



# Shaping the Future: Agronomic Research Capacity in Western Canada

## WORKSHOP SUMMARY

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## **Executive Summary**

Agricultural industry representatives, farm leaders, commodity groups, public and private sector researchers, policy makers and funders have all expressed concern that the future capacity for agronomic research in western Canada is in jeopardy. A significant number of research scientists are reaching retirement age without succession plans in place, fewer graduates focus on agronomic-related studies, and reductions in research funding are all contributing factors. As a result, there is concern that needs in agronomic research may not be able to be met in the future.

In response to this situation, the Western Grains Research Foundation (WGRF) has launched initiatives to investigate capacity concerns. In 2014, WGRF sponsored a survey to document agronomic research capacity. The survey confirmed that agronomic research capacity is declining, particularly in the public sector, and will continue to decline rapidly into the future. To explore the issues related to agronomic research capacity, WGRF convened a workshop of stakeholders. On April 13th, 2015, 110 participants from across western Canada came together to discuss topics relevant to agronomic research capacity and to consider their vision to address capacity needs into the future. Workshop participants included producers; commodity groups; scientists; private industry representatives; agrology practitioners; and, policy makers. This report summarizes the results of the workshop.

Participants were asked to discuss three broad-based questions:

- 1) What future changes in agricultural production and practices will occur?
- 2) What are the agronomic research implications that emerge in response to these anticipated changes?
- 3) What capacity requirements are needed to address future agronomic research needs?

Participants were divided into small consultation groups made up of approximately 10 individuals per group. Small group discussion highlights were recorded and reported back to the larger group during a debriefing session. In addition, each small consultation group was provided with a recorder who maintained notes of their discussions. These documented notes have been organized to identify common themes and areas of greatest importance.

This Executive Summary Report refers to the key topics discussed by the majority of the participants. The remaining sections of the Workshop Report provide comprehensive detail of discussion points associated with each of the questions.

### **Changes in Agricultural Production and Practice in the Future.**

Participants believe that western Canadian farms will continue to grow larger and will rely on new technologies to advance production techniques and to limit labour requirements. Large farms will specialize in the production of bulk commodities, leaving opportunities for smaller

operations to respond to the demand for minor and niche crops. These emerging crop opportunities will require agronomic research support to be successful.

All farmers will utilize advanced technologies to improve efficiencies, to maximize profitability and enhance sustainability. Large, technology advanced farms will produce large amounts of data. Farmers will rely on the data that is generated to support their decision-making. Farmers will require advanced education and specialized training to manage and operate their farm operations and to interpret data. Larger, more technologically advanced farms will require greater financial, marketing and agronomic management skills. Farmers may choose to employ professional agronomists to assist in their planning and operational efforts.

Participants reported that in the future, the demands of consumers and international buyers will continue to influence production decisions and agronomic practices. Demands for sustainable, energy efficient, traceable farm practices will have an important impact on agronomic research requirements.

The effects of climate change will place increased pressure on farmers' production decisions as they work to ensure the most effective use of land and water resources. The effects of climate change will continue to influence agricultural production. It will result in the introduction of new plant diseases and pests requiring alternative pest management responses and agronomic research. In addition, there may be opportunities to grow new crops that previously could not be grown in a western Canadian climate and soil zone. Greater crop diversity (i.e. introducing corn, soybean, etc.) will require new production techniques and agronomic research to determine how to grow and rotate new crops efficiently and economically.

In future, competition for resources, human and financial, will continue to put pressure on the ability of the public and private sector to invest in agronomic research. Research funding will rely on the contributions of commodity groups through the collection of levies. Collaboration between commodity groups, cooperation amongst scientists (both public and private) and an overall cooperative approach to address research needs, will result in more efficient and effective research initiatives.

### **Implications for Future Agronomic Research**

The changes that participants anticipate for the future of western Canadian agriculture have direct impacts on the need for agronomic research. Workshop participants believe that a team approach, or a "systems approach", will be needed; incorporating scientists, researchers with a variety of specializations, policy makers and consumers in the research. Collaborative research, involving public and private researchers, will ensure efficient, cost-effective research initiatives addressing the concerns of a broad range of producers, across a number of commodity groups.

Regardless of the size of the farm operation, the emerging potential for diverse crop types; from canola to corn and from barley to beans; will result in important research needs to help farmers better understand implications of rotations, to determine the right crops for the right

growing conditions, and to maximize the potential profits generated from various crops in various locations.

New technologies require additional research to determine the most effective and efficient use of the technology. Farmers need assistance to test technologies prior to making major investments. Larger farm operations generate larger amounts of data requiring data management and analysis tools.

Climate change will require research to respond to emerging crop opportunities (corn, soybean) and to manage emerging pests that will become evident in an evolving climate. Future soil and water health, nutrient management and pest management will be influenced by climate change and will require specific agronomic research initiatives.

Research specific to localized areas and to specific growing conditions will continue to be needed. As resources (financial and human) and infrastructure decline, there will be a need to engage farmers in on-farm research initiatives. The most useful agronomic research will deliver practical, timely and easily applied research.

In future, farmers will be expected to document their sustainable farm practices. Traceability will grow in importance as consumers and large retailers influence production. In future, there is an expectation that natural disease and pest management techniques will gain acceptance and be used more broadly. This will be in response to the need to reduce the impact of chemicals on the environment. All of these considerations will influence the need for agronomic research in the future.

### **Capacity Requirements for Agronomic Research the Future**

There were a number of important capacity issues addressed through the discussions. Some topics were identified by the majority of the participants and are summarized as follows:

Virtually all of the workshop participants expressed concern that there would not be sufficient resources (financial, human and/or infrastructure - land and equipment) to address the agronomic research needs of the future. Most agreed that leadership will be needed to develop and provide a plan to attract and retain the necessary resources.

Research requirements in the future will need to be collaborative, to include all interested parties and to ensure that limited resources are used efficiently and effectively without undue overlap in effort. Commodity groups will play an important role in providing the financial resources for research in the future.

To address regional, location-specific research, producers will need to be engaged to support and conduct on-farm research (this may be done through their commodity groups). This offers the potential to focus on climatic areas, soil zones, types of farming operations, etc. and overcomes some concerns related to reduced infrastructure.

There is a continued need for practical, applied research. Participants reported that the need for technology transfer and extension services is an important tool for agronomic researchers. Participants realize that these services have been cut back over the past several

years, in all provinces, and that there is a role for others (commodity groups) to fund extension services where needed.

Agronomic research requires long-term, stable funding in order to be able to address research questions that will influence production and farm management considerations. There is also a need for funding for short-term, immediate concerns as well as for funding of innovation.

## Conclusion

The participants in the Workshop provided a strong vision of how they thought future agronomic research should be conducted. The following points can be used as guiding principles to direct future efforts:

- Through strong leadership, a team approach, or a systems approach should be used to bring together a broad range of skills and abilities to agronomic research questions.
- To avoid overlap and duplication, there is a need for a central repository of information that documents the agronomic research that is being conducted and shares the results of the research with a broad audience. Transparent sharing of information is the goal.
- Future funding of research initiatives will require that commodity groups allocate funds to research concerns of broad-based interest. Funding for long-term research initiatives will require long-term commitments.
- To enhance efficiency, researchers require simple, effective and coordinated funding application procedures.
- Support for innovative research is also important. A fund that allows researchers to be creative and to explore new and ground-breaking ideas is valuable for the whole industry.
- Access to highly trained scientists, support personnel, advanced technologies and equipment and a land base are all important tools to successful research programming. In future, there will be fewer resources available. Methods to attract and retain the necessary human resources and to acquire the infrastructure will need to be put into place in order for a successful research program to be maintained.

