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Towards a Western Canadian Crop Ingredient Strategy

Darren Walkey, MSc
Business Director
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Executive Summary:

"*Towards a Western Canadian Crop Ingredient Strategy*" focuses on the question: "Why has a value-added crop ingredient manufacturing/processing industry not emerged within western Canada?"

As a region, western Canada exports the majority of its crop and agricultural resources into global food, beverage, and personal care markets to be broken into ingredients and finished products, which are then imported back into the region. As global markets increasingly favor the utilization of value-added ingredients that are fractionated, extracted or isolated from plants and agriculture, there is a growing opportunity for western Canada to add economic value to its domestic and export markets by processing a variety of value-added crop ingredients domestically. Western Canada could gain a competitive advantage in high value-added cereal crop ingredients.

Yet, even with a surplus of cereal crops, available infrastructure, and growing global demands for value-added ingredients, a value-added cereal crop ingredient industry has not yet emerged within western Canada. The development of such an industry would increase the economic opportunities for producers, small and medium sized companies within western Canada, and each of the Prairie Provinces. Additionally, a western Canadian initiative would utilize existing processing infrastructure and expertise, and contribute towards increasing the stability and sustainability of Canada's food processing industry.

Data for this project was compiled through interviews with key industry, government, international trade, research and academic people across Canada and internationally. Going into the project it was anticipated that such factors as low populations, high labor costs, energy costs, logistics, the regulatory process, and provincial competition were preventing the industry's growth and development. The project's findings revealed that although these factors impact the region's value-added ingredient industry, they are not the most limiting to growth. The barriers/factors that are include: western Canada is not a unified region, cereals are perceived as being a mature product, a lack of branding for western Canadian ingredients and companies being highly resistant to change.

Understanding these barriers will provide the groundwork for developing a cereal crop ingredient strategy. Such a strategy will assist with developing an ingredients industry which in turn will create further economic opportunities and benefits for producers, regional manufacturers, and western Canada as a whole. The information compiled through this project will be combined with similar research that has been conducted by Pulse Canada and the Canola Council of Canada. The combined research will be utilized to develop an inclusive value-added crop ingredient strategy for western Canada.

Introduction:

Western Canada is one of the world's largest crop producers within the international market. Crops produced within western Canada are shipped around the world and utilized as commodity and value-added ingredients in a diverse range of products within the food, beverage, personal care, industrial, nutrition, nutraceutical, and medical industries. For a number of reasons, such as crop surpluses, low populations, small markets, and established transportation infrastructure and networks western Canada has traditionally focused on exporting the majority of its agricultural crops to meet international demands.

Global market demands, specifically within the food, beverage and personal care industries, are increasingly favoring the utilization of ingredients that are fractionated, extracted or isolated from plants and agricultural crops. This industry demand is being driven by consumers who are looking for natural, sustainable, innovative, and cost effective ingredients and products. As global ingredient demands steadily increase there is an opportunity for western Canada to develop and grow a crop based ingredient manufacturing and processing industry. The development of this type of industry will contribute to the region's economic development, add value to the region's agricultural commodities, and increase western Canada's competitive advantages within the food, beverage, and personal care industries.

Even with significantly increasing demands for crop based ingredients, an ingredient manufacturing and processing industry has been slow to develop within western Canada. Outside of the canola crushing industry, grain millers, and a handful of small to medium companies supplying niche markets there has not been any significant development within this area over the past several decades. This lack of development raised the question of "why isn't crop fractionation and ingredient manufacturing/processing occurring more on a commercial scale within western Canada than it currently is?"

To address this question, this work focuses specifically on the utilization of cereal crops (barley, oats, and wheat) within the food, beverage and personal care industries. An emphasis was placed on cereal crops in order to compliment the industry work that has already been undertaken on pulse and canola crops by Pulse Canada and the Canola Council of Canada respectively. Production of cereal crops is well established within western Canada. The food, beverage and personal care industries were selected as established markets that have a growing demand for value-added and commodity ingredients that derived from cereal crops.

Data for this work was contributed through interviews, product information, economic and trade information, etc. from 90 individuals representing 43 companies, 3 provincial governments (Alberta, Manitoba and Saskatchewan), 3 universities (Universities of Alberta, Manitoba and Saskatchewan), 21 research organizations and facilities, Canadian trade officials in 9 countries, and 4 internationally recognized industry consultants. Additional product and company information was compiled on an additional 40 companies through conferences, tradeshows, websites, product information, and annual reports. The project participants represent as much of the supply chains from the seed to the table (breeders to end consumers) as possible within the food, beverage and personal care industries.

Western Canadian Ingredient Industry Barriers and Limiting Factors:

When it comes to identifying barriers to developing an ingredient processing or manufacturing industry within western Canada there are a number of initial factors that are typically identified during a basic discussion or brainstorming session on the topic. The barriers/factors that are most commonly identified include:

- Technology limitations in processing beyond the bench top and specifically within the scale up and commercialization processes. Infrastructure does exist within western Canada, however, it is not well connected and there are some significant gaps within the commercialization process. In other words a new ingredient cannot be effectively taken from the idea to commercialization with the infrastructure and technology that is currently available within western Canada.
    - Limitations around understanding food security, traceability, and processing/handling/storing of innovative ingredients, fractions and extracts
- Regulations
    - Expensive, and time consuming and it takes multiple years to obtain approvals
        - Applies to all industries, including food, beverages, personal care and industrial
    - Small companies, and entrepreneurs require external support while waiting for regulatory approvals on their products
        - Under most circumstances a product cannot be sold until regulatory approvals have been granted
- Proximity to Market
    - Traditionally processing facilities are located close to the intended market
    - Western Canada is perceived to be a small and rather insignificant market in terms of population and location
- Infrastructure Costs and Constraints
    - Labor and energy costs are high within western Canada
    - Shortage of labor in the construction industry
    - High competition for resources, labor, etc. with other industries such as oil and gas, mining, etc.
    - Problems attracting and keeping specialized expertise within the food, beverage and personal care industries
- Logistics/Distribution
    - It is less expensive to transport long distances by rail than by truck therefore processing and manufacturing facilities are locating closer to large populations
    - Commodities are less restrictive to ship (fewer tariffs, regulations, and safety concerns)
    - Whole grain is more durable, inexpensive, and can easily be transported in bulk volumes, whereas ingredients are lower volume and may require specific packaging, storage conditions, etc.
    - Shipping commodities out of western Canada is very well established and efficient
        - Supply chains and transportation routes have been established for over 100 years
    - Storage costs and limitations within western Canada are high especially for ingredients, and non-cereal crops

        - Within the feed industry there are issues with consistent available access to ingredient supplies
- Political Aspect
    - Competition between the provinces for industry
        - Industry can make the provinces compete against each other to obtain the best business opportunities
        - Competition between the provinces is very evident within international markets
    - Politics determine where clusters are located
    - Prairie provinces are exporters by necessity, since they produce far more in terms of crops, plants and livestock then they can utilize domestically

Although the barriers and factors that are identified above do affect the growth and development of an ingredient manufacturing industry within western Canada they are not perceived as being the significant ones that are blocking the industry's development. This perception stems from the fact that these barriers/factors have been established for a long period of time. As a result many successful businesses have either found ways around them, such as labor attraction and retention or they have integrated methods for dealing with the barriers into their business practices and planning, such as logistics planning.

Data on the significant barriers/factors affecting the development and growth of a western Canadian ingredient manufacturing industry was collected from as many stages of the supply/value chain as possible encompassing the entire process from seed to table. The identified barriers are categorized into 7 key areas that relate to key segments of the supply/value chains, which include: Producer Factors, Accessing Public Research and Facilities, western Canada Issues, Industry Factors, Crop Development Factors, Marketing Factors, and Political/Funding Issues[1]. Each of these key areas is composed of one or more identified barriers that are impacting the development and growth of western Canada's crop ingredient industry. The following points are the most significant and common barriers/factors that were identified within these 7 key areas. Addressing these significant barriers will provide the means to address the remaining barriers.

Significant Barriers to a Western Canadian Ingredient Industry

1. Western Canada is not a Unified Region
   From an industry perspective western Canada is perceived as being composed of three individual competitive provinces with similar agricultural resources, disconnected infrastructure, and small populations/markets. The highly competitive nature of the western provinces has resulted in limited communication, the duplication of investments in infrastructure, research and expertise, competition for industry development and investment, caused each province to be "pigeon holed" into certain areas, and has generated a strong emphasis on exporting commodities and raw materials rather than the development of value-added products. Each province wants to win in every area in order to maximize its returns on investment and the benefits for its own populations.

[1] A complete list of barriers can be found in section 1 of the Appendix

There is no clear identification or map of the infrastructure and expertise that exists within western Canada's private and public sectors. Without an understanding of what resources are available many companies are utilizing international networks to find resources, equipment and expertise that are in many cases available within the region. Without knowing what resources and capabilities are available across the region and the strengths/weaknesses of each province it is challenging to determine the region's competitive advantages as an ingredient manufacturer/supplier within the global food, beverage and personal care industries.

2. Western Canada is Physically and Mentally Removed from its Consumers
   From a physical perspective western Canada is logistically and geographically remote from the major population centers within North America and internationally. The region has a relatively small population which is comprised of a variety of small and niche markets. Since processing facilities and ingredient manufacturers are typically located near large population centers for reasons involving proximity to clients and consumers, logistics, access to markets, etc. locating within western Canada has traditionally not made economic sense beyond branch plants or small scale facilities for the production of commodity ingredients, such as milling products. As such a small market, multinational companies often overlook the potential of the region and its resources.

   The region is mentally removed from industry consumers and consumers in the sense that the region has traditionally focused on the development of commodity crops and ingredients, and the corresponding export markets. By not taking into consideration the changing demands of the market end users, in terms of input, quality, processing or nutritional requirements western Canada has overlooked opportunities within the value-added ingredient sector which could add additional economic value to the region.

3. Lacking Knowledge About Western Canadian Ingredients
   Industry and consumers want to know as much about new ingredients, processes, technologies or innovations as possible. They want to know such aspects as how the ingredients can be used in formulations, how do they compare to what is being used, is there a stable supply chain(s), is there a market pull, what about regulatory/clinical requirements, etc. From an international perspective there is a lack of understanding about the capabilities of the crop resources (ingredients, fractions, components, extracts, etc.) or by-product streams, available infrastructure, expertise and funding resources that western Canada has to offer.

   There is a lack of scientific, regulatory and technical support for a significant portion of the value-added ingredients that can be derived from cereal, and specialty crops, native/traditional plants, and corresponding processing stream by-products. The combination of this type of scientific information with clearly demonstrated benefits and product testing information (formulations, ingredient comparisons, application data, etc.) is needed to convince industry and consumers of the value and market potential of western Canadian crop ingredients. Ingredient suppliers/manufacturers and end users need strong, clear and compelling reasons and evidence to adopt, demand or reformulate

with new ingredients. More often than not this type of information is required to properly educate the other agents within the supply chain as well.

4. Need to Develop Local Markets and Maintain Exports
   For the last century western Canada has emphasized the development of an exporting environment for crops, commodity ingredients, and food products. This system has become so refined that grain cars can be unloaded while they are still moving. As result of this export focus there has been a limited or inconsistent drive or support for value-added processing, and research and development within the food, beverage and personal care industries.

   Investment within these industries is typically limited due to the long term and comparatively low returns on financial investment. Government support for these sectors has traditionally emphasized farm-gate applications that address producer needs, breeding/genetics, development of basic research, and to a limited extent applied research to address industry needs. The focusing of financial support on these areas has generated a significant lack of available funding for early stage commercial development, in terms of scale up, regulatory approvals, consumer testing, by-product utilization, market development, and the securing of intellectual property, which are key components of the commercialization process. Many early stage companies have failed due to a lack of stable, accessible and sustainable funding in these areas, and the lack of investment limits researchers from developing innovative value-added processes or technologies or undertaking applied research.

5. Traditional and Established Cereals
   Cereal crops are well established and mature within the marketplace as commodity ingredients and value-added ingredients, fractions and extracts have been emerging for wheat and oats over the last decade. As a result companies and consumers perceive the crops as being established, traditional and uninteresting. To overcome this type of perspective further research and commercial development needs to be targeted towards the unique properties and characteristics of the crop, their fractions, extracts, isolates and processing by-product streams. Within the marketplace value-added cereal ingredients and by-product streams need to be targeted towards niche or specialty markets in order to develop a market pull and consumer interest.

