2011). "Effect of fungicide and N application on lodging and disease in flax.", Soils and Crops Workshop 2011, Prairieland Park, Saskatoon, SK, Canada, March 15-16, 2011. (Poster)

### **Fernandez, Myriam (Swift Current)**

#### Technology Transfer Publications:

#### 2012

- Dokken-Bouchard, F.L., Miller, S.G., Northover, P.R., Weitzel, C.N., Shiplack, J.J., and Fernandez, M.R. (2012). "Fusarium Head Blight in Barley in Saskatchewan in 2011.", *Canadian Plant Disease Survey*, 92, pp. 65-66.
- Dokken-Bouchard, F.L., Miller, S.G., Northover, P.R., Weitzel, C.N., Shiplack, J.J., and Fernandez, M.R. (2012). "Fusarium head blight in common and durum wheat in Saskatchewan in 2011.", *Canadian Plant Disease Survey*, 92, pp. 102-104.
- Fernandez, M.R., Dokken-Bouchard, F.L., Miller, S.G., and Northover, P.R. (2012). "Leaf rust and stripe rust of common wheat and durum wheat in Saskatchewan in 2011.", *Canadian Plant Disease Survey*, 92, pp. 96-97.
- Fernandez, M.R., Lim, S.R., Dokken-Bouchard, F.L., Miller, S.G., and Northover, P.R. (2012). "Leaf spotting diseases of common and Durum Wheat in Saskatchewan in 2011.", *Canadian Plant Disease Survey*, 92, pp. 98-101.

#### 2011

- Fernandez, M.R. (2011). "Associations of glyphosate with Fusarium diseases of cereal and pulse crops.", National Research Council Canada - Plant Biotechnology Institute (NRC-PBI), Saskatoon, SK,, October 5, 2011. (Presentation)
- Fernandez, M.R. (2011). Reaction to leaf spots of registrations (C-level) and pre-registration (B-level) entries in 2011 at different locations in Saskatchewan., Agriculture and Agri-Food Canada (AAFC)/Agriculture et Agroalimentaire Canada (AAC). (Report)
- Fernandez, M.R., Dokken-Bouchard, F.L., Northover, P.R., and McCartney, C. (2011). "Leaf spotting and rust diseases of common and durum wheat in Saskatchewan in 2010.", *Canadian Plant Disease Survey*, 91, pp. 92-94.

- Fernandez, M.R., May, W.E., Chalmers, S., Savard, M.E., and Singh, A.K. (2011). "Effectiveness of fungicide applications at various growth stages on head/kernel diseases, and productivity of durum wheat in southern Saskatchewan.", 7th Canadian Workshop on Fusarium Head Blight (CWFHB) / Colloque canadien sur la fusariose, Delta Winnipeg Hotel, Winnipeg, MB, Canada, November 27-30, 2011, pp. 87.
- Fernandez, M.R., Zentner, R.P., Basnyat, P., Gehl, D.T., Selles, F., Huber, D., and Kremer, R.J. (2011). "Glyphosate associations with Fusarium diseases of cereal and pulse crops.", *Canadian Journal of Plant Pathology*, 33(2), pp. 240. (Abstract)
- Fernandez, M.R., Zentner, R.P., and Gehl, D.T. (2011). "Influence of Pesticides on Pathogen Populations and Biological Control Agents.", 2011 Soil and Crops Workshop, University of Saskatchewan, Extension Division, Saskatoon, SK, Canada, March 7-8, 2011. (Presentation)
- Fernandez, M.R., Zentner, R.P., and Gehl, D.T. (2011). "Influence of environmental pesticides on pathogen populations and biological control agents.", 2011 Soil and Crops Workshop, University of Saskatchewan, Extension Division, Saskatoon, SK, Canada, March 7-8, 2011. (Presentation)
- Fox, S.L., Hucl, P.J., Spaner, D.M., and Fernandez, M.R. (2011). "Breeding wheat for organic production systems.", Organic Field Day 2011, AAFC Semiarid Prairie Agricultural Research Centre (SPARC), Swift Current, SK, Canada, July 10-14, 2011.
- Miller, S.G., Dokken-Bouchard, F.L., Northover, P.R., Weitzel, C.N., Shiplack, J.J., and Fernandez, M.R. (2011). "Fusarium Head Blight in common and durum wheat in Saskatchewan in 2010.", *Canadian Plant Disease Survey*, 91, pp. 90-91.
- Miller, S.G., Dokken-Bouchard, F.L., Northover, P.R., Weitzel, C.N., Shiplack, J.J., and Fernandez, M.R. (2011). "Fusarium head blight in barley in Saskatchewan in 2010.", *Canadian Plant Disease Survey*, 91, pp. 60-61.

## ENTOMOLOGY

### Otani, Jennifer (Beaverlodge)

Technology Transfer Publications:

2014

- Otani, J.K., Floate, K.D., Herve, V.A.D., Hummel, J.D., Broatch, J.S., Reid, P., Erlandson, M.A., Evenden, M.L., Meers, S., Barkley, S., Laird, R.A., Sharanowski, B., Hartley, S., and Gavloski, J.E. (2014). "Cutworm update.", Agronomy Update Conference 2006, Red Deer, AB, Canada, January 10-11, 2006, pp. 5.

2013

- Olfert, O.O., Elliott, R.H., Meers, S., Hartley, S., and Otani, J.K. (2013). "Forecast of wheat midge in Saskatchewan and Alberta for 2013. 2012 Crop Variety Highlights and Insect Pest Forecasts.", *Saskatoon Research Centre Technical Bulletin*, 2013(1), pp. 12-13.
- Olfert, O.O., Giffen, D.W., Hartley, S., Vadnais, M., Gavloski, J.E., Meers, S., and Otani, J.K. (2013). "The 2013 Prairie Grasshopper Forecast. 2012 Crop Variety Highlights and Insect Pest Forecasts.", *Saskatoon Research Centre Technical Bulletin*, 2013(1), pp. 10-11.
- Olfert, O.O., Meers, S., Gavloski, J.E., Hartley, S., and Otani, J.K. (2013). "Bertha armyworm in western Canada. 2012 Crop Variety Highlights and Insect Pest Forecasts.", *Saskatoon Research Centre Technical Bulletin*, 2013(1), pp. 8-9.



- Olfert, O.O., Meers, S., Hartley, S., and Otani, J.K. (2013). "Cabbage seedpod weevil in Alberta and Saskatchewan for 2012. 2012 Crop Variety Highlights and Insect Pest Forecasts.", *Saskatoon Research Centre Technical Bulletin*, 2013(1), pp. 14-15.
- Otani, J.K. (2013). "IPM Program and Activities.", BC climate change action initiative workshops (#3), Taylor, BC, Canada, February 6, 2013. (Presentation)
- Otani, J.K. (2013). "IPM Program and pest update for 2013.", BC Grain Producers Association AGM, Dawson Creek, BC, Canada, February 12, 2013. (Presentation)
- Otani, J.K. (2013). "Pests and predators – avoiding friendly fire.", Peace Pest Update, Falher, AB, Canada, March 28, 2013. (Presentation)
- Otani, J.K. (2013). "Wheat midge in northern Alberta – a research update.", Prairie Pest Monitoring Network Meeting, Saskatoon, SK, Canada, March 19, 2013.
- Otani, J.K., O'Donovan, J.T., Yoder, C., Azooz, R.H., and Burton, S.L. (2013). Competitive contract production of forage seed in western Canada (DIAP# PRO-05147/AGR-05846). AAFC's Developing Innovative Agri-Products Initiative. Final Report 2010-2013, April 19, 2013. (Report)
- Otani, J.K., Olfert, O.O., Weiss, R.M., and Giffen, D.W. (2013). "Canola surveying in the Peace River region.", Joint Annual Meeting of the Entomological Societies of Ontario and Canada, Guelph, Ontario, Canada, October 20-23, 2013, pp. 63.

## 2012

- Floate, K.D., Broatch, J.S., Erlandson, M.A., Evenden, M.L., Gavloski, J.E., Hartley, S., Hummel, J.D., Laird, R.A., Meers, S., Olivier, C.Y., Otani, J.K., and Sharanowski, B. (2012). "New projects for control of cutworms (Lepidoptera: Noctuidae) affecting canola crops on the prairies.", Entomological Society of Canada 62nd and Entomological Society of Alberta 60th joint Annual Meeting, Coast Edmonton Plaza Hotel, Edmonton, AB, Canada, November 4-7, 2012, #61. (Abstract)
- Mori, B.A., Evenden, M.L., Otani, J.K., and Yoder, C. (2012). "A research update on the Red clover casebearer.", *The Back Forty – SARDA & AESA Newsletter*, 2012(February), pp. 1 & 4.
- Mori, B.A., Evenden, M.L., Otani, J.K., and Yoder, C. (2012). "Red clover casebearer update.", *The Back Forty – SARDA & AESA Newsletter*(February 2012), pp. 1-4. (Newsletter)
- Otani, J.K. (2012). "An 2012 insect update for the Peace River region.", Alberta Canola Producers Commission's Regional Meetings, Falher, AB, Canada, November 28, 2012. (Presentation)
- Otani, J.K. (2012). "An 2012 insect update for the Peace River region.", Alberta Canola Producers Commission's Regional Meetings, LaCrete, AB, Canada, November 21, 2012. (Presentation)
- Otani, J.K. (2012). "An 2012 insect update for the Peace River region.", Alberta Canola Producers Commission's Regional Meetings, Sexsmith, AB, Canada, November 29, 2012. (Presentation)
- Otani, J.K. (2012). "Pest and natural enemies – up close and personal.", CanoLAB 3D Workshop, St. Albert, AB, Canada, March 5, 2012.
- Otani, J.K. (2012). "Pest update.", Peace Region Forage Seed Association Annual Field Tour, Fort St. John, BC, Canada, July 4, 2012.
- Otani, J.K. and Yoder, C. (2012). "Curious cutworm incidence in the Peace.", 2012 Peace Region Seed Association Production and Marketing Seminar, Fairview AB, Canada, March 15, 2012.
- Otani, J.K. and Yoder, C. (2012). "Cutworm monitoring in the Peace River region.", Forage Agronomy Update 2012, Nisku, AB, Canada, February 8-9, 2012, pp. 10-11.
- Otani, J.K., Meers, S., Hartley, S., Gavloski, J.E., Dossdall, L.M., Cárcamo, H.A., and Olfert, O.O. (2012). "Coordinated monitoring, forecasting and risk warning systems for field crop insects.",

24th International Congress of Entomology (ICE 2012) and International Organization for Biological Control (IOBC) Global Symposium, Daegu, South Korea, August 19-25, 2012.

- Otani, J.K., Meers, S., Olfert, O.O., and Giffen, D.W. (2012). "What's bugging you – an insect pest update for Alberta.", *FarmTech 2012*, Edmonton, AB, Canada, January 24, 2012, pp. 109-111.
- Otani, J.K., Yoder, C., and Barbarich, J. (2012). "Cutworms in the Peace River region.", *The Back Forty – SARDA & AESA Newsletter*, 2012(February), pp. 11.
- Soroka, J.J., Elliott, R.H., Otani, J.K., and Gavloski, J.E. (2012). "Changing flea beetle species – what you see isn't what you had but does it matter?", *Saskatchewan Ministry of Agriculture Agronomy Update 2012*, Saskatoon, SK, Canada, December 14, 2012. (Presentation)
- Soroka, J.J., Otani, J.K., Gavloski, J.E., and Elliott, R.H. (2012). "The biology and control of flea beetles in Western Canadian canola crops: Is a species shift in progress?", *Entomological Society of Canada 62nd and Entomological Society of Alberta 60th joint Annual Meeting*, Coast Edmonton Plaza Hotel, Edmonton, AB, Canada, November 4-7, 2012, #180. (Abstract)
- Yoder, C., Azooz, R.H., and Otani, J.K. (2012). "Forage Seed Program Update.", *Peace Region Forage Seed Association Industry Field Tour*, Beaverlodge, AB, Canada, July 10, 2012.

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- Evenden, M.L., Mori, B.A., Otani, J.K., and Yoder, C. (2011). "The development of pheromone-based management for the red clover casebearer in Alberta.", *Peace Region Forage Seed Association AGM*, Fort St. John, BC, Canada, March 22, 2011.
- Olfert, O.O., Giffen, D.W., Hartley, S., Vadnais, M., Gavloski, J.E., Meers, S., and Otani, J.K. (2011). "The 2011 Saskatchewan and Manitoba grasshopper forecast. 2010 Crop Variety Highlights and Insect Pest Forecasts.", *Saskatoon Research Centre Technical Bulletin*, 2011(1), pp. 10-11.
- Olfert, O.O., Meers, S., Gavloski, J.E., Hartley, S., Otani, J.K., and Clark, K. (2011). "Bertha armyworm in western Canada. 2010 Crop Variety Highlights and Insect Pest Forecasts.", *Saskatoon Research Centre Technical Bulletin*, 2011(1), pp. 8-9.
- Olfert, O.O., Meers, S., Hartley, S., and Otani, J.K. (2011). "Cabbage seedpod weevil in Alberta and Saskatchewan for 2010. 2010 Crop Variety Highlights and Insect Pest Forecasts.", *Saskatoon Research Centre Technical Bulletin*, 2011(1), pp. 14-15.
- Otani, J.K. (2011). "Barley and Bugs.", *2011 Alberta Pulse Growers Zone 4 & Barley Commission Region 6 Joint Annual Meeting*, Falher, AB, Canada, November 29, 2011.
- Otani, J.K. (2011). "Insect update.", *2011 Direct Seeding Workshop*, North Peace Applied Research Association, Fairview, AB, Canada, January 12, 2011. (Presentation)
- Otani, J.K. (2011). "Insects of 2010 and 2011.", *2011 Peace Forage Agronomy Update*, Rycroft, AB, Canada, February 23, 2011. (Presentation)
- Otani, J.K. and Yoder, C. (2011). "*Coleophora deauratella* in red clover.", *2011 Alberta Pest Surveillance Network Meeting*, Grande Prairie, AB, March 31, 2011. (Presentation)
- Otani, J.K. and Yoder, C. (2011). "Pest status of the red clover casebearer (Lepidoptera: Colephoridae: *Coleophora deauratella*) in clover seed production.", *Entomological Society of Canada 61st and Acadian Entomological Society 71st joint Annual Meeting*, Westin Nova Scotian Hotel, Halifax, NS, Canada, November 6-9, 2011, pp. 76.
- Soroka, J.J., Otani, J.K., and Cárcamo, H.A. (2011). "Survey to detect potential flea beetle (Coleoptera: Chrysomelidae) species composition shift in Canadian oilseed rape fields.", *13th*

International Rapeseed Congress, Prague, Czech Republic, June 5-9, 2011, Abstract P 290, pp. 465.

### **Cárcamo, Héctor (Lethbridge)**

Technology Transfer Publications:

2013

- Olfert, O.O., Cárcamo, H.A., and Meers, S. (2013). "Wheat stem sawfly in Alberta in 2012. 2012 Crop Variety Highlights and Insect Pest Forecasts.", *Saskatoon Research Centre Technical Bulletin*, 2013(1), pp. 16-17.
- Olfert, O.O., Meers, S., Cárcamo, H.A., and Hartley, S. (2013). "Pea leaf weevil in Alberta and Saskatchewan in 2012. 2012 Crop Variety Highlights and Insect Pest Forecasts.", *Saskatoon Research Centre Technical Bulletin*, 2013(1), pp. 18-19.

2012

- Beres, B.L., Cárcamo, H.A., Weaver, D.K., Dosdall, L.M., Evenden, M.L., Hill, B.D., McKenzie, R.H., Yang, R.-C., and Spaner, D.M. (2012). "Integrating the building blocks of agronomy and biocontrol into an IPM strategy for wheat stem sawfly (*Cephus cinctus*).", Entomological Society of America (ESA) 60th Annual Meeting, Knoxville Convention Centre, Knoxville, TN, USA, November 11-14, 2012, D0471. (Poster)
- Cárcamo, H.A. (2012). "The pea leaf weevil (*Sitona lineatus* L.) - an overview of recent research and knowledge gaps.", Entomological Society of Canada 62nd and Entomological Society of Alberta 60th joint Annual Meeting, Coast Edmonton Plaza Hotel, Edmonton, AB, Canada, November 4-7, 2012, #26. (Abstract)
- Cárcamo, H.A., Herle, C.E., Broadbent, A.B., Garipey, T.D., and Gualtieri, L. (2012). "Neo-classical biocontrol of *Lygus* in canola in the Canadian Prairies-treading lightly.", Entomological Society of Canada 62nd and Entomological Society of Alberta 60th joint Annual Meeting, Coast Edmonton Plaza Hotel, Edmonton, AB, Canada, November 4-7, 2012, #27. (Abstract)
- Cárcamo, H.A., Hervet, V.A.D., Dosdall, L.M., Kher, S.V., and Chelle, C.D. (2012). "Host range assays of *Tetrastichus julis* - an effective biocontrol agent of cereal leaf beetle.", Entomological Society of Canada 62nd and Entomological Society of Alberta 60th joint Annual Meeting, Coast Edmonton Plaza Hotel, Edmonton, AB, Canada, November 4-7, 2012, #28. (Abstract)
- Kher, S.V., Cárcamo, H.A., Dosdall, L.M., and Goettel, M.S. (2012). "Laboratory bioassay of *Beauveria bassiana* strain GHA (BotaniGard™) efficacy on cereal leaf beetle (*Oulema melanopus*) and non-target effects on its parasitoid *Tetrastichus julis*.", Entomological Society of Canada 62nd and Entomological Society of Alberta 60th joint Annual Meeting, Coast Edmonton Plaza Hotel, Edmonton, AB, Canada, November 4-7, 2012, #97. (Abstract)
- Kher, S.V., Dosdall, L.M., and Cárcamo, H.A. (2012). "Host-plant nutrients and plant vigor effects on spatio-temporal distribution patterns of cereal leaf beetle, *Oulema melanopus* (Coleoptera: Chrysomelidae).", Entomological Society of Canada 62nd and Entomological Society of Alberta 60th joint Annual Meeting, Coast Edmonton Plaza Hotel, Edmonton, AB, Canada, November 4-7, 2012, #95. (Abstract)
- Kher, S.V., Dosdall, L.M., and Cárcamo, H.A. (2012). "Understanding host-finding behaviour of cereal leaf beetle, *Oulema melanopus* (Coleoptera: Chrysomelidae) and its principal parasitoid *Tetrastichus julis* (Hymenoptera: Eulophidae) using olfactory bioassays.", Entomological Society of Canada 62nd and Entomological Society of Alberta 60th joint Annual Meeting, Coast Edmonton Plaza Hotel, Edmonton, AB, Canada, November 4-7, 2012, #96. (Abstract)

- Otani, J.K., Meers, S., Hartley, S., Gavloski, J.E., Dosdall, L.M., Cárcamo, H.A., and Olfert, O.O. (2012). "Coordinated monitoring, forecasting and risk warning systems for field crop insects.", 24th International Congress of Entomology (ICE 2012) and International Organization for Biological Control (IOBC) Global Symposium, Daegu, South Korea, August 19-25, 2012.

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- Cárcamo, H.A. (2011). "One shot management of lygus and seedpod weevils in canola.", Agronomy Update Conference 2011, Lethbridge, AB, Canada, January 18-19, 2011.
- Cárcamo, H.A. and Herle, C.E. (2011). "Phenology of Lygus bugs and parasitism by Peristenus wasps in alfalfa and canola in southern Alberta.", Entomological Society of Canada 61st and Acadian Entomological Society 71st joint Annual Meeting, Westin Nova Scotian Hotel, Halifax, NS, Canada, November 6-9, 2011, pp. 50.
- Cárcamo, H.A. et al. (2011). "Alberta Research Report Summaries. Minutes.", Annual Meeting 2011 Western Forum on Crop Pests, Delta Grand Okanagan Resort & Conference Centre, Kelowna, BC, Canada, October 16-18, 2011.
- Kher, S.V., Dosdall, L.M., and Cárcamo, H.A. (2011). "Biology of the cereal leaf beetle, *Oulema melanopus* (coleoptera: chrysomelidae) on different cereal hosts and exploration of antibiotic characters in exotic wheat germplasm.", Entomological Society of Canada 61st and Acadian Entomological Society 71st joint Annual Meeting, Westin Nova Scotian Hotel, Halifax, NS, Canada, November 6-9, 2011, pp. 65.
- Olfert, O.O., Cárcamo, H.A., and Meers, S. (2011). "Wheat stem sawfly in Alberta in 2010. 2010 Crop Variety Highlights and Insect Pest Forecasts.", *Saskatoon Research Centre Technical Bulletin*, 2011(1), pp. 16-17.
- Olfert, O.O., Meers, S., Cárcamo, H.A., and Hartley, S. (2011). "Pea leaf weevil in Alberta and Saskatchewan in 2010. 2010 Crop Variety Highlights and Insect Pest Forecasts.", *Saskatoon Research Centre Technical Bulletin*, 2011(1), pp. 18-19.
- Soroka, J.J., Otani, J.K., and Cárcamo, H.A. (2011). "Survey to detect potential flea beetle (Coleoptera: Chrysomelidae) species composition shift in Canadian oilseed rape fields.", 13th International Rapeseed Congress, Prague, Czech Republic, June 5-9, 2011, Abstract P 290, pp. 465.