This WGRF sponsored Agronomy Workshop session has provided a wealth of information, derived from both large and small group discussions. The Workshop notes provide a rich compilation of information. The transcription of these discussions provides an excellent resource for further analysis from which to draw conclusions, supporting the creation of a future action strategy to address the needs of western Canadian agronomic research.

## 1.0 Introduction

Over the past several years, research in agronomy in western Canada, has experienced an overall reduction in capacity. Today, there is a growing concern that research agencies (government, university and private) will not have the capacity to supply the human resources, equipment and infrastructure needed to support future agronomic research requirements.

Farmers, scientists and policy makers recognize that good agronomic research continues to be a crucial factor in efficient and sustainable crop production. Western Canada's agricultural success is dependent on quality agronomic research.

Given the importance of agronomic research, and an overall concern about diminishing capacity, a number of farm organizations have asked the Western Grains Research Foundation (WGRF) to lead a process designed to create a future plan. In response to this request, WGRF commissioned a survey designed to create an inventory of the capital and human resources of agronomic research capacity in Western Canada. Completed in late 2014, the research documented the current capacity and projected future capacity needs to 2020.<sup>1</sup>

To create a future-looking strategy for agronomic research in western Canada, it is necessary to understand current and future research capacity as well as to have a good knowledge of the research needs of the agricultural industry. Therefore, to gain a better knowledge of future needs, WGRF convened a Workshop in April, 2015, in Saskatoon. The intent of the Workshop was:

***To provide insight into future agronomic research needs and to determine a vision for the capacity needed to address these needs.***

There were over 110 participants, representing farm organizations, commodity groups, private industry, universities, Agriculture and Agri-Food Canada, provincial governments, funders and other related farm industry associations, from across western Canada. Participants were asked to consider three broad-based questions deigned to contemplate future needs in agronomic research.

For the purpose of the workshop, agronomy has been defined as: "The science of field crop production and management" and included the following disciplines: integrated agronomy; plant pathology; entomology; weed science; soil science; physiology; sustainability; economics; agrometeorology; and, engineering. Participants were directed to consider pure and applied science and not to include on-farm demonstrations and extension activities as part of their discussions related to agronomic research needs.

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<sup>1</sup> **Fertile Ground; Agronomic Research Capacity in Western Canada**, Toma and Bouma Management Consultants, November, 2014

**Workshop Questions:**

- 1) What are the changes in western Canadian crop production that are likely to occur over the next 10 to 20 years?
- 2) Based on the changes that you have identified in Question #1, what are the agronomic research implications?
- 3) What is your vision of what's required to address future needs in agronomic research for western Canada in the following areas:
  - Systems approach to agronomic research?
  - Crop systems related to farm size?
  - Research needs of various regions?
  - Adaptation to climate change?
  - Sustainability with respect to soils, pests, water, etc.?
  - Meta-data collection, analysis and management?
  - Needs of basic, applied and farm-based research?
  - Training, education and technology transfer?
  - Other?

The Workshop participants were asked to work in small consultation groups to thoroughly discuss the questions that were posed throughout the day. (There were eleven small consultation discussion groups in total.) Each small group nominated a Reporter. The Reporter's task was to report the highlights of the small-group discussion back to the overall, larger group, during a short de-briefing session. A different reporter was nominated for each of the three questions. The make-up of the small groups remained the same for the first two questions. The participants were moved into new groupings for the third question. Each group was also provided with a scribe who documented the small-group discussions in some detail.

This workshop summary report provides the results of the participants' discussion in two ways:

- 1) A point-form summary of the large group debriefing session for each question, supplemented by flipchart notes, where appropriate.
- 2) A compilation and analysis of the small group session discussions with a focus on **common themes** and documentation of the unique and/or distinct ideas that were discussed at individual tables.

## 2.0 Anticipated Changes in Crop Production

### **Question #1    *What are the changes in western Canadian crop production that are likely to occur over the next 10 to 20 years?***

Developing a vision of the future requires knowledge of the current state of the industry along with an ability to imagine what possible change could occur. A future vision is based on an understanding of trends and recognition of key indicators that merge to determine what will ‘likely’ occur. The combined expertise of the participants in the WGRF Agronomy Workshop has provided a consistent picture of what can be expected in the future for western Canadian agriculture. Their experience and understanding of the industry provide a reliable view of the future. This vision provides the basis for the industry to plan for the future of agronomic research.

### **2.1 Large Group De-Briefing – Question 1**

The following is a compilation of the comments, as they were reported back to the whole group of participants, after round-table, small group discussions had been completed. Each small group nominated a ‘Reporter’, and this individual was given the responsibility to report the highlights of their group discussions back to the whole group. (Comments are provided in no particular order of importance. The comprehensive notes from each of the small groups have been analyzed and sorted into common themes. This analysis is provided in Section 2.2 of the report.)

- Consumers will have a voice in how farmers grow their crops. Consumers will demand an emphasis on production sustainability, consideration of the environment and traceability.
- The average consumer will have less connection to farming and the farming life as future generations will not have parents, grandparents or great-grandparents connected to farming as an occupation.
- The application of new technologies will influence and impact how farmers grow crops and manage their land base. Technologies such as remote sensing drones, non-manned technologies, advanced precision farm techniques and other developments will change the face of farm operations.
- There will be a reduced need for labour on the farm as a result of technological advances however more advanced training will be required for those that do farm.
- There will be a generational change in the next 20 years, requiring fewer, highly educated farmers.

- Farmers will need advanced training and education to understand how to manage the large amount of data available. Data can enhance knowledge but farmers will need to be educated to use the data effectively. Alternatively, farmers will increasingly make use of specialized services.
- There will be significant farm consolidation resulting in larger farms with higher production of a smaller number of crops, some small farms growing niche products and fewer farmers required to farm and manage the land. Smaller farms may be able to respond quicker to specific niche crop opportunities.
- Larger, more technologically advanced farms, will require greater financial, marketing and agronomic management and skills.
- Farm ownership will change from individual family ownership to larger, corporate ownership.
- Farmers will want to grow high value crops, not necessarily high bulk crops. Consideration will be given to reducing crop transportation costs as a way to cut input costs as well as to respond to environmental concerns related to transportation.
- The largest markets for western Canadian crops are international, with a growing need for food in high population areas such as China, India, Asia, etc. Therefore, international consumers will influence production practices in Canada.
- Canada's current agricultural competitors (Australia, Argentina, United States, Ukraine, etc.) will continue to put pressure on access to international markets.
- Farmers will employ agronomists to assist them in planning for and making agronomic decisions in the future. This will result in greater on-farm diagnostics and data.
- There will be new diseases requiring new chemical responses and integrated pest management will be important.
- In future, there is an expectation that natural disease and pest management techniques will gain acceptance and be used more broadly. This will be in response to the need to reduce the impact of chemicals on the environment.
- There will be increased strain on our current pest management strategies given the inevitable breakdown of resistance and adaptation to current control practices.
- Climate change will also provide new pest management challenges.
- Climate change provides new opportunities for new crops and analysis of which crops will thrive in a changing environment.
- It is expected that water will be in shorter supply and will need to be shared with urban areas. This will require that farmers use techniques to manage their production with less water.
- Climate changes will result in greater volatility of weather patterns.