6. Western Canadian Ingredients do not have a Story or Brand
   There is a significant and growing consumer demand, especially within the nutrition markets for new, innovative, healthy, exotic, and natural products and ingredients. Consumers are looking for products that have cleaner labels, ingredients with names that they can understand and pronounce, and ingredients that they can trust. Consumer attention and interest in an ingredient can be captured by an engaging story about the ingredient or how it is used. Stories that are relatable, factual or imaginative are memorable and as a result will resonate within the consumer. Established or recognizable brands can build consumer trust and loyalty for ingredients and products. Without either a story or a brand western Canada crop ingredients will have a challenge establishing a consumer base and generating a market pull within the targeted industries.

7. Need to Generate Market Pulls
   As part of the investment process companies, especially Small and Medium Enterprises (SMEs), need to prove that there is a market demand or pull for their ingredients or fractions. Companies need to have ingredient or product sales, and regulatory approval is required before ingredients can be sold to demonstrate that there is a market demand. This generates a Catch-22 for early stage and SME ingredient manufacturers. These companies are small, have limited revenue streams and are unable to sell their ingredients/products because they are working their way through the regulatory process. As a result they cannot sell their ingredients to generate a market pull, and they cannot secure investment to further develop the ingredient/product without the market pull.

8. Declining Canadian Food Processing Industry
   As multinational food companies either close or scale back their branch facilities within Canada the domestic demand for local and imported ingredients declines. One of the factors that are thought to be contributing to the industry's decline is the increasing need for companies to import ingredients which are not locally or regionally available. Higher costs associated with tariffs, transportation, regulatory requirements, logistics, storage, etc. of imported ingredients lowers the profitability, regulatory and economic stability of branch plants and facilities within Canada.

9. Supply Chain Development
   The development of sustainable, consistent quality ingredients at commercial scale requires the development of stable supply chains that can source quality and consistent raw materials. There are increasing consumer demands for increased food security, traceability to the farm-gate, and ethical/environmental sourcing of ingredients and raw materials. Consumers also want to ensure that they are getting quality ingredients for reasonable prices. In order to meet these types of demands western Canada will need to ensure that its crop production processes meet industry requirements, that processed grains are more consistent terms of quality, are free of contaminants, and are traceable back to at least the farm-gate. Western Canadian supply chains will need to be further developed in order to provide the varieties, specialty crops, and raw material consistency that is required by industry to manufacture value-added ingredients.

10. Need for Further Education
    Education of the various agents within the supply chain is needed. SMEs, entrepreneurs and academics need assistance with such factors as scale up, marketing, business development, etc. SMEs need to be educated about the risks associated with the ingredient market and they need to be assisted with becoming less risk adverse. Larger companies need to be educated about how to utilize western Canadian ingredients and how they can benefit from the ingredients. Consumers need to be educated about crop production processes and ingredient processing practices. Understanding of these areas will assist with increasing consumer understanding of and control within the supply chains. Within the food, beverage and personal care industries small companies are often not aware of what they need, large companies focus on the immediate and short term needs, and consumers need to be informed about their needs. Investors need to be

educated about the benefits of the food ingredient industry and how to effectively overcome the risks associated with it.

11. By-Product Utilization

    Typically, ingredient utilization focuses on one or two key extracts from the crop (such as protein or oils), which results in a number of by-products (such as starch) of varying quality. This raises the questions of what can be done with the processing by-products to either reduce waste, processing costs or increase economic returns. Once a catalogue of components has been generated a method or process needs to be developed for the purpose of rating these components for regulatory approval and commercial utilization potential of these materials.

    To ensure that the by-product streams can be utilized as viable feed stocks methods or processes for ensure quality and consistency of the raw materials need to be developed and implemented. The quality and consistency of the raw materials will impact processing and regulatory requirements, and the properties, characteristics, and quality of the manufactured ingredients or finished products.

12. Resistance to Change (Plug and Evaluate Approach)

    Modifying processes and reformulating products can be an expensive endeavor. As a result companies within the food and beverage industries want to take a plug, test and evaluate approach to reformulation that provides a monetary advantage. For example: A company is approached with the proposition that ingredient Y should be utilized to substitute ingredient X in a formulation. Under ideal circumstances the company would like to remove ingredient X and replace it with ingredient Y without having to change the formulation, equipment or processing. In reality the company may substitute ingredient Y for ingredient X provided that: a) if there is any equipment or formulation adjustment Y must be less expensive than X, b) if there is no formulation adjustment, Y must be slightly cheaper than X because of handling or storage, or c) if there is a significant market advantage to the change, and the price is equal.

    In addition the economic aspect a direct substitution of new ingredients does not always work due to the fact that each ingredient, crop or even variety has its own unique properties, characteristics, and interactions with other ingredients within the formulation or product. As a result there is a need to know as much about each ingredient as possible.

13. Difficult to Access Academic Innovations

    Accessing academic innovations, technologies, and applied research is challenging and difficult under the current models. There are too many barriers that are set by university technology transfer offices who want to transfer their intellectual property costs to industry as soon as possible, but fail to consider that the technology is too early stage for industry to take the financial risk of commercial development.

Potential Barrier and Factor Solutions

1. Developing a Western Canadian Brand for Crop Ingredients
   The development of a distinctly western Canadian brand for crop ingredients, fractions, extracts and isolates would serve a number of purposes:
   - It would provide a common ground and a starting point for developing a western Canadian region and initiating interprovincial collaboration. The brand can be developed in correlation to the strengths, expertise, infrastructure and resources of each province, while representing the region as a whole. Equal investment in the brand can be drawn from each of the western provinces and brand successes would benefit the region as a whole.
   - The development of an internationally recognizable western Canadian brand for crop ingredients or agricultural products would increase opportunities for ingredient manufacturing/supply, increasing the region's connection to end consumers, increase industry engagement/investment in the region, and it would strength the economic development of regional and local markets.
   - Would increase each province's access to infrastructure, expertise, capacities/services across the region. Increasing the utilization of these resources would increase the economic benefits of each province in addition to increasing each provinces capabilities and strengths. More would be able to be accomplished with current levels of investment.
   - The developed brand would need to be supported by a strong and growing value-added ingredients industry within western Canada.
   - A unified region would reduce the opportunities for companies to make the provinces compete against each other for investments and developments. Investments would benefit the region as a whole and be made in the geographic areas where they make the most sense and would have the most benefit. This would lead to generating more win-win-win partnerships.
   - A western Canadian brand would provide a platform for developing supporting stories for the region's ingredients. Supporting stories for ingredients may attract consumer attention and make the ingredients more memorable for the consumers. Increased familiarity among end users can generate a market pull for new innovations, ingredients or technologies. Development and distribution of such stories under a brand can be assisted through social media applications.
   - A recognizable brand would increase consumer and industry familiarity, trust in and loyalty to the region in the long term.

2. Development of Regional Markets and Companies
   In order to become competitive in international markets western Canadian crop ingredients will need to be developed and proven within domestic markets first. Within the food, beverage and personal care markets SMEs are perceived as the initial adopters and developers of processes, innovations, and technologies. These companies focus on developing these innovations for commercialization within specialty, niche or emerging markets. These companies are responsible for obtaining the necessary regulatory approvals and for maintaining the appropriate intellectual property (trade secrets, patents, etc.). As SMEs become increasingly successful they contribute to regional economies

(labor, taxes, utilities, etc.), utilize local resources (contracts with producers), active in communities, etc. Collaborations between SMEs for the utilization of by-products or resource/infrastructure sharing will increase the value-added potential of the region. Multinational companies that acquire SMEs typically do not move the infrastructure or the employees, which maintain the economic investment within the region and increases access to international markets. Therefore maintaining support for SMEs and developing domestics is key to building and establishing a western Canadian ingredient industry and corresponding ingredient brand.

3. Development of a Regional Network

The need to develop and support a regional network is prevalent across each of the provinces. Over the last several decades various networks have been established and abandoned. The main reasons for the failure of these networks include:

- Lack of financial support or sustainable investment in the network
- No one party within the network wanted to take the lead to facilitate, operate and maintain the network
    - Regional networks were found to be overly time consuming and expensive
- Government ran networks tend to fall apart as soon as the individuals involved returned to being focused on their own provincial objectives and workloads

A regional network for western Canada would need to have the following attributes:

- Needs to be aligned with provincial strengths and objectives in order to maintain provincial support
- Needs to be able to garner support from all government parties in order to weather changes in provincial governments and to ensure sustainable, long term financial and political support
- Needs a strong, regionally minded coordinator and board or steering committee
- Build and maintain network collaborations between regional infrastructure, service providers, expertise, trade organizations, and networks (for both the private and public sectors)
    - Maintaining the infrastructure/capabilities/services map for the region
    - Be able to facilitate the sharing of resources and the directing of industry clients
- Needs to be able to engage industry
    - Portfolio of ingredients, services, infrastructure, etc.
    - Build collaborations with relevant medium and large companies internationally
        - Within the nutraceutical industry the United States has fewer regulations to deal with and as a result companies have more flexibility and resources to contribute to scale up trials, clinical research, marketing, etc.
- Needs the capacity to assist with the development of specific ingredients, such as technology orphans[2]

[2] These are promising technologies, innovations or processes that have a lack of support or industry interest or investment

- Needs the ability to draw up contracts, and confidentiality, joint development, licensing agreements
- Needs the ability to kill bad projects
- Work with 1-2 technologies from each province for a 5 year term
- Have the ability to work with or establish sub-companies, such as university food sales
    - Purpose of these companies would be to sell products with the ingredients and to compile relevant consumer data on the ingredients
- Needs to be arm's length from yet supported by the regional governments
    - Should be able to direct companies to the best solutions or suit resources without a provincial bias

In order to operate the network will require financial support from each of the provinces, in addition to being able to generate revenue from licensing agreement or projects. Additionally, there should be a larger scale capital mechanism for companies who were assisted by or benefited from the network to provide funding support. This funding can be utilized to assist companies that have promising ideas; however, the risks associated with commercialization are too high for traditional funding agencies, such as banks or governments.

4. Development of Product Testing Facilities

   Companies need to be convinced to change, reformulate or to utilize new ingredients, processes or technologies. Specifically, they need to be educated on such aspects as why the ingredient is better than what they are using, and how it will benefit their products or processes. There are four main types of information that are needed to educate ingredient suppliers and manufactures. The first type is scientific data relating to in vitro, in vivo, sensory, clinical and other forms of testing. This data can also be applied to regulatory requirements. The second category of information relates to supply chains, raw material quality, market potential, consumer data, costs, processing/technical requirements, utilization of by-products, etc. which is used to demonstrate the market and economic potential of the ingredients. The third category compares the ingredient to other ingredients in terms of properties, characteristics, functions, storage/handling, cost, quality, etc. The last category focuses on ingredient testing in various formulations, applications, conditions (freezing, thawing, heating), etc. This particular category assists with demonstrating the benefits of the ingredient or the product. For food applications the food development centers within western Canada, specifically those in Leduc, AB, Saskatoon, SK, and Portage La Prairie, MB have the capacity to collect the majority of this information for food products. Within western Canada there is an opportunity to leverage both public and private sector resources, expertise and infrastructure to develop a network or agency that could conduct this type of testing on new or emerging western Canadian crop ingredients for non-food applications. Such an agency could be operated by the public sector and supported financial on a project basis. If successful in the long term these types of facilities could eventually be privatized.

5. Increase Producer's Tolerance for Risk
   In order to increase the producers' tolerance for risk, producers will want to be assured that there is more than one market for the crops that they grow. Therefore it is important that multiple applications be considered for innovative ingredients and the resulting processing by-products that are developed. These applications should take into consideration, where possible, industries beyond food, beverage and personal care. The greater the market potential and applications for the ingredients or crops the more likely producers will be willing to grow the specific crop or variety and to adhere to the specific inputs that the industry or consumers require.

   Methods or applications for salvaging value from years when quality is reduced below acceptable levels needs to be further explored. Potential options for recovering more grains from poor quality years could include improved seed sorting, cleaning or industrial by-product utilization. Being able to recover value-added components from poor yielding or damaged crops can still provide some economic support to producers, and provide a supply of quality raw materials for the existing supply chains.