### **Elliott, Robert (Saskatoon)**

Technology Transfer Publications:

2013

- Doane, J.F., Olfert, O.O., Elliott, R.H., Hartley, S., and Meers, S. (2013). "*Sitodiplosis mosellana* (Géhin), Wheat Midge (Diptera: Cecidomyiidae).", in Mason, P.G. and Gillespie, D.R. (eds.) - Biological Control Programmes in Canada 2001-2012, CABI Publishing, Wallingford, UK.
- Elliott, R.H. (2013). "Effect of temperature and moisture on the efficacy of seed treatments for control of crucifer and striped flea beetles.", Prairie Pest Monitoring Network Meeting, Saskatoon, SK, Canada, March 19, 2013. (Presentation)
- Olfert, O.O., Elliott, R.H., Meers, S., Hartley, S., and Otani, J.K. (2013). "Forecast of wheat midge in Saskatchewan and Alberta for 2013. 2012 Crop Variety Highlights and Insect Pest Forecasts.", *Saskatoon Research Centre Technical Bulletin*, 2013(1), pp. 12-13.

2012

- Elliott, R.H. (2012). "Factors influencing flea beetle damage and efficacy of seed treatments in canola.", Field tour, Saskatoon, SK, Canada, June 2012. (Presentation)
- Elliott, R.H. (2012). "Impact of seed quality and vigour on the performance of spring-type canola.", International Seed Testing Association (ISTA) Vigour Workshop, Edmonton, AB, Canada, September 11-13, 2012, Invited lecture.
- Elliott, R.H. (2012). "Investigations on the origin of seed treatment failures in canola in western Canada.", International Seed Testing Association (ISTA) Vigour Workshop, Edmonton, AB, Canada, September 11-13, 2012, Invited lecture.
- Elliott, R.H. (2012). "Investigations on the origin of seed treatment failures in canola.", Saskatchewan Ministry of Agriculture Agronomy Update, Saskatoon, SK, Canada, December 2012. (Presentation)
- Elliott, R.H. (2012). Evaluation of seed treatments for control of crucifer and striped flea beetles in canola. Final Report to Canola Industry. November 2012. 57 pages. (Report)
- Elliott, R.H., Soroka, J.J., and Mann, L.W. (2012). "Lab bioassays to evaluate the effect of temperature and soil moisture on the toxicity of seed treatments to crucifer and striped flea beetles.", Prairie Pest Monitoring Network, Saskatoon, SK, Canada, March 2012. (Presentation)
- Soroka, J.J. and Elliott, R.H. (2012). "Innovative methods of managing flea beetles in canola.", *Top Crop Manager (Western edition)*, 2012(November), pp. 76-78.
- Soroka, J.J., Elliott, R.H., Otani, J.K., and Gavloski, J.E. (2012). "Changing flea beetle species – what you see isn't what you had but does it matter?", Saskatchewan Ministry of Agriculture Agronomy Update 2012, Saskatoon, SK, Canada, December 14, 2012. (Presentation)
- Soroka, J.J., Otani, J.K., Gavloski, J.E., and Elliott, R.H. (2012). "The biology and control of flea beetles in Western Canadian canola crops: Is a species shift in progress?", Entomological Society of Canada 62nd and Entomological Society of Alberta 60th joint Annual Meeting, Coast Edmonton Plaza Hotel, Edmonton, AB, Canada, November 4-7, 2012, #180. (Abstract)

## 2011

- Elliott, R.H., Mann, L.W., and Labun, T. (2011). "Impact of thiamethoxam seed treatments on flea beetle damage, vigour and performance of canola, *Brassica napus*.", Global Forum on the Vigor Effect of Cruiser, Ho Chi Minh City, Vietnam, November 2011, 8 pages.
- Elliott, R.H., Mann, L.W., and Olfert, O.O. (2011). "Methods of forecasting emergence of adult wheat midge and its parasitoid, *M. penetrans*.", Prairie Pest Monitoring Network Annual Meeting, Saskatoon, SK, Canada, March 10, 2011.
- Elliott, R.H., Mann, L.W., and Soroka, J.J. (2011). "Factors influencing flea beetle damage and the efficacy of neonicotinoid seed treatments.", Prairie Pest Monitoring Network Annual Meeting, Saskatoon, SK, Canada, March 10, 2011.
- Levy, B. and Elliott, R.H. (2011). "Weather can make flea beetle predictions tricky.", *Western Producer*, 2011(October).
- Olfert, O.O., Elliott, R.H., Meers, S., and Hartley, S. (2011). "Forecast of wheat midge in Saskatchewan for 2011. 2010 Crop Variety Highlights and Insect Pest Forecasts.", *Saskatoon Research Centre Technical Bulletin*, 2011(1), pp. 12-13.

## Olfert, Owen (Saskatoon)

Technology Transfer Publications:

2013

- Doane, J.F., Olfert, O.O., Elliott, R.H., Hartley, S., and Meers, S. (2013). "*Sitodiplosis mosellana* (Géhin), Wheat Midge (Diptera: Cecidomyiidae).", in Mason, P.G. and Gillespie, D.R. (eds.) - Biological Control Programmes in Canada 2001-2012, CABI Publishing, Wallingford, UK.
- Munir, S., Dosedall, L.M., Soroka, J.J., Olfert, O.O., and Andrahennadi, R. (2013). "Diamondback moth, *Plutella xylostella* (L.) (Lepidoptera: Plutellidae).", in Mason, P.G. and Gillespie, D.R. (eds.) - Biological Control Programmes in Canada 2001-2012, CABI Publishing, Wallingford, UK.
- Olfert, O.O., Cárcamo, H.A., and Meers, S. (2013). "Wheat stem sawfly in Alberta in 2012. 2012 Crop Variety Highlights and Insect Pest Forecasts.", *Saskatoon Research Centre Technical Bulletin*, 2013(1), pp. 16-17.
- Olfert, O.O., Elliott, R.H., Meers, S., Hartley, S., and Otani, J.K. (2013). "Forecast of wheat midge in Saskatchewan and Alberta for 2013. 2012 Crop Variety Highlights and Insect Pest Forecasts.", *Saskatoon Research Centre Technical Bulletin*, 2013(1), pp. 12-13.
- Olfert, O.O., Giffen, D.W., Hartley, S., Vadnais, M., Gavloski, J.E., Meers, S., and Otani, J.K. (2013). "The 2013 Prairie Grasshopper Forecast. 2012 Crop Variety Highlights and Insect Pest Forecasts.", *Saskatoon Research Centre Technical Bulletin*, 2013(1), pp. 10-11.
- Olfert, O.O., Meers, S., Cárcamo, H.A., and Hartley, S. (2013). "Pea leaf weevil in Alberta and Saskatchewan in 2012. 2012 Crop Variety Highlights and Insect Pest Forecasts.", *Saskatoon Research Centre Technical Bulletin*, 2013(1), pp. 18-19.
- Olfert, O.O., Meers, S., Gavloski, J.E., Hartley, S., and Otani, J.K. (2013). "Bertha armyworm in western Canada. 2012 Crop Variety Highlights and Insect Pest Forecasts.", *Saskatoon Research Centre Technical Bulletin*, 2013(1), pp. 8-9.
- Olfert, O.O., Meers, S., Hartley, S., and Otani, J.K. (2013). "Cabbage seedpod weevil in Alberta and Saskatchewan for 2012. 2012 Crop Variety Highlights and Insect Pest Forecasts.", *Saskatoon Research Centre Technical Bulletin*, 2013(1), pp. 14-15.
- Otani, J.K., Olfert, O.O., Weiss, R.M., and Giffen, D.W. (2013). "Canola surveying in the Peace River region.", Joint Annual Meeting of the Entomological Societies of Ontario and Canada, Guelph, Ontario, Canada, October 20-23, 2013, pp. 63.

## 2012

- Bahar, M.H., Soroka, J.J., Dosedall, L.M., and Olfert, O.O. (2012). "Survival and development of diamondback moth and its parasitoid *Diadegma insulare* under various short-term high extreme temperature regimes.", Entomological Society of America (ESA) 60th Annual Meeting, Knoxville Convention Centre, Knoxville, TN, USA, November 11-14, 2012, #1024.
- Beckie, H.J., Weiss, R.M., Olfert, O.O., and Leeson, J.Y. (2012). "Range Expansion of *Kochia* (*Kochia scoparia*) in North America under a Changing Climate.", *Topics in Canadian Weed Science*, 8, pp. 33-46.
- Munir, S., Dosedall, L.M., Soroka, J.J., and Olfert, O.O. (2012). "Impact of water-stressed host plant on oviposition choices of diamondback moth, *Plutella xylostella*.", Entomological Society of Canada 62nd and Entomological Society of Alberta 60th joint Annual Meeting, Coast Edmonton Plaza Hotel, Edmonton, AB, Canada, November 4-7, 2012, #136. (Abstract)
- Olfert, O.O., Haye, T., Weiss, R.M., and Kuhlmann, U. (2012). "Insights into the Potential of Classical Biological Control in a Changing Climate.", Invited speaker at 24th International Congress of Entomology (ICE 2012): Phloemophagous insects: Strategies and impacts on plants, Daegu, South Korea, August 19-25, 2012.

- Olfert, O.O., Weiss, R.M., Turkington, T.K., Beckie, H.J., and Kriticos, D.J. (2012). "Bioclimatic approach to assessing the potential impact of climate change on representative crop pests in North America.", *Topics in Canadian Weed Science*, 8, pp. 47-70.
- Olfert, O.O., Weiss, R.M., and Haye, T. (2012). "Modeling the biological requirements of insects to assess the potential impact of climate change.", Entomological Society of Canada and the Entomological Society of Alberta 2012 Joint Annual Meeting, Coast Edmonton Plaza Hotel, Edmonton, AB, Canada, November 4-7, 2012. (Presentation)
- Otani, J.K., Meers, S., Hartley, S., Gavloski, J.E., Dossdall, L.M., Cárcamo, H.A., and Olfert, O.O. (2012). "Coordinated monitoring, forecasting and risk warning systems for field crop insects.", 24th International Congress of Entomology (ICE 2012) and International Organization for Biological Control (IOBC) Global Symposium, Daegu, South Korea, August 19-25, 2012.
- Otani, J.K., Meers, S., Olfert, O.O., and Giffen, D.W. (2012). "What's bugging you – an insect pest update for Alberta.", FarmTech 2012, Edmonton, AB, Canada, January 24, 2012, pp. 109-111.

## 2011

- Elliott, R.H., Mann, L.W., and Olfert, O.O. (2011). "Methods of forecasting emergence of adult wheat midge and its parasitoid, *M. penetrans*.", Prairie Pest Monitoring Network Annual Meeting, Saskatoon, SK, Canada, March 10, 2011.
- Floate, K.D., Watson, D.W., Weiss, R.M., and Olfert, O.O. (2011). "Introducing new species of dung beetles into Canada to improve pasture productivity.", Entomological Society of Canada 61st and Acadian Entomological Society 71st joint Annual Meeting: Canadian Forum for Biological Control, Westin Nova Scotian Hotel, Halifax, NS, Canada, November 6-9, 2011.
- Klein-Gebbinck, H.W., Turkington, T.K., Olfert, O.O., Weiss, R.M., Kriticos, D.J., Kutcher, H.R., Falk, K.C., and Strelkov, S.E. (2011). "Projected distribution and severity of clubroot of canola in the Canadian prairies under incremental temperature and precipitation, and potential climate change scenarios.", Climate Change and the Implications for Plant Science: The science, the impacts, and the options, University of Guelph, Guelph, ON, Canada, June 7-9, 2011.
- Mason, P.G., Weiss, R.M., and Olfert, O.O. (2011). "Predicting insect distributions: CLIMEX as a tool, Better Models – Better Assessments: The Use of Models in Plant Health and Biotechnology Risk Assessment.", Plant and Biotechnology Risk Assessment Unit, Canadian Food Inspection Agency (CFIA) Workshop, Lord Elgin Hotel, Ottawa, ON, Canada, February 22-23, 2011.
- Olfert, O.O., Cárcamo, H.A., and Meers, S. (2011). "Wheat stem sawfly in Alberta in 2010. 2010 Crop Variety Highlights and Insect Pest Forecasts.", *Saskatoon Research Centre Technical Bulletin*, 2011(1), pp. 16-17.
- Olfert, O.O., Elliott, R.H., Meers, S., and Hartley, S. (2011). "Forecast of wheat midge in Saskatchewan for 2011. 2010 Crop Variety Highlights and Insect Pest Forecasts.", *Saskatoon Research Centre Technical Bulletin*, 2011(1), pp. 12-13.
- Olfert, O.O., Giffen, D.W., Hartley, S., Vadnais, M., Gavloski, J.E., Meers, S., and Otani, J.K. (2011). "The 2011 Saskatchewan and Manitoba grasshopper forecast. 2010 Crop Variety Highlights and Insect Pest Forecasts.", *Saskatoon Research Centre Technical Bulletin*, 2011(1), pp. 10-11.
- Olfert, O.O., Haye, T., Weiss, R.M., and Kuhlmann, U. (2011). "A Role for Bioclimate Modelling in Development of IPM Strategies: Case Study – Insights into the Potential of Classical Biological Control in a Changing Climate", OECD Workshop on Integrated Pest Management (IPM): Technology and Information, Berlin, Germany, October 16-19, 2011.

- Olfert, O.O., Meers, S., Cárcamo, H.A., and Hartley, S. (2011). "Pea leaf weevil in Alberta and Saskatchewan in 2010. 2010 Crop Variety Highlights and Insect Pest Forecasts.", *Saskatoon Research Centre Technical Bulletin*, 2011(1), pp. 18-19.
- Olfert, O.O., Meers, S., Gavloski, J.E., Hartley, S., Otani, J.K., and Clark, K. (2011). "Bertha armyworm in western Canada. 2010 Crop Variety Highlights and Insect Pest Forecasts.", *Saskatoon Research Centre Technical Bulletin*, 2011(1), pp. 8-9.
- Olfert, O.O., Meers, S., Hartley, S., and Otani, J.K. (2011). "Cabbage seedpod weevil in Alberta and Saskatchewan for 2010. 2010 Crop Variety Highlights and Insect Pest Forecasts.", *Saskatoon Research Centre Technical Bulletin*, 2011(1), pp. 14-15.
- Olfert, O.O., Weiss, R.M., Soroka, J.J., and Dosedall, L.M. (2011). "Modeling Tools Provide Advance Warnings of Potential Distribution of Diamondback Moth and Crop Risk Associated with the Number of Generations.", 13th International Rapeseed Congress, Prague, Czech Republic, June 5-9, 2011, Abstract P 304, pp. 478. (Abstract)
- Olfert, O.O., Weiss, R.M., and Soroka, J.J. (2011). "Modeling Tools Provide Advance Warnings of Potential Distribution of Diamondback Moth and Crop Risk Associated with the Number of Generations.", OECD Workshop on Integrated Pest Management (IPM): Technology and Information, Berlin, Germany, October 16-19, 2011.
- Turkington, T.K., Klein-Gebbinck, H.W., Olfert, O.O., Weiss, L.M., Kriticos, D.J., Kutcher, H.R., Falk, K.C., and Strelkov, S.E. (2011). "Projected distribution and severity of clubroot of canola in the Canadian prairies.", *Phytopathology*, 101(6), pp. S179. (Abstract)
- Weiss, R.M. and Olfert, O.O. (2011). "Bioclimatic approaches to assessing the potential impact of present and future climate on insect distribution and abundance.", Entomological Society of Saskatchewan 2011 Spring Meeting, Saskatoon, SK, Canada, March 25, 2011.

### Soroko, Julie (Saskatoon)

#### Technology Transfer Publications:

2013

- Bahar, M.H., Olivier, C.Y., Bekkaoui, D.R., Hegedus, D.L., and Soroka, J.J. (2013). "Detection, quantification and within-plant distribution of Aster yellows phytoplasmas through digital PCR (ddPCR).", 32nd new phytopologist symposium, Universidad Católica, Puerto Madero Campus, Buenos Aires, Argentina, November 20-22, 2013, pp. 53.
- Munir, S., Dosedall, L.M., Soroka, J.J., Olfert, O.O., and Andrahennadi, R. (2013). "Diamondback moth, *Plutella xylostella* (L.) (Lepidoptera: Plutellidae).", in Mason, P.G. and Gillespie, D.R. (eds.) - Biological Control Programmes in Canada 2001-2012, CABI Publishing, Wallingford, UK.

2012

- Bahar, M.H., Soroka, J.J., Dosedall, L.M., and Olfert, O.O. (2012). "Survival and development of diamondback moth and its parasitoid *Diadegma insulare* under various short-term high extreme temperature regimes.", Entomological Society of America (ESA) 60th Annual Meeting, Knoxville Convention Centre, Knoxville, TN, USA, November 11-14, 2012, #1024.
- Bahar, M.H., Soroka, J.J., Hegedus, D.D., and Dosedall, L.M. (2012). "Thermal tolerance and HSP70 gene expression in DBM and *Diadegma insulare*.", Entomological Society of Canada 62nd and Entomological Society of Alberta 60th joint Annual Meeting, Coast Edmonton Plaza Hotel, Edmonton, AB, Canada, November 4-7, 2012, #7. (Abstract)



- Bassendowski, K.A., Soroka, J.J., and Gossen, B.D. (2012). "Foliar disease severity on alfalfa in Saskatchewan, 2012.", *Canadian Plant Disease Survey*, 93, pp. 142.
- Elliott, R.H., Soroka, J.J., and Mann, L.W. (2012). "Lab bioassays to evaluate the effect of temperature and soil moisture on the toxicity of seed treatments to crucifer and striped flea beetles.", Prairie Pest Monitoring Network, Saskatoon, SK, Canada, March 2012. (Presentation)
- Munir, S., Dosedall, L.M., Soroka, J.J., and Olfert, O.O. (2012). "Impact of water-stressed host plant on oviposition choices of diamondback moth, *Plutella xylostella*.", Entomological Society of Canada 62nd and Entomological Society of Alberta 60th joint Annual Meeting, Coast Edmonton Plaza Hotel, Edmonton, AB, Canada, November 4-7, 2012, #136. (Abstract)
- Soroka, J.J. (2012). "Flea beetles in western Canada: Is a species shift in progress?", Entomological Society of Canada 62nd and Entomological Society of Alberta 60th joint Annual Meeting, Coast Edmonton Plaza Hotel, Edmonton, AB, Canada, November 4-7, 2012, Abstract 180.
- Soroka, J.J. (2012). "Innovative methods of managing flea beetles in canola.", *Top Crop Manager (Western edition)*(November), pp. 76-78.
- Soroka, J.J. and Elliott, R.H. (2012). "Innovative methods of managing flea beetles in canola.", *Top Crop Manager (Western edition)*, 2012(November), pp. 76-78.
- Soroka, J.J., Elliott, R.H., Otani, J.K., and Gavloski, J.E. (2012). "Changing flea beetle species – what you see isn't what you had but does it matter?", Saskatchewan Ministry of Agriculture Agronomy Update 2012, Saskatoon, SK, Canada, December 14, 2012. (Presentation)
- Soroka, J.J., Otani, J.K., Gavloski, J.E., and Elliott, R.H. (2012). "The biology and control of flea beetles in Western Canadian canola crops: Is a species shift in progress?", Entomological Society of Canada 62nd and Entomological Society of Alberta 60th joint Annual Meeting, Coast Edmonton Plaza Hotel, Edmonton, AB, Canada, November 4-7, 2012, #180. (Abstract)