- There will continue to be a larger world population impacting on the type of grain produced to meet the needs of changing diets and requirements. There is potential for food shortages as a result of population growth.
- Food safety issues will grow in importance as consumers become more demanding and as international markets grow and evolve. The end-users are going to drive agronomic decisions.
- When farmers use identity preserved seed, the way of the future, the agronomic practices will be dictated by the company who owns the intellectual property.
- Energy costs will drive production decisions in the future.
- There will be a greater emphasis on livestock production to meet the growing demand for animal protein. This will influence agronomic practices related to manure management and increase the need for feed production research. It is expected that there will be fewer mixed grain/livestock operations, with greater emphasis on specialization in the future.
- Farm practices will be greatly influenced by the size of the farm – the logistics of farming large acres will “trump” agronomic practices in some cases. The importance of machinery speed and technologies that support reduced labour will be as important as agronomic considerations.
- Political policies will influence agriculture and in turn will have an impact on agronomic practices (i.e. change in risk management programming).
- There will be a decrease in minor crops.
- There will be a greater demand for agricultural education programming as agriculture evolves – a greater need for researchers, agronomists, financial managers, farm operations managers, etc.
- Better forecasting models (for weather forecasting as well as for pest and other risk management concerns) will be required to support farm operations.
- There will be a need to forecast what crops and acres will be required to meet global demand. While there may be a need for greater production of some bulk crops, there will also be niche and specialized crop opportunities.
- There is a need to focus on soil health to ensure that the important soil resource is maintained and managed effectively.
- New herbicide technologies will be limited in their growth requiring that alternatives be explored.
- Various farm types, from dry land to irrigation operations, will require specialized agronomic research and recommendations for future practice.
- Western Canadian agriculture will be influenced by increased Aboriginal land ownership. Future agricultural practice will consider Aboriginal cultural issues and the Aboriginal view of land management.

- There will be significant need for additional research on nutrient management – particularly related to animal manure – with a focus on environmental impacts.
- Large farms will access alternative sources of financing (i.e. venture capital, international ownership, private sector companies, etc.). These new ownership models may influence production practices and agronomic research needs.

### 2.3 Small Group Common Themes and Distinct Ideas – Question 1

There were a total of eleven (11) small groups comprised of approximately 10 participants each. To gain an understanding of how frequently a particular topic was identified, an analysis of the written transcriptions of the small group discussions has been conducted. The following is a summary of common themes that emerged as discussion topics at each of the tables. The number in the first column indicates the number of small table groups that discussed each of the topics. Additionally, where there were distinct and unique ideas discussed at individual tables. These topics have been provided and are identified with a number “1” in front of the topic, suggesting that the discussion topic was raised at one table specifically.

# of Tables	Changes in Western Canadian Crop Production in the Future Common Themes
11	New technologies influence efficiency and production practices (i.e. remote sensing, precision farming, drones, etc.), crop rotation choices,
11	Climate change and environmental concerns impact future production decisions and agronomic practices to maximize land and water. Need for weather modeling, prediction tools and environmental analysis.
10	Larger, consolidated, high-yielding commodity specific farm operations, resulting in fewer farms. Reduction in family farm operations with greater international ownership.
10	Consumer/Corporate End-Users (i.e. MacDonald's) will influence production practices. Traceability, food safety and sustainability important factors in the future. International customers will also determine production practice.
10	New crop opportunities emerge providing greater diversity (i.e. corn, soybean) and requiring new production techniques. Diversity will require agronomic research to grow crops efficiently and economically in specific regions of a northern climate.
8	Greater access to targeted education opportunities for farmers in farm management (financial mgmt., risk mgmt., data mgmt.) and the application of new technologies are needed.
7	‘Big–Data’ will be created in future. Farmers will need support to manage all of the data that is generated and to interpret what data results apply to their farm operation.
7	Opportunity for intensive, smaller farm operations in response to niche markets, where high value crops are produced. Specialization in minor crops may occur.
7	Professional agronomists support farmers and farm operations – need to train more.
7	Labour shortages and generational change (retiring farmers) will influence farm management and production decisions.

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# of Tables	Changes in Western Canadian Crop Production in the Future Common Themes
6	Transportation and energy consumption will influence production decisions.
6	Integration of research disciplines needed in future to develop a “systems approach” to agronomic research.
5	Agronomic decisions will be driven by economics – choices based on price and profit.
5	Increase in biological management of pests.
5	Greater emphasis on nutrient management, soil microbiology and mineralization.
5	Greater demand for western Canadian commodities in response to global population growth.
5	There will be a need to consider “Right to Farm/Social License” concerns in future.
4	Need for research on proper rotation practices – what to grow, in what order, in what circumstances, etc.?
4	Plant breeding and biotechnology will expand and grow in importance. It will need to provide a greater number of varieties, faster and respond to international market demands.
4	Fungicide / chemical resistance will require new production and agronomic practices.
4	Land/Soil micro-biology and water management will become more important to manage disease and pests using natural methods as well as chemical applications.
4	Growing opportunity for organic production.
4	Influence of political and policy decisions will have to be considered in any future strategy going forward.
4	There will be a greater need for localized, on-farm testing and validation of agronomic practices to improve reliability and understand the implications of regional environments.
3	Protein demand (served by higher meat consumption and crops with high protein content) will require research for production in future – resulting in greater need for forage varieties and associated agronomy research.
3	Growth in GMO crops, particularly wheat.
2	Need to understand the impact of using Glyphosate herbicides.
2	Contract production using identity preserved seed will require its own agronomy package giving farmers less independent control.
2	Opportunity for international collaborations for future breeding programs.
2	There is a need for broader distribution of research results to interested parties.
2	Need to engage Aboriginal farmers and younger farmers in future discussions.
1	Opportunity for crops that respond to human health concerns – neutraceuticals.
1	Opportunities to utilize marginal land for new crop production will emerge.
1	Research the long-term impact of zero-till.
1	Use of agricultural production for bio-fuels.
1	Research in nitrogen and phosphorous use efficiency required.
1	In future, social media tools will be used to share research results.
1	High risk research will continue to be done by the public sector.

## 3.0 Implications for Future Agronomic Research

Based on the responses to Question #1 which described the expected changes in western Canadian agricultural operations and production over the next 10 – 20 years, participants were asked to identify what the agronomic research implications might be in response to anticipated changes. Section 3.1 is a summary of the large group debriefing session after the small group discussions. Section 3.2 represents an analysis of the small group discussions. The analysis identifies how often particular topics of importance were discussed, providing an overall set of common themes to consider in future agronomic research.

### 3.1 Large Group De-Briefing – Question 2

This section of the report provides a compilation of the comments, reported back to the whole group of participants, for Question #2. The responses have been sorted into broad themes identified by the facilitators. In Section 3.2 of this report, small group discussion notes have been analyzed and sorted into themes that emerged during the course of the discussions.

Anticipated Change	Agronomic Research Implications
<b>A Systems Approach to Agronomic Research</b>	
A team approach/systems approach will be needed to manage research.	<ul style="list-style-type: none"><li>• There is a lot of research that is needed in the package of agronomic research – there is a need to work more collaboratively to determine how the research can be linked and systemized. We need more of an integrated approach to agronomic research.</li><li>• Funding for research needs to be systems based and not specific to crop, area, etc.</li></ul>
Greater collaboration will be required in the future.	<ul style="list-style-type: none"><li>• Need to branch out to include people who can do modeling, robotics, weather modeling, economic analysis. These areas need to be integrated into agronomic research – a cross-disciplinary approach to research is needed. Need a more holistic approach to agronomy. Integrate the areas of agronomy.</li></ul>
Increased role for bio-diversity.	<ul style="list-style-type: none"><li>• There is a need to ensure that we do not ignore bio-diversity.</li></ul>
The role of identify-preserved crops will grow.	<ul style="list-style-type: none"><li>• Private companies should be paying to develop agronomic packages that are focused on specific crops.</li></ul>
Change in Research Models	<ul style="list-style-type: none"><li>• Importance of on-farm research and applied research. We will need to have multi-factor research around specific topics. (Systems approach)</li><li>• Considering farmer limitations and trade-offs must be addressed for each issue.</li></ul>