6. Mapping Existing Infrastructure, Expertise and Resources
   Multiple companies and organizations within western Canada and internationally confessed to not knowing what infrastructure, expertise, service capabilities and resources were available within the region. This lack of knowledge was very prevalent among SMEs within the region. These companies are heavily relying on their international network connections, which are established through conferences and trade shows, to access the resources, equipment and services they need. A starting point to address this issue is to map out all of the existing infrastructure, expertise, capabilities/services, and resources that are available within the public and private sectors across western Canada. Such a map would also illustrate technology, equipment, service or expertise gaps within the region that could potentially be addressed through targeted funding initiatives or addressed through network/collaborations with international sources. Making such a map publically accessible and current would enable companies to best determine where they can source expertise, equipment or resources regionally. .

7. Targeting High Value-Added Applications
   Western Canada cannot compete as a commodity ingredient manufacturer/supplier within international markets. Commodity ingredients are produced in large volumes and sold for low or inexpensive prices. With low labor costs, fewer regulations, and high demand for commodities developing countries, such as China and India can produce commodity ingredients more efficiently and at lower costs than western Canada can. Therefore, the area that western Canada can gain a competitive advantage is through the development, processing or manufacturing/supplying of high value-added ingredients[3] from crops or processing by-product streams. By targeting the manufacturing of high value-added ingredients, especially those that are extracted from by-product or waste streams, can assist with eliminating or reducing such negative factors as low domestic consumption, logistics or transportation. The concentration on high value-added ingredients enables

[3] High value ingredients that are produced by extractions and fractionations which go beyond the initial transformation state within the crop fractionation process

access to world markets and the production center for these ingredients becomes western Canada since the raw material resources are there.

There are a number of factors that must be taken into consideration in order to secure and maintain a competitive advantage within the ingredient manufacturing industry. These factors include:

- Secure supply of consistent quality crops or raw materials
    - Full control over the supply chain makes it difficult for competitors to source raw materials, and companies can be assured of the quality, stability and traceability of materials within the supply chains
- Targeted crops and plants should be native to western Canada or at least have limited international production
    - Reduces the opportunities for competitors to develop alternative supply chains
- Proprietary processing, ingredients, innovations or technologies
    - Parts of the supply chain need to be protected by some form of intellectual property (patents, trade secrets, etc.)
- Offering a complete service package in support of the ingredients or a regional brand
- Target multi-industry applications for the ingredients and processing by-products in an effort to move towards full crop utilization
    - More applications generate increase opportunities for revenue generation and higher volume demands for crops
- The volumes of crops required becomes significantly reduced as value-added processing increases
    - It is extremely imported to find value-added applications for each of the by-product streams that are generated by the processing
    - Maximize the utilization of the crop
- Value-added ingredients, innovations and technologies must be developed from the consumer back to the point of production
- Start by developing a small portfolio of select ingredients and expanding as domestic or North American market demands increase
- Extracting high value ingredients from process by-product or waste streams ensures a stable supply of the ingredients and provides a feedstock that is acceptable to the majority of industries and international markets

The production of high value-added ingredients (such as antioxidant peptides, protein delivery systems, gels, modified starches, etc.) will result in the generation of commodity ingredients (such as starches, enriched flours, fibers, etc.). These commodity ingredients can be either utilized within the domestic or North American markets or exported into high demand foreign markets, such as Africa, Turkey, the Middle East, China or India. Any revenues from these sales would benefit the regional economy. The volumes associated with value-added processing are significantly lower than those required for commodity markets. For international markets the economic viability of commodity ingredients will need to take into consideration the compared shelf life of these ingredients to that of the original materials. For example: how long can extracted

starches resist oxidation without being in an intact seed where natural constituents limit or prevent oxidation.

8. Industry Before Food Approach
   SME's, entrepreneurs and start-ups that are manufacturing or producing ingredients often encounter financial sustainability issues while waiting for regulatory approvals by Health Canada. Companies that are waiting for regulatory approvals tend to get caught in a Catch-22 where they cannot secure funding support without a proven market and they cannot develop a market without being able to sell their ingredients or products. Beyond government and angel investor support there are not a lot of investors who want to invest in food, beverage or personal care applications due to the long term and low returns on investments. As a result these companies tend to become very dependent upon government and angel investor support until they are able to sell their ingredients or products.

   A potential solution to this barrier is for companies to identify and develop industry applications for their ingredients or by-product streams that can be undertaken while they are waiting for regulatory approvals. Industrial applications have higher volumes, shorter regulatory timeframes, and can offer supplementary revenue streams to the business. Having an industrial market will enable the company to attract other non-government investment opportunities.

   Within the nutraceutical industry another potential solution is building collaborative partnerships between Canadian SMEs and medium to large sized companies within the United States. Nutraceutical companies within the United States face fewer regulatory barriers for ingredients that are derived from food, and they are typically able to acquire intellectual property access at lower costs. As a result these companies have more funding and resources to invest in clinical research, scale up trials and the marketing required to sell the ingredients then their Canadian counterparts. Collaborations and partnerships between Canadian and American companies could potentially get Canadian innovations into the US market faster and provide American companies with access to stable and high quality supply chains. For Canadian companies owning the intellectual property rights allows for an additional revenue stream through licensing or royalty fees.

9. Full Service Support Packages
   Within current markets simply providing a proprietary ingredient, product or process is not enough to secure a competitive advantage or to maintain a client base. In order to be competitive the ingredient must be supported by a complete package of scientific, business development, product, technical and problem solving support. Clients and consumers want assistance with formulating, adapting or customizing the ingredients, they may need technical support for problem solving or they may need access to specialized expertise or equipment for various applications. Offering higher levels of support can increase consumer trust/loyalty in the company or brand and the ingredients, and it can create additional opportunities for collaboration, providing services or attracting new customers.

10. Challenging the Traditional

    For the last several centuries western Canada has placed a significant amount of investment and effort into developing efficient methods for exporting raw materials and excess commodities. Under this system grains are exported to international markets for processing and the resulting ingredients and finished products are imported back into the region. The exporting process is so established within western Canada that there has been very little support or drive for the development of a value-added ingredients industry within the region. In order to further develop an ingredient manufacturing/processing industry within western Canada the economics that support the traditional export model will need to be challenged. It will need to be proven through an economic model that manufacturing/processing select ingredients for domestic use within the region and export is more economically beneficial than exporting the whole crop. The type of required economic model is discussed in more detail in Section 3.

    Challenging the traditional methods goes beyond incorporating a value-added ingredients market into an established commodities market within western Canada. In order to effectively develop a western Canadian ingredients industry and corresponding brand the thinking has to be shift from a grain to table scenario (market push) to table to grain scenario (market pull). It needs to be understood how the ingredients will benefit the end consumers, why they would want/need the ingredient, who they trust to supply it, and why they would pay a premium to get it. It is also important to understand the agencies that influence consumer knowledge and understanding about ingredients and products within the food, beverage and personal care industries. Once these needs are understood then it is possible to develop the corresponding supply/value chains to meet the consumer needs. Generating sufficient market pulls will increase the demand for western Canadian ingredients and brands.

    In certain industries, such as personal care, market pushes from suppliers and manufacturers can be just as effective as market pulls. What makes market or supplier pushes successful within the personal care industry is strong marketing that educates the customer or target market about how the new ingredient is important and that they cannot work without utilizing it. Under certain circumstances waiting for a market pull will increase the levels of competition within a market segment or niche. Therefore, market and commercialization approaches should be determined on a component or ingredient basis and should be aligned with the processes of the industry that is being targeted.

    The determination of which ingredients (such as antioxidants, antimicrobials, specialty chemicals, natural delivery systems, etc.) that retailers and consumers will pay a premium for will provide an indication of the areas where western Canada can gain a competitive advantage within the value-added ingredients market.

11. Education and Assistance for SMEs

    Within the commercialization process technology and innovations that are developed by academics, entrepreneurs and small companies are typically further developed, customized/expanded, and commercialized by Small and Medium Sized Enterprises (SMEs). Since these types of companies are important for commercially developing

value-added ingredients and products it is necessary to ensure that they have access to the resources and expertise they need. One area that these companies typically have issues in is accessing the appropriate expertise for such areas as business planning, marketing, business development, scale up, innovation, etc. Access to this type of expertise can be provided through industry mentoring programs, which can be operated through industry organizations, such as the provincial Food Processors Associations.

Another area that SMEs need to be educated about is risk tolerance. The development of value-added ingredients within the food, beverage and personal care industries carries with it high levels of risk. Companies need to be educated about managing the risks, informed about the sources that can assist with mitigating or reducing some of the risks, and they need to be educated about the potential opportunities and rewards that accompany the risks. Effective mentoring programs enable companies to access the knowledge they need to address their problems or major issues at an affordable cost, thereby improving their overall chances for success.

As SMEs are supported and developed there needs to be a way of keeping the companies accountable for the funding and educational assistance that they receive. Each supported company should be responsible for meeting a set of milestones that are determined in relation to the company's commercialization process. Take a company that produces specific peptide extract from wheat that can be utilized as an antioxidant as an example. To commercialize this value-added ingredient the company would need to prove success in such commercialization milestones or stages as: 1. Bench Scale, 2. In Vitro Testing, 3. In Vivo Testing (toxicity, efficacy, dosage, etc.), 4. Pilot Scale (varying quantities), 5. Regulatory Approval, 6. Sensory Testing, and 7. Commercial Scale Production. If the company misses a milestone, such as pilot scale up trials, it may mean that they will not be able to manage a success or the technology is poor and the supporting organization(s) should cut their losses. Those companies that can meet their objectives and whose technologies are still competitively valid can continue on. Financial supporting agencies should increase their processes for due diligence in selecting successful companies or technologies. They should always ask if "it still makes sense." The increased emphasis and support that is given to winners will improve the region's economic outcomes. Systems for selecting and supporting successful companies or potential winners is already being utilized by the region's food development centers and in some of the provincial and federal government funding assistance programs.

Successful SME's with the region will assist with developing within or attracting large or multinational companies to the region. Large and multinational companies often expand or diversify through the acquisition of SME's and they have the resources, infrastructure and expertise to establish large scale commercial facilities or branch plants within a region. These types of companies also have the capabilities and expertise to manufacture, process, and handle commodity scale ingredients.

12. Developing Western Canada's Agriculture Industry as a Whole
    In order to increase the economic potential and the opportunities for success within the food, beverage and personal care industries western Canada has to develop the grain and

livestock industries together. Western Canada has a strong livestock industry which is the primary utilizer of low quality or low cost grain products and processing by-products. Since the livestock and feed industries are resistant to paying premium prices opportunities need to be found for increasing ingredient and product quality without increasing costs. By strengthening both industries the region can reduce costs (transportation, logistics, exportation, etc.), improve livestock and ingredient qualities and significantly strengthen its food production for domestic and international markets.

Strengthening both industries also creates new opportunities for innovation. For instance improving grain screening practices increases the quality, reduces variability and improves consistency of grains that are utilized within food and feed markets. Increasing these factors will likely result in higher quality grains for value-added processing, healthier by-product streams for livestock production, and increased food security and traceability within the industries.

13. Supply Chain Development

An ingredient industry within western Canada will need to establish and grow supply chains that are targeted towards value-added processing and manufacturing. These supply chains will need to be developed collaboratively with as many agents of the chain as possible (including: breeders, producers, grain handlers, processors, manufacturers, and end consumers). The supply chains would benefit from improved crop screening methods, such as near infrared spectrometry (NIRS), which could be effectively utilized to reduce variability, increase raw material consistency and effectively remove infected or poor quality seed from the feed stock materials. The use of higher quality raw materials allows for the production of higher quality ingredients. Additionally, the further development and customization of crop screening and sorting methods can increase the opportunities for food security and traceability to the farm-gate level within niche, specialty or other low volume food markets and the personal care industry. Increasing traceability and food security will increase consumer confidence in and support for a western Canadian brand and ingredients industry. The developing of processors or methodologies for salvaging or recovering quality raw materials from either poor yielding or damaged crops would provide producers with the ability to meet part or all of their supply agreements during years with negative growing or harvesting conditions. Such methods would be useful for ensuring stable and quality supplies of raw materials within the supply chains.