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- Elliott, R.H., Mann, L.W., and Soroka, J.J. (2011). "Factors influencing flea beetle damage and the efficacy of neonicotinoid seed treatments.", Prairie Pest Monitoring Network Annual Meeting, Saskatoon, SK, Canada, March 10, 2011.
- Gruber, M.Y. and Soroka, J.J. (2011). "Hairy Canola Meets the Crucifer Flea Beetle.", published by Agriculture and Agri-Food Canada (AAFC)/Agriculture et Agroalimentaire Canada (AAC).
- Olfert, O.O., Weiss, R.M., Soroka, J.J., and Dosedall, L.M. (2011). "Modeling Tools Provide Advance Warnings of Potential Distribution of Diamondback Moth and Crop Risk Associated with the Number of Generations.", 13th International Rapeseed Congress, Prague, Czech Republic, June 5-9, 2011, Abstract P 304, pp. 478. (Abstract)
- Olfert, O.O., Weiss, R.M., and Soroka, J.J. (2011). "Modeling Tools Provide Advance Warnings of Potential Distribution of Diamondback Moth and Crop Risk Associated with the Number of Generations.", OECD Workshop on Integrated Pest Management (IPM): Technology and Information, Berlin, Germany, October 16-19, 2011.
- Olivier, C.Y., Ghani, S., Galka, B., Séguin-Swartz, G.T., and Soroka, J.J. (2011). "Investigation of the use of *Burkholderia phytofirmans* strain PsJN for flea beetle control in canola.", 13th International Rapeseed Congress, Prague, Czech Republic, June 5-9, 2011, Abstract P 303, pp. 477.
- Soroka, J.J. (2011). "Alfalfa insect survey 2010 and survey needs 2011.", Saskatchewan Ministry of Agriculture Forage Specialists and Senior Managers, Saskatoon, SK, Canada, April 6, 2011. (Presentation)

- Soroka, J.J. (2011). "Estimating flea beetle damage in canola.", published by Canola Council of Canada. (Factsheet)
- Soroka, J.J. (2011). "Impact of crop rotations on insect pests.", Saskatchewan Ministry of Agriculture Agronomy Research Update 2011, Saskatoon, SK, Canada, December 8, 2011. (Presentation)
- Soroka, J.J. (2011). "Insect pests of alfalfa hay - what China doesn't want to see.", Canadian Food Inspection Agency alfalfa hay pest training session, Lethbridge, AB, Canada, June 27, 2011. (Presentation)
- Soroka, J.J. (2011). "National Forage Pest Report 2010.", Annual Meeting 2011 Canadian Forum on Forages and Grasslands, Saskatoon, SK, Canada, December 13-14, 2011.
- Soroka, J.J. (2011). "Research Report.", Annual Meeting 2011 Western Forum on Crop Pests, Delta Grand Okanagan Resort & Conference Centre, Kelowna, BC, Canada, October 16-18, 2011.
- Soroka, J.J. (2011). "What's eating my crop? Research on insects in oilseed rape on the Canadian prairies.", Plant Protection Institute, Hungarian Academy of Sciences, Budapest, Hungary, June 9, 2011. (Presentation)
- Soroka, J.J. and Dosedall, L.M. (2011). "Coping with root maggots in prairie canola - a research review.", *Top Crop Manager (Western edition)*, 2011(November), pp. 24-26.
- Soroka, J.J. and Goerzen, D.W. (2011). "Alfalfa Seed Insect Pest Management.", *Saskatchewan Seed Producers' Association Newsletter*, 24(2), pp. 7-14.
- Soroka, J.J., Otani, J.K., and Cárcamo, H.A. (2011). "Survey to detect potential flea beetle (Coleoptera: Chrysomelidae) species composition shift in Canadian oilseed rape fields.", 13th International Rapeseed Congress, Prague, Czech Republic, June 5-9, 2011, Abstract P 290, pp. 465.

### Peng, Gary (Saskatoon)

#### Technology Transfer Publications:

2014

- Gossen, B.D., Peng, G., Deora, A.D., and McDonald, M.R. (2014). "Clubroot resistance: Expression, durability, and metabolic cost.", Invited seminar, Department of Plant Agriculture, University of Guelph, Guelph, ON, Canada, March 5, 2014. (Presentation)
- Lahlali, R.L., McGregor, L., Song, T., Gossen, B.D., Narisawa, K., and Peng, G. (2014). "*Heteroconium chaetospora* suppresses clubroot by inducing host resistance via ethylene, jasmonic acid and auxin pathway signaling.", *PLoS ONE*, 9(4: e94144), pp. 1-9. doi : 10.1371/journal.pone.0094144
- Song, T., Lahlali, R.L., Yu, F.Q., Gossen, B.D., and Peng, G. (2014). "Transcriptome analysis of the clubroot-resistant gene *Rpb1* using high-throughput RNA sequencing.", *Canadian Journal of Plant Pathology*. (Abstract)

2013

- Gossen, B.D., Deora, A.D., Peng, G., and McDonald, M.R. (2013). "Environmental parameters that affect clubroot risk on the Canadian prairies.", International Clubroot Workshop, Edmonton, AB, Canada, June 2013, Oral presentations, pp. 8.
- Gossen, B.D., Deora, A.D., Peng, G., and McDonald, M.R. (2013). "Update on environment and clubroot risk.", Planning Meeting, Clubroot in GF2, Edmonton, Canada, December 5, 2013. (Presentation)

- Gossen, B.D., Kasinathan, H., Strelkov, S.E., Manolii, V.P., Hwang, S.F., Peng, G., Cao, T., and McDonald, M.R. (2013). "Risk potential of clubroot on the Canadian prairies, based on soil type and pH.", *Canadian Journal of Plant Pathology*, 35(1), pp. 112. (Abstract)
- Gossen, B.D., McDonald, M.R., Sharma, K., Deora, A.D., and Peng, G. (2013). "Cost of resistance to *Plasmodiophora brassicae* when inoculum pressure is high.", International Clubroot Workshop, Edmonton, AB, Canada, June 2013, also International Congress of Plant Pathology, Beijing, China. August 2013. Also, *Can. J. Plant Pathol.* 36: xxx-xxx (in press), pp. 3.
- Hwang, S.F., Ahmed, H.U., Zhou, Q-X., Strelkov, S.E., Gossen, B.D., Peng, G., and Turnbull, G.D. (2013). "Efficacy of Vapam to control clubroot (*Plasmodiophora brassicae*) in canola.", International Congress of Plant Pathology, Beijing, China, August 25 - 28, 2013.
- Hwang, S.F., Howard, R.J., Strelkov, S.E., Gossen, B.D., and Peng, G. (2013). "Management of clubroot on canola in western Canada.", International Clubroot Workshop, Edmonton, AB, Canada, June 2013, pp. 7. (Workshop)
- Hwang, S.F., Strelkov, S.E., Howard, R.J., Gossen, B.D., and Peng, G. (2013). "Management of clubroot on canola in western Canada.", Planning Meeting, Clubroot in GF2, Edmonton, Canada, December 5, 2013. (Presentation)
- Lahlali, R.L., Peng, G., McGregor, L., McDonald, M.R., Gossen, B.D., Hwang, S.F., Hynes, R.K., Boyetchko, S.M., and Geissler, H.J. (2013). "Induced host defense responses are involved in suppressing clubroot on canola with *Bacillus subtilis*, *Clonostachys rosea* and *Heteroconium chaetospora*.", Canadian Phytopathological Society (CPS) 83rd Annual Meeting and International PPV Meeting, Marriott Gateway On The Falls, Niagara Falls, ON, Canada, June 24-27, 2012, Published in: *Canadian Journal of Plant Pathology*, 35(1), pp.117 (Abstract).
- McClay, A.S., Peng, G., Bailey, K.L., Hynes, R.K., and Hinz, H.L. (2013). "*Tripeurospermum inodorum* (L.) Sch. Bip. (= *Matricaria perforata* Mérat), Scentless Chamomile (*Asteraceae*).", in Mason, P.G. and Gillespie, D.R. (eds.) - *Biological Control Programmes in Canada 2001-2012*, CABI Publishing, Wallingford, UK.
- Miller, S.G., Anderson, K., Bassendowski, K.A., Britz, L., Buitenhuis, N., Campbell, E., Chant, S., Christopher, J., Cowell, L.E., Cranston, R., Dokken-Bouchard, F.L., Friesen, S., Gugel, R.K., Hicks, L., Ippolito, J., Jurke, C., Kennedy, V., Kirkham, C.L., Martinka, T., Moore, M., Oster, K., Peng, G., Phelps, S.M., Platford, R.G., Senko, S., Stonehouse, K., and Vakulabharanam, V. (2013). "Survey of canola diseases in Saskatchewan, 2012.", *Canadian Plant Disease Survey*, 93, pp. 149-153.
- Peng, G. (2013). "Managing blackleg of canola – new concepts and tools.", Soils and Crops Workshop 2013, Prairieland Park, Saskatoon, SK, Canada, March 5-6, 2013.
- Peng, G. and Gossen, B.D. (2013). "Clubroot - A threat to canola production in western Canada.", AAFC – STB booth at the Crop Production Show, Saskatoon, SK, Canada, January 7-11, 2013. (Presentation)
- Peng, G., Gossen, B.D., Strelkov, S.E., Hwang, S.F., and McDonald, M.R. (2013). "Clubroot.", published by Agriculture and Agri-Food Canada (AAFC)/Agriculture et Agroalimentaire Canada (AAC), #4065141. (Factsheet)
- Peng, G., Hynes, R.K., Hwang, S.F., and Gossen, B.D. (2013). Synergy of biofungicides with cultivar resistance for control of clubroot on canola. Final report on ADF Project 20090359. 59 pp. (Report)
- Peng, G., Lahlali, R.L., Hwang, S.F., Pageau, D., Hynes, R.K., McDonald, M.R., Gossen, B.D., and Strelkov, S.E. (2013). "Integrated management of clubroot on canola with crop rotation, cultivar

resistance, and fungicides/biofungicides.", International Clubroot Workshop, Edmonton, AB, Canada, June 2013, Oral presentation, pp. 7. (Workshop)

- Peng, G., Lahlali, R.L., Hynes, R.K., Boyetchko, S.M., Gossen, B.D., Hwang, S.F., Pageau, D., McDonald, M.R., and Strelkov, S.E. (2013). "*Plasmodiophora brassicae* Woronin, Clubroot of Crucifers (Plasmodiophoraceae).", in Mason, P.G. and Gillespie, D.R. (eds.) - Biological Control Programmes in Canada 2001-2012, CABI Publishing, Wallingford, UK, Chapter 65.
- Peng, G., Lahlali, R.L., Pageau, D., Hwang, S.F., Hynes, R.K., Anderson, K., McDonald, M.R., Gossen, B.D., Strelkov, S.E., Turkington, T.K., Yu, F.Q., Falk, K.C., Boyetchko, S.M., McGregor, L., Hupka, D., and Geissler, H.J. (2013). "Assessment of crop rotation, resistance and *Bacillus subtilis* for management of clubroot on canola.", *Canadian Journal of Plant Pathology*, 35, pp. 112. (Abstract)
- Peng, G., Pageau, D., Strelkov, S.E., Lahlali, R.L., Gossen, B.D., Anderson, K., Hwang, S.F., McDonald, M.R., Yu, F.Q., Falk, K.C., Turkington, T.K., Hynes, R.K., Boyetchko, S.M., and McGregor, L. (2013). "Management of clubroot disease on canola with crop rotation combined with host resistance or biofungicide seed dressing.", *Canadian Journal of Plant Pathology*, 35, pp. 519. (Abstract)
- Peng, G., Yu, F.Q., and Gossen, B.D. (2013). "Clubroot on canola -Disease development & Management.", Seminar at Zhejiang University, Hangzhou, China, April 1, 2013. (Presentation)

## 2012

- Cross, D.J., Liban, S.H., Peng, G., Fernando, W.G.D., Kutcher, H.R., Yu, F.Q., Kirkham, C., Dokken-Bouchard, F.L., McLaren, D.L., and Kubinec, A.M. (2012). "The race structure of *Leptosphaeria maculans* in commercial canola fields based on 2010 disease surveys in Manitoba and Saskatchewan.", 4th Joint Saskatchewan-Alberta Plant Pathology Conference: Mapping and cloning of clubroot resistance genes in Brassica species, Lloydminster, SK, Canada, November 5-7, 2012. (Poster)
- Dokken-Bouchard, F.L., Anderson, K., Bassendowski, K.A., Bouchard, A., Brown, B., Cranston, R., Cowell, L.E., Cruise, D., Gugel, R.K., Hicks, L., Ippolito, J., Jurke, C., Kirkham, C.L., Kruger, G., Miller, S.G., Moats, E., Morrall, R.A.A., Peng, G., Phelps, S.M., Platford, R.G., Schemenauer, I., Senko, S., Stonehouse, K., Strelkov, S.E., Urbaniak, S., and Vakulabharanam, V. (2012). "Survey of canola diseases in Saskatchewan, 2011.", *Canadian Plant Disease Survey*, 92, pp. 125-129.
- Gossen, B.D., Kasinathan, H., McDonald, M.R., and Peng, G. (2012). "Effect of soil type and compaction on severity of clubroot (*Plasmodiophora brassicae*).", *Phytopathology*, 102(Suppl. No.4), pp. 46. (Abstract)
- Gossen, B.D., Kasinathan, H., Peng, G., and McDonald, M.R. (2012). "Effect of soil type on assessment of biofungicide efficacy against clubroot under controlled conditions.", *Canadian Journal of Plant Pathology*, 34(3), pp. 464. (Abstract)
- Gossen, B.D., McDonald, M.R., Adhikari, K.K.C., Kasinathan, H., Sharma, K., Hwang, S.F., Gludovacz, T.V., and Peng, G. (2012). Impact of soil temperature and pH, and plant growth stage on clubroot of canola. Final Report, ADF Project # 20080153. February 24, 2012. 72 pp. (Report)
- Gossen, B.D., Peng, G., and McDonald, M.R. (2012). "Biology/Pathology, CRMI.", SARM representatives and SK Agriculture and Food agronomy specialists, Moose Jaw, SK, Canada, April 2012. (Presentation)
- Hwang, S.F., Cao, T., Xiao, Q., Ahmed, H.U., Manolii, V.P., Turnbull, G.D., Strelkov, S.E., Gossen, B.D., and Peng, G. (2012). "Efficacy of fungicide, seeding date, and seedling age on seedling

emergence, clubroot severity, and yield of canola.", *Canadian Journal of Plant Pathology*, 34, pp. 335-336. (Abstract)

- Hwang, S.F., Strelkov, S.E., Gossen, B.D., Peng, G., and Howard, R.J. (2012). "Progress in canola clubroot management in Alberta, Canada.", CRMI Planning Meeting, Edmonton, AB, Canada, December 6, 2012. (Presentation)
- Jurke, C., Peng, G., and Fernando, W.G.D. (2012). "Blackleg of Canola – Is there an answer?", Canola Industry Meeting 2012, TCU Place, Saskatoon, SK, Canada, December 5, 2012, Invited Speaker.
- Kasinathan, H., Gossen, B.D., Peng, G., and McDonald, M.R. (2012). "Efficacy of Serenade and Prestop against clubroot is affected by soil type.", *Canadian Journal of Plant Pathology*, 34, pp. 336-337. (Abstract)
- Kutcher, H.R. and Peng, G. (2012). "Disease issues with intensive canola rotations.", Saskatoon Coop Agro Seed Launch, Saskatoon, SK, Canada, November 4, 2012.
- Lahlali, R.L., Peng, G., McGregor, L., Geissler, H.J., McDonald, M.R., Gossen, B.D., and Hwang, S.F. (2012). "Suppression of clubroot by *Heteroconium chaetospora* may be mediated by modulation of jasmonic acid pathway signalling.", Canadian Phytopathological Society (CPS-SK) Saskatchewan Regional 2011 Meeting, Saskatoon, SK, Canada, December 6, 2011, Published in: *Canadian Journal of Plant Pathology*, 34(2), pp.320 (Abstract).
- Liban, S.H., Cross, D.J., Fernando, W.G.D., Kutcher, H.R., and Peng, G. (2012). "Characterization of *Leptosphaeria* race structure in western Canada.", Canadian Phytopathological Society (CPS) 83rd Annual Meeting and International PPV Meeting, Marriott Gateway On The Falls, Niagara Falls, ON, Canada, June 24-27, 2012. (Poster)
- Liu, C., Fernando, W.G.D., Gan, Y.T., Kutcher, H.R., and Peng, G. (2012). "Baseline sensitivity of *Leptosphaeria maculans* to strobilurin fungicides.", Canadian Phytopathological Society (CPS) 83rd Annual Meeting and International PPV Meeting, Marriott Gateway On The Falls, Niagara Falls, ON, Canada, June 24-27, 2012. (Poster)
- McDonald, M.R., Peng, G., and Riches, L. (2012). "Efficacy of the endophytic biological control agent *Heteroconium* for the management of clubroot in napa Cabbage, 2011.", *Muck Vegetable Cultivar Trial and Research Report*, 61, pp. 56-57.
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- Peng, G. (2012). "A comparison of clubroot (*Plasmodiophora brassica* Woronin) development and management on Brassica vegetables and canola.", 4th Joint Saskatchewan-Alberta Plant Pathology Conference: Mapping and cloning of clubroot resistance genes in Brassica species, Lloydminster, SK, Canada, November 5-7, 2012, Invited presentation.
- Peng, G. (2012). "Blackleg of canola in western Canada – current status and control.", Western Forum on Pest Management (WFPM) 2012, Hotel Saskatchewan, Regina, SK, Canada, October 15-17, 2012.
- Peng, G. (2012). "Control of clubroot with cultivar resistance crop rotation.", 4th Joint Saskatchewan-Alberta Plant Pathology Conference: Mapping and cloning of clubroot resistance genes in Brassica species, Lloydminster, SK, Canada, November 5-7, 2012.