Anticipated Change	Agronomic Research Implications
<b>A Systems Approach to Agronomic Research (continued)</b>	
A need for a new Reporting Metric	<ul style="list-style-type: none"> <li>• Measuring profitability for practice change. What are the major influencers that impact profitability? There are big considerations and there are smaller considerations – need to be able to determine what the big influencers are so that farmers can determine where to make the right investments.</li> </ul>
Role of Public Sector and Private Sector Research	<ul style="list-style-type: none"> <li>• Private sector research is based on marketing a product. Public sector research requires a different skill-set to bring the public concerns to the forefront of research. Commercialization is not the only end-point in public sector research. Public sector is better equipped to deal with the systems approach to research.</li> </ul>
<b>Cropping Systems Related to Farm Size</b>	
Larger farm sizes will emerge.	<ul style="list-style-type: none"> <li>• Agronomic Research will need to be implemented on the larger farms.</li> </ul>
	<ul style="list-style-type: none"> <li>• There will be a need to foster agronomic research programs that respond to the specific needs of the farmers.</li> </ul>
Farm efficiency will improve	<ul style="list-style-type: none"> <li>• Equipment needs to keep up to the changes on the farm. Equipment needs to reflect the actual practices that are being used – whether small or large farms.</li> </ul>
Broader types of information made available.	<ul style="list-style-type: none"> <li>• There is a need to move towards larger scale research on larger tracts of land.</li> </ul>
Farming systems will become more complex.	<ul style="list-style-type: none"> <li>• Crop diversity will change – monoculture in large farms and specialization in smaller farms. What is the implication of these differences in farm sizes? We may be more vulnerable to new problems.</li> </ul>
Large farms may speed the spread of problems.	<ul style="list-style-type: none"> <li>• Need to be able to move quickly to identify global risks so that we can curb the spread of these issues more rapidly. (i.e. clubroot in Alberta)</li> </ul>
Value-Added implications.	<ul style="list-style-type: none"> <li>• Need to conduct agronomic research to determine how local production can be modified to improve marketability of commodities in international markets.</li> </ul>
Rotations on large vs. small farms.	<ul style="list-style-type: none"> <li>• Larger farms are less likely to be diverse. Small farms will use a wider range of rotations to respond to niche opportunities. The agronomy that is being done in one area may not apply to other areas or to producers in other areas.</li> </ul>
<b>The Research Needs of Various Regions</b>	
Multi-location research will be required to address the needs of various regions.	<ul style="list-style-type: none"> <li>• Transparent information and a broad exchange across multiple audiences.</li> <li>• Increased application of research at various on-farm sites.</li> <li>• Collaboration and mentorship opportunities need to be provided.</li> <li>• Implement the use of social media as a tool for agronomic research and communication.</li> </ul>

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<b>Anticipated Change</b>	<b>Agronomic Research Implications</b>
Increased adoption of new crops.	<ul style="list-style-type: none"> <li>Understanding sustainability and adaptability of the crops in a variety of regions.</li> </ul>
Different Crops are likely to emerge on the prairie.	<ul style="list-style-type: none"> <li>Producers will need to validate the ability to grow crops in specific areas/regions.</li> </ul>
	<ul style="list-style-type: none"> <li>Research stations will need to focus on how crops will work in specific regions and areas in response to Climate Change</li> </ul>
	<ul style="list-style-type: none"> <li>Identify strengths and weaknesses of the crops that are impacted by change in climate. (this includes cereals, new crop opportunities like corn and faba beans etc.)</li> </ul>
<b>Adaptation to Climate Change</b>	
Climate change will influence farming practices.	<ul style="list-style-type: none"> <li>Need to tie agronomic data to specific climate conditions.</li> </ul>
	<ul style="list-style-type: none"> <li>Long-term research needed to determine how farms should respond to the implications of climate change. (University may not be the best venue for this research.)</li> </ul>
	<ul style="list-style-type: none"> <li>Need to be responsive to the variety of changes that may result from climate change.</li> </ul>
	<ul style="list-style-type: none"> <li>“Meteorology is not based on solid science” – we need better research to understand what is going to happen in the future weather patterns.</li> </ul>
<b>Sustainability with Respect to Soils, Pests, Water, etc.</b>	
Soil health will be important.	<ul style="list-style-type: none"> <li>A Team Approach to managing the soil and biological issues will be needed. A whole systems approach will be needed, and this will require more dollars and more people.</li> </ul>
	<ul style="list-style-type: none"> <li>There could be an opportunity to use the data that is generated from the soil survey.</li> </ul>
Improved nutrient management.	<ul style="list-style-type: none"> <li>Improved mineralization, increased efficiency will be the focus of research.</li> </ul>
Reduced role for pesticides.	<ul style="list-style-type: none"> <li>There is a role to move away from pesticide research – renewed effort is needed around biological pesticide research. Natural and biological management of pests.</li> </ul>
New diseases and pests will emerge.	<ul style="list-style-type: none"> <li>There will be a need for additional training and education to deal with the new and emerging diseases and pests. Need to be proactive and responsive to the needs of the producer/farmer.</li> </ul>
Greater crop diversity in future.	<ul style="list-style-type: none"> <li>There needs to be research to determine the variety of alternatives that are available to manage crop diversity. More tools to control pests.</li> </ul>

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Anticipated Change	Agronomic Research Implications
<b>Meta-Data Collection, Analysis and Management</b>	
Mega data available.	<ul style="list-style-type: none"> <li>Who owns the data? How can the data be interpreted and used on the farm? Validate the data on the farm – with the support of others.</li> </ul>
There will be a need for faster info and research for technology and products.	<ul style="list-style-type: none"> <li>We need people to oversee applied research, farmer-generated research, to ensure that the data is collected properly and usefully. Who will lead, who will pay?</li> </ul>
<b>Needs of Basic, Applied and Farm-Based Research</b>	
Rotations will be important and may change in the future.	<ul style="list-style-type: none"> <li>There is a need for more long-term research to better understand the impact and requirements for good rotation practices.</li> </ul>
Better methods of forecasting will emerge.	<ul style="list-style-type: none"> <li>Forecasting pest infestations as an example.</li> </ul>
	<ul style="list-style-type: none"> <li>There are 3 different stages of research – there is a need to understand these stages 1) discovery, 2) agronomics, 3) validation.</li> </ul>
Rapid technology change.	<ul style="list-style-type: none"> <li>More private industry cooperation. Private sector may drive technology change. Regulations will need to keep pace with the changes in technology.</li> </ul>
<b>Training, Education and Technology Transfer</b>	
Need to forecast new and emerging problems.	<ul style="list-style-type: none"> <li>There is a need to train people to work on the forecasting of emerging problems. We lack people with specialized skills in the area of modeling.</li> </ul>
Research results will need to be provided in a timely fashion.	<ul style="list-style-type: none"> <li>There is a need for more extension services and a quicker turn around on research results.</li> </ul>
Technology will be complex.	<ul style="list-style-type: none"> <li>There will be a need to access highly qualified people who understand the technology. Precision agriculture research. Always incorporate economics into the research.</li> </ul>
More training required for larger farms.	<ul style="list-style-type: none"> <li>People who are managing the bigger farms must be educated so that they make the right choices in production. We want to ensure that there is enough training and information to support the large farm operator.</li> </ul>

Anticipated Change	Agronomic Research Implications
<b>Other Topics and Research Implications</b>	
Need for Traceability and Social License in the International Market Place	<ul style="list-style-type: none"><li>Researchers need to speak to commodity groups to be able to respond to the needs of the international market place.</li></ul>
Increased Livestock	<ul style="list-style-type: none"><li>There will be a need for research in forages and range management. There will be a need for nutrient management research. Will economics support the livestock sector – researchers will have to look at raising cattle, feeding cattle and marketing cattle.</li></ul>
Grain Drying	<ul style="list-style-type: none"><li>Need to advance grain drying technology.</li></ul>
Food Quality	<ul style="list-style-type: none"><li>Make sure that the standards of production that we are using are meeting the specifications of customers. How does agronomic practice impact the end product that we are producing?</li></ul>
Aboriginal Involvement	<ul style="list-style-type: none"><li>Agronomic research will need to be responsive to the specific needs of the Aboriginal culture as we develop research initiatives going forward.</li></ul>
Regulation	<ul style="list-style-type: none"><li>Sometimes decisions are made on the basis of politics and not on science. Future regulation needs to be based on science.</li></ul>
Societal Pressure	<ul style="list-style-type: none"><li>New research must be based on trust. There may be more restrictions and more controls on research.</li></ul>

### 3.3 Small Group Discussion – Question 2

Participants in the small group discussions were asked to discuss and identify the ‘Agronomic Research Implications of Crop Production Change’. Each small table discussion group determined what areas were of the greatest importance to them. As a result, the focus of the discussion varied from one table to another.