Another aspect that needs to be considered in developing supply chains is the determination of the manufacturing or production scale that is required to meet commercial needs. For example within the nutraceutical, speciality chemical and cosmetic/personal care industries pilot scale or entry level commercial scales may be large enough to meet commercial supply demands. The pilot scale infrastructure that is available across western Canada could be utilized on a toll manufacturing basis to establish initial ingredient supplies for these industries.

14. Second Stage and beyond Ingredient Development

    Western Canada has a developed a growing infrastructure for fractionating crops into primary fractions, such as starch, proteins, oils, fibers, etc. There is a need within the region for companies to develop and modify these fractions further for utilization within the food, beverage and personal care industry. For instance, the food industry does not have a high demand for native starches, although it does have an increasing demand for modified starches, such as Cargill's EmulTru starch or Tate & Lyle's food starches. Developing modified starches requires the use of advanced processing, chemicals, etc. which increases the associated risks and the need for specialized knowledge within the manufacturing process.

    As ingredients become more refined through fractionation and processing the greater their value within specific markets and applications. As a result there is a need to go beyond the initial fractionation processing of cereal crops into second, third, fourth, etc. stages. Any extracts or components that can be manufactured from by-product or waste streams will assist with securing a regional material supply for the ingredients, and will increase the ingredient's stability and marketability within the marketplace.

15. By-Product Utilization

    Opportunities within other markets should be considered for all processing by-products that are generated through a company's ingredient manufacturing processing. Considerations need to be given to industries beyond the food, beverage and personal care industries, due to the fact that by-product streams for these industries can be feed stocks for other industries. By-product utilization is a step towards full crop utilization and zero waste processing. As a result this approach may provide the basis for the development of multi-industry clusters that utilize the same crop raw material sources.

    Within the cosmetics/personal care, nutraceutical, and other life science industries by-product streams are perceived as the preferred feedstock for ingredient manufacturing and product development. This perception is generated by the demands by the industry's consumers for zero-waste, lower carbon foot prints, and a desire not to directly remove resources from the food and feed industries. Therefore, being able to extract high value ingredients from by-product or waste streams increases the value and sustainability of the ingredients within the industry. The utilization of local or regional by-product streams that are unique to the region can provide a competitive advantage in terms of raw material supplies.

    Since by-product streams can be variable in terms of quality and consistency processes or methods need to be developed to ensure that by-product streams are sustainable and can viably be utilized as a feed stock. Potential screening methods for processing include near infrared spectrometry, seed sorting or mainstream processing improvements.

    An example of a hypothetical cluster for the manufacturing of value-added ingredients from fractionated barley, and the utilization of corresponding by-product streams is illustrated in section 2 of the Appendix.

16. Proximity to Booming Markets
    Western Canada is well positioned to access the booming and expanding markets for China, India, Japan and South Korea. The close geographic proximity combined with established transportation and logistical networks provides western Canada with a competitive advantage over Eastern Canada and the eastern United States in terms of accessing and selling food and personal care ingredients into these markets. Once regulatory approvals are in place Asia represents a fast to sales market for western Canada crop ingredients.

Technical and Research Gaps within the Supply/Value Chains

Along with the industry barriers a number of issues or gaps within the current supply/value chains were identified. The purpose of identifying these issues/gaps was to provide a list of areas and industry needs that could be addressed through future research or government/industry funding initiatives to assist with developing and improving ingredient supply/value chains and commercialization within western Canada.

Supply/Value Chain Considerations:

The following points should be taken into consideration when considering ways to improve or further develop the existing ingredient supply chains within the region:

- Improving the quality and consistency of the raw materials will improve and ensure ingredient/product quality further down the supply chain, and it will assist with reducing waste through the entire process
- Effectively understanding, evaluating and utilizing by-product streams through the supply chains
  - Understanding the by-product streams can identify value-added applications within other industries, which generates opportunities for full crop utilization
- Reducing waste streams or products resulting from such factors as poor crops, spoiled food, etc.
  - Poor, inconsistent, damaged or spoiled ingredients can significantly impact the supply chains for the food, beverage, and personal care industries, in addition to wasting revenues and increasing costs
  - Depending on the biomass, ingredient, product or process there may be other industry opportunities that can add value
- The increasing desire by consumers to have more control over food and ingredient sourcing, consumer's high valuation of perceived taste and nutrition, and the increasing support for ethical and environmental values
  - This is leading to increased sourcing of products from farmer's markets, the farm-gate, fair trade companies, etc.
    - Consumers want to be assured of traceability and knowing where their food comes from
      - This is leading to traceability trends in grocery stores, such as Loblaws and Save-On Foods which demonstrate traceability and direct connections with producers

Another useful consideration when considering how to address gaps within existing supply chains or in developing new ones is to understand they types of questions that ingredient manufacturers/suppliers utilize when considering or evaluating a new ingredient or product. The following are examples of the types of questions that ingredient manufacturers/suppliers ask when considering or evaluating a new ingredient or product:

- Is there an established supply chain for the ingredient? What quantities and qualities are available? If, so what are the costs?
- What are the feed stocks or raw material sources? Are supplies available and stable? If so, at what are the costs?
- Is there established manufacturing or processing?
- Is the ingredient proprietary? Are there other barriers to manufacturing?
- How does the ingredient compare to what is already available within the marketplace?
    - What are the yields? Quality?
- What is the state of regulatory approvals?
- What are the by-products? Volume/Quantities? Applications? Costs?
    - Other value applications
    - Need to take the by-product streams seriously and understand how the streams can be utilized even by other industries

On an internal basis suppliers will ask the following types of questions when considering a new or innovative ingredient:

- Do we have the facilities or the expertise to process the crop or components?
- What are the values of the fractions? (Cost, functionality, uniqueness, innovation, etc.)
- What is the advantage over other existing ingredients?
    - How innovative is the ingredient?
- Where on the commercialization spectrum does the ingredient fall?

Gaps and Issues within Existing Supply/Value Chains:

The gaps and issues that have been identified within the region's existing ingredient supply and manufacturing chains are fairly diverse and include the following aspects:

- Equipment, Facilities or Infrastructure:
    - Establishment of a stable commodity ingredient supply, such as a cereal fractionation facility to provide commodity ingredients to small companies for the manufacture of specialty ingredients
    - Western Canada is lacking drying capacity for crops, fruits and vegetables at the pilot and commercial scales that is accessible to small companies
    - A lack of bottling and packaging lines within western Canada that are accessible to and affordable for smaller companies
    - Food Processing and Development Centers have gaps within their equipment, expertise and capabilities
        - Public facilities can be expensive for small companies, entrepreneurs, etc.
    - Need for a processing facility to conduct formulation and product testing that can be utilized by regional businesses
    - Automation is required to compete within international markets, however, it is expensive to install and it cannot adapt quickly to changes in consumer demand

- Knowledge/Research:
    - Need to increase the understanding of the environmental effects on and varietal differences between crops in terms of value-added ingredient processing. For example, research conducted by the Cereal Protein and Cellulose Program ($(CP)^2$) has demonstrated that certain barley varieties are well suited for the development of coatings and delivery systems, while others are more suited for antioxidant extraction due to their higher nutrition and fiber levels.
    - Clearer understanding of the nutritional components that are contained within cereal crops and how these components can best be extracted, processed, stored, and utilized is needed
    - Crop components need to be understood better in relation to the crop as a whole
        - How do each of the fractions or components work together within the whole grain
        - Does removing the fraction or extract from the whole decrease its functionality or alter/reduce its properties?
    - Needs to be more scientific and/or clinical support for cereal crops, fractions, ingredients, isolates, and extracts. Health claims are a starting point; however, on their own they are not sufficient enough
    - Small companies need to be connected with sources of expertise, innovation and scale up infrastructure and technical services
    - Lack of compiled or available baking knowledge available regarding the properties, processing and utilization of barley and ancient grains
        - Understanding these will increase opportunities for bakery and snack applications within the food industry both domestically and internationally
    - A lack of industry engagement by academics in terms of applied research, expertise, innovation or technology transfer
    - Need to change traditional technology transfer, marketing methods, and ways of commercializing
    - Need to identify value-added opportunities for established industries, such as malting
    - Lack of value-added research on barley and oat starches, and ancient grains
    - Research into the value-added potential of by-product streams within established processing
    - Research into making raw materials more consistent in terms of quality
    - Methods for increasing ingredient food security and traceability of the ingredients/products

- Technical:
    - Component extraction processes need to be improved, refined or developed
        - Includes factors like storage, transportation, shelf life, etc.
    - By-product stream identification and utilization
        - Needs to be further cataloguing of the components that are being produced within existing industry processing
    - Packaging innovation for small companies

- Need to expand NIRS capabilities and calibrations for sorting and selection processing
  - This would assist with ensuring consistent quality feed stocks to produce high value, low volume ingredients for niche markets or specialty industries, like personal care
  - Assist with improving food, feed, nutritional formulations in response to varietal or environmental differences in cereal grains
  - Improves food safety – removal of mycotoxins within supply chains
  - Need to build consistency throughout the supply chains – inconsistency with feed impacts livestock weights which need to meet processor needs and expectations
- Breeding records on environmental conditions, varietal properties and characteristics need to be maintained in an accessible database
  - Increase the understanding of varietal differences within crops and how these differences or characteristics affect their utilization in food, feed or value-added applications and/or products

High Level Market Trends Analysis

Within the food, beverage and personal care industries cereal crops compose two main types of ingredients: commodity ingredients (β-glucan, bran, flour, germ, malt, starch, protein, etc.) or high value/specialty ingredients (antioxidants, fibers, malt extracts, protein/starch isolates, etc.). Commodity ingredients are typically produced in high volumes for low cost, and are traditionally manufactured near the target market(s). However, through innovation there are exceptions where a commodity ingredient can gain a premium price within the market. Within the food industry an example of this type of ingredient is Cargill's Grainwise Wheat Aleurone Flour. The flour which is produced from extracting the Aleurone layer can be utilized to substitute a portion of white flour within baking products[4]. This addition adds properties of whole wheat grains to the product without impacting or altering the white bread characteristics that consumers prefer. As flour wheat Aleurone can be considered a commodity ingredient, however, with its unique high value nutritional properties it can command a slightly higher price within the food markets.

High value ingredients are produced in lower volumes and generally obtain higher prices within the market. The market demand for these ingredients is most often generated through a market pull in relation to manufacturer needs or consumer demands. Examples of these types of ingredients include: antioxidants and nutritional components extracted from wheat that have nutritional and pharmaceutical properties, sweeteners extracted from cereal starches, specialty alcohols, malt extracts for food and beverage applications, etc.