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- Peng, G. (2012). Mitigate the risk of blackleg and clubroot on canola – research update. Report of Western Forum for Pest Management. 5 pages. (Report)
- Peng, G., Fernando, W.G.D., Kirkham, C.L., Lange, R., Kutcher, H.R., McLaren, D.L., Johnson, E.N., and Turkington, T.K. (2012). "Mitigating the risk of blackleg disease of canola using fungicide strategies.", Soils and Crops Workshop 2012, University of Saskatchewan, Saskatoon, SK, Canada, March 13-14, 2012, [CD], 7 pages.
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- Peng, G., Lahlali, R.L., Hwang, S.F., Pageau, D., Hynes, R.K., Anderson, K., McDonald, M.R., Gossen, B.D., Boyetchko, S.M., and Strelkov, S.E. (2012). "Fungicides/biofungicides, cultivar resistance, crop rotation for control of clubroot on canola.", Clubroot Summit 2012, Edmonton, AB, Canada, March 6, 2012, Invited presentation.
- Peng, G., Lahlali, R.L., Pageau, D., Hwang, S.F., Hynes, R.K., Anderson, K., McDonald, M.R., Gossen, B.D., Strelkov, S.E., Turkington, T.K., Yu, F.Q., Falk, K.C., Boyetchko, S.M., McGregor, L., Hupka, D., and Geissler, H.J. (2012). "Assessment of crop rotation, resistance and *Bacillus subtilis* for management of clubroot on canola.", Canadian Phytopathological Society (CPS) 83rd Annual Meeting and International PPV Meeting, Marriott Gateway On The Falls, Niagara Falls, ON, Canada, June 24-27, 2012, Published in: *Can. J. Plant Pathol.* (2013) 35(1), pp. 112.
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- Peng, G., Lahlali, R.L., Pageau, D., McDonald, M.R., Gossen, B.D., Strelkov, S.E., Turkington, T.K., Yu, F.Q., Falk, K.C., Boyetchko, S.M., McGregor, L., Hupka, D., and Geissler, H.J. (2012). "Assessment of crop rotation and host resistance in combination with *Bacillus subtilis* for management of clubroot on canola.", Canadian Phytopathological Society (CPS) 83rd Annual Meeting and International PPV Meeting, Marriott Gateway On The Falls, Niagara Falls, ON, Canada, June 24-27, 2012, Published in: *Canadian Journal of Plant Pathology*, 35(1), pp.122.
- Strelkov, S.E., Hwang, S.F., Howard, R.J., Rahman, H., Kutcher, H.R., Turkington, T.K., Gossen, B.D., Peng, G., McLaren, D.L., LeBoldus, J.M., Feng, J., Cao, T., and Manolii, V.P. (2012). "Clubroot Risk Mitigation Initiative: Pathology Pillar.", Clubroot Summit 2012, Edmonton, AB, Canada, March 6, 2012, Invited presentation.
- Yu, F.Q., Chu, M.G., Falk, K.C., and Peng, G. (2012). "Identification and mapping of clubroot resistance genes in Brassica species.", Canadian Phytopathological Society (CPS) 83rd Annual Meeting and International PPV Meeting, Marriott Gateway On The Falls, Niagara Falls, ON, Canada, June 24-27, 2012, Published in: *Can. J. Plant Pathol.* (2013), 35(1), pp. 116.
- Yu, F.Q., Falk, K.C., and Peng, G. (2012). "Genetic Control of Clubroot.", Clubroot Summit 2012, Edmonton, AB, Canada, March 6, 2012. (Presentation)

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- Gossen, B.D., McDonald, M.R., Kalpana, K.C., Hwang, S.F., Strelkov, S.E., and Peng, G. (2011). "Impact of climate change on clubroot of canola on the Canadian prairies.", *Canadian Journal of Plant Pathology*, 33(2), pp. 277. (Abstract)
- Hwang, S.F., Ahmed, H.U., Strelkov, S.E., Gossen, B.D., Peng, G., and Turnbull, G.D. (2011). "Clubroot development in resistant and susceptible canola cultivars affects soil populations of *Plasmodiophora brassicae*.", 13th International Rapeseed Congress, Prague, Czech Republic, June 5-9, 2011, pp. 1122-1125.
- Hwang, S.F., Ahmed, H.U., Strelkov, S.E., Gossen, B.D., Peng, G., and Turnbull, G.D. (2011). "Clubroot development in resistant and susceptible canola cultivars affects soil populations of *Plasmodiophora brassicae*.", 13th International Rapeseed Congress, Prague, Czech Republic, June 5-9, 2011, pp. 488. (Abstract)
- Hwang, S.F., Ahmed, H.U., Zhou, Q-X., Strelkov, S.E., Gossen, B.D., Peng, G., and Turnbull, G.D. (2011). "Impact of clubroot resistance on root hair infection, disease severity, and growth of canola in soil inoculated with *Plasmodiophora brassicae*.", American Phytopathological Society (APS) 2011 Joint Annual Meeting & International Association for the Plant Protection Sciences (IPPC), Honolulu, HI, USA, August 6-10, 2011, Published in: *Phytopathology* (2011), 101(6S), pp. S77.
- Hwang, S.F., Ahmed, H.U., Zhou, Q-X., Strelkov, S.E., Gossen, B.D., Peng, G., and Turnbull, G.D. (2011). "Ratio of resistant to sensitive canola plants affects resting spore populations of *Plasmodiophora brassicae*.", 31st Annual Meeting of the Plant Pathology Society of Alberta, Lethbridge, AB, Canada, October 12-14, 2010, Published in: *Canadian Journal of Plant Pathology*, 33(2), pp.260 (Abstract).
- Hwang, S.F., Strelkov, S.E., Gossen, B.D., Peng, G., and Howard, R.J. (2011). "Management of clubroot in canola.", Clubroot Summit 2011, Saskatoon, SK, Canada, March 9, 2011, Invited presentation.
- Hwang, S.F., Strelkov, S.E., Peng, G., and Gossen, B.D. (2011). "Novel strategies for the management of clubroot of canola in western Canada.", Cross-Strait Symposium on Biological Control of Crop Pests 2011, Taipei, Taiwan, October 20-21, 2011, pp. 22.
- Hynes, R.K., Bailey, K.L., Boyetchko, S.M., Erlandson, M.A., Peng, G., and Traquair, J.A. (2011). "Formulation and delivery of biopesticides.", Canadian Society of Microbiologists (CSM) 61st Annual Conference / Conférence annuelle de la Société Canadienne des Microbiologistes (SCM), Memorial University of Newfoundland, St. John's, NL, Canada, June 20-23, 2011.
- Hynes, R.K., Bailey, K.L., Boyetchko, S.M., Erlandson, M.A., Peng, G., and Traquair, J.A. (2011). "Formulation development and delivery of biopesticides.", Canadian Society of Microbiologists (CSM) 61st Annual Conference / Conférence annuelle de la Société Canadienne des Microbiologistes (SCM), Memorial University of Newfoundland, St. John's, NL, Canada, June 20-23, 2011.
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- Kasinathan, H., Gossen, B.D., Peng, G., and McDonald, M.R. (2011). "Efficacy of Serenade and Prestop against clubroot is affected by soil type.", Plant Canada 2011, Saint Mary's University,

Halifax, NS, Canada, July 17-21, 2011, Published in: *Canadian Journal of Plant Pathology*, 34(2), pp. 336-337 (Abstract).

- Lahlali, R.L., Peng, G., Gossen, B.D., Hynes, R.K., Boyetchko, S.M., Hwang, S.F., and McDonald, M.R. (2011). "Investigation on modes of action for the biofungicides Serenade and Prostop in clubroot control.", *Canadian Journal of Plant Pathology*, 33, pp. 573. (Abstract)
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- Peng, G. (2011). "Control of blackleg on canola in western Canada.", Inner Mongolian Academy of Agricultural Science, China, November 18, 2011. (Presentation)
- Peng, G. (2011). "Management of blackleg and clubroot on canola in western Canada.", Anhui Academy of Agricultural Science Seminar, Anhui Academy of Agricultural Science, Hefei, China, November 15, 2011. (Presentation)
- Peng, G., Bailey, K.L., Hynes, R.K., and Boyetchko, S.M. (2011). "Bioherbicide R&D - progresses and challenges.", Chinese National Institute of Rice Research, Hongzhou, China, November 11, 2011. (Presentation)
- Peng, G., Boyetchko, S.M., Hynes, R.K., McGregor, L., Sawchyn, K., and Hupka, D. (2011). "Isolation and evaluation of soil microorganisms for control of clubroot on canola.", Plant Canada 2011, Saint Mary's University, Halifax, NS, Canada, July 17-21, 2011, Published in: *Can. J. Plant Pathol.* (2012) 34:342.
- Peng, G., Falk, K.C., James, B., and Gugel, R.K. (2011). "Evaluation of *Brassica* germplasm for resistance to clubroot of canola.", *Canadian Journal of Plant Pathology*, 33(2), pp. 261. (Abstract)
- Peng, G., Falk, K.C., James, B., and Gugel, R.K. (2011). "Evaluation of *Brassica* germplasm for resistance to clubroot.", 31st Annual Meeting of the Plant Pathology Society of Alberta, Lethbridge, AB, Canada, October 12-14, 2010. (Poster)
- Peng, G., Falk, K.C., Yu, F.Q., and Gossen, B.D. (2011). "Identification of new clubroot-resistance sources and development of clubroot resistance canola germplasm.", Clubroot Summit 2011, Saskatoon, SK, Canada, March 9, 2011.
- Peng, G., Hynes, R.K., Boyetchko, S.M., Gossen, B.D., and Pageau, D. (2011). "Biocontrol of canola.", Clubroot Summit 2011, Saskatoon, SK, Canada, March 9, 2011, Invited presentation.
- Peng, G., Hynes, R.K., Hwang, S.F., Pageau, D., McDonald, M.R., Gossen, B.D., and Boyetchko, S.M. (2011). "Assessment of microbial biofungicides for control of clubroot on canola.", Clubroot Summit 2011, Saskatoon, SK, Canada, March 9, 2011.
- Peng, G., Lahlali, R.L., Hwang, S.F., Hynes, R.K., McDonald, M.R., Pageau, D., Gossen, B.D., Strelkov, S.E., and McGregor, L. (2011). "Control of clubroot on canola using the biofungicide Serenade plus cultivar resistance.", 13th International Rapeseed Congress, Prague, Czech Republic, June 5-9, 2011, pp. 1134-1137.
- Peng, G., Yu, F.Q., Hynes, R.K., Pageau, D., McDonald, M.R., and Gossen, B.D. (2011). "Managing clubroot and blackleg on canola in western Canada - current status of research.", Anhui Academy of Agricultural Science Seminar, Anhui Academy of Agricultural Science, Hefei, China, November 14, 2011. (Presentation)
- Strelkov, S.E., Hwang, S.F., Howard, R.J., Rahman, H., Kutcher, H.R., Turkington, T.K., Gossen, B.D., Peng, G., McLaren, D.L., LeBoldus, J.M., Feng, J., Cao, T., and Manolii, V.P. (2011). "Clubroot



Risk Mitigation Initiative: Pathology Pillar.", Clubroot Summit 2011, Saskatoon, SK, Canada, March 9, 2011, Invited presentation.

- Strelkov, S.E., Hwang, S.F., Howard, R.J., and Peng, G. (2011). "Clubroot in the Canadian canola (*Brassica napus*) crop: challenges and successes in dealing with an emerging disease.", 13th International Rapeseed Congress, Prague, Czech Republic, June 5-9, 2011, pp. 1126-1127.

### **White, Noel (Winnipeg)**

Technology Transfer Publications:

2011

- Emadi, T.A., Shafai, C., Thomson, D.J., Freund, M.S., White, N.D.G., and Jayas, D.S. (2011). "Polymer-based micromachined chemically modified gas sensor on a temperature controlled platform.", 10th IEEE Sensors Conference, Limerick, Ireland, October 28-31, 2011, Article number 6127017, pp. 1024-1027.
- Mahesh, S., Jayas, D.S., Paliwal, J., and White, N.D.G. (2011). "Neural network prediction of wheat classes and moisture contents using near-infrared (NIR) hyperspectral images of bulk samples from different growing locations and crop years.", 2011 ASABE Annual International Meeting, Louisville, KY, USA, August 7-11, 2011, Vol. 6, pp. 4609-4626.

### **Fields, Paul (Winnipeg)**

Technology Transfer Publications:

2014

- Li, Y.Y., Floate, K.D., Fields, P.G., and Pang, B. (2014). "Review of treatment methods to remove *Wolbachia* bacteria from arthropods. Symbiosis. (online)".

2013

- Abdelghany, A.Y. and Fields, P.G. (2013). "Distribution and mortality of *Cryptolestes ferrugineus* and *Rhyzopertha dominica* adults in small bin trial in response to low temperatures.", Proc. Man. Entomological Society. (Abstract)
- Akhtar, J., Hynes, R.K., Taylor, W.G., Fields, P.G., and Isman, M.B. (2013). "Toxicity and feeding deterrent effects of a pea extract and pea protein against the cabbage looper, *Trichoplusia ni* (Lepidoptera: Noctuidae).", 1st International Conference on Pesticidal Plants, Nairobi, Kenya, 21-24 January, 2013.
- Fields, P.G., Abdelghany, A.Y., Taylor, W.G., and Hynes, R.K. (2013). "Small bin trial of pea extract to control stored-product insects.", IOBC-WPRS, Integrated Protection of Stored Products, Bordeaux, France, July 2-4, 2013.
- Li, Y.Y., Floate, K.D., Fields, P.G., and Pang, B. (2013). "Effect of antibiotics on *Wolbachia* infections in *Tribolium confusum* and on host reproduction.", 61st Annual meeting of the Entomological Society of Alberta, Olds College, Olds, AB, Canada, October 10-11, 2013.
- Li, Y.Y., Floate, K.D., Fields, P.G., and Pang, B. (2013). "Effect of antibiotics on *Wolbachia* infections in *Tribolium confusum* and on host reproduction.", 69th Annual Meeting of the Entomological Society of Manitoba, Winnipeg, MB, Canada, November 1-2, 2013.
- Li, Y.Y., Floate, K.D., Fields, P.G., and Pang, B. (2013). "Effect of antibiotics on *Wolbachia* infections in *Tribolium confusum* and on host reproduction.", Joint Annual Meeting of the Entomological Societies of Ontario and Canada, Guelph, Ontario, Canada, October 20-23, 2013.

## CROPPING SYSTEM MICROBIOLOGY

### Lupwayi, Newton (Lethbridge)

#### Technology Transfer Publications:

2014

- Larney, F.J., Li, L., Lupwayi, N.Z., Angers, D.A., Pearson, D.C., and Blackshaw, R.E. (2014). "Irrigated crop rotations: soil quality.", Irrigated Crop Production Update, Lethbridge, AB, Canada, January 21-22, 2014.
- Lupwayi, N.Z., Harker, K.N., Larney, F.J., Blackshaw, R.E., and O'Donovan, J.T. (2014). "Correlating soil microbial properties with crop yields in the Canadian prairies: two case studies.", Soil's Role in Restoring Ecosystem Services Conference, Sacramento, CA, USA, March 6-9, 2014. (Abstract)
- Lupwayi, N.Z., Larney, F.J., Pearson, D.C., Kanashiro, D.A., and Blackshaw, R.E. (2014). "Shifts in soil microbial community structure after 12 years of conservation management on irrigated crop rotations.", 51st Annual Alberta Soil Science Workshop, Calgary, AB, Canada, February 12-14, 2014, pp. 37. (Abstract)

2013

- Pageni, B.B., Lupwayi, N.Z., Akter, Z., Larney, F.J., and Kawchuk, L.M. (2013). "Characterization of bacterial endophytes from potato (*Solanum tuberosum* L.) reveals growth-promoting and antagonistic properties in vitro.", 50th Annual Alberta Soil Science Workshop, Lethbridge, AB, Canada, February 19-21, 2013.
- Pearson, D.C., Larney, F.J., Blackshaw, R.E., and Lupwayi, N.Z. (2013). "Soil carbon changes over 12 years on the Vauxhall irrigated rotation study.", 50th Annual Alberta Soil Science Workshop, Lethbridge, AB, Canada, February 19-21, 2013. (Abstract)

2012

- Larney, F.J., Pearson, D.C., Blackshaw, R.E., Lupwayi, N.Z., Regitnig, P.J., and Balasubramanian, P.M. (2012). "Irrigated crop rotation research: Findings from the Vauxhall rotation study over 12 years (2000-11).", 2012 Irrigated Crop Production Update Conference, Lethbridge, AB, Canada, January 31-February 1, 2012. (Abstract)
- Larney, F.J., Pearson, D.C., Blackshaw, R.E., Lupwayi, N.Z., and Balasubramanian, P.M. (2012). "Irrigated dry bean response to cropping history and soil management practices in southern Alberta.", 9th Canadian Pulse Research Workshop, Niagara Falls Marriott Gateway, Niagara Falls, ON, Canada, November 6-12, 2012. (Abstract)
- Larney, F.J., Pearson, D.C., Blackshaw, R.E., Lupwayi, N.Z., and Regitnig, P.J. (2012). "Building soil quality on irrigated rotations in southern Alberta.", 49th Annual Alberta Soil Science Workshop, Ramada Inn, Edmonton, AB, Canada, February 14-16, 2012. (Abstract)
- Larney, F.J., Pearson, D.C., Blackshaw, R.E., Lupwayi, N.Z., and Regitnig, P.J. (2012). "What have we learned about potatoes in the 12 yr Vauxhall irrigated rotation study.", Potato Growers of Alberta Annual Meeting, Red Deer, AB, Canada, November 13-15, 2012. (Poster)
- Olson, M., Lupwayi, N.Z. (2012). "Has the faba bean's time arrived?", *Pulse Crop News*, 2012(Winter), pp. 23-24.

- Pageni, B.B., Lupwayi, N.Z., Larney, F.J., Kawchuk, L.M., Pearson, D.C., Blackshaw, R.E., and Gan, Y.T. (2012). "Characterization of bacterial endophytes associated with *Solanum tuberosum* in irrigated cropping systems.", 112th General Meeting of American Society for Microbiology, San Francisco, CA, USA, June 15-19, 2012. (Abstract)
- Pageni, B.B., Lupwayi, N.Z., Larney, F.J., Kawchuk, L.M., Pearson, D.C., Blackshaw, R.E., and Gan, Y.T. (2012). "Preceding crop, rotation length and soil management effects on bacterial endophytes.", 49th Annual Alberta Soil Science Workshop, Ramada Inn, Edmonton, AB, Canada, February 14-16, 2012. (Abstract)

## 2011

- Akter, Z., Lupwayi, N.Z., and Balasubramanian, P.M. (2011). "Nitrogen-use efficiency and biological nitrogen fixation of dry beans.", 49th Annual Alberta Soil Science Workshop, Ramada Inn, Edmonton, AB, Canada, February 14-16, 2012. (Abstract)
- Akter, Z., Lupwayi, N.Z., and Balasubramanian, P.M. (2011). "Nitrogen-use efficiency and biological nitrogen fixation of dry beans.", Biennial Meeting of the Bean Improvement Cooperative and North American Pulse Improvement Association (BIC/NAPIA 2011), Verdanza Hotel, San Juan, Puerto Rico, October 30-November 2, 2011. (Abstract)
- Akter, Z., Lupwayi, N.Z., and Balasubramanian, P.M. (2011). "Nitrogen-use efficiency and biological nitrogen fixation of dry beans.", Pulse Science Cluster Scientific Meeting 2011, Radisson Hotel, Saskatoon, SK, Canada, November 17-18, 2011. (Abstract)
- Dai, M., Hamel, C., St. Arnaud, M., Grant, C.A., Lupwayi, N.Z., Janzen, H.H., Yang, X.Q., and Zhou, Z. (2011). "Composition and diversity of arbuscular mycorrhizal fungi in cropping system associated with different soil zones using pyrosequencing.", Soils Ecology Society Meeting 2011, University of British Columbia - Okanagan, Kelowna, BC, Canada, May 24-27, 2011, pp. 43.
- Grant, C.A., Zebarth, B.J., Malhi, S.S., Soon, Y.K., Selles, F., Lupwayi, N.Z., O'Donovan, J.T., Harker, K.N., and Clayton, G.W. (2011). "Changes in soil ammonium and nitrate concentration over the growing season in western Canada as affected by urea or controlled release urea application.", 12th International Symposium on Soil and Plant Analysis, Mediterranean Agronomic Institute of Chania, Crete, Greece, June 6-10, 2011.
- Larney, F.J., Pearson, D.C., Blackshaw, R.E., Lupwayi, N.Z., Regitnig, P.J., and Balasubramanian, P.M. (2011). "Dry bean performance in the Vauxhall irrigated rotation study over 12 growing seasons (2000-11).", Pulse Science Cluster Scientific Meeting 2011, Radisson Hotel, Saskatoon, SK, Canada, November 17-18, 2011. (Abstract)
- Larney, F.J., Pearson, D.C., Blackshaw, R.E., Lupwayi, N.Z., and Regitnig, P.J. (2011). "A soil conservation package for irrigated rotations in southern Alberta.", 2011 ASA-CSSA-SSSA International Annual Meeting: Fundamental for life: soil, crop and environmental sciences, San Antonio, TX, USA, October 16-19, 2011. (Abstract)
- Larney, F.J., Pearson, D.C., Blackshaw, R.E., Lupwayi, N.Z., and Regitnig, P.J. (2011). "Potato performance in the Vauxhall irrigated rotation study over 12 growing seasons (2000-11).", 2011 Annual Meeting of Potato Growers of Alberta, Calgary, AB, Canada, November 15-18, 2011. (Abstract)
- Lupwayi, N.Z. (2011). "Conserving biological soil health.", Southern Alberta Soil Conservation Association (SACA) AGM, Taber, AB, Canada, February 26, 2011. (Presentation)
- Lupwayi, N.Z. (2011). "Crop residues for improving biological soil health.", International No Till Conference, Dnipropetrovsk, Ukraine, June 29-July 1, 2011.