To prepare a summary, the small group comments and discussion topics have been amalgamated under broad headings and research themes. The number in front of the statement indicates the number of groups that identified and discussed the issue as a research implication to consider in the future.

		<b>Small Group Discussion Analysis</b> <b>Important Research Implications – Sorted into Common Themes</b>
# of Tables	<b>Research Implications</b>	
<b>Important Research Practices and Considerations:</b>		
6		Research initiatives can incorporate a broad spectrum of expertise; from soil scientists to food scientists; from marketing experts to consumers. Future agronomic research will need to incorporate government, academic and private-sector researchers. The Systems/Interdisciplinary Approach to research is needed.
6		Research must move from the “science-stage” to “practical application” in order for it to provide value to producers.
6		The private industry conducts product development research and high volume crop research – public sector has a role to validate this research and to conduct research in niche crop opportunities.
5		There will continue to be a need for third-party, independent and unbiased research.
5		Recognize the importance of consumers and the public in the research continuum.
4		Long-term, coordinated research strategies are required with a look to achieve proactive research results. Long-term research requires long-term funding commitment. Multiple year trials are valuable, using multiple locations.
4		Agronomic research must assess the economic viability (risk management) of applying new practices. Economics drive change (i.e. greater yields). Research must address increases in productivity and quality.
4		Change in agriculture is rapid – often research cannot keep up with the pace of change – there is a need for quick initiatives with short-term results. Focus on “Real-time Agronomy”
4		Research funding is always in short supply therefore researchers will need to be flexible and will need to be able to ‘do more with less’. (3) Funding for multi-crop agronomic issues is required.
4		There is a role and need for pure science as well as for basic and applied research
4		Coordination and collaboration is important in order to eliminate duplication and build on each others’ work.
3		There is a need for localized agronomic research that can be applied to specific farms in specific locations – at the same time, networking between sites is important.
2		Research initiatives must be transparent so that results can be shared and that they can contribute to overall knowledge and understanding.
2		There is a role for ‘closed-loop’ research (supply chain research with a strong emphasis on the role of business and profit generation). Most agronomic research however, is done by the public sector.
2		Use the research results from other jurisdictions/countries to enhance the research program in Canada; i.e. learn what is known about fusarium in other jurisdictions and apply this learning to Canadian research.
2		Growing identity-preserved seed will require its own agronomic package that will be determined by the owner of the seed. Contract production may have restrictions on sharing of information.

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# of Tables	Research Implications
<b>Important Research Practices and Considerations:</b>	
2	It is important to ensure that research is done in minor crops and different cropping systems. The temptation will be to focus on the larger crops.
2	Agronomic research will need to be supported by extension services.
2	Some research that was done, as many as 20 years ago, may need to be replicated today to validate.
1	There is a significant role for commodity groups to fund research; collaboratively.
1	At times, regulation drives the research agenda. In future, proactive research can and should drive the regulatory agenda
1	Agronomic research must have the ability to respond to immediate concerns as they arise and before they become bigger concerns.
1	Use of Expert Committees to identify research priorities is valuable.
1	Involve Aboriginal people in planning research.
<b>Specific Crop Research and Crop Production Related Research:</b>	
6	Large commodities (canola, wheat, pulses) have access to funding for research. Small, niche, specialty crops need access to funding. Without funding, niche and minor crop opportunities will diminish (i.e hemp, old-world grains. etc.).
4	Greater emphasis being placed on organic production – driven in part by consumer demand.
3	Determine what crops can be incorporated into rotations to maximize sustainable production – integrated crop management – what pests and diseases emerge in certain crop rotations?
3	Need for more research on soybean and corn. (In northern regions)
2	Greater need for research in forages as livestock sector grows.
1	Research on manure management.
1	Research needed to assess the potential for by-products such as straw / biomass.
1	Agronomic research required for malt barley and other minor crops such as mustard.
1	Research needed to better understand the viability of intercropping – cover crops.
1	Determine the future for GMO's.
<b>Technology:</b>	
4	More research into advanced precision farming techniques.
3	There is a strong interest in the use of robotics, drones and other technologies. Need to understand use, applicability, cost and regulatory considerations.
2	Traceability will grow in importance over time requiring technology to support the demand for traceability.
1	Determine what equipment and technology is needed to most effectively and efficiently farm large and small farm operations.
1	New technologies must be tested on the farm to determine application and efficacy. Adoption of new technology can be enhanced through practical research application and testing. Individual farmers cannot afford to do this testing.
1	More research needed to perfect variable rate spraying technology.
1	Research is needed to assess the technologies of the future.

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# of Tables	Research Implications
<b>Farm Size, Farm Location</b>	
5	There is a need for location-specific research in order to provide recommendations that are relevant to a particular location (i.e. fertility recommendations). This will require on-farm research. Care must be given to assess risk to farmers who participate in on-farm research.
5	There is a need for research that can be applied to specific farms (both large scale and smaller farms) in specific regions and locations.
<b>Climate Change:</b>	
5	Introduce new crops that have potential to be grown in new areas due to climate change - what regions?, what crops? at what economic return?
4	What new pests (weeds, diseases and insects) will emerge as a result of changes in climate – drought, flooding, other environmental considerations and what will be an appropriate response to manage these emerging production concerns?
3	Improved weather forecasting and modeling required.
2	Determine what adaptations in operational and managerial practices will be required to respond to climate change.
2	Identify which crops will be most resilient to climate change (new and existing crops).
2	Determine carbon footprint (greenhouse gas emissions) of agriculture and determine ways to reduce dependence on petrol-based inputs.
2	Assess and quantify the impact of transportation in sustainable agricultural practices.
2	Research needed to improve water use efficiencies.
1	Ensure that the broad range of researchers in the topic of climate change are communicating and sharing information.
1	Research needed to understand the importance of biodiversity in specific growing regions and areas.
<b>Human Resources, Information Management and Infrastructure</b>	
6	Retiring researchers must be replaced with new – this will require an ability to attract and retain researchers who are interested in agronomy. Retirees can serve as mentors. Currently a small number of agronomy researchers.
3	Information generated from research must be broadly shared and include farmers, agronomists, scientists, policy makers and consumers. Greater transparency is the objective.
2	Large farming operations will require professional agronomy specialists. This requires that more people be educated and trained in agronomic fields.
2	There is a reduction in research land and equipment – particularly with AAFC withdrawing – private farm land will become the research infrastructure of the future.
1	One individual agronomist cannot have expertise in all areas. It is important to create and maintain a network of people that work collaboratively with one another to create solutions to farm problems.
1	Agrology is not necessarily short of people – but is short of leadership.
1	Data collection and <u>analysis</u> is important.