Existing Markets:

Commodity ingredients (such as flours, whole grains, β-glucan, gluten, starch, germ, bran, etc.) are frequently utilized throughout the food, beverage and personal care industries in a wide variety of applications. These types of ingredients are manufactured or processed near larger

[4] Cargill Inc. 2005, Grainwise Wheat Aluerone Flour: Healthy Benefits of whole Grains, Horizon Milling, viewed 27 February 2014, www.cargillfoods.com/wcm/groups/public/@cseg/@food/@all/documents/document/na3032890.pdf

populations centers. As a result the majority of commodity ingredients that are identified in the following market areas are produced internationally from exported Canadian cereal grains, and are imported back into western Canada as ingredients or finished products. Existing and developing market opportunities for cereal crop commodity ingredients include:

- Bio-Plastics
    - Plastic bags made from wheat starch
- Cosmetics and Personal Care
    - Starches as delivery systems
    - Wheat germ oil
- Ethanol
    - Utilization of wheat and barley
- Food
    - Flours for baking, pasta, snacks, pizzas, etc.
    - Bran for breakfast and snack products
    - Flakes, rolled, and whole grains
    - B-glucan as a nutritional additive
    - Gluten as baking additive
    - Alcohol production
    - Starch derived delivery systems
- Other
    - Starch based packaging peanuts
    - Foams and insulations from starch
- Paper Making
    - Cereal Starch
- Pharmaceuticals
    - Starch based delivery systems

Value-added or high value ingredients from cereals (particularly wheat) are established throughout a variety of markets, which encompass the following areas:

- Cosmetics and Personal Care
    - Hydrolyzed barley, oat, triticale, and wheat proteins are utilized in hair care products
    - Extracts from wheat and oats are utilized in skin care products
    - Barley malt extracts are used as texturizers or color additives
    - Moisturizing agents
- Food and Beverages
    - Specialty alcohols
        - Food, beverage, industrial applications
    - Flavoring, Texturizing, sweetening, coloring extracts
        - Typically from malt, starch and other components
            - Potential with malt wheat extracts
        - Wheat beer is increasing in interest within the craft markets
- Industrial
    - Bio-Plastics from Wheat fractions
        - Established market that is consumer driven due to the demand for sustainable products

        - Need to ensure a stable supply of consistent quality starch
            - Direct competition with the ethanol industry
        - Opportunity to identify unique or innovative properties or characteristics
    - Specialty Chemicals – extracted from wheat
        - Detergents, soaps, etc.
        - Industrial
    - Wheat Straws – composites, car panels, building materials, etc.
    - Natural non-woven fibers within personal care products, such as tissue paper, diapers, etc.
- Livestock and Pet Care
    - Starch additives from wheat and barley
    - Concentrated feed supplement pellets that are custom formulated for livestock feed markets
    - Animal feed ingredients[5]
        - Strong investment in R&D to take advantage of the benefits of the "natural" tag
        - The global animal feed ingredient additive market was worth $12.19 Billion in 2012, expected to reach $17.28 B in 2019
        - Encompasses vitamins, trace minerals, amino acids, enzymes and other ingredients such as antioxidants/shelf life stabilizers, probiotics and fatty acid compounds
            - Amino acids generates 33.8% of the revenue globally (largest segment)
    - Cat litter
        - Cost effective, sustainable alternative to clay litters[6]
        - $1.89 Billion industry in 2009 and expected to continue growing[7] [8]
    - Aquaculture
        - Barley protein as a replacement for traditional fish feeds[9] [10]
        - Pond cleaners – barley straw extracts
- Nutraceuticals, Nutrition, Natural Health, Etc.
    - Customizable delivery systems for ingredients or components (Barley and other crop proteins)
        - Utilize the unique properties of the crop's or variety's proteins
        - Micro/nano-encapsulations, emulsifiers

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[5] Shanahan, C., 2013. Analysis of the Global Animal Feed Ingredients Market, viewed 25 November 2013, http://animal.supplysideinsights.com/reports/2013/11/animal-feed-ingredients-market.aspx?endpointurl=%2f%7e%2fmedia%2fFiles%2fNutrition%2fEbooks%2f2013%2f11%2f11-13SSI-AN-Feed-Report-s.ashx

[6] Boncy, J., 2012. The Scoop on Natural Cat Litter, Pet Business, viewed 21 January 2014, http://www.petbusiness.com/articles/2012-05-01/The-Scoop-on-Natural-Cat-Litter

[7] Doty, NC., 2012. Value-added Opportunities and Alternative Uses for Wheat and Barley, AURI, viewed 11 September 2013, http://www.auri.org/assets/2013/02/12-12-wheat-barley.pdf

[8] Newman, AA., 2010. Addressing Your Cat's… Ahem… Solid Waste, The New York Times, viewed 21 January 2014, http://www.nytimes.com/2010/10/08/business/media/08adco.html?_r=0

[9] Barrows R., 2011. Advances in Alternative Aquafeeds, Aquaculture Innovation Workshop, viewed 12 December 2013, http://tidescanada.org/wp-content/uploads/files/salmon/10.45-Barrows-alternative.pdf

[10] NOFIMA, 2013. Creating Value: Project Year 2013, viewed 16 January 2014, http://nofima.mediabok.no/c2013/files/assets/common/downloads/Creating%20value%202013.pdf

        - Oil soluble or water soluble ingredients
    - Sensory masking agents
        - Flavor, odor, color, etc.
    - Light, oxidation, temperature protecting agents
- Other
    - Textile finishing agent[11]
- Pharmaceuticals
    - Cereal starches are used as delivery systems, coatings, and fillers

Impacting Market Trends:
The following are notable and growing high level market trends that are either impacting the cereal ingredients industry or offer potential opportunities for developing a western Canadian ingredient industry.

Gluten Free (Intolerance or Avoidance):
One of the growing consumer trends that is having a direct impact on the cereal ingredient market is the Gluten Free trend, which encompasses those individuals with a gluten allergy and those who are either intolerant of gluten or avoiding it for various reasons. As Gooch et al note the Canadian food intolerance market in 2007 was worth over US$265 Million[12]. It is anticipated that the gluten free market will take 10-15% of the food market away from wheat based products. This trend generates a growing opportunity for other crop based ingredients, such as oats, ancient grains, canola and pulses.

Local Ingredient Sourcing:
The demand for locally sourced ingredients and products is increasing in response to such trends as consumers increasing their control over ingredient sourcing and supply chains, and the increasing awareness of the impacts of food and ingredient production on carbon footprints, fair trade, ethical values and the environment[13]. Through local sourcing from farmers markets, the farm-gate, fair trade companies, local markets, etc. consumers are able to build connections with producers and suppliers which enables them to increase their confidence in the quality of ingredients that they are purchasing and how the ingredients/products are produced. Sourcing directly from the producer provides end consumers with a level of trust, familiarity and loyalty.

The appeal of sustainably produced local ingredients is a trend that has been adopted by food retailers, specifically Loblaws and Save On Foods. Both organizations run marketing campaigns which showcase local producers and their corresponding products and ingredients. By identifying the suppliers these retail organizations have established a connection between the end consumer and the producers. This connection assists with building consumer familiarity and trust with the ingredients, brands or companies.

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[11] Texas Wheat Producers Board, Wheat Uses: Alternative & Industrial Uses, viewed 12 January 2014, http://www.aghost.net/images/E0161001/alternative_uses.pdf
[12] Gooch, M. et al,, 2011. Assessing the Opportunities and Challenges Facing Canada's Speciality Food Industry, viewed 17 December 2013, http://www.georgemorris.org/publications/file.aspx?id=6c66aa4f-e1ac-4ee9-9d2c-44a53fbd8adc
[13] ConAgra Foods 2010, ConAgra Foods 2010 Annual Report, ConAgra Foods, viewed 3 February 2014, http://thomson.mobular.net/thomson/7/3004/4313/

Ancient Grains:
Consumer demand for ancient grains, such as amaranth, buckwheat, millet, quinoa, sorghum, etc., fluctuate over time. Over the last several years consumer demand for these grains within the food industry has increased in part in response to the growth within the gluten free market, and the desire for healthy, nutritional products.

The bakery applications for ancient grains with Western Europe have dramatically increased in response to the nutrition and health properties that are associated within them. During 2013 the highest levels of growth was seen in terms of sorghum (up 190%), chia (up 153%) and amaranth (up 133%)[14]. Within the cosmetic and personal care industries the interest and utilization of components, fractions and extracts from these crops has been gradually increasing. For instance, Alberta Agriculture's Specialty Chemical Initiative found that millet fractions possess unique properties that can be utilized within cosmetic formulations and Tri – K Industries manufacture hydrolyzed quinoa proteins, called Quinoa Pro Ex[15] for hair care products.

Although there is a growing interest within both industries to utilize ancient grains there are issues with processing and supply chains that need to be addressed. In terms of food and bakery applications the bread making processes for ancient grains are not well standardized, which is generating interest in alternative processing methods, such as fermentation[16]. This lack of standardization in processing makes it difficult to ensure consistent quality products for consumers. The processing issue for western Canada is the lack of infrastructure from the pilot to commercial scale that is capable of producing the desired fractions, and there currently is not a system in place for effectively utilizing the by-product streams. The lack of information around the utilization of by-product streams is an opportunity for future research and potential value-added ingredient development. The other main issue that ancient grains face is in terms of supply and acreage. Within western Canada these crops are considered speciality crops, which are primarily grown on a contract basis for specific companies or research applications. On a global scale these crops are traditionally produced by developing countries, such as Peru, which cannot guarantee stable consistent quality supplies to ingredient companies.

Organic Foods:
The trend towards organic ingredients and products is developing in a similar manner to the gluten free trend. A segment of this trend is increasingly being driven by parents who perceive organic food as being healthier for their children. Organic ingredients are perceived as being sustainable, subjected to fewer chemical inputs, and more natural and generally healthier. Consumers within the GMO free trend utilize similar reasoning. Consumers that follow this trend are ones who want to know more about their ingredients, their properties, processing and origins. These consumers want to increase their control over ingredient sourcing[17], and they are

[14] FoodNavigator, 2014. Bakery Top Category for Ancient Grain Boom, viewed 24 January 2014, www.foodnavigator.com/Market-Trends/Bakery-top-category-for-ancient-grain-boom
[15] Tri – K Industries. Hair Care: Elegant Hair Care Solutions, Tri – Industries, viewed 15 October 2013, www.tri-k.com/sites/default/files/Hair%20Care%20International%20TRI-K%20Brochure.pdf
[16] Culliney, K., 2014. Processing with Ancient Grains – Consider Fermentation, FoodNavigator, viewed 23 January 2014, www.foodnavigator.com/Science-Nutrition/Processing-with-ancient-grains-Consider-fermentation
[17] ConAgra Foods 2010, ConAgra Foods 2010 Annual Report, ConAgra Foods, viewed 3 February 2014, http://thomson.mobular.net/thomson/7/3004/4313/

making improvements to their diets in response to their increasing awareness of the links between food and health[18]. Although the organic trend and others like it are unlikely to significantly impact cereal ingredients as a whole, they do present growing market segment opportunities that can be targeted by specialized ingredient manufacturers and suppliers.

Food Security and Traceability:
Consumers expect their food to be safe, high quality and affordable, and expectations for convenient food that is produced and sold in ethically and environmentally sustainable ways is increasing[19]. Tractability within the food industry has been applied to meat products and ingredients for decades within both the retail and food service sectors. In fact companies, such as McDonalds, operate traceability systems which enable them to trace ingredients back to their farm or even animal of origin. When combined with transparency these types of systems assist with developing consumer trust in company ingredients and products, while ensuring that the company has complete control over its own supply chains. Through this approach companies and consumers need to understand that there will be higher input costs to ensure that food security and traceability standards are met and maintained.

As consumers increase their control over their own ingredient sourcing, and their desire to know as much as possible about the origins and processing of their ingredients, traceability and food security within crop and plant ingredients will become increasingly important. Developing these types of systems along with the development of an ingredient manufacturing/supply industry will strengthen the capabilities of western Canada, and assist with building the trust of industry clients, consumers and end users.

Demand for Functional Products:
Innovations and technical developments within the food, beverage and personal care industries are developed and driven primarily by changes in the consumer market and in response to consumer demands[20]. Consumer markets are strongly influenced by the demographics that compose the region or the market. For example, Canada is starting to see the impact within the food, and beverage markets of an aging population. As individuals age they require fewer calories, and they demand healthier foods, and foods that help manage chronic diseases[21]. When combined with the consumer demand for convenience[22] and affordability there is an increasing need to develop functional foods, beverages and snacks that are suitable for elderly populations in terms of preparation, nutrition, and ease of use.