- Lupwayi, N.Z. (2011). "Crop rotation effects on soil biology and health.", Agronomy Update Conference 2011, Lethbridge, AB, Canada, January 18-19, 2011. (Presentation)
- Lupwayi, N.Z. (2011). "Microbial decomposition of legume crop residues and N release.", Soils Ecology Society Meeting 2011, University of British Columbia - Okanagan, Kelowna, BC, Canada, May 24-27, 2011. (Abstract)
- Lupwayi, N.Z. and Soon, Y.K. (2011). "Nitrogen fixation and multi-year N release from pulse crop residues.", Pulse Science Cluster Scientific Meeting 2011, Radisson Hotel, Saskatoon, SK, Canada, November 17-18, 2011. (Abstract)
- Lupwayi, N.Z. and Soon, Y.K. (2011). "Nitrogen released from legume crop residues during two succeeding non-legume crops.", Plant Canada 2011, Saint Mary's University, Halifax, NS, Canada, July 17-21, 2011. (Abstract)
- O'Donovan, J.T., Blackshaw, R.E., Grant, C.A., Harker, K.N., Lafond, G.P., Johnson, E.N., Gan, Y.T., May, W.E., Turkington, T.K., and Lupwayi, N.Z. (2011). "Legume Crops to Improve Soil Fertility for Enhanced Canola Production.", 2011 ASA-CSSA-SSSA International Annual Meeting: Fundamental for life: soil, crop and environmental sciences, San Antonio, TX, USA, October 16-19, 2011. (Poster)
- Pageni, B.B., Lupwayi, N.Z., Larney, F.J., Kawchuk, L.M., Pearson, D.C., Blackshaw, R.E., and Gan, Y.T. (2011). "Preceding crop, rotation length and soil management effects on bacterial endophytes.", Pulse Science Cluster Scientific Meeting 2011, Radisson Hotel, Saskatoon, SK, Canada, November 17-18, 2011. (Abstract)
- Pageni, B.B., Lupwayi, N.Z., Larney, F.J., Pearson, D.C., and Blackshaw, R.E. (2011). "Soil microbial biomass and diversity in irrigated crop systems.", Soil Ecology Society Meeting, Kelowna, BC, Canada, May 24-27, 2011. (Abstract)

### **Hamel, Chantel (Swift Current)**

#### Technology Transfer Publications:

2013

- Herath, A., Zhang, T.Q., Tan, C.S., Hamel, C., Bittman, S., Parkin, G.W., and Goss, M.J. (2013). "Development of a soil test for prediction of long-term potential for phosphorus loss in typical Canadian soils.", ASA/CSSA/SSSA International annual meeting, Tampa, Florida, USA, November 3-6, 2013.
- Herath, A., Zhang, T.Q., Tan, C.S., Hamel, C., Welacky, T.W., Parkin, G.W., Goss, M.J., and O'Halloran, I.P. (2013). "Effects of liquid, solid and compost swine manure on soil phosphorus fractions in a clay loam soil under corn-soybean rotation.", CSSS Annual Meeting, AB, Canada.
- Ziadi, N., Bélanger, G., Grant, C.A., Cade-Menun, B.J., Lalonde, R., Hamel, C., Lafond, J., Lajeunesse, J., Pageau, D., Tremblay, G.F., and Zhang, T.Q. (2013). Soil and plant phosphorus assessment and modeling in Canadian agro-ecosystems. Final report SAGES#1475. (Report)

2012

- Bazghaleh, N., Hamel, C., Ellouze, W., and Singh, D. (2012). "Tweaking biological environments with flower power.", Meeting with wheat-breeding and farmers, Semiarid Prairie Agricultural Research Centre, Swift Current, SK, Canada, March 9, 2012. (Presentation)
- Dai, M., Sheng, M., Bremer, R., He, Y., Wang, H., and Hamel, C. (2012). "Estimating AM fungal resources in wheat fields.", Soils and Crops Workshop 2012, University of Saskatchewan, Saskatoon, SK, Canada, March 13-14, 2012, CD-ROM.

- Hamel, C. (2012). "Beneficial Microorganisms.", 24th Annual Conference of the Saskatchewan Soil Conservation Association (SSCA), Saskatoon Inn, Saskatoon, SK, Canada, January 11, 2012.
- Hamel, C. (2012). "Mycorrhiza for agriculture and forestry.", FABS432/APMC832 Microbial Bioproducts in Agriculture, February 16, 2012. (Presentation)
- Micali, C., Nadimi, M., Hamel, C., Hijri, M., and St-Arnaud, M. (2012). "Advances in the Characterization of Soil and Root Microbial Communities and their Role in Sustainable Agriculture.", Canadian Organic Science Conference and Organic Science Cluster Strategic Meetings, University of Manitoba, Winnipeg, MB, Canada, February 21-23, 2012, pp. 50.
- Navarro-Borrell, A., Dai, M., Sheng, M., Bremer, E., Hamel, C., He, Y., and Wang, H. (2012). "Current state of soil P and AM fungal resources in Canadian Prairie wheat fields.", General Meeting of the Saskatchewan Organic Directorate, Farmers' Market, Saskatoon, SK, Canada, March 23, 2012.

## 2011

- Bazghaleh, N., Hamel, C., Knight, J.D., Gan, Y.T., Ishii, T., and Cruz, A.F. (2011). "Chickpea root antifungal activity and mycorrhization.", Pulse Science Cluster Scientific Meeting 2011, Radisson Hotel, Saskatoon, SK, Canada, November 17-18, 2011, pp. 17.
- Dai, M., Hamel, C., St. Arnaud, M., Grant, C.A., Lupwayi, N.Z., Janzen, H.H., Yang, X.Q., and Zhou, Z. (2011). "Composition and diversity of arbuscular mycorrhizal fungi in cropping system associated with different soil zones using pyrosequencing.", Soils Ecology Society Meeting 2011, University of British Columbia - Okanagan, Kelowna, BC, Canada, May 24-27, 2011, pp. 43.
- Dai, M., Sheng, M., and Hamel, C. (2011). "AM fungal resources in Prairie soils: Monitoring changes in diversity with commercial soil testing laboratory.", 1st Annual World Congress of Microbes-2011, Beijing, China, July-August 1, 2011.
- Ellouze, W., Hamel, C., Bouzid, S., and St. Arnaud, M. (2011). "Mycorrhizosphere interactions mediated through rhizodepositions and arbuscular mycorrhizal hyphodeposition and their application in sustainable agriculture", in Fulton, S.M. (ed.) - Mycorrhizal Fungi: Soil, Agriculture and Environmental Implications, Nova Science Publishers Inc, pp. 133-152.
- Ellouze, W., He, Y., Hamel, C., Wang, H., Hanson, K.G., and Singh, A.K. (2011). "Arbuscular mycorrhiza interaction with historical and modern wheat genotypes.", 1st Canadian Wheat Symposium, Winnipeg, MB, Canada, November 30-December 2, 2011. (Poster)
- Ellouze, W., St-Arnaud, M., Hamel, C., Gan, Y.T., Cruz, A.F., and Ishii, T. (2011). "Phytochemicals and spore germination: at the root of AMF host preference?", Soils Ecology Society Meeting 2011, University of British Columbia - Okanagan, Kelowna, BC, Canada, May 24-27, 2011, pp. 64.
- Hamel, C. (2011). "Adapted crop plants.", *Prairie Steward Newsletter*. (Newsletter)
- Hamel, C. (2011). "Analysis de comunidades con "R".", IV Congreso Colombiano de Biotecnología – Conciencia Industrial, Universidad Nacional de Colombia sede Medellín, Medellín, Colombia, August 8-11, 2011.
- Hamel, C. (2011). "Chemical Ecology: Using flower power to feed a sustainable world.", Soils Ecology Society Meeting 2011, University of British Columbia - Okanagan, Kelowna, BC, Canada, May 24-27, 2011.
- Hamel, C. (2011). "Micorriza en un mundo sostenible.", IV Congreso Colombiano de Biotecnología – Conciencia Industrial, Universidad Nacional de Colombia sede Medellín, Medellín, Colombia, August 8-11, 2011.

- Hamel, C. (2011). "Mycorrhiza arbuscular en un mundo sostenible.", IV Congreso Colombiano de Biotecnología – Conciencia Industrial, Universidad Nacional de Colombia sede Medellín, Medellín, Colombia, August 8-11, 2011.
- Hamel, C., Bazghaleh, N., Dai, M., Furrázola Gomez, E., Torres-Arias, Y., and Singh, A.K. (2011). "Arbuscular mycorrhizal in a sustainable World.", Plant Canada 2011, Saint Mary's University, Halifax, NS, Canada, July 17-21, 2011.
- Hamel, C., Furrázola Gomez, E., and Torres-Arias, Y. (2011). "Diversity of arbuscular mycorrhizal fungi in cultivated soils of the Canadian Prairie.", Canadian Organic Science Conference and Organic Science Cluster Strategic Meetings, University of Manitoba, Winnipeg, MB, Canada, February 21-23, 2012, pp. 50.
- Hamel, C., Yang, C., Taheri, A.E., Bazghaleh, N., Navarro-Borrell, A., Cruz, A.F., Ishii, T., Vujanovic, V., Knight, J.D., Germida, J.J., and Gan, Y.T. (2011). "Microbial pipeline to next generation pulses.", Pulse Science Cluster Scientific Meeting 2011, Radisson Hotel, Saskatoon, SK, Canada, November 17-18, 2011, pp. 5.
- Knight, J.D., Chao, T., Bazghaleh, N., Navarro, A., Taheri, A.E., Hamel, C., and Gan, Y.T. (2011). "Crop Rotation Effects on Soil Biology.", Agronomy Update Conference 2011, Lethbridge, AB, Canada, January 18-19, 2011.
- Mavragani, D., Hamel, C., and Vujanovic, V. (2011). "Species-specific PCR-DGGE markers to distinguish *Pyrenophora* species associated to cereal seeds. [Fungal Biology 115 (2): pp. 169-175 (2011)] (Corrigendum).", *Fungal Biology*, 115(9), pp. 933.
- Navarro-Borrell, A., Furrázola, E., Rodes, R., Torres-Arias, Y., Collazo-Albernas, E., Gomez, O., Massia, C., and Hamel, C. (2011). "Influence of arbuscular mycorrhizal fungi inoculation on antioxidant metabolism and physiological development of black bean (*Phaseolus vulgaris* L.) under drought stress conditions.", Western Mycorrhiza Gathering 2011, Winfield Camp, BC, Canada, May 21-23, 2011.
- Navarro-Borrell, A., Hamel, C., Germida, J.J., and Gan, Y.T. (2011). "Arbuscular mycorrhiza fungi and dark septate endophytes colonization patterns are related with nutrient content in pulse and wheat Brown in the semiarid Canadian Prairie.", Pulse Science Cluster Scientific Meeting 2011, Radisson Hotel, Saskatoon, SK, Canada, November 17-18, 2011, pp. 18.
- Navarro-Borrell, A., Hamel, C., Germida, J.J., and Gan, Y.T. (2011). "Dark septate endophytes and arbuscular mycorrhiza fungi colonization patterns related with plant nutrient content in pulse and wheat.", Pulse Science Cluster Scientific Meeting 2011, Radisson Hotel, Saskatoon, SK, Canada, November 17-18, 2011, pp. 4.
- Navarro-Borrell, A., Hamel, C., Germida, J.J., and Gan, Y.T. (2011). "Elucidating the tripartite association plant-Arbuscular mycorrhizal fungi-dark septate endophytes [CD-Rom].", Soils and Crops Workshop 2011, Prairieland Park, Saskatoon, SK, Canada, March 15-16, 2011.
- Navarro-Borrell, A., Hamel, C., Hanson, K.G., McDonald, C.L., Germida, J.J., and Gan, Y.T. (2011). "Pulse and wheat crops' influence on soil dehydrogenase activity, soil nutrient content and microbial community.", Soils Ecology Society Meeting 2011, University of British Columbia - Okanagan, Kelowna, BC, Canada, May 24-27, 2011, pp. 67.
- Yang, C., Hamel, C., Gan, Y.T., and Vujanovic, V. (2011). "Isolation of hydrogen-oxidizing bacteria with positive effects on plant growth from chickpea field.", Pulse Science Cluster Scientific Meeting 2011, Radisson Hotel, Saskatoon, SK, Canada, November 17-18, 2011.

## ECONOMIST

### Smith, Elwin (Lethbridge)

#### Technology Transfer Publications:

2013

- Cagdas, A., Jeffrey, S.R., Smith, E.G., and Boxall, P. (2013). "Adoption of BMPs and Technical Inefficiency in Canadian Canola Production.", Agricultural and Applied Economics Association and the Canadian Agricultural Economics Society annual joint meeting, Washington DC, USA, August 4-6, 2013, Selected paper presentation.
- Le Roy, D. and Smith, E.G. (2013). Biotechnology innovation in Canadian canola. Report to the Canola Council of Canada., Department of Economics, University of Lethbridge. (Report)
- Smith, E.G. (2013). "Energy and Economics.", Agronomy and the Canadian Society of Agronomy annual joint meeting, Tampa, FL, USA, November 3-6, 2013.
- Smith, E.G. (2013). "Survey of Canola Growers: Practices, Inputs and Production.", Soils and Crops 2013, Saskatchewan, SK, Canada, March 6, 2013.
- Smith, E.G. and Warner, K. (2013). Canola Yield as impacted by Inputs, Management Decisions and the Environment., Agriculture and Agri-Food Canada, Lethbridge Research Centre. (Report)
- Smith, E.G. and Wregget, J. (2013). Selected Responses by Canola Growers to a 2011 Survey - Report prepared for the Canola Council of Canada, January 24, 2013,. (Report)
- Smith, E.G., Carew, R., and Warner, K. (2013). "Decision Making Among Canola Growers in the Prairie Provinces: The impact of Farm and Grower Characteristics.", Agricultural and Applied Economics Association and the Canadian Agricultural Economics Society annual joint meeting, Washington DC, USA, August 4-6, 2013.

2012

- Dunbar, J., Le Roy, D., and Smith, E.G. (2012). "Assessing the Risk and Returns From Alternative Canola Production Methods on the Canadian Prairies.", 2012 Annual Meeting of the Canadian Agricultural Economics Society (CAES), Niagara Falls, ON, Canada, June 17-19, 2012.
- Miller, J.J., Chanasyk, D.S., Curtis, T.W., Lastuka, D., Rogness, D., Ross, C.M., Schmitt, K., Smith, E.G., and Willms, W.D. (2012). "Watershed Evaluation of Beneficial Management Practices (WEBs project) in the Lower Little Bow River Basin of Southern Alberta.", 49th Annual Alberta Soil Science Workshop, Ramada Inn, Edmonton, AB, Canada, February 14-16, 2012. (Poster)
- Miller, J.J., Chanasyk, D.S., Curtis, T.W., Olson, B.M., Lastuka, D., Lewis, M., Petry, S., Rogness, D., Ross, C.M., Schmitt, K., Smith, E.G., and Willms, W.D. (2012). "Influence of P- and N-based Manure Application on Runoff Quality.", 64th Annual International Conference of the Soil and Water Conservation Society (SWCS), Dearborn, MI, USA, July 11-15, 2009, Poster #41, pp. 68. (Poster)
- Smith, E.G. (2012). "Economics of F<sub>2</sub> canola seed.", Agronomy Update Conference 2012, Red Deer, AB, Canada, January 17-18, 2012. (Presentation)
- Smith, E.G. (2012). "Production Risk: An Application to Malting Barley in Alberta.", Alberta Agricultural Economics Association Annual Meeting, Red Deer, AB, Canada, May 3-4, 2012. (Presentation)
- Smith, E.G., O'Donovan, J.T., Henderson, W.J., Turkington, T.K., and Clayton, G.W. (2012). "Malting Barley Production: Profitability and Risk.", 2012 Annual Meeting of the Canadian Agricultural Economics Society (CAES), Niagara Falls, ON, Canada, June 17-19, 2012.

2011

- Johnson, E.N., Brandt, S.A., Hall, L.M., and Smith, E.G. (2011). "Agronomic challenges and opportunities for second generation crops with novel traits and new crops.", in Beckie, H.J. and Hall, L.M. (eds.) - Topics in Canadian Weed Science, Vol. 8. New Crops and Crops with Second-Generation Traits: Weed Management Challenges, Canadian Weed Science Society – Société canadienne de malherbologie, Pinawa, MB, pp. 31-48.
- Larney, F.J., Willms, W.D., Smith, E.G., Janzen, H.H., Ellert, B.H., and Miller, J.J. (2011). "Other long-term experiments at Lethbridge Research Centre.", Historical Rotations Workshop, Lethbridge, AB, Canada, June 21-22, 2011. (Presentation)

### **Khakbazan, Mohammad (Brandon)**

Technology Transfer Publications:

2013

- Block, H.C., Durunna, O.N., Robins, C.D., Entz, M.H., Khakbazan, M., and Scott, S.L. (2013). "Effect of rested grazing and alfalfa inclusion in bromegrass pastures on cow-calf productivity.", CSAS-CMSA Joint Annual Meeting, Banff Park Lodge Resort Hotel and Conference Centre, Banff, AB, Canada, June 18-20, 2013, O36, pp. 17.

2012

- Khakbazan, M. (2012). "Economic and Biophysical Impacts of Land Management Practices in Southern Manitoba.", 67th Annual International Conference of the Soil and Water Conservation Society (SWCS), Fort Worth, TX, USA, July 22-25, 2012, pp. 31.

2011

- Khakbazan, M. (2011). "Practices and Impacts on Water Quality and Quantity in Canada.", 6th IWA Specialist Conference on Efficient Use and Management of Water, Dead Sea, Jordan, March 29-April 2, 2011.
- Khakbazan, M. (2011). "The economic and biophysical modeling of beneficial management practices in Agriculture.", Department of Agribusiness and Agricultural Economics, University of Manitoba, Winnipeg, MB, October 24, 2011. (Presentation)
- Khakbazan, M. and Hamilton, C. (2011). "WEBS STC Economics.", Manitoba STC - WEBS meeting, Winnipeg, MB, Canada, May 24-25, 2011.
- Khakbazan, M. and Hamilton, C. (2011). "Watershed Evaluation of Beneficial Management Practices – South Tobacco Creek Project.", 125th Anniversary of the Brandon Research Centre, Brandon, MB, Canada, August 11, 2011. (Poster)
- Khakbazan, M. and Hamilton, C. (2011). "Watershed Evaluation of Beneficial Management Practices - South Tobacco Creek Project – Economics.", Manitoba STC - WEBS meeting, Winnipeg, MB, Canada, May 24-25, 2011.

## **RELATED AGRONOMY CAPACITY**

### ***Environmental Soil Agronomy***

#### **Janzen, H. Henry (Lethbridge)**

Technology Transfer Publications:



## 2013

- Chai, L.L., Kröbel, R., Janzen, H.H., Beauchemin, K.A., McGinn, S.M., Bittman, S., Atia, A., and Edeogu, I. (2013). "A mass balance model based on total ammoniacal nitrogen for estimating ammonia volatilization from beef cattle manure management in Alberta in Canada.", ASABE Annual International Meeting, Kansas City, MO, USA, July 21-24, 2013, paper #:1596572.
- Ellert, B.H., Gregorich, E.G., and Janzen, H.H. (2013). "Measuring and Monitoring Soil Carbon Storage.", ASA/CSSA/SSSA International annual meeting, Tampa, Florida, USA, November 3-6, 2013, Oral presentation.
- Flaten, D.N., Janzen, H.H., Ominski, K.H., and Taylor, A.A. (2013). "Video-conferencing to deliver a graduate course on agricultural sustainability.", Joint annual meetings of the Canadian Society of Soil Science, Manitoba Soil Science Society, and Canadian Society of Agricultural and Forest Meteorology, Fort Garry Hotel, Winnipeg, MB, Canada, July 22-25, 2013, Oral presentation.
- Janzen, H.H. (2013). "Agricultural sustainability: some thoughts from a Canadian (science) perspective.", T2013 Tetrapartite meetings, Norwich, UK, June 2-5, 2013.
- Janzen, H.H. (2013). "Earth's malleable membrane.", Joint Annual Meetings of the Canadian Society of Soil Science, Manitoba Soil Science Society, Canadian Society of Agricultural and Forest Meteorology, Winnipeg, MB, Canada, July 22-25, 2013, Oral presentation.
- Janzen, H.H. (2013). "Managing soil carbon for manifold benefits.", STAP/GEF Special Session, Washington DC, USA, October 10, 2013, Oral presentation.
- Kröbel, R., Janzen, H.H., Little, S.M., and Li, S. (2013). "Preliminary Holos model assessment of GHG emissions from crop production in the Black-Brook watershed, NB, during the years 1988 – 1997.", CSSS/MSSS/CSAFM 2013 Annual Meeting, Winnipeg, MB., Canada, June 22-25, 2013.
- Kröbel, R., Janzen, H.H., Little, S.M., and Li, S. (2013). "Preliminary Holos model assessment of GHG emissions from crop production in the Black-Brook watershed, NB, during the years 1988 - 1997.", Canadian Soil Science Society 2013 Annual Meeting, Winnipeg, Manitoba, Canada, July 22-25, 2013.
- Li, L., Janzen, H.H., Larney, F.J., and Angers, D.A. (2013). "Long-term recovery of soil organic matter and aggregate stability in an artificially eroded soil under various one- time amendments.", Canadian Society of Soil Science-Manitoba Soil Science Soc.-Can. Soc. Agric. Forest Meteorology Joint Ann. Meeting, Winnipeg, MB, Canada, July 22-25, 2013, pp. 111. (Abstract)
- Li, L., Janzen, H.H., Larney, F.J., and Angers, D.A. (2013). "Long-term recovery of soil organic matter and aggregate stability in an artificially eroded soil under various one- time amendments.", Joint Annual Meetings of the Canadian Society of Soil Science, Manitoba Soil Science Society, Canadian Society of Agricultural and Forest Meteorology, Winnipeg, MB, Canada, July 22-25, 2013. (Poster)
- Little, S.M., Beauchemin, K.A., Janzen, H.H., Kröbel, R., and Maclean, K. (2013). "Holos - Methodology & Algorithms for Version 2.0.", AAFC Lethbridge, Lethbridge, AB, March 21, 2013. (Presentation)
- McGeough, E.J., Little, S.M., Janzen, H.H., McAllister, T.A., McGinn, S.M., and Beauchemin, K.A. (2013). "Greenhouse gas emissions from dairying in Eastern Canada – Effects of varying dairy cow replacement rate.", CSAS-CMSA Joint Annual Meeting, Banff Park Lodge Resort Hotel and Conference Centre, Banff, AB, Canada, June 18-20, 2013, P42, pp. 42. (Poster)

## 2012

- McGeough, E.J., Little, S.M., Janzen, H.H., McAllister, T.A., McGinn, S.M., and Beauchemin, K.A. (2012). "Life-cycle assessment of greenhouse gas emissions from dairy production in Eastern Canada: A case study.", Symposium on "Agriculture and greenhouse gases", Oslo, Norway, November 5-6, 2012, Oral Presentation.