# of Tables	Research Implications
<b>Soil and Water Management/Health:</b>	
4	Need for integrated research to understand the sustainability of specific practices and the impact that specific practices have on long-term health of soil and water resources.
2	Studies are needed to understand the impact of biodiversity on soil and water health.
2	How can a producer determine the health of the soil (soil biology)? How does he/she know what nutrients are missing and how can they be reinstated?
1	Soil health research requires long-term studies – done by the public sector and based on soil climatic areas/eco-zones.
<b>Disease and Pesticide Considerations:</b>	
3	Research is needed to understand the implications of glyphosate restrictions.
1	More research on natural (biological) management of disease and pests.
1	Better research and understanding of the soybean cyst nematode.
<b>Other:</b>	
1	Research required respecting recycling of wastes to improve sustainability.
1	Research to assess the efficient use of energy supplies (fossil fuels).

## 4.0 Vision for the Future of Agronomic Research

The overall intent of the Workshop was to create a vision of what can be done to address the agronomic research needs of western Canadian agriculture in the future. The last question of the day focused on the creation of that vision. Participants were asked to work in their small group discussions to identify what is needed to address a future vision for agronomic research. Small group participants were encouraged to discuss how to address future research and capacity needs within the following broad themes:

***Question #3 What is your vision of what is required to address future needs in agronomic research for western Canada?***

1. A ‘Systems Approach’ to Agronomic Research;
2. Cropping systems related to farm size;
3. The research needs of various regions;
4. Adaptation to climate change;
5. Sustainability with respect to soils, pests, water, etc.;
6. Meta-Data Collection, Analysis and Management;
7. Needs of basic, applied and farm-based research;
8. Training, education and technology transfer; and
9. Other areas.

Section 4.1 and 4.2 outline the key points that were raised in the group discussions. Section 4.1 summarizes the results of the large group debriefing session, where the Reporters from each of the groups reported the highlights of their discussions. The comments are sorted within the nine broad themes that were provided in the Question.

Section 4.2 summarizes the analysis of the small group discussions. The comments within the small groups are sorted according to themes and topics that generally focus on “how” research is conducted. In some cases the themes are the same as those that were provided in Question 3, while in other cases, the theme has emerged from the analysis of the small table discussions. The analysis allows for insight into relevant issues such as research design, research funding, human resources, training, research efficiencies, etc.

#### 4.1 Large Group Debriefing – Question 3

<b>What agronomic research capacity is needed to address:</b>
<b>1. A Systems Approach to Agronomic Research</b>
<ul style="list-style-type: none"><li>• Primarily people and money needed. People need to be coordinated and there could be centralized positions created to address the issue.</li><li>• Research done at a regional level.</li><li>• There is a need for a mind-set change in the industry. The commodity groups need to work together to address the systems needs.</li><li>• There is a need for on-farm research to validate the research results and this could be shared with a larger group of farmers.</li><li>• A long-term vision for the research must be developed.</li><li>• Need a leader or a leadership group that can guide the efforts in agronomy. Agronomy and agronomic systems can explore the “Expert Committee” Model. Use this model to go forward in managing agronomic research.</li><li>• Need for land, both on and off of the research stations.</li><li>• AAFC has equipment – uncertain whether it can be shared with others over several regions.</li><li>• Better communication amongst the research community is important.</li><li>• Remove the “gag” orders that stop the potential for sharing – this is particularly true in the private sector research efforts.</li><li>• Limitations on scientist travel are a barrier to ability to do their work.</li><li>• Good potential for a western Canadian funding consortium to assist in the collaboration across provincial boundaries. There is a need for a new funding model.</li><li>• Need a central data base to determine what is going on across the country so that we know what others are doing.</li><li>• Need to re-evaluate the pay scales of researchers so that we can attract and retain high quality, well trained people to do the science.</li><li>• Potential to expand the land base by collaborating with producers /scientists / researchers to expand the potential to conduct research.</li></ul>

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- We have several different soils in western Canada. We might be better advised to focus on climatic zones.
- Could have ten to twelve sites across western Canada to conduct research – with bricks and mortar and adequate field resources. Need modern and adequate labs. An additional 20 sites required to ensure that farmers get the right information and that research is adopted; incorporating data managers, statisticians, etc. At the adoption sites you need processing facilities and labs.
- Universities, provincial orgs, AAFC and some ARAs in the 3 prairie provinces all contribute to core projects and objectives with some regional opportunity to explore projects.
- There needs to be collaboration between livestock and cropping areas of focus
- Need collaboration between livestock and cropping areas of focus.
- Need technologists at the field sites – both at the technical and adoption sites.
- Continuous renewal of equipment is required (field and lab)
- 20% of scientist's time needs to be set aside for "blue-sky" research efforts
- There is a need for longitudinal studies as well as short projects.
- Surveillance studies are also needed.
- Partnerships key to moving forward on research in western Canada.
- We need a gap analysis for infrastructure in the western Canadian provinces.

**2. Crop systems related to farm size.**

- We need to determine whether it is really true that large farms are not as diverse as small farms.
- Large farms will require professional support. (agronomists)
- There will be a need for a variety of different technologies to support larger farmers
- Large farms may be able to do better on-farm research.
- There is a farm leader in every community. These farm leaders provide guidance to other farmers that are watching and researching what is needed in the future.
- Smaller farms may be more horticultural and animal related – therefore their issues would be different due to the commodities that they are growing.
- Simple vs. diverse might be a better description vs. small and large. Can agronomy keep up to the needs of farm operators who are growing the large commodities?
- There may be a lack of specialized people for diverse crops. There is a people gap in smaller commodities. For example, is there an expertise to focus on some of the smaller crops.
- Farmers may not be able to acquire the larger acres – these farmers will want to do more with the acres that they have. The large farmers are often highly focused on producing bulk – they don't have the time to focus on the agronomic issues that are important to production.
- Technology is changing everything. Basic agronomic research is being left out of the future research plans.

**3. The research needs of various regions.**

- Depending on the specific area or region, there will be crops that are grown in the area. Therefore there will be agronomic research relevant to specific crops in specific regions.
- There is also a difference in dry land vs. irrigation areas.
- We need more research locations to explore the agronomic issues relevant to specific regions.
- Cluster projects can also be used to advance regional agronomic research issues.

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- Networks – we used to have type of network, however that network is no longer functioning using the same methods. Prairie Soil and Crop Network could be revitalized to provide an opportunity for collaboration and coordination.
- The outposts are very important in order to be able to replicate the research findings.
- Public money for new crop development needs to be tested at outposts as well.
- We need personnel and money to be able to address the issues related to all agronomic issues.
- There is a need for high level scholarships to be able to attract students, scientists and researchers to focus their efforts on agronomy. There is a need for qualified people – there is great demand for research – but not enough people to fill the positions that are required.
- We are funded on three-year or five-year cycles to conduct research. It is difficult to manage long-term research when the funding is not dedicated over the long-term.
- There are also a large number of senior researchers that are leaving and these positions will need to be filled.
- Funding for programs rather than projects allows for scientists to explore science in a creative way.
- Agronomy has been off of the radar screen for a long time – commend WGRF for getting it back on the table.
- Investing in coordination is vital.
- A decentralized model rather than centralized model would be valuable.
- Institutional collaboration would be valuable – sharing equipment.
- Being able to attract and retain good, qualified people working in some of the remote research stations is very difficult. There is a need to offer scholarships and opportunities for advancement from these areas.
- Regional centres provide an opportunity to explore issues beyond commodities – stronger coordination amongst the research sites would add integrity to a overall research agronomic system.