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[18] Conference Board of Canada, 2013. Alberta Unbound: Research and Innovation Opportunities in Alberta's Food Sector, Alberta Innovates Bio Solutions, viewed 3 January 2014, http://bio.albertainnovates.ca/media/61384/conference_board_-_alberta_unbound__2013-11-18__final_report.pdf
[19] Ibid 18
[20] Conference Board of Canada, 2013. Alberta Unbound: Research and Innovation Opportunities in Alberta's Food Sector, Alberta Innovates Bio Solutions, viewed 3 January 2014, http://bio.albertainnovates.ca/media/61384/conference_board_-_alberta_unbound__2013-11-18__final_report.pdf
[21] Ibid 20
[22] International Markets Bureau, 2010. Consumer Trend Report: Convenience, Agriculture and Agri-Food Canada, viewed 15 January 2014, http://www.ats-sea.agr.gc.ca/inter/pdf/5527-eng.pdf

Market Opportunities:

The widespread and long term utilization of the cereal derived ingredients within a variety of industries raises the question of "are there any market opportunities for cereal ingredients within which western Canada can gain a competitive advantage?" As indicated previously in the barriers section western Canada cannot effectively compete within the commodity ingredient market, however, opportunities do exist within the manufacturing and processing of value-added, speciality, and niche market ingredients. Countries, such as Denmark, Germany, Ireland, New Zealand, Scotland, and the Netherlands, have developed economically beneficial value-added manufacturing industries which contribute to a wide variety of international markets. The following is a sampling of the identified market opportunities for value-added cereal derived fractions, ingredients, components, extracts and isolates:

- Agriculture and horticulture
    - Biodegradable covers/plastics, twine or biodegradable soil fillers
    - Breeding: new varieties that have characteristics or properties that are targeted towards specific ingredient applications or product development
- Cosmetics and Personal Care
    - Increasing need to substitute plastic micro beads which are utilized in facial cleansers and other cosmetic products, due to environmental concerns
        - State legislations within the United States are considering banning the plastic ingredients
    - Antioxidants, delivery systems, shelf life extenders
    - Sustainable fibers, wipes, etc.
- Fibers
    - Utilization of fractions, such as proteins, in non-woven fibers
        - Applications in medical garments, wound care, personal care, filters, etc.
- Films, coatings and plastics
    - Industrial, food, cosmetics, personal care, wound care applications
    - Sustainable packaging
        - Derived from starches or proteins
        - Variable moisture or oxygen permeability
    - Thermoplastics for vehicle components and panels
    - Food and industrial coatings
        - Protection, appearance enhancers, stabilizers, etc.
- Food and Beverages Industry
    - Antioxidants and other nutritional extracts for nutritional foods and increase shelf life
    - Innovative delivery systems (micro/nano-encapsulations, emulsions, gels) for functional foods and beverages
    - Meat or egg substitutes/analogues
        - Expanding industry within North America
        - Fat substitutes or replaces for vegan markets
    - Modified starches
    - Food gels
        - Texturizers, meat analogues, delivery systems, fat substitutes, etc.
    - Specialized or enriched flours as feed stocks or ingredients
        - Flours that have specific nutritional or baking properties

        - Flours that are enriched with specific components (starch, protein or β-glucan) which can provide a starting material for further value-added processing
    - Value-added potential in malt processing by-products and distillers grains
    - Crop protein and starch based delivery systems
    - Identifying biological activity of crop extracts, molecules and their functionality
    - Breakfast cereal ingredients
        - The breakfast cereal ingredients market is expected to reach $755.4 Million by 2019
            - Targets the following crops: wheat, oats, corn, rice and barley
            - Increasing demand for natural, nutritive foods and safety concerns with respect to processed products drives the market
    - Blends with other crop fractions, extracts, isolates, etc. such as pulses, canola, vegetables, etc. to manufacture more nutritious ingredients and products
- Fractionation
    - Increasing interest in oat fractions, components and extracts within a number of industries
        - Growing industry interest in oat components and extracts beyond β-glucan
    - Potential with ancient grains and other crops in terms of specialty ingredients or specific extracts
- Industrial
    - Specialty Chemicals – chemicals extracted from crop fractions or components (barley, oats, ancient grains, other crops)
        - Fungicides, herbicides, insecticides, etc.
        - Paints, inks, etc.
            - Water soluble ink components[23] have a market potential in children's toys
        - Detergents, soaps, etc.
    - Modified and unmodified starches
- Livestock and Pet Food/Care
    - Food additives, such as antioxidants, for healthier products
        - Valuable source of vitamins, minerals, etc.
- Medical
    - Natural delivery systems (emulsions, encapsulations, gels, films) for therapeutics
    - Sustainable fibers for wound care or protection
    - Sustainable textiles for surgical garments and masks
- Nutraceuticals, Nutrition, Natural Health Products, Etc.
    - Antioxidants
        - Emerging market for cereals with high potential
        - Research in to cost effective and efficient processes for extracting specific components or isolates

[23] Texas Wheat Producers Board, Wheat Uses: Alternative & Industrial Uses, viewed 12 January 2014, http://www.aghost.net/images/E0161001/alternative_uses.pdf

    - Antimicrobials, Antifungals, etc. extracted from crops
        - For use in cleaning agents or food, beverage, personal care, medical applications, etc.
    - Natural shelf life extenders, preservatives
    - Sports Nutrition
        - Extracts, proteins and additives for sports nutrition
            - Industry has a high demand for proteins
        - Looking for benefits derived from combinations, such as soy and whey
            - Potential area for cereal-pulse combinations
- Other Applications
    - Golf tees, skeet pigeons from wheat or other cereal starch[24]
- Pharmaceuticals
    - Extracts from wheat and other cereals that have pharmaceutical or preventative properties
    - Native starches

Within western Canada the number of companies that are successfully operating within these markets is fairly low, however, the numbers are slowing increasing as consumer demands for more natural, sustainable, and healthier ingredients increase.

Further value-added opportunities can be generated in each of the above markets through the effective understanding and utilization of process by-products. The estimated economic potential for the United States wheat industry through the development of new value-added applications for wheat starch is $500 Million[25]. Understanding the potential of by-product streams is important. By-product streams can contain value-added or high value ingredients that are useful not only to the industry that is producing the stream but a variety of other industries. The selling of by-product streams to other companies or as a feedstock to other industries opens of a variety of new revenue streams for ingredient manufacturers or processors. The effective utilization of by-product streams is a step towards full crop utilization, which significantly adds value to the crop and significantly reduces waste throughout the manufacturing process. The corn industry is a classic example of how effective by-product stream utilization can be.

In order to maintain a competitive advantage within the ingredient industry western Canada will need to support its produced ingredients with full service packages. Such service packages will need to provide technical services, reformulation assistance, innovation, product development assistance, scientific expertise/support, access to infrastructure, problem solving, etc. along with the produced ingredients.

Other aspects that would assist with developing a competitive advantage include:

- Proprietary processing and intellectual property protection (trade secrets, patents, trademarks, etc.) as a way of protecting the region's right and access to the processes and ingredients
- Utilizing crops or plants that are native to or primarily grown within the region

[24] Ibid 23

[25] Doty, NC., 2012. Value-added Opportunities and Alternative Uses for Wheat and Barley, AURI, viewed 11 September 2013, http://www.auri.org/assets/2013/02/12-12-wheat-barley.pdf

- This prevents other international suppliers from undercutting prices (reduces potential competition)
- Provides control over any potential commodity ingredient markets
- Provides direct control over supply chains, and production methods to ensure a consistent, stable, quality supply of raw materials that are traceable
- Reduces transportation costs

All of these factors need to be combined with strong region research programs which develop new innovations, problem solve and generate scientific support, regional producers that produce quality crops, government support, and a marketing presence, such as a regional brand to educate consumers to generate a market pull.

Economic Analysis Needs

For the last century the economic models that western Canada has traditionally utilized for cereal crops are export focused. Factors such as low populations, excess cereal crops, global demands for quality cereals, and established transportation/elevator networks within the region have contributed to sustaining these types of models for over a century. Such traditional models work well for commodities ingredients and products, such as raw grains, seeds, flours, etc., which are required in high volumes and typically command lower prices.

As international markets within the food, beverage and personal care industries increase the demand for value-added ingredients there are opportunities for western Canada to become a recognized crop ingredient manufacturing/processing region.

From an economic perspective there are two key models that will need to be developed in order to support the development of a value-added ingredients industry within western Canada. The first model needs to challenge the current export models by proving that it is more economically beneficial to produce select ingredients within western Canada for domestic use and potentially export than it is to export the crop and import the ingredients. The second model needs to address the benefits of developing a collaborative western Canadian region where resources and infrastructure are equally shared to benefit not only each province but the Prairie Provinces as a region. This particular model will be needed to overcome the current system of each province investing 100% of its resources within its own boundaries and competing directly with its neighboring provinces for economic gains and benefits.

Economic Model 1: Regional Production

Under the current export models western Canada has been utilizing the cereal grains it produces in three primary ways. First, a small portion of its cereal grains are utilized for domestic commodity ingredient production (flours, brans, flakes, etc.), ethanol production, malt, and livestock feed. Second, a small number of companies produce specialized ingredients for niche markets (cosmetics, personal care, food, etc.). Third, the excess amounts of grains are exported to international markets for further processing, and the required ingredients or products are imported back into the country.

The supply chains for these types of export markets are fairly straight forward producers sell their grains to an elevator, grain handler or through a direct contract, the grain is loaded into rail cars and shipped internationally through ports or rails to various international buyers. The grain is then processed into a variety of commodity (bran, β-glucan, flakes, flour, germ, protein, starch, etc.) and value-added ingredients (antioxidants, color additives, delivery systems, flavors, texturizers, etc.). Following the processing both the commodity and value-added ingredients are imported back into western Canada for product development or as finished products.

Western Canada can challenge the these traditional economic export models by developing an economic model that demonstrates that the manufacturing/processing of value-added crop ingredients, components, extracts or isolates, within the region for export has a greater economic benefit than importing the value-added ingredients or products. This type of economic model could be utilized to assist western Canadian companies that are manufacturing crop derived ingredients within the region to grow and further develop.

The economic model to demonstrate the benefits of regional crop ingredient manufacturing will need to take into consideration the following aspects:

- The model needs to initially focus on a single crop ingredient, fraction, extract or isolate to prove that there are more economic benefits to manufacturing/processing it regionally than there are in the traditional export/import models
    - The select ingredient will need to have a variety of value-added applications
        - Ideally, the applications would be suitable in multiple industries, such as food, beverage, personal care and industrial or sport's nutrition
- The selected crop must be native or at least be producible within western Canada at commercially sustainable levels
    - Crops where western Canada can gain a competitive advantage
        - Crops that cannot grow in the United States or have limited acreage within competing countries
    - The infrastructure for processing the desired crop components should already exist within the region
    - Needs to be sustainable enough that commercial scale supply or value chains either exist or can be efficiently developed
    - Under ideal circumstances the crop component will already have or will be close to obtaining regulatory approval for use within the feed, food, beverage or personal care industries
        - With regulatory approvals in place the crop component's time to market will be significantly reduced and the chances of commercial success with be greater
        - The crop component should be fairly well supported with scientific data and research
            - An improved understanding of the crop component will increase such factors as traceability, food security, utilization in formulations, product development, transportation/shipping, storage/shelf life, scale up processing, etc.

        - Improved traceability and crop component understanding would reduce the need to blend to minimum standards by diluting high quality grains
        - Established quality assurances at each processing step combined with improved traceability would assist with making ingredient manufacturing and processing more economical
- The by-product streams that are generated by producing the crop component should be identifiable and their value-added potentials should be identified and accounted for within the model
    - Utilization of the by-products should take into consideration applications within other industries (such as agriculture, feed, industrial, pharmaceutical, sports nutrition, etc.) when relevant
- In order to effectively strengthen the food industry within western Canada the model will need to take into consideration benefits and costs that affect both the grain and livestock industries.
    - These industries are closely linked within the region and the sustainable economic development of both industries will strengthen the region's sustainability and competitive advantages
- Will need to identify the things that need to happen in order to make local/regional processing more economical than exporting/importing
- The model will need to be continually peer reviewed and developed in stages to ensure is accuracy and reliability
- Will need costs on shipping different ingredients, crops and components
    - Over the long term freight costs are going to increase
- The model will need to be developed by thinking back from the consumer and not forward from the crop
    - Processes and economics will be revealed
    - Need to listen to the processor and the consumer – understand the needs of both
    - Ensure market pulls opposed to market pushes
- Consideration: the food processing industry within Canada is decreasing because there is an increasing need to import all of the ingredients
    - This is true even for crops that are grown and produced here
    - Processing is found in clusters
        - Human capital, maintenance, energy, raw materials and quality ingredients that are competitive
        - Loss in processing companies decreases the demand for local ingredients

The following crop components are examples of the potential ingredients that the economic model can be developed around:

- Antioxidants derived from barley, oats or wheat
    - Emerging interest within the food and nutrition industries
    - Clinical research on wheat extracts is being conducted in Minnesota
    - Work with barley antioxidant and metal chelating extracts is being conducted by the Cereal Protein and Cellulose Program ($(CP)^2$) at the University of Alberta

    - Work with antioxidants from cereal grains is being conducted at the University of Manitoba and extensive work in this area has been conducted during the Health Grain EU project
- Anti-fungal extract from cereal crops
    - Specialty chemical from natural plant based sources
- Food gels derived from cereal proteins
    - Protein gels for food, beverage and snack products
- Mustard or other oilseed extracts
- Oat extracts
    - High value within the personal care industry and there are established manufacturers within western Canada
    - Interest in oat fractionation is increasing within western Canada
- Millet starch
    - High value cosmetic and personal care applications
- Medicinal plant extracts
    - University of Calgary is conducting research on extracting opiates and other pharmaceutical components from poppies
- Nutritional pulse protein extracts
    - Industry focused work that is being conducted at the University of Saskatoon by Dr. Mike Nickerson's program
- Lipid Quality and Utilization
    - Dr. Martin Reaney's research program at the University of Saskatchewan is developing technology packages to cost effectively extract multiple compounds from a seed simultaneously for industrial applications

Once the model has been proven to work with a single ingredient or crop component it can be expanded to incorporate or be applied to other crop extracts, components or fractions. This type of economic modelling can be utilized to identify key value-added ingredients or crop fractions or components that can be effectively manufactured or processed within western Canada. The development of these value-added ingredients will complement the existing commodity process that is already in place. This type of model will also have application in identifying the areas where western Canada can gain competitive advantages in terms of processing, manufacturing, research, product development, etc., and it will provide an indication of the economic benefits and costs that correspond to the identified advantages.