2011

- Beauchemin, K.A., McGeough, E.J., Little, S.M., Janzen, H.H., McAllister, T.A., McGinn, S.M., and Maclean, K. (2011). "GHG modelling activities: an overview.", Seminar on Greenhouse Gases from Agriculture, Norwegian University of Life Sciences, Norway, June 29, 2011. (Presentation)
- Beauchemin, K.A., McGeough, E.J., Little, S.M., Janzen, H.H., McAllister, T.A., McGinn, S.M., and Maclean, K. (2011). "The Holos Model: reflections on progress and future plans.", Norway, June 2011. (Presentation)
- Beauchemin, K.A., McGeough, E.J., and Janzen, H.H. (2011). "Life cycle assessment - A holistic approach to assessing greenhouse gas emissions from beef and dairy production.", 1st Joint meeting of the American Society of Animal Science and the Association Argentina de Production Animal, Mar del Plata, Argentina, October 4-7, 2011. (Presentation)
- Dai, M., Hamel, C., St. Arnaud, M., Grant, C.A., Lupwayi, N.Z., Janzen, H.H., Yang, X.Q., and Zhou, Z. (2011). "Composition and diversity of arbuscular mycorrhizal fungi in cropping system associated with different soil zones using pyrosequencing.", Soils Ecology Society Meeting 2011, University of British Columbia - Okanagan, Kelowna, BC, Canada, May 24-27, 2011, pp. 43.
- DePauw, R.M., Malhi, S.S., Bullock, P.R., Gan, Y.T., McKenzie, R.H., Larney, F.J., Janzen, H.H., Cutforth, H.W., and Wang, H. (2011). "Wheat Production in Northern High Latitudes – Canadian example.", in Bonjean, A., Angus, W., and Van Ginkel, M. (eds.) - *The World Wheat Book A History of Wheat Breeding*. Vol. 2, Lavoisier Tech et Doc, Paris, France, pp. 607-651.
- Janzen, H.H. (2011). "After 100 years, what is left to learn?", Lethbridge Historical Plots Centennial Workshop, Lethbridge, AB, Canada, June 21-22, 2011. (Presentation)
- Janzen, H.H. (2011). "Changes in cropping and tillage practices in Alberta: A recent revolution.", No-till and Crop Diversification as Base for Soil Conservation and Achieving National Food Security, Shortandy, Kazakhstan, July 23-24, 2011, pp. 78-84.
- Janzen, H.H. (2011). "Listening to the land, from one century to the next.", Dr. Alex Johnston Lecture,, Galt Museum, Lethbridge, AB, Canada, November 10, 2011. (Presentation)
- Janzen, H.H. (2011). "Trial plots have stories to tell.", *Western Producer*, September 22, 2011, pp. 18-19.
- Janzen, H.H. and Ellert, B.H. (2011). "Rotations ABC and U: A centennial tribute.", Lethbridge Historical Plots Centennial Workshop, Lethbridge, AB, Canada, June 21-22, 2011. (Presentation)
- Larney, F.J. and Janzen, H.H. (2011). "Use of manure for restoring soil productivity.", Manure Management Update 2011, Lethbridge, AB, Canada, January 17, 2011, pp. 9-16.
- Larney, F.J., Willms, W.D., Smith, E.G., Janzen, H.H., Ellert, B.H., and Miller, J.J. (2011). "Other long-term experiments at Lethbridge Research Centre.", Historical Rotations Workshop, Lethbridge, AB, Canada, June 21-22, 2011. (Presentation)

### Ellert, Ben (Lethbridge)

Technology Transfer Publications:

2013

- Ellert, B.H., Gregorich, E.G., and Janzen, H.H. (2013). "Measuring and Monitoring Soil Carbon Storage.", ASA/CSSA/SSSA International annual meeting, Tampa, Florida, USA, November 3-6, 2013, Oral presentation.

2011

- Janzen, H.H. and Ellert, B.H. (2011). "Rotations ABC and U: A centennial tribute.", Lethbridge Historical Plots Centennial Workshop, Lethbridge, AB, Canada, June 21-22, 2011. (Presentation)
- Larney, F.J., Willms, W.D., Smith, E.G., Janzen, H.H., Ellert, B.H., and Miller, J.J. (2011). "Other long-term experiments at Lethbridge Research Centre.", Historical Rotations Workshop, Lethbridge, AB, Canada, June 21-22, 2011. (Presentation)

## **Remote Sensing**

### **Smith, Anne (Lethbridge)**

Technology Transfer Publications:

2013

- Kloppenburg, C., Smith, A.M., Staenz, K., Bouchier, R.S., and Coburn, C.A. (2013). "Detecting Leafy Spurge in Native Grassland Using Hyperspectral Image Analysis.", 34th Canadian Symposium on Remote Sensing, Victoria, BC, Canada, August 27-30, 2013.
- Oseen, I., Smith, A.M., Kloppenburg, C., Larson, G.L., and Bouchier, R.S. (2013). "Mapping the invasive weed species leafy spurge: the influence of image spatial and spectral resolution.", 34th Canadian Symposium on Remote Sensing, Victoria, BC, Canada, August 27-30, 2013.

2012

- Smith, A.M. (2012). "Eye in the sky – Earth observation tools monitor grassland productivity.", AgExpo 2012, Lethbridge, AB, Canada, February 29-March 2, 2012. (Presentation)

2011

- Kloppenburg, C., Smith, A.M., Staenz, K., Bouchier, R.S., and Van Hezewijk, B.H. (2011). "Detecting leafy spurge (*Euphorbia esula* L.) in native grassland using hyperspectral image analysis.", 32nd Canadian Symposium on Remote Sensing/14e Congrès de l'association québécoise de télédétection, Bishops University, Lennoxville, QC, Canada, June 13-16, 2011.
- Xu, W., Ren, X., and Smith, A.M. (2011). "Remote sensing, crop yield estimation and agricultural vulnerability assessment: A case of Southern Alberta.", 19th International Conference on Geoinformatics, Shanghai, China, June 24-26, 2011, published in Proceedings - 2011 19th International Conference on Geoinformatics, Article number 5980692, Category number CFP1132H-ART; Code 86318. (Presentation).

## **DEVELOPMENT**

### **Vera, Cecil (Melfort)**

Technology Transfer Publications:

2012

- Slaski, J.J. and Vera, C.L. (2012). "Northern Adapted Flax Agronomy Program: 2012 annual progress report and summary of the Phase I study to The Saskatchewan Flax Development Commission."

## 2011

- Blackshaw, R.E., Hao, X., Clayton, G.W., Harker, K.N., O'Donovan, J.T., Johnson, E.N., and Vera, C.L. (2011). "Canola response to polymer-coated urea versus urea in a four-year zero-tillage cropping system on the Canadian prairies.", 13th International Rapeseed Congress, Prague, Czech Republic, June 5-9, 2011, pp. 61-64.
- Fenn, D., Lukow, O.M., Vera, C.L., DePauw, R.M., Fox, S.L., Smith, M.A.H., Wise, I.L., and Procnier, J.D. (2011). "Kernel quality of hard red spring wheat damaged by the Orange Wheat Blossom Midge insect.", in Chibar, R.N. and Dexter, J. (eds.) - Wheat Science Dynamics: Challenges and Opportunities, Agrobias International, Jodhpur, India, pp. 193-198.
- Vera, C.L. and Rashid, K.Y. (2011). "Lodging in association with disease in flax breeding plots.", Soils and Crops Workshop 2011, Prairieland Park, Saskatoon, SK, Canada, March 15-16, 2011. (Poster)
- Vera, C.L., Irvine, R.B., Duguid, S.D., and Rashid, K.Y. (2011). "Effect of fungicide and N application on lodging and disease in flax.", Soils and Crops Workshop 2011, Prairieland Park, Saskatoon, SK, Canada, March 15-16, 2011. (Poster)

## ANNEX C) AAFC SCIENCE – STRATEGIC OBJECTIVES AND AREAS OF FOCUS

Strategic Objectives	Cereals and Pulses	Oilseeds	Horticulture	Forages and Beef
<b>Increase agricultural productivity</b>	<p>Increase the genetic potential of cereal and pulse crops</p> <p>Increase cereal and pulse crop ability to achieve genetic yield potentials</p>	<p>Increase the yield potential of oilseed crops and mitigate the impacts of abiotic stress factors, using genetic improvement, germplasm development, the creation of new breeding tools, and variety development</p> <p>Decrease the yield gap for oilseed crops by supporting integrated oilseed production systems, involving agronomy, crop protection, biology and early-generation and variety testing for crop adaptation to regional conditions</p>	<p>Minimize losses due to existing and emerging biotic and abiotic stresses through integrated crop production and management systems, and the development of knowledge and predictive tools</p> <p>Improve yield potential and tolerance to biotic and abiotic stresses for some major horticultural crops through genetic information and germplasm development</p>	<p><b>Forages</b></p> <ul style="list-style-type: none"> <li>• Germplasm and variety development in native and tame species for yield, persistence and nutritive value</li> <li>• Integrated forage crop management to optimize yield, persistence and nutritive value</li> </ul> <p><b>Beef</b></p> <ul style="list-style-type: none"> <li>• Animal feed efficiency - Reduction in animal stress</li> <li>• Advanced technologies in animal breeding and production</li> </ul>
<b>Enhance environmental performance</b>	<p>Improve efficiency of nutrient utilization</p> <p>Develop integrated crop management (ICM) practices to reduce the impact of insects, disease and weeds on cereal and pulse production systems</p>	<p>Enhance sustainable oilseed production practices</p> <p>Improve nutrient and water use efficiency</p> <p>Develop sustainability metrics for oilseed crop production</p>	<p>Improve efficiency of nutrient, water and energy utilization in horticultural practices</p> <p>Reduce environmental impacts of horticulture crop production through practices such as integrated pest management and integrated crop production</p>	<p><b>Forages</b></p> <ul style="list-style-type: none"> <li>• Develop industry and market-driven sustainability metrics</li> <li>• Increase resource use efficiency</li> </ul> <p><b>Beef</b></p> <ul style="list-style-type: none"> <li>• Develop market-driven sustainability metrics</li> <li>• Reduce environmental impact</li> </ul>

<b>Improve attributes for food and non-food uses</b>	Market-driven cereal and pulse genetics and production practices  Maximize the health potential of cereals	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 market demand for consistent composition and quality traits through crop management techniques Improve crop attributes for some major horticultural crops through genetic information and germplasm development	<b>Forages</b> • Identification and development of novel attributes of native and tame species <b>Beef</b> • Improve key beef quality characteristics • Market-driven quality assessment technologies • Improve beef by-product utilization • Alternatives to antimicrobials
<b>Address threats to the value chain</b>	Improve safety of cereals by reducing the presence of mycotoxins  Mitigate emerging biotic threats to Canadian cereal and pulse production	Develop new knowledge and tools to mitigate factors that threaten oilseed value chains including new and emerging biotic stresses	Develop knowledge and predictive capacity to anticipate emerging biotic factors that threaten the horticulture value chain, and develop tools and practices to mitigate them  Develop knowledge and tools necessary to meet the requirements for safety and marketability that are particular to horticultural products, from production practices through postharvest handling, storage and distribution	<b>Beef</b> • Current and future beef value chain pathogens
<b>Strategic Objectives</b>	<b>Dairy, Pork, Poultry and Other Livestock</b>	<b>Agri-Food</b>	<b>Bioproducts</b>	
<b>Increase agricultural productivity</b>	Increase the efficiency and productivity of dairy and pork production at the gene, animal and production system levels, to improve: - disease resistance - animal welfare of swine - sow and piglet productivity - lactation persistence	Support the sector in developing cost-effective agri-food processes and new agri-food products  Enhance by-product utilization in the development of agri-food products	Increase biomass yield potential and improve feedstock availability through: - genomics - germplasm development - agronomic improvement	

	<p>of dairy cattle</p> <ul style="list-style-type: none"> <li>- input use efficiency for dairy and swine</li> </ul>			
<b>Enhance environmental performance</b>	<p>Reduce the environmental impact of dairy and pork production at the animal level, to:</p> <ul style="list-style-type: none"> <li>- reduce greenhouse gas emissions and nutrient excretion in dairy cattle</li> <li>- reduce nutrient excretion and odours in swine</li> </ul> <p>At the production system level, reduce greenhouse gas and ammonia emissions, and improve nutrient management and efficiency of natural resource use in dairy, swine, poultry and other livestock operations</p>	<p>Develop greener alternative agri-food processing and preservation techniques including approaches to improve resource management, reduce waste and losses due to spoilage during production, processing and distribution</p>	<p>Improve sustainability of feedstock production and develop quantitative measures to support industry in the development of sustainability metrics</p>	
<b>Improve attributes for food and non-food uses</b>	<p>Identify and develop value-added characteristics for pig carcass and meat quality to help improve pork quality attributes for food uses and ensure the preservation of quality throughout the value chain</p>	<p>Generate new knowledge of attributes that differentiate Canadian agri-food products and ingredients while meeting quality and cost requirements</p> <p>Identify Canadian crops, livestock and agri-food products with bioactive or functional properties of economic interest, along with their nutritional and physicochemical properties and/or bio-functional benefits</p>	<p>Identify components and properties in existing crops and livestock for value-added industrial applications, and develop new purpose-grown biomass crops</p> <p>Increase biomass quality through:</p> <ul style="list-style-type: none"> <li>- genomics</li> <li>- germplasm development</li> <li>- agronomic improvement</li> </ul>	
<b>Address threats to the value chain</b>	<p>Improve the safety of the dairy and pork value chains:</p> <ul style="list-style-type: none"> <li>- improve the health status of cows and pigs</li> <li>- increase the safety of milk</li> <li>- reduce antibiotic use</li> <li>- decrease risks from manure / slurry pathogens and other</li> </ul>	<p>Identify pathogens and other chemical and biochemical threats to the food supply and generate knowledge of their ecology across the food processing value chain</p> <p>Develop novel approaches to reduce the incidence of</p>	<p>Mitigate emerging biotic and abiotic threats to bioproduct feedstock</p>	

	compounds  Improve gut health, reduce antibiotic use and develop	microbiological, chemical and bio-chemical threats to the food processing supply chain		
<b>Strategic Objectives</b>	<b>Biodiversity and Bioresource Collections</b>			
<b><i>Increase agricultural production</i></b>	<ul style="list-style-type: none"> <li>• Enhance crop productivity and resiliency by providing genetic variability for genetic improvement</li> <li>• Identify species and enhance understanding of pests and beneficial organisms that impact productive capacity</li> <li>• Enhance understanding of the impact of environmental perturbations (e.g., climate change) on biodiversity and its impact on productivity</li> </ul>			
<b><i>Enhance environmental performance</i></b>	<ul style="list-style-type: none"> <li>• Characterize ecological and evolutionary processes relevant to agriculture that enhance environmental performance</li> <li>• Enhance understanding of the impact of environmental perturbations on organisms relevant to agriculture, to support development of mitigation strategies</li> <li>• Enhance understanding and utilization of crop and livestock genetic diversity to support sustainable production</li> </ul>			
<b><i>Improve attributes for food and non-food uses</i></b>	<ul style="list-style-type: none"> <li>• Provide / utilize sources of genetic variability to improve the attributes of Canadian agricultural commodities, or to support new opportunities for food and non-food uses</li> </ul>			
<b><i>Address threats to the value chain</i></b>	<ul style="list-style-type: none"> <li>• Provide information on the incidence and movement of new pests or invasive species that pose a risk to Canadian agriculture</li> <li>• Enhance knowledge of invasive species and pests to improve risk identification and support development of diagnostic tests</li> <li>• Mitigate impact of pests and invasive species on production by providing science to develop and implement risk reduction strategies</li> <li>• Provide authoritative science to support other government departments/agencies in meeting requirements of domestic legislation/regulations</li> <li>• Mitigate genetic erosion of production systems by enhancing and conserving crop and farm animal genetic diversity</li> </ul>			
<b>Strategic Objectives</b>	<b>Agro-Ecosystem Productivity and Health</b>			
<b><i>Increase agricultural productivity</i></b>	<ul style="list-style-type: none"> <li>• Water - Improve land and crop management strategies and technologies in response to water stress</li> <li>• Climate and Air - Enhance production system performance to anticipated weather and climate impacts</li> <li>• Land and Soil - Enable informed land-use decisions based on land suitability; increase resource use efficiencies to reduce input costs to production</li> <li>• Biodiversity for Integrated Production Systems - Reduce impact of known pests through integrated crop and livestock management strategies</li> </ul>			
<b><i>Enhance environmental performance</i></b>	<ul style="list-style-type: none"> <li>• Water - Maintain/enhance quality of surface water and groundwater</li> <li>• Climate and Air - Maintain/enhance air quality by reducing undesired inputs into the atmosphere</li> <li>• Land and Soil - Maintain and enhance soil productive capacity; improve nutrient management; capture resource synergies and efficiencies</li> <li>• Biodiversity for Integrated Production Systems - Maintain and/or enhance desired ecosystem functions that directly benefit agricultural production</li> </ul>			
<b><i>Improve attributes for food and non-food uses</i></b>	<ul style="list-style-type: none"> <li>• Provide the sector with quantitative scientific measures that can be used to support development of environmental goods and services and sustainability metrics to preserve market access / capture opportunities</li> </ul>			
<b><i>Address threats to the value chain</i></b>	<ul style="list-style-type: none"> <li>• Climate and Air - Improve ability to address extreme weather risks to production; provide information to assess the agricultural production situation and extreme weather patterns to support sector and Government of Canada decision-making</li> <li>• Biodiversity for Integrated Production Systems - Mitigate impacts from emerging pest threats; mitigate loss of habitat for beneficial organisms (e.g., pollinators)</li> </ul>			



## ANNEX D) SCIENCE AND TECHNOLOGY BRANCH PILLARS

### Roles of Science and Technology Branch

- Informing regulatory and policy decisions
- Producing far-from-adoption applied science with broad stakeholder application
- Supporting innovation to improve economic prosperity

Pillar 1 Providing science that enhances the sector's resiliency	Pillar 2 Fostering new areas of opportunity for the sector	Pillar 3 Supporting sector competitiveness
<p>Addresses challenges to the resource base/sector's capability to produce</p> <ul style="list-style-type: none"> <li>• Upstream research – fundamental disciplines</li> <li>• AAFC is major provider</li> </ul> <p>Includes:</p> <ul style="list-style-type: none"> <li>• Maintaining the collections of invertebrate, plant, fungi and animal genetic resources to identify invasive species/new pests</li> <li>• Investigating the interactions of agricultural production with water, air, soils, and climate</li> <li>• Investigating crops and livestock biological mechanisms that may offer protection against threats and challenges</li> </ul>	<p>Addresses new and non-traditional commercial opportunities for the sector</p> <ul style="list-style-type: none"> <li>• AAFC leads in upstream research through to tech transfer/application for activities with public and broad stakeholder benefits</li> <li>• Moves into a supportive role as research moves downstream, for activities that will generate commercial benefits to private firms</li> </ul> <p>Includes:</p> <ul style="list-style-type: none"> <li>• Developing bioenergy, bio-industrial chemicals, and bio-based materials derived from crops and livestock</li> <li>• Supporting development of novel food and non-food products</li> </ul>	<p>Addresses existing sector's ability to respond to market demands</p> <ul style="list-style-type: none"> <li>• AAFC capacity is maintained to             <ul style="list-style-type: none"> <li>– Leverage research resources to address key challenges and opportunities</li> <li>– Provide expertise that industry can access through collaboration</li> </ul> </li> </ul> <p>Includes:</p> <ul style="list-style-type: none"> <li>• Developing improved production traits (e.g., resistance to specific pests, disease or weeds; yield enhancements)</li> <li>• Strategies to reduce risk to food value chain (pathogens, infectious agents)</li> <li>• Production practices that improve productivity, sustainability and profitability</li> <li>• BMPs that facilitate compliance with environmental regulations and enable sector participation in markets for environmental goods and services</li> <li>• Understanding critical factors influencing product quality</li> <li>• Finding alternatives to the use of antibiotics in livestock production</li> </ul>

Categories: Associations: Producer (Assoc.), Industry (Assoc. Ind.); Governments: Federal (Gvt. Fed.), Provincial (Gvt. Prv.); Institutes: 3P (Inst. 3P), College (Inst. College), Other (Inst. Other), University (Inst. Univ.), University Organization (Inst. Univ. Org.); Private (Priv.)