#### 4. Adaptation to Climate Change

- There is a need for more study in the abiotic stress issue – drought simulation, elevated CO<sub>2</sub> levels, etc.
- Forecasting is needed – ag meteorologists are required to assist in the ability to forecast and develop better prediction models.
- There is a gap in research done in the Peace River Region of western Canada and this area could be important to the long term understanding of climate change.
- How can we do research to get seeds that can adapt to a variety of conditions – drought to flood?
- Is there an ability to learn from other countries and regions on the issue of Climate Change?
- Pest prevalence and severity in years where we have had uncharacteristic weather patterns can be studied to determine what can be learned for the future.
- Soil microbiological environment may also be impacted by climate change and this should also be addressed in the future.
- Climate change might provide opportunity for farmers – society may look to farmers to provide solutions to climate change. Farmers will need to rely on agronomists to determine how they can provide climate change solutions.

## **5. Sustainability with respect to soils, pests, water, etc.**

- We need people who are dedicated to long-term issues. There is a need for science to “crystal-ball” what is going to happen in the future.
- We need to develop a strategy to compete for people who could focus on sustainability. Also need to get agronomists interested in sustainability.
- We can attract people to agronomy through sustainability – as this provides a future career for students who have an interest in sustainability. There will need to be salaries and opportunity to attract and retain.
- Sustainability is not well researched in an environment where there is a lot of short-term funding. There needs to be opportunities for scientists to benefit from the long-term studies as well as they benefit from short-term studies (i.e. publications are easier in short-term studies).

## **6. Meta-Data Collection, Analysis and Management**

- We need people here. We can collect data but we have a shortage in the ability to analyze data. There is a need to ensure that we have people to teach and to learn and apply the skills in the future.
- There is a need to integrate with people that we don’t really know – expand the team of people that work on agronomic research and in analyzing data analysis.
- To lead this area, we will need a champion.
- Managing existing data is often lost when people retire. A method to save data that already exists is important. Archiving data sets would be valuable.
- The literature research work being done by doctoral and post doctoral students provides a source for data.
- We need expertise to manage information that is available. How can data be distilled into practical information so that farmers can make good use of the info.
- There is a lot of data being generated and often this information and data does not get back to the farm level.
- Maybe the WGRF could provide a library of information that is searchable for others to use.

## **7. Needs of basic, applied and farm-based research.**

- Scientists for the future are needed.
- A land-base is required. There is a need for a group of cooperating farmers who could be counted on to support the applied, on-farm research.
- It is important to maintain capacity at the research stations.
- We need to have the infrastructure that will allow us to use a farm-based research approach. ARA's have a role to play in regional research.
- There is a role for equipment-based research (i.e. PAMI)
- Recognize the importance of all three levels of research. The challenge is to have coordination without bureaucracy.
- Farmers want to do research but they often want to know how research will work in their own system. In addition, they would like to have research done that is immediate in nature.
- Agronomic research can be done at all three levels of research. Coordinating this research from one level to another is extremely different. Integration is complex and results in bureaucracy that drags down the process.

<b>8. Training, education and tech. transfer.</b>
<ul style="list-style-type: none"><li>• We need to develop a plan to ensure that we retain the knowledge base that is currently in place with existing scientists – much of this may be lost as people retire.</li></ul>
<ul style="list-style-type: none"><li>• Training new graduate students requires more professors so that we can train and retain young people.</li></ul>
<ul style="list-style-type: none"><li>• We need research technicians so that we can train competent agronomists. We need continued funding to train students.</li></ul>
<ul style="list-style-type: none"><li>• It is difficult to fund the basic tools (equipment) that agronomists need to be able to do the research.</li></ul>
<ul style="list-style-type: none"><li>• Funding for research technicians is difficult to retain. These people are essential to maintaining a good research program.</li></ul>
<ul style="list-style-type: none"><li>• Need to attract and retain post-docs.</li></ul>
<b>9. Other</b>
<ul style="list-style-type: none"><li>• We are using data from the 1960s at times – we need to update research data so that we are relevant to the practices that are currently being used.</li></ul>

#### 4.2 Small Group Discussion – Question #3

There were several key points raised and discussed in the eleven table groups with respect to a future vision for developing agronomic research capacity in western Canada. Most groups agreed that a greater emphasis needs to be placed on human, infrastructure and financial resources in future. In addition, there is strong support for a coordinated, integrated and interdisciplinary approach to agronomic research. The small group analysis provides an opportunity to consider “how” research will need to be conducted in the future in order for it to be relevant and useful.

The following analysis identifies the topics raised within the individual groups and documents the number of tables that discussed each of the topics.

<b>Question #3      What Agronomic Research Capacity is Needed?</b>	
<b># of Tables</b>	<b>Topics Discussed</b>
<b>Systems Approach</b>	
11	A “Systems Approach” is needed which requires Coordination, Integration, Collaboration and Interdisciplinary Research.
7	Centralized leadership is required to coordinate the research being done and to avoid duplication and overlap. (This will include involvement of commodity groups.)
7	A long-term plan and focus for research is required – this may require a centralized institute/agency to coordinate – involve all interested parties in the plan.

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<b>Overall Research Planning and Design Considerations</b>	
7	To address location-specific research, on-farm research will be required. This offers the potential to focus on climatic areas, soil zones, types of farming operations, etc.
6	There is a role for both basic (pure science) and applied research (farm-based research).
6	There is a need for research capacity and infrastructure to be available in all major production regions (soil zones and climatic regions).
6	There will be a continued need to incorporate technology transfer and extension services in future strategies.
4	Involve farmers in the design of the research to ensure applicability and ‘buy-in’. Involve advisory councils, research groups, expert advisors. (Link advanced producers to research stations.)
2	Advanced forecasting and modeling is required to guide production management.
2	Make research results available to farmers in practical, applicable and manageable data packages.
1	There is a need for 10 – 12 multi-disciplinary research sites and 20 adaptation sites to test research.
<b>Research Resources –Funding, Infrastructure and Efficiency</b>	
9	Long-term, stable funding is required to conduct research. (Funding will likely need to come from commodity groups.)
4	Funding needs to be available for short-term research issues – quick responses. A non-bureaucratic research consortium could be useful to fund these types of projects.
4	Ensure funding for public/private/producer partnership research.
4	Financial resources to upgrade and acquire equipment and infrastructure will be required.
4	Land resources for research initiatives will continue to be required. (Research institutions and private farm land.)
2	Creative/Innovative Research Fund needed to be available to allow for scientists to do “blue-sky” research.
1	Conduct gap analysis for western Canadian infrastructure.
1	Equipment sharing between research stations and researchers possible.
1	Funding required for all aspects of research, including travel.
<b>Human Resources</b>	
10	There is a need to train a larger number of agronomists – a greater focus needs to be placed on agronomy at the University level. Retiring academics can provide mentorship and prepare new scientists to take over long-term studies (succession plan).
7	Need for statisticians, computer scientists, modeling expertise, meteorologists, etc. to manage large data sets.
5	A strategy is required to attract and retain more people (young) to agronomy (both scientists and technicians). A particular focus placed on staffing at research stations.
5	Fund academics, Science Chairs at universities with agronomy focus. Provide scholarships. Provide field-based post-doc opportunities.
4	Farmers need greater access to professional expertise in management, agronomy, data management, technical advice, etc.