Economic Model 2: Provincial Collaboration Benefits

Currently, provincial economic investment within the food/agriculture sector focuses on investing all or at least the majority of its resources and finances within its own provincial boundaries. The goal is to develop industries within the province, such as food, beverage, energy, personal care, etc. that generate sustainable, stable long term economic growth that provides economic benefits and returns for the investment. This type of economic investment is reflected in Figure 1.

Figure 1: Current Provincial Investment Approach[26]

	Alberta	Saskatchewan	Manitoba
Investment	100% Internal	100% Internal	100% Internal
Anticipated Outcome	<200%	<200%	<200%

This type of approach for economic investment is dependent upon the amount of available resources and infrastructure for investment. Internal revenues for investments in research, infrastructure, business development, marketing, etc. are typically derived from royalties generated by the province's raw materials, such as oil, gas, potash, hydro, etc. These revenues are impacted by resource prices and markets. As a result high prices generate larger revenues and lower prices result in budget decreases. As revenue reserves fluctuate, provinces are limited in what they can accomplish in terms of supporting economic development. For instance in times of high revenues a province may be able to hypothetically generate double their economic investments, whereas with low revenues their investment capabilities would be reduced and they may result in cuts. With low revenues a province could take a loss on their economic investments.

With such a model each province is spending all of its resources developing the research, technology, infrastructure it needs to attract industry investment and to export its resources. The ultimate goal for each province is to increase its economic returns on its exports and profit in terms of economic, resource and business development.

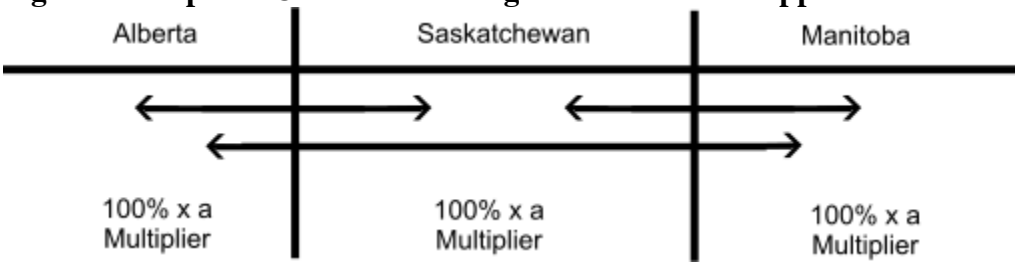
Issues:

- Limitations what can be done – projects could be beneficial but were cut due to lack of funds
- Potentially limited resources (raw materials, finances, expertise)
- Competition from other provinces – they offer a better deal then you
- Mass duplication in infrastructure across the region
- Need to for each province to be an expert in everything
- Need for each province to provide a full service package to industry
- Creates an environment where companies and other investors can play each province against one another

The limitations and problems that are generated by the traditional investment model can be overcome through the utilization of a more collaborative regional economic model. Such a model would see each province investing 100% of their resources into economic development. However, instead of being restricted by provincial boundaries finances, resources, infrastructure and expertise could be utilized across the region by each province and utilized in a manner that strengthens each province and the region as whole. Under such a collaborative regional approach the resources that flow out of a province will be balanced out by the resources that flow into the province. The end result should be that each province maintains the 100% resource investment and gains an equal or greater amount of economic benefit from the collaborative multiplier.

[26] This figure represents an example outcome to be considered as a point of comparison to the proposed Collaborative Regional Economic Investment Model

Figure 2: Proposed Collaborative Regional Investment Approach



Benefits of this type of model:

- Collaborative investment in project, research, business development, marketing, etc.
    - Provincial resources can go further
    - Increases the number of highly trained individuals and regional expertise
- Infrastructure is accessed on a regional basis
    - Ensure the facilities are fully utilized on a consistent basis
    - Reduces the duplicity of infrastructure
        - Localized infrastructure, such as pilot facilities, may still be needed
- Improving logistics through joint or shared infrastructure
- Value-added opportunities
    - By-product utilization
    - Multi-industry utilization of crop ingredients and components
- Opportunity to generate a regional presence
    - Includes regional brands, promotion of regional expertise and infrastructure
    - Selling/exporting regionally produced ingredients and products
- Reduces unnecessary competition between provinces
- Shared resources can extend economic, research and infrastructure investments
    - Increased resources for projects

If designed properly this type of collaborative regional economic model can be applied to industries beyond food, beverage and personal care, and can be utilized to strengthen and further develop western Canada into an internationally recognized region rather than a group of competing provinces.

Conclusion:

Developing a value-added ingredient manufacturing industry for cereal crops within western Canada that supplies the food, beverage and personal care industries will be challenging. The barriers and factors that are limiting the emergence of the industry go beyond those which are commonly identified and include: low population base, small markets, high labor and input costs, and highly competitive provinces. This report found revealed that although these factors impact the region's value-added ingredient industry, they are not the most limiting to growth. The barriers/factors that are impacting the industry include: western Canada is not a unified region, cereals are perceived as being a mature product, a lack of branding for western Canadian ingredients and companies being highly resistant to change.

Understanding these barriers, market trends/opportunities and gaps in existing supply chains will provide the groundwork for developing a cereal crop ingredient strategy. Such a strategy will assist with developing an ingredients industry which in turn will create further economic opportunities and benefits for producers, regional manufacturers, and western Canada as a whole. The information compiled through this project will be combined with similar research that has been conducted by Pulse Canada and the Canola Council of Canada. The combined research will be utilized to develop an inclusive value-added crop ingredient strategy for western Canada.

Appendix:

Section 1: Complete List of Industry Barriers and Limiting Factors

Area 1 – Producer Factors:

This area addresses barriers, issues or problems that are faced by producers at the farm-gate level.

- Companies need to be educated about how to approach and connect with producers in a way that is beneficial to both sides. The majority of producers are aware of market trends, input requirements, quality specifications, etc.
    - Companies need to be made aware of the existing methods and opportunities for connecting with producers
- The agriculture industry is dependent upon the use of chemistry to ensure that they can produce the quantities of quality crops that industry and consumers demand, however, the end consumers are demanding more environmental, sustainable, natural processes and products that are less chemistry dependent
- The time delay that is generated by the crop registration process is causing producers a problem in terms of meeting consumer needs, market trends, and addressing production issues. Producers need solutions within a couple of years and the current registration system takes over eight years to provide a solution
    - Bring all the players to the table to discuss what traits, properties, etc. are needed in new plant varieties
    - Generate a market pull opposed to a market push for crops, fractions, extracts and isolates
    - Emerging varieties are eight years old
- Information overload for producers – need ways of making the relevant information more focused and applicable
- From the producer perspective there is a need to educate the end consumer and urban dwellers – impact the regulations, generate demand, influence retailer requirements, and impact farming practices and revenues
- A segment of producers within western Canada are not actively or desire to be engaged in the supply/value chain beyond the farm-gate. These producers typically run small to medium sized operations that are primarily focused on immediate returns and do not care or pay attention to where the grain goes after it is sold to the grain handler.
    - By not looking beyond the farm-gate level producers are potentially unaware of industry opportunities, potential growing premiums/incentives, industry/market quality and quantity requirements for specific crops, industry/company specific growing contracts, etc. Therefore, they are not adjusting to the input and quality requirements that would enable them to obtain higher investment returns.

Area 2 – Accessing Public Research and Facilities:

This area addresses industry's ability to access public research from government organizations and universities, in addition to accessing and utilizing public research facilities.

- It is challenging to effectively transfer technology and innovations out of universities, and it can be difficult to access basic research and academic expertise
    - Academics are too attached to their technologies, and innovations, which makes transferring the technology more difficult

        - Most research is not proven beyond the bench scale, which generates a significant amount of uncertainty regarding scale up and eventual commercialization
        - The majority of research does not go any further than publications and is not actively transferred to industry
    - No mechanism to allow for trade secrets, which is a limiting factor for smaller companies and to an extent larger companies that cannot afford intellectual property fees for patenting
    - There is a need to identify value-added innovations and technologies that will generate wealth and benefits for the local region
    - Academics are unfamiliar with the commercialization process and they do not possess the necessary skills to be successful
    - Academics work with 5% success and 95% failure and industry requires 95% success and tolerates 5% failure
    - Companies are unaware of the research, expertise, and services that universities have, this is primarily a result of a lack of industry engagement by academics
- Poor or limited communication and collaboration between industry and researchers limits the opportunities for success within food innovation and technology development
- Entrepreneurs, academics, and small companies need to be educated about the commercialization process
    - These individuals are seeing a small segment of the larger picture or they only know a small piece of the puzzle
- Education is lacking in terms of regulations, marketing, scale-up and distribution (niche, mass marketing, exporting, etc.)
- Activities of researchers and companies within the food industry are often misaligned and the connections between academics and multinationals are either very poor or non-existent

Area 3 – Regional Barriers and Global Scope:

This area focuses on the barriers and issues that are impacting western Canada as a region and not as individual provinces or industry sectors. These barriers need to be addressed in order to create a strong western Canadian market presence.

- Overall, there is a lack of understanding about western Canada's capabilities, resources, expertise, etc. This is prevalent perception in all sizes of companies from local to multinational.
    - Existing facilities are too small for commercial production of many ingredients
    - Western Canada is perceived as a small market with a low, spread out population that is "logistically faraway" from American consumers and manufacturing centers
    - The Prairie Provinces are also perceived as being highly competitive against each other.
- Western Canada cannot compete with bulk commodities since other countries, such as China, India, and South America, are in a position to undercut the commodity prices
    - Focus needs to be shifted to high value, reasonable volume ingredients or services/expertise

    - Need to identify which value-added ingredients that North America can get a competitive advantage with
- Each crop has the potential to produce a variety of value-added components which can be utilized by a variety of industries
    - Need supply companies that are willing to develop, produce and distribute the value-added ingredients
- Developed countries have too many players within the supply/value chains
    - Within Canada's food industry there are at least 2000 players
- Limited industry awareness of the ingredients, expertise, services, plants and crops that are available within western Canada
    - Need to add value to the mainstream crops, however, there is a need to identify specific specialty crops that have a high value-added potential
- The existence of the Canadian Wheat Board monopoly prevented companies from investing in the region since they could not guarantee control of or stability within their supply chains
- Maintaining regional networks requires time and resources. Initially, the networks operate really well, however, with time the networks breakdown as people focus on their specific areas. Governments are busy and primarily focused on maintaining and benefiting their own jurisdictions, so interprovincial networks become perceived as a luxury rather than a necessity

Area 4 – Industry Factors:

This area is focusing on industry limitations, consumer demands, economic factors, etc. that are limiting industry's involvement within western Canada.