CATEGORY	NAME	LOCATION	PR	WEBSITE	NOTES
Assoc.	AB Barley Comm.	Calgary	AB	albertabarley.com	... Alberta Barley is a farmer-directed, not-for-profit organization representing Alberta's barley farmers. Alberta Barley collects a mandatory, but refundable, check-off and reinvests it to grow the barley industry ... founded in 1991. In the 20+ years since, it has advocated the interests of Alberta barley producers within the province and around the world. At the time of its creation, Alberta Barley was the first established wheat or barley commission in Canada ...
Assoc.	AB Canola Producers Commission (ACPC)	Edmonton	AB	canola.ab.ca	... the Agronomic Research Committee allocates producer dollars to various agronomic research projects that meet ACPC's mission of increasing the long term profitability of Alberta's canola growers ...
Assoc.	AB Fed. Of Agric.	Lacombe	AB	afaonline.ca	
Assoc.	AB Pulse Growers	Leduc	AB	pulse.ab.ca	... promotes the benefits of including pulses in a sustainable crop rotation and in a healthy diet through research and marketing initiatives, all in an effort to increase the sustainability and profitability of pulse production in Alberta ...
Assoc.	AB Wheat Comm.	Calgary	AB	albertawheat.com	(est. 2012 Aug) ... will replace the Alberta Winter Wheat Producers Commission and Alberta Soft Wheat Producers Commission ...
Assoc.	Agric. Producers Assoc. of SK (APAS)	Regina	SK	apas.ca	
* Assoc.	Agricultural Research and Extension Council of Alberta (ARECA)	Sherwood Park	AB	arec.ab.ca	... provincial association of non-profit producer groups dedicated to enhancing the sustainability and profitability of agriculture in Alberta ... members: Farming Smarter, SARDA, others ...
Assoc.	Barley Development Council		AB		est. 1994 ... comprised of private and public groups with an interest in barley ... includes barley producers, barley users, govt. institutions and the scientific community from across W Canada ... manage the Canadian Barley Symposium, support the various conferences and competitions related to the barley industry in Canada, as well as manage the money needed for administration and publishing.
* Assoc.	BC Grain Producers Association (BCGPA)	Fort St. John	BC	bcgrain.com	... purpose of the BC Grain Producers Association (BCGPA) is to improve the viability of the grains and oilseed industry in the BC Peace River region ...
Assoc.	Canadian Canola Growers Association	Winnipeg	MB	ccga.ca	
Assoc.	Canola Council of Canada	Winnipeg	MB	canolacouncil.org	... The Canola Council is the first industry association in Canada to encompass all links in the value chain. Together, we are building on the strengths of canola, Canada's greatest agricultural success story. Our members include canola growers, crop input suppliers, grain handling companies, exporters, processors, food and feed manufacturers and governments. All sit at the same table to develop a common platform for growth ...
Assoc.	Cereals Canada	Winnipeg	MB	(tba)	... Canada's national cereal grains council ... formed in 2012 ... 2014 Jan selected Winnipeg as HO ... follows the Canola Council of Canada's model of bringing together stakeholders from throughout a crop's value chain ...
* Assoc.	Chinook Applied Research Association (CARA)	Oyen	AB	www.chinookappliedresearch.ca	... memb. of ARECA ... established in 1979 ... a producer-directed society dedicated to expanding agricultural research activity in the Special Areas and MD of Acadia. Our program of applied research, demonstration and extension projects provides a link in the transfer of knowledge and technology between research and the producer. ...

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CATEGORY	NAME	LOCATION	PR	WEBSITE	NOTES
*	Assoc. Farming Smarter	Lethbridge	AB	farmingsmarter.com	... memb. of ARECA ... (formerly SARA & SACA) ... conducts a wide range of applied research projects within a geographic area of 14 million acres. This region contributes 43 per cent of the total gross farm receipts for Alberta as the area includes almost all of the province's irrigated acreage, substantial acres dedicated to crops of very high value, high concentrations of livestock, and large areas of dryland cropping and pasture ...
	Assoc. Flax Council of Canada	Winnipeg	MB	flaxcouncil.ca	... a national organization which promotes Canadian flax and flax products for nutritional and industrial uses in domestic and international markets ...
*	Assoc. Gateway Research Organization (GRO)	Westlock	AB		... memb. of ARECA ... areas served by GRO include: Westlock, Barrhead, Parkland County, Athabasca, Lesser Slave River
*	Assoc. Lakeland Ag Research Association (LARA)	Bonnyville	AB	areca.ab.ca/members/larahome.html	... memb. of ARECA ...
*	Assoc. Mackenzie Applied Research Association (MARA)	Fort Vermillion	AB	areca.ab.ca/marahome.html	... memb. of ARECA ... serve producers within our region by meeting the special needs that result from our unique climatic, geographic and soil conditions and to facilitate the transfer of Best Management Practices (BMPs) to producers on reducing production costs, marketing strategies, alternative practices and environmental sustainability ...
	Assoc. MB Buckwheat Growers Assoc.	Winnipeg	MB	specialcrops.mb.ca/crops/buckwheat.html	... The Canadian Special Crops Association and the Manitoba Buckwheat Association work to provide quality product and 'reliable service for buckwheat customers around the world ... In Canada, Kade Research Ltd. conducts buckwheat research in collaboration with Agriculture and Agri-Food Canada at Morden, MB ...
	Assoc. MB Canola Growers Association	Winnipeg	MB	mcgacanola.org	... Research and technology is a priority for MCGA. MCGA maintains the funding to agronomic research projects to ensure that Canadian and Manitoba canola remains a high quality crop. The majority of canola check-off dollars go to research that focuses on increasing the quality and yield of canola while decreasing the costs of production ...
	Assoc. MB Pulse Growers	Carman	MB	manitobapulse.ca	... provide Manitoba pulse grower members with production knowledge and market development support, through focused research, advocacy and linkages with industry partners ...
	Assoc. MB Wheat and Barley Growers Assoc.	Carman	MB	mbwheatandbarley.ca	... As of January 1, 2014 the Manitoba Wheat and Barley Growers Association joins other equivalent organizations established in Alberta (2012) and in Saskatchewan (2013) to strategically invest in research and market development initiatives that advance the profitability and sustainability of wheat and/or barley production for growers ...
*	Assoc. North Peace Applied Research Assoc. (NPARA)	Manning	AB	areca.ab.ca/members/nparahome.html	... memb. of ARECA ...
*	Assoc. Peace Country Beef & Forage Association (PCBFA)	Fairview and High Prairie		peacecountrybeef.ca	... memb. of ARECA ... formally known as North Peace Forage Association, was founded in 1982 by livestock producers in the Fairview and Hines Creek area for the purpose of demonstrating new forage varieties and technology in the Peace Country.
	Assoc. POGA - Prairie Oat Growers Assoc.	Regina	SK	poga.ca	... mission statement translates into POGA activities with strong emphasis on: Production and agronomic research; Communicating research results to farmers; Supporting market development initiatives; Networking with participants in research, processing and handling; Representing oat growers' views in policy development and regulatory matters ... also office for 3 prov. membs.: AB Oat Gr. Comm., SK Oat Dev. Comm., MB Oat Gr. Assoc.)

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Assoc.	POGA -AB Oat Growers Comm.		AB	poga.ca	
Assoc.	POGA -MB Oat Growers Assoc.		MB	poga.ca	
Assoc.	POGA -SK Oat Dev. Comm.		SK	poga.ca	
Assoc.	Pulse Canada	Winnipeg	MB	pulsecanada.com	... created 1997 ... is the national industry association that represents growers, processors and traders of pulse crops in Canada. Direction and funding for Pulse Canada is provided by the Alberta Pulse Growers Commission, Saskatchewan Pulse Growers, the Manitoba Pulse Growers Association, the Ontario Bean Growers, and the processors and exporters of Canadian peas, lentils, beans and chickpeas that are members of the Canadian Special Crops Association (CSCA) ...
Assoc.	SK Barley Dev. Commission (SBDC)	Saskatoon	SK	saskbarleycommission.com	(est. 2013 Jun) ... SBDC is a producer-led organization established to build a platform for growth in the province's barley industry. Check-off dollars administered by the SBDC will go toward research, market development and promotion initiatives that will lead to improved barley varieties, grow their marketability and provide higher value to producers. ...
Assoc.	SK Canola Development Commission	Saskatoon	SK	saskcanola.com	... In 2013-14 SaskCanola's research budget is \$1.8 million, with projects examined from researchers all over the world. The projects that are selected for funding are approved by SaskCanola's Research Committee which is comprised of producers from the Board of Directors who work with the research manager and experts in the community to carefully analyze the proposals that are received. SaskCanola's Research Committee has strict standards for approval. The research agenda of the commission remains focused on the producer ...
Assoc.	SK Flax Dev. Commission	Saskatoon	SK	saskflax.com	
Assoc.	SK Mustard Dev. Commission	Saskatoon	SK	saskmustard.ca	... SMDC is a producer-funded levy organization that operates under the Agrifood Act to administer a mandatory, but refundable check-off of 0.5 percent of gross sales on all mustard produced in SK. SMDC was created in 2004, originating from the SK Mustard Growers Association ...
Assoc.	SK Pulse Growers	Saskatoon	SK	saskpulse.com	... formed 1976 ... represents 17,000 SK pulse growers ... SPG invests approximately 60% of its annual budget into research and development (R&D) to ensure the competitiveness of SK growers and the profitability of the pulse industry as a whole. Our investments have provided significant benefits to the pulse industry ...
Assoc.	SK Seed Growers Assoc.	Yorkton	SK	saskseed.ca	... Formed in 1928, SSGA is an incorporated, non-profit organization, representing the interests of more than 800 pedigreed seed growers in SK, who produce approximately 400,000 acres of pedigreed seed every year – nearly a third of all the pedigreed seed acreage in Canada ...
Assoc.	SK Wheat Dev. Comm.	Saskatoon	SK	saskwheatcommission.com	(est. 2013 Jun) ... SWDC is a producer-led organization established to build a platform for growth in the province's wheat industry. Check-off dollars administered by the SWDC will go toward research, market development and promotion initiatives that will lead to improved wheat varieties, grow their marketability and provide higher value to producers ...
Assoc.	SK Winter Cereals Dev. Commission		SK	swcdc.info	(see detail in Winter Cereals Can. Inc., Minnedosa, MB)

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* Assoc.	Smoky Applied Research & Demonstration Association (SARDA)	Falher	AB	sarda.ca	... memb. of ARECA ... Established in 1986 to address local agricultural issues. SARDA is a non-profit organization directed by producers from the Municipal Districts of Smoky River, Big Lakes, Greenview and Northern Sunrise County ... applied research, distribute information, etc. ...
* Assoc.	West Forages (?= West Central Forage Association)	Evansburg	AB	www.westcentralforage.com	... memb. of ARECA ... Leading edge extension, innovative demonstration ... our projects, which can vary in anything from annual and perennial forage trials to silvopasture projects to supporting local watershed groups. ...
Assoc.	Winter Cereals Canada Inc.	Minnedosa	MB	wintercerealscanada.org	... Our Mission: To promote the development of winter cereals as viable crop choices for western Canadian farmers. Winter Cereals Canada Inc. is involved in promotion of the three major winter cereal crops (winter wheat, fall rye, winter triticale). Our Major Focus Is On: Research and Development Market Facilitation Extension ...
Assoc.	Winter Cereals MB Inc. (WCMI)	Minnedosa	MB	wcml.info	(see detail in Winter Cereals Can. Inc., Minnedosa, MB)
Assoc. Ind.	Brewing & Malting Barley Research Inst. (BMBRI)	Winnipeg	MB	bmbri.ca	... Strong industry membership is the foundation of BMBRI, providing the resources and expertise necessary to critically evaluate new malting barley varieties and identify industry needs. BMBRI currently represents eleven leading North American maltsters and brewers ...
Assoc. Ind.	Canadian International Grains Inst. (CIGI)	Winnipeg	MB	cigi.ca	... For 40 years Citi (Canadian International Grains Institute) has worked with the agricultural community worldwide in the promotion and utilization of Canadian field crops. Citi is an industry leader in delivering customized training programs and technical expertise and providing ongoing specialized technical support to customers around the world. Through unique projects and applied research activities Citi is also working with industry to identify diverse applications for Canada's field crops ...
Assoc. Ind.	Canadian Malting Barley Technical Ctr. (CMBTC)	Winnipeg	MB	cbtbc.com	... CMBTC is a non-profit, independent organization that was set up to provide technical assistance to the malting barley and brewing industries. The CMBTC is a unique one of a kind organization that was created to add value to Canadian malting barley and there is no other organization similar to it in the world ...
Assoc. Ind.	Canadian Special Crops Assoc. (CSCA)	Winnipeg	MB	specialcrops.mb.ca	... CSCA is a national trade association established in 1987. It represents companies involved in the merchandising of Canadian pulse and special crops, including bean, chickpea, lentil, pea, canary seed, buckwheat, sunflower seed and mustard seed. The CSCA currently has more than 110 members and partners, ranging from large multi-national organizations to single-plant processors. Together they represent more than 85% of the pulse and special crops produced in Canada ...
Assoc. Ind.	The Potash & Phosphate Inst. Of Canada	Saskatoon	SK	ppi-ppic.org	... The Potash & Phosphate Institute of Canada (PPIC), located in Saskatoon, SK, administers the Institute's international programs. The Foundation for Agronomic Research (FAR) was created by PPI to expand the Institute's research and education programs and allow the participation of others interested in improving the yields and efficiency of production agriculture ...
Gvt. Fed.	Ag & Agri-food Can. - Applied Technology Division	Saskatoon	SK		

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*	Gvt. Fed. Ag & Agri-food Can. - Brandon Research and Development Centre	Brandon	MB	www.agr.gc.ca/eng/science-and-innovation/research-centres	... expertise in agronomic, soil, water, nutrients, manure, beef nutrition, range meant, agroforestry, landscape based resource management and barley breeding to develop and evaluate crop and cow-calf production systems ...
	Gvt. Fed. Ag & Agri-food Can. - Cereal Research Centre	Winnipeg	MB	www.agr.gc.ca/eng/science-and-innovation/research-centres	... centre is dedicated to the development of superior varieties of high quality and disease resistant cereals, oilseeds and pulse crops ... / ... associated with three satellite locations: the Morden Research Station, the Canadian Centre for Agri-Food Research in Health and Medicine, and the Richardson Centre for Functional Foods and Nutraceuticals ...
*	Gvt. Fed. Ag & Agri-food Can. - Lacombe Research Centre	Lacombe	AB	www.agr.gc.ca/eng/science-and-innovation/research-centres	... integrated, sustainable crop, animal and honey bee production systems and crop varieties for the short-season environments ... / ... satellite research location: Beaverlodge Research Farm ...
*	Gvt. Fed. Ag & Agri-food Can. - Lethbridge Research Centre	Lethbridge	AB	www.agr.gc.ca/eng/science-and-innovation/research-centres	... sustainable crop production systems under dry land and irrigated conditions, environmental issues associated with a semi-arid climate, and beef production systems ... / ... three research substations located in Onefour, Vauxhall, and Stavely ...
*	Gvt. Fed. Ag & Agri-food Can. - Saskatoon Research Centre	Saskatoon	SK	www.agr.gc.ca/eng/science-and-innovation/research-centres	... research on prairie crops to support the agri-food industry in Western Canada ... / ... three field sites: the Melfort Research Farm, the <b>Scott</b> Research Farm and the Outlook Canada-SK Irrigation Diversification Centre (CSIDC) ...
*	Gvt. Fed. Ag & Agri-food Can. - Semiarid Prairie Agricultural Research Centre, Swift Current	Swift Current	SK	www.agr.gc.ca/eng/science-and-innovation/research-centres	... conducts major agricultural research on the dryland regions of Canada's prairies. The research centre was established in 1920 with the mandate to address severe drought, erosion, frost, pests, and crop disease related problems ... / ... associated research site at <b>Indian Head</b> ...
	Gvt. Fed. Ag & Agri-food Can. rsch. station - Pacific Agri-Food Research Centre - Agassiz	Agassiz	BC	www.agr.gc.ca/eng/science-and-innovation/research-centres	... horticultural and field crop production and protection including small fruits, greenhouse vegetables, special crops and forages; advanced processing, utilization, quality and safety of plant products; the cellular and molecular biology of plant pathogens; soil resource conservation and land evaluation and dairy cattle behaviour and welfare ...
	Gvt. Fed. Ag & Agri-food Can. rsch. station - Pacific Agri-Food Research Centre - Summerland	Summerland	BC	www.agr.gc.ca/eng/science-and-innovation/research-centres	... wholesome foods and novel bioproducts from high-value horticultural crops / home of the Canadian Plant Virus Collection ...
	Gvt. Fed. Canadian Grains Commission (CGC)	Winnipeg	MB	grainscanada.gc.ca	... The Canadian Grain Commission offers a variety of services as part of its mandate under the Canada Grain Act. The fees for these services form part of the Canadian Grain Commission's annual operating budget ...
	Gvt. Fed. Grain Research Lab - Canadian Grain Comm.	Winnipeg	MB	grainscanada.gc.ca	... The Grain Research Laboratory is the research division of the Canadian Grain Commission ... ongoing research to enhance the reputation of Canadian grains for quality and safety ... two kinds of research: crops, technology

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Gvt. Prv.	AB Ag - Ag Tech. Ctr.	Lethbridge	AB	www1.agric.gov.ab.ca/ \$department/deptdoc s.nsf/all/eng3096	... specialize in producing information based on research, development and evaluation for agricultural machinery and technology ...
Gvt. Prv.	AB Ag - Crop Diversification Ctr. South	Brooks	AB	www1.agric.gov.ab.ca/ \$department/deptdoc s.nsf/all/opp4386	... horticulture and special crops research development and extension ...
Gvt. Prv.	AB Ag - Field Crop Development Ctr.	Lacombe	AB	agric.gov.ab.ca	... FCDC conducts cereal breeding and development programs focused on feed barley (2-row, 6-row, and hullless), 2-row malting barley, spring and winter triticale, and winter wheat ...
Gvt. Prv.	AB Ag Research Inst. (AARI)	Edmonton	AB	entreprisescanada.ab.ca	... AARI is the primary agency in Alberta for funding, coordinating and promoting strategic agricultural initiatives in research, development and technology transfer for the agriculture and agri-food sector ...
* Gvt. Prv.	AB Innovates Bio Solutions (div of AB Innovates Tech Futures (AITF))	Edmonton	AB	bio.albertainnovates.ca	... delivering on the potential of agriculture and forestry in areas such as: value chain sustainability, advancing the biorefinery, quality food for health, industry challenges and emerging opportunities, and prion and prion-like protein misfolding diseases ... div of Alberta Innovates Tech Futures, albertatechfutures.ca ...
Gvt. Prv.	Agri-ARM: Conservation Learning Centre (CLC)	Prince Albert	SK	conservationlearningcentre.com	agriculture.gov.sk.ca/Agri-ARM - The Conservation Learning Centre (CLC) was established in 1993 through the Parkland Agriculture Research Initiative and Green Plan. In 1997, it was incorporated as a non-profit corporation with charitable status. The CLC encompasses 480 acres in the R.M. of Prince Albert. The applied research activities at this site include environmental stewardship, as well as public and agriculture educational programs. 2010-2014 CLC-SRC 5 yr. strategic relationship.
* Gvt. Prv.	Agri-ARM: East Central Research Foundation (Canora) / Parkland College	Canora	SK	parklandcollege.sk.ca	agriculture.gov.sk.ca/Agri-ARM - Agriculture, Development and Diversification Boards 12, 13, 18 and 19 joined to form the East Central Research Foundation (ECRF) in 1996. ECRF is an incorporated organization with the research farm located on 185 acres west of Canora on land leased from the town. The applied research activities at this site include projects on flax and crop residues, as well as manure management and forages. ... Parkland College and ECRF plan to continue agriculture research trial programs in the Yorkton area for the long term.
* Gvt. Prv.	Agri-ARM: Indian Head Agricultural Research Foundation	Indian Head	SK	iharf.ca	agriculture.gov.sk.ca/Agri-ARM - The Indian Head Agricultural Research Foundation (IHARF) was incorporated in July 1993 and is directed by a nine member Board of Directors. IHARF's mission is to promote profitable and sustainable agriculture by facilitating research and technology transfer activities for the benefits of its members and the agricultural community at large.
* Gvt. Prv.	Agri-ARM: Irrigation Crop Diversification Corporation (ICDC)	Outlook	SK	irrigationsaskatchewan.com	agriculture.gov.sk.ca/Agri-ARM - The Irrigation Crop Diversification Corporation (ICDC) was established under The Irrigation Act, 1996. Its purpose is to research and demonstrate to producers and irrigation districts profitable agronomic practices for irrigated crops. The Board of Directors includes representatives from irrigation districts across the province. ICDC is an industry partner at the Canada SK Irrigation Diversification Centre (CSIDC) in Outlook. Together, the ICDC and the SK Irrigation Projects Association (SIPA) host an Annual Irrigation Conference in December.