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<b>Data Management</b>	
8	Large amounts of data will be created – it needs to be accessible. Data must be digitized and available to researchers and producers fast and accurately. The research process must collect and share data that supports managerial decision making.
7	A centralized database of current research projects must be maintained. A data manager may be required.
4	Consideration will need to be given to data ownership and sharing of data. (Proprietary research and intellectual property considerations will influence data sharing.)
<b>Climate Change</b>	
4	Weather monitoring/predictions and weather information needs to be available and at a regional level. There is potential to link farmers and farm organizations that have their own weather monitoring systems.
3	There is a general lack of science infrastructure (human, infrastructure and funding) to address the issues relevant to climate change. There is a need to fund innovative research in this area of study.
3	Explore integrated crop management to respond to climate change. What crops are best grown in what areas in a changing climate? Are there new crop opportunities that emerge as a result of climate change?
<b>Sustainable Agriculture – Soils and Water</b>	
4	Sustainable farming practices will require a research focus – i.e. What nutrients are required? What practices maximize soil and water resources? What pesticides, fertility tools and biological interventions can be used to enhance sustainability? etc.
2	Benchmarks need to be established for optimal application of nutrients.
2	Research to consider benefit/impact of biodiversity on soils and water.
1	Studies in appropriate rotation practice and fertility needed.
1	Study methods of water conservation.
1	Consider research based on watersheds and not on regional/provincial boundaries.
1	Specific disease and pest research required, focused on specific regions.
<b>Crop Specific Research</b>	
2	Research related to minor crops – soybean, corn, sunflower, hemp, etc.
<b>Technology</b>	
3	Advanced skills and greater resources will be required to respond to new technologies (satellites, precision farming, drones, etc.)
3	Advanced technologies will need to be tested and validated.
1	Work collaboratively with technology equipment suppliers to conduct research.
<b>Other Considerations</b>	
2	Research and farm practices responsive to consumer and end-user demands.
2	Streamline reporting procedures, data collection procedures and funding deadlines for project work to reduce the amount of time spent on paper-work.
1	Need access to phenotyping services and personnel to manage.

## Appendix 1      Participants in the Agronomy Workshop

Name	Organization
Allison Fletcher	Sask Pulse Growers
Andrea deRoo	University of Saskatchewan (Recorder)
Anthony Anyia	Alberta Innovates
Barbara Podhorodeski	Conservation Learning Centre
Blair Goldade	Saskatchewan Wheat Development Commission
Brian Beres	Agriculture & Agri-Food Canada (AAFC)
Bryan Nybo	Wheatland Conservation Area
Cam Goff	Saskatchewan Barley Commission
Candice Lajeunesse	Western Grains Research Foundation (WGRF)
Charles Fossay	Manitoba Canola Growers Association
Charles Turcotte	Smoky Applied Research and Demonstration Association (SARDA)
Chris Barker	Genome Prairie
Christiane Catellier	Indian Head Agricultural Research Foundation (IHARF)
Clint Jurke	Canola Council of Canada
Corey Loessin	Saskatchewan Pulse Growers Association
Cornelia Kreplin	Alberta Innovates
Craig Shaw	Alberta Crop Industry Development Fund
Curtis Rempel	Canola Council of Canada
Dale Leftwich	SaskCanola
Danny Petty	Indian Head Agricultural Research Foundation (IHARF)
Daryl Domitruk	Manitoba Agriculture, Food and Rural Initiatives (MAFRI)
Daryl Tuck	Alberta Canola Producers Commission
Dave Sefton	Western Grains Research Foundation (WGRF)
Don Dewar	Keystone Agricultural Producers
Don Sluth	Wheatland Conservation Area
Don Flaten	University of Manitoba
Doug Walkey	Alberta Crop Industry Development Fund
Doyle Wiebe	Canadian Canola Growers Assoc.
Dr SS Malhi	Agri Trend
Eric Johnson	University of Saskatchewan
Eric Oliver	Wheatland Conservation Area Inc.
Errin Tollefson	SaskCanola
Garry Hnatowich	Irrigation Crop Diversification Corporation
Garson Law	Alberta Barley Commission
Garth Patterson	Western Grains Research Foundation (WGRF) (Recorder)
George Clayton	Agriculture & Agri-Food Canada (AAFC)

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Name	Organization
George Lewko	Conservation Learning Centre
Gina Feist	Western Grains Research Foundation (WGRF) (Recorder)
Ginni Braich	Alberta Innovates
Glenda Clezy	Pioneer
Glenn Tait	Saskatchewan Wheat Development Commission
Graham Scoles	University of Saskatchewan
Greg Rekken	Olds College
Gurcharn Brar	University of Saskatchewan (Recorder)
Gwen Machnee	Parkland College
Hannah Konschuh	Alberta Wheat Commission
Harvey Brooks	Sask Wheat Development Commission
Heather Krahn	Richardson Pioneer
Jack Froese	Manitoba Canola Growers Association
Jan Slaski	Alberta Innovates
Janette McDonald	Agricultural Research and Extension Council of Alberta (ARECA)
Janice Tranberg	SaskCanola
Jeff Braidek	Government of Saskatchewan (Recorder)
Jeff Schoenau	University of Saskatchewan
Jillian McDonald	Sask Barley Commission
Jim Bessel	Agri Trend
Joelle Harris	Western Grains Research Foundation (Recorder)
John Harrington	Producer
John Ippolito	Government of Saskatchewan
Kara Barnes	Alberta Barley Commission
Karen Churchill	Cereals Canada
Katherine Stanley	University of Saskatchewan (Recorder)
Keith Degenhardt	Alberta Federation of Ag
Kelly Farden	Government of Saskatchewan
Kelly Turkington	Agriculture & Agri-Food Canada
Ken Coles	Farming Smarter
Kevin Dow	Prairie Agricultural Manufacturing Institute (PAMI)
Lacey Wilton	Ag Grow Consulting
Lana Shaw	South East Research Farm (SERF)
Laura Reiter	Sask Wheat Development Commission
Laurie Wakefield	Sask Seed Growers Association
Linda Hall	University of Alberta
Lisette Mascarenhas	Sask Pulse Growers
Lyle Cowell	Crop Production Services

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Name	Organization
Manjit Deol	Battle River Research Group
Mark MacNaughton	Alberta Agriculture & Rural Development
Mary Buhr	University of Saskatchewan
Mike Espeseth	Western Grains Research Foundation (WGRF) (Recorder)
Mike Hall	Parkland College
Muriel Garven	Garven & Associates (Facilitator)
Nancy Johns	Sask Flax Development Commission
Nathan Gregg	Prairie Agricultural Manufacturing Institute (PAMI)
Nicole Philp	Canola Council of Canada
Owen Olfert	Agriculture & Agri-Food Canada
Patricia Flaten	Western Grains Research Foundation (WGRF) (Recorder)
Pree Edirisinghe	University of Saskatchewan (Recorder)
Ralph Lange	Alberta Agriculture & Rural Development
Randy Kutcher	University of Saskatchewan
Richard Fritzler	Farming Smarter
Rob Gulden	University of Manitoba
Shawn Fraser	Saskatchewan Seed Growers Association
Sherilyn Phelps	Saskatchewan Pulse Growers
Sidney Friesen	Government of Saskatchewan
Stan Blade	University of Alberta
Steven Shirtliffe	University of Saskatchewan
Stewart Brandt	Northeast Agriculture Research Corporation
Stuart Garven	Garven & Associates (Facilitator)
Taryn Dickson	Canola Council of Canada
Tom Jensen	International Plant Nutrition Institute (IPNI)
Tom Steve	Alberta Wheat Commission
Tracy Antonenko	Western Grains Research Foundation (WGRF) (Logistics)
Tracy Jones	SaskCanola
Vance Yaremko	Smoky Applied Research and Demonstration Association (SARDA)
Venkata Vakulabharanam	Government of Saskatchewan
Wade Annand	Ag Grow Consulting
Ward Toma	Alberta Canola Producers Commission
Wayne Thompson	Saskatchewan Flax Development Commission
Wayne Truman	SaskCanola
Yvonne Lawley	University of Manitoba
Zenneth Faye	Saskatchewan Barley Commission
<b>110 Total</b>	