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*	Gvt. Prv. Agri-ARM: Northeast Agriculture Research Foundation (NARF)	Melfort	SK	agriculture.gov.sk.ca/Agri-ARM	agriculture.gov.sk.ca/Agri-ARM - The Northeast Agriculture Research Foundation (NARF) was formed in 1996 as a farmer-managed and directed vehicle to conduct local applied research and demonstration. Projects have been located at the AAFC Melfort Research Farm and the in the surrounding district. The facility also contributes land and access to equipment, technical support and an administration office.
*	Gvt. Prv. Agri-ARM: South East Research Farm (SERF)	Redvers	SK	agriculture.gov.sk.ca/Agri-ARM	agriculture.gov.sk.ca/Agri-ARM - The South East Research Farm (SERF) was incorporated as a non-profit producer corporation in 2001 and is located on 160 acres southeast of Redvers. SERF's mission is to provide quality applied research and demonstrations that are producer-driven with results extending to and beyond the farm gate to improve agricultural sustainability and encourage environmental stewardship.
*	Gvt. Prv. Agri-ARM: Western Applied Research Corporation (WARC)	Scott	SK	agriculture.gov.sk.ca/Agri-ARM	agriculture.gov.sk.ca/Agri-ARM - (WARC) is a producer based organization that facilitates applied research and demonstration projects as well as ensures the transfer of technology from research to the farm level. Affiliation with Agriculture and Agri-Food Canada (AAFC) at Scott and SK Agriculture at North Battleford has provided WARC with the needed expertise, guidance, and leadership to ensure success of the projects in order to benefit producers in northwest SK and the province.
*	Gvt. Prv. Agri-ARM: Wheatland Conservation Area Inc.	Swift Current	SK	agriculture.gov.sk.ca/Agri-ARM	agriculture.gov.sk.ca/Agri-ARM - The Wheatland Conservation Area Inc. was incorporated in 1983 and has managed and operated a very successful applied research site in the brown soil zone of southwest SK since 1997. This program has been widely accepted by producers, industry, and other funding sources. Success is due to quality research coupled with an industrious business development strategy, and an aggressive extension program.
	Gvt. Prv. Agriculture Demonstration of Practices and Technologies (ADOPT)		SK		... program is to accelerate the transfer of knowledge to SK producers and ranchers. The ADOPT program will provide funding to help producer groups demonstrate and evaluate new agricultural practices and technologies at the local level. The results of successful trials can then be adopted by farming operations in the region ...
	Gvt. Prv. AgWestman Agricultural Diversification Organization (WADO)	Melita	MB		
	Gvt. Prv. AgWestman Agricultural Diversification Organization (WADO)	Dauphin	MB		
*	Gvt. Prv. Alberta Ag & Rural Development (AA&RD)	Edmonton	AB	www.agric.gov.ab.ca	
	Gvt. Prv. Canada-Manitoba Crop Diversification Centre (MCDC)	Portage la Prairie	MB		... The Centre's mission in brief is to develop agronomic solutions to enhance crop diversification and support sustainable water management ...
*	Gvt. Prv. MB Agriculture Food and Rural Development (MAFRD)	Winnipeg	MB		Dr. Daryl Domitruk, , PhD, PAg, Director, Agri-Industry Dev and Advancement Div., MB Ag Fd and Rural Dev (MAFRD), (204) 823-1145 / Tracy Gilson, PhD, PAg, Res & Innov Mgr, MAFRD, Agri-Food Innovation and Adaptation Knowledge Ctr, #13-59 Scufield Blvd, Win, MB, R3Y 1V2, 204.232.0923



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Gvt. Prv.	PAMI Head Office & Western Beef	Humboldt	SK	pami.ca	... PAMI is an ISO 9001:2008-registered and ISO/IEC 17025:2005-accredited applied research, development, and testing organization serving agriculture and industry in W. Canada and beyond. ... Today, PAMI not only continues its research and development work for advancing agricultural technology, but has diversified and secured clients in forestry, mining, transportation, and the military. ... satellite offices in Winnipeg, MB; Saskatoon, SK; and Ottawa, ON. ...
Gvt. Prv.	PAMI MB facility	Portage la Prairie	MB		
Gvt. Prv.	Parkland Crop Diversification Foundation (PCDF)	Roblin	MB		... est. 1996 ... PCDF works with other Diversification Centers, to support rural entrepreneurs and farm businesses with small plot research information on crops and cropping programs that will lead to new crop developments, diversification and value added opportunities to the rural economy of the North West area. PCDF has a range of facilities and plot equipment for applied research activities ... currently focusing on industrial hemp, high yielding wheat for ethanol, higher oil & higher yielding canola for biodiesel and pulse crops ...
Gvt. Prv.	Prairies East Sustainable Agriculture Initiative, Inc.	Arborg	MB		
* Gvt. Prv.	SK Ministry of Ag	Regina	SK	agriculture.gov.sk.ca	Jalil Abdul, PhD, PAg, Dir., Research Br / Doug Pchajek, MSc, PAg, Manager, Research & Dev / SK Min of Ag, 3085 Albert St, Regina, SK,
Inst. 3P	Global Institute for Food Security	Saskatoon	SK	globalinstituteforfoodssecurity.org	... The Global Institute for Food Security (GIFS) is a unique public-private partnership that enables innovative, multi-disciplinary research, training, and technology development to improve sustainable crop production, enhance human and animal nutrition, and address the growing global demand for safe, reliable food. ...
* Inst.	AB Colleges: Fairview, <u>Lakeland</u> , Lethbridge,		AB		... The Olds College Centre for Innovation ... actively pursues involvement in applied research that advances innovation-based rural economic development in Alberta ...
* College	<u>Olds</u> , SAIT, NAIT				
Inst. College	MB Colleges - Red River College: Winnipeg, Southport, Selkirk, Portage la Prairie, Steinbach, Winkler		MB		
Inst. College	SK Colleges - Parkland College: Canora, Esterhazy, For Qu'Appelle, Melville, Yorkton, Kamsack		SK		... first year of Univ. of SK Ag & Bioresources / Parkland College and Lakeland College ... program to prepare students with little or no agricultural experience to work on grain farms
Inst. College	SK Colleges - SIAST: Saskatoon, Regina, Moose Jaw, Prince Albert		SK		
Inst. Other	Genome Prairie - Head Office	Saskatoon	SK	genomeprairie.ca	... Genome Prairie supports stakeholders across Manitoba and SK in capturing and maximizing the benefits of advanced research in genomics and related biosciences. This role is achieved by aligning the partners and resources needed to develop and manage targeted projects addressing regional priorities. Genome Prairie also enables participation among regional researchers in Genome Canada's competitive granting process for large-scale projects ...
Inst. Other	Genome Prairie -MB Office	Winnipeg	MB	genomeprairie.ca	

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*	Inst. Univ. Crop Development Centre (CDC)	Saskatoon	SK	agbio.usask.ca/research/centres-facilities/crop-development-centre.php	... The Crop Development Centre (CDC) is a field crop research organization within the Department of Plant Sciences at the University of SK. CDC scientists integrate basic research with genetic improvement of spring wheat, durum, canaryseed, barley, oat, flax, field pea, lentil, chickpea, fababean and dry bean ...
*	Inst. Univ. Univ. of AB	Edmonton	AB	ualberta.ca	... Department of Agricultural, Food and Nutritional Science (AFNS) ... AFNS attracted over \$43 million in research funding during the 2010/2011 fiscal year. The academic staff, consisting of 64 professors, 27 adjunct professors and 54 postdoctoral fellows, was responsible for 276 refereed publications and nearly 500 extension publications/presentations ...
	Inst. Univ. Univ. of Lethbridge	Lethbridge	AB	uleth.ca	... Our location's strong farming and ranching economy offers the opportunity to experience the practical application of agricultural research and methodology ...
*	Inst. Univ. Univ. of MB	Winnipeg	MB	umanitoba.ca	... crop research: The Ian N. Morrison Research Farm in Carman, MB. The Plant Science Field Station with a vegetable storage research facility, a pilot-scale food processing plant, as well as greenhouses, growth chambers and several special laboratories equipped to conduct research utilizing modern techniques in biotechnology. The Canadian Wheat Board Centre for Grain Storage Research is a 4.5 million facility for conduction research on various aspects of handling, drying and storing of grains, oilseeds, pulses and their derived products. And the Faculty is actively involved in the research conducted at the Richardson Centre for Functional Foods and Nutraceuticals ...
*	Inst. Univ. Univ. of SK	Saskatoon	SK	agbio.usask.ca	... College of Agriculture and Bioresources: Dept. of Plant Sc. (+CDC), Soil Sc., Kernon Crop Research Farm; Global Institutes for Water and Food Security; Indigenous Land Management Institute ...
*	Inst. Univ. University of Calgary	Calgary	AB	ucalgary.ca	
	Inst. Univ. Ag West Biotech (AWB) Org.	Saskatoon	SK	agwest.sk.ca	... Ag-West Bio, SK's bioscience industry association, works with innovators and investors to help bring research to market ...
	Inst. Univ. Canadian Light Source - Synchrotron Org.	Saskatoon	SK	lightsource.ca	... the application of synchrotron light to imaging plants to support the selection and development of superior crop lines ... imaging all components of the plant, from root to stem, and will explore ways plants can be structurally and functionally imaged, in-vivo to in-situ, and applying this information to aid in the development and selection of higher yielding crop varieties. It is believed that imaging will be a key tool in achieving substantial increases in crop productivity ...
	Inst. Univ. Canadian Wheat Alliance Org. (CWA)	Saskatoon	SK	canadianwheatalliance.ca	... CWA represents an unprecedented 11-year commitment among Agriculture and Agri-Food Canada, the University of SK, the province of SK and the National Research Council Canada, to support and advance research that will improve the profitability of Canadian wheat producers. CWA will align their complementary areas in six high-priority research areas. CWA also welcomes the engagement of both the public and private sector ...
	Inst. Univ. Innovation Place Res. Park Org.	Saskatoon	SK	www.innovationplace.com	... Adjacent to the Univ. of SK ... includes: SK Research Council, the National Hydrology Research Centre, Ag-West Bio, Genome Prairie, the Proteins Oils and Starch pilot plant and the Bioprocessing plant, plus several private research firms (total 130 clients) ...

Categories: Associations: Producer (Assoc.), Industry (Assoc. Ind.); Governments: Federal (Gvt. Fed.), Provincial (Gvt. Prv.); Institutes: 3P (Inst. 3P), College (Inst. College), Other (Inst. Other), University (Inst. Univ.), University Organization (Inst. Univ. Org.); Private (Priv.)

CATEGORY	NAME	LOCATION	PR	WEBSITE	NOTES
Inst. Univ. Org.	POS Pilot Plant	Saskatoon	SK	pos.ca	... est. 1977 ... work with leading industries to develop new products and expand processing capacity. From ingredients to bio-products to green solutions, our team brings bench strength and brilliant solutions to help companies grow ...
Inst. Univ. Org.	Western Canadian Feeds Innovation Network (WCFIN)	Saskatoon	SK	www.wcfin.ca	... leadership and direction for the feed value chain in W Canada ... free flow of information, technologies and research development to all members of the feed industry ... crop producers, livestock producers, feed manufacturers, private and public researchers, as well as agencies dedicated to funding high quality scientific development ... to capture our competitive advantage through cooperative development between research, industry and communities. WCFIN is an initiative of the Feed Innovation Inst (FII) at the Univ. of SK, with funding provided by the AB Meat and Livestock Agency (ALMA) ...
* Priv.	AgQuest - Head Office	Minto	MB	agquest.com	... Ag-Quest, Inc. began operations in 1983 with the aim of providing top quality, cost effective research to the Agricultural Industry ... Head Office, Minto MB ... Regional Offices AB and SK
Priv.	AgQuest -Research Station	Taber	AB	agquest.com	
Priv.	AgQuest -Research Station	Elm Creek	MB	agquest.com	
Priv.	AgQuest -Research Station	Saskatoon	SK	agquest.com	
* Priv.	Agritrends	Red Deer	AB	agritrend.com	... In 1997, AGRI-TREND was established with the goal of helping farming make better decision on crop input purchases ... representative across W. Can.
Priv.	Agrium -Crop Protection Services - Canola & Flax Breeding	Saskatoon	SK	cpsagu.ca	... CPS has made significant investments in seed research and development in W Canada ... canola and flax breeding programs located in Saskatoon, we have three research farms: Neapolis, AB; Watrous, SK; Rosebank, MB / acquisition of well over 200 of Viterra's Agri-Products Centers, we'll bring together innovative products and knowledge from over 1,250 retail outlets on three continents ...
Priv.	Agrium -Crop Protection Services - Research Farm	Neapolis	AB	cpsagu.ca	
Priv.	Agrium -Crop Protection Services - Research Farm	Rosebank	MB	cpsagu.ca	
Priv.	Agrium -Crop Protection Services - Research Farm	Watrous	SK	cpsagu.ca	
Priv.	Bayer - Headquarters	Calgary	AB	www.cropscience.bayer.ca	... Headquartered in Calgary, we also operate our seed processing facility in Lethbridge, our formulation and distribution facilities in Regina, our seed-breeding centre in Saskatoon, our eastern Canadian operation centre in Guelph and our regulatory office in Ottawa ... Bayer 2012, €782 million, or roughly 26% of the Bayer Group's research and development budget, was spent at Bayer CropScience ...
Priv.	Bayer -Formulation & Distribution	Regina	SK	www.cropscience.bayer.ca	
Priv.	Bayer -Seed Breeding	Saskatoon	SK	www.cropscience.bayer.ca	
Priv.	Bayer -Seed Processing	Lethbridge	AB	www.cropscience.bayer.ca	

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CATEGORY	NAME	LOCATION	PR	WEBSITE	NOTES
Priv.	Canterra Seeds	Winnipeg	MB	canterra.com	... mutual success through strategic partnerships that create the opportunities required to produce and sell top quality crop seed ...
Priv.	Dow AgroSciences Canada Inc. - Calgary Headquarters		AB	dowagro.ca	
Priv.	Dow AgroSciences Canada Inc. - Saskatoon Global Canola Research Centre		SK	dowagro.ca	... Nexera Canola, Mycogen Seeds, Hyland Seeds ... Dow AgroSciences Canada Inc. is headquartered in Calgary, Alberta, with commercial and research operations across Canada. Key research facilities include corn and soybean breeding in St. Marys and Blenheim, Ontario, cereals breeding in Nairn, Ontario, and a global canola research center in Saskatoon, SK ...
Priv.	Dow AgroSciences Canada Inc. - Saskatoon Wheat Breeding Collaboration		SK	dowagro.ca	(2013 May) ... Dow AgroSciences, a wholly owned subsidiary of The Dow Chemical Company (NYSE: DOW) announced today a significant wheat breeding collaboration with the University of SK's Crop Development Centre, one of the nation's premier plant breeding establishments. Under the R&D collaboration, Dow AgroSciences will partner with the Crop Development Centre on the development of wheat varieties for quality improvements and agronomic performance ...
Priv.	Farmers Edge Head Office	Winnipeg	MB	farmersedge.ca	HO +5 Hub offices MB, 2 Hub offices SK, 1 Hub office AB ... crop production more profitable and sustainable for our customers by assisting in the adoption of innovative agricultural practices. With the development and use of advanced tools and technologies ...
Priv.	Farmers Edge -Hub Office	Lethbridge	AB	farmersedge.ca	
Priv.	Farmers Edge -Hub Office	Kamsack	SK	farmersedge.ca	
Priv.	Farmers Edge -Hub Office	Outlook	SK	farmersedge.ca	
* Priv.	ICMS - Manitoba (Head Office & Regional Office)	Portage la Prairie	MB	icms-inc.com	est. 1985 ... Head Office MB; Regional Offices SK, AB, BC ... associates in E Canada ... expert services in environmental fate studies in compliance with OECD Good Laboratory Practices (GLP) ...
Priv.	ICMS -Regional Office	Fort Sask.	AB		
Priv.	ICMS -Regional Office	Abbotsford	BC		
Priv.	ICMS -Regional Office	Saskatoon	SK		
Priv.	Koch Agronomic Services (KAS)	Brandon	MB	kochind.com	... Based in Wichita, Kan.,one of the largest private companies in America, owns a diverse group of companies ... Koch Fertilizer Canada, ULC owns a fertilizer complex in Brandon, Manitoba; and product distribution terminals in Watson and Tuxford, Saskatchewan; and Oak Bluff, Manitoba, capability to market and distribute more than 13 million tons of fertilizer products annually, recently announced it will expand storage capacity at its Watson terminal by 10,000 tons ...
Priv.	Monsanto - Head Office	Winnipeg	MB	monsanto.ca	
Priv.	Monsanto -Carman Breeding Facility	Carman	MB	monsanto.ca	
Priv.	Monsanto -Oakville Research Facility	Oakville	MB	monsanto.ca	
Priv.	Monsanto -Production Facility	Cranbrook	BC	monsanto.ca	

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CATEGORY	NAME	LOCATION	PR	WEBSITE	NOTES
Priv.	Monsanto - Production/Breeding Facility	Lethbridge	AB	monsanto.ca	
Priv.	Monsanto -Research Farm	Edmonton	AB	monsanto.ca	
Priv.	Monsanto -Research Farm	Saskatoon	SK	monsanto.ca	
Priv.	Monsanto -Research Farm	Yorkton	SK	monsanto.ca	
Priv.	Pioneer Hi-Bred (DuPont) - Western Commercial Unit	Saskatoon	SK	dupont.ca	... Pioneer Hi-Bred, a DuPont business, is expanding its operations in Canada, including the introduction of Eastern and Western Canada commercial units. These units will have responsibility for sales and marketing, production, and research. As Canada's leading seed company, Pioneer also plans to add a number of positions over the next five years, including agronomists, research scientists, production technicians and sales professionals ... The western commercial unit will be based in Saskatoon, SK ... head office and a number of national positions in the new DuPont Can headquarters in Mississauga, ON ...
Priv.	Syngenta	Calgary	AB	syngenta.com	HO Guelph ON (+offices Arva, ON, Cottam ON, St-Pie QB, Calbary AB. ... In Canada, Syngenta owns three research farms and two laboratory facilities dedicated to advancing its existing comprehensive portfolio of products and services. ... New varieties are developed at the research facility outside of London , Ontario, in collaboration with the global research network of Syngenta Seeds Inc.
Priv.	Viterra		SK	viterra.com	2014 Jan: Viterra Inc. ("Viterra") and the Crop Development Centre (CDC) in the Col. of Ag and Biores. Univ. of SK ... Viterra investing \$5 million to CDC's wheat research and breeding. / five-year agreement builds on a longstanding partnership, focuses on development of wheat and durum varieties with enhanced yield, improved resistance to disease and insect pests, and improved quality characteristics ...
Priv.	Western Ag	Saskatoon	SK	westernag.ca	... Western Ag Group of Companies is a private and growing group that was established in 1994. Headquartered at Innovation Place Research Park in Saskatoon ... W. Ag. Divisions: Innovations, Professional Agronomy, Global, and Seed Innovations ... representative across W. Can. / me.hammer@westernag.ca

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