- Cereal crops are primarily perceived by industry and consumers as being traditional, established and commodities. Within the food, beverage/brewing, and personal care industries cereal crops are primarily utilized as commodity ingredients in the form of flours, malts, bran, β-glucan, protein/gluten or starch. There is a lack of a complete understanding of the value-added opportunities for cereal crops at the research and commercial levels.
- Manufacturers, suppliers and consumers want to know as much about the ingredients and components as possible
    - Ingredients require scientific support, understanding of how they can be utilized within product formulations, support with relevant scientific information, health benefits/claims, crop/ingredient comparisons, and clinical/in vivo testing data, etc.
    - Need to create more value from cereal crops to meet ingredient and value-added demands and export opportunities
    - Need to understand by-product streams and the potential utilization of the identified steams
    - Need to educate ingredient suppliers, end users, distributors, food service, finished product manufacturers about the ingredients
        - How to use the ingredient, innovation or product
        - Benefits of the ingredient or product, and how it is better than what they are currently using
        - Reasons for the company to reformulate their products to use the ingredient

- Low profit margins on existing food products, such as breads and other baked goods, will not support industry innovation
    - Limited resources for R&D
- Looking to minimize the distance between the field and consumer
    - Determinate for locating new facilities near larger populations
- Malt industry the consumer dictates how your plant operates and what components you pull out of the crop
    - Each malt plant operates differently
    - For brewers consumer demand controls the types and levels of innovation
- Automation is needed to be globally competitive
    - Responding to changes in consumer demand is more challenging
    - Automation is more difficult to respond to changes in consumer demands
    - Securing the necessary funding for the automation can be difficult
- Lack of market development for innovative ingredients or speciality crops
- Small companies are not often aware of what they need and large companies focus on immediate and short term needs
- Limited and inconstant drive from industry, producers, government, researchers, etc. for value-added applications and development
    - Limited resources for this type of work, and this area is often overlooked in terms of support

Area 5 – Crop/Ingredient Factors:

Topics addressed within this area focus on the barriers that are affecting the supply and value chains at that breeding, crop, variety or ingredient levels. These barriers are impacted by regulatory environment and may take multiple years to solve.

- Need a more complete understanding of what the components the crops contain, how they can be utilized, and a further development of the technologies for obtaining/extracting them
    - Need to further catalogue and identify ingredients and components within existing processing by-product streams
    - Cereal research has primarily focused on breeding and has overlooked market potential and value-added applications
    - Existing research in the area needs to be compiled
- From a breeding perspective the time and process required to generate a new variety is a barrier for the brewing industry
- For the personal care industry the source (natural image, allergenic material, etc.), the biological activity (differentiation from what is already commercialized), the cost (based on its advantages for finished cosmetic product manufacturers), the stability (potential odor, color issues), and the regulatory requirements from different countries are all challenges
    - Preservation, texture, color and stability are also issues
- Address producer needs and concerns to ensure that the early stages of the supply chain are stable, sustainable and producing quality crops
- Need to improve consistency and reduce variability within grains that are utilized as feed stocks for ingredient manufacturing

- Need within industry for consistent, high quality grain sources for high value ingredient manufacturing for industries, such as personal care
- Internationally, feed varieties of grains cannot optically be utilized for food applications

Area 6 – Market Factors:

These topics address barriers and factors that are being generated by market trends, consumer demands, competing crops, global markets, etc. Addressing these particular barriers will enable western Canada and western Canadian manufactured to effectively compete within global markets.

- Consumer support and demand for gluten free, GMO free and organic will continue to increase
    - The gluten free market is expected to take 5-10% out of the market for wheat based foods
    - Consumers are demanding clean labels that feature ingredients that they can understand
    - Consumer demand and influence is impacting mainstream brands, for instance General Mills has announced that its flagship brand Cheerios will be GMO free
- Western Canadian ingredients don't have a "story"
    - Need to attract consumers attention and to create a market or brand
    - Consumers new, innovative ingredients and cereals are seen as being traditional and uninteresting
    - "Local" and "natural" are key words that attract consumer attention
    - Consumers are not excited about cereal grains and ingredients
- Strong emphasis on cereal grains as commodities. Canada's agricultural industry has spent decades focusing on efficiently moving cereal grains out of the country.
    - Value-added processing has been overlooked within Western Canada
    - A Canadian ingredient industry cannot compete within the commodity industry
        - Other countries, specifically China and India, are more efficient and effective commodity processors
        - Cannot compete in terms of price or volume within the commodity ingredients market
            - Commodities have razor thin margins
        - Commodities have very little product differentiation
- Inconsistent consumer demand for ingredients derived from cereals over the long term
    - Impacted by a lack of consumer knowledge, social trends (Gluten Free, Gluten Avoidance), books, media, cost, etc.
    - US consumers want what is new, innovative, exotic, and cutting edge
        - Cereals are seen as established, non-exotic, and traditional
    - Continued increase within the gluten avoidance market will impact ingredients that contain gluten and other cereal components
- Traceability of crops and ingredients to the farm level
    - Consumers want to know where their products and ingredients are coming from
    - Assists with ensuring the quality and stability of supply chains
    - Sustainability for at least 5 years
    - Secure potential value-added ingredients with proprietary means
    - Security in terms of traceability, food safety, cost, supply quantities

- Communication with and education of the end consumer is lacking
    - Counteract the bad information that is being publically accepted, such as "wheat belly"
        - How do we present science in such a way that the general public will understand it
    - Media and social media influence popular trends and the distribution of information
- Need to develop innovations that fit with or target industry needs (can generate a profit within the market)
    - Food service companies, such as Moxie's, Booster Juice, the Key and Original Joes are always looking for innovations that will provide them with a competitive advantage or make them standout from their competition
        - Looking for what is new, innovation and will attract costumer attention, interest, and generate a growing demand
        - Food service industry is highly competitive
    - Companies will do anything to meet their customers need to start new trends
        - Will buy the ingredient to make the innovation happen
        - Will conduct in-house testing on promising innovations
        - Goal is to get new products into the market to sell
            - Time to market varies: 3 months to several years
    - Need to educate the marketplace to generate a market pull for new ingredients, innovations or technologies at all levels
        - Companies make decisions in response to consumer demands
    - Need a product to generate a market, and you need a market to support investment in a product or ingredient
    - Need to identify areas where Canada can have a competitive advantage with unique innovations, expertise or ingredients
    - Need to increase research into other cereal crops and crop components
- Consumers typically follow the most cost effective options
- Do the economics for the ingredient(s) and by-product(s) work?
    - Is it cheaper to process in another country where the process infrastructure is already established or where they have the expertise to process and utilize the ingredient
    - Two types of ingredients
        - Bulk (commodity) – cost, stability, quality, consistency, availability, don't necessarily require scientific support
        - Specialty – Claims which require scientific support, value-added
    - Innovation needs to make the economics of the value chain work
- Increasing and high demand for plant proteins, including cereals, which are making them commodity products
    - Reduce prices as companies race to produce the most inexpensive ingredients
- Consumers (worldwide) want quality ingredients that offer real value for the lowest price. However, most consumers are unwilling to pay a premium for products that are made in the US or Canada, which are typically higher priced.
    - Consumers want to waste less food, reduce impulse purchases and make fewer trips to the grocery store

- Consumers are looking for "new" and "exotic" ingredients that unique, innovative and that capture attention through intriguing stories
- Through the internet and social media consumers have easy access to information, which is often wrong or inaccurate, yet they believe it
- The west is physically and mentally removed from the consumers
- Food processing within Canada is declining due to the increase need and costs associated with importing ingredients

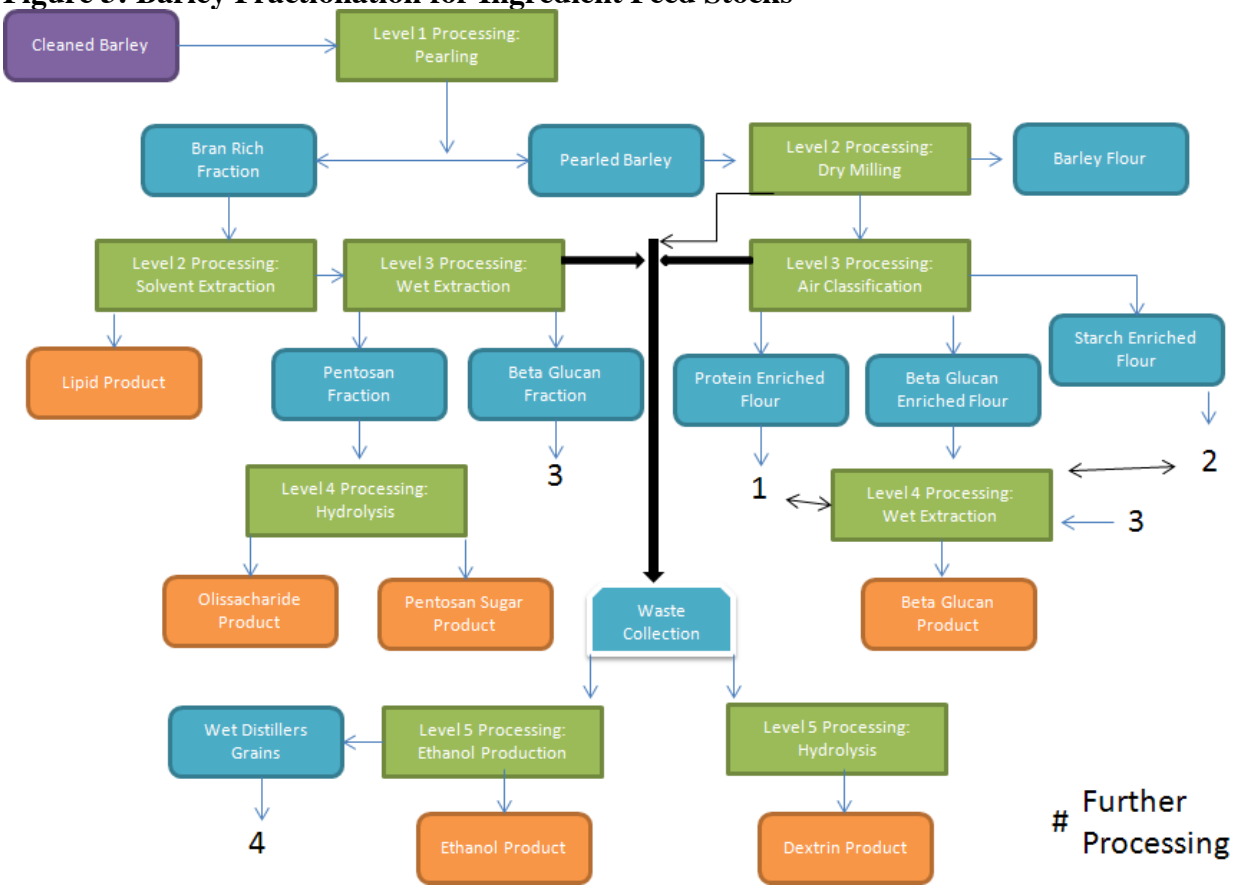
Area 7 – Government and Funding Factors:

- Needs to be funding for western Canadian projects
    - The majority of available funding is distributed by provincial sources
    - Funding doesn't travel over provincial boundaries very well
- Small companies require some form of support while they are waiting for regulatory approvals for their products
    - Can be an 8 year period without a source of revenue
    - Many are dependent upon governmental support, loans and grant/project funding programs
    - Lack of support for small to medium sized companies that are developing value-added technologies or services
- Each province needs to accept that they will each be winners in some endeavors and losers in others
- Food safety concerns
    - Fractions, extracts, isolates all have different shelf lives and storage/packaging requirements which can increase the packaging and transportation costs
    - Different health regulations for different components and times to obtain the different regulatory approvals
- Provinces are pigeon holed from a federal/international perspective
    - Alberta is perceived as being the oil/gas province
        - Alberta is an exporter by necessity
        - There is a need to ensure that the large market players are supporting the province's international activities, since they are the primary suppliers, handlers and processors of the raw materials
    - Saskatchewan has been pigeon holed for breeding and genetics
    - Manitoba has small scale value-added infrastructure
    - All three provinces have the right to pursue value add opportunities within processing and ingredient manufacturing
- Companies are making the provinces compete against one another for better business deals
    - A unified western Canada would reduce this type of deal making and would potentially increase the benefits to the region as a whole
- There are a limited number of investors and government support for the later segments of the commercialization process, especially within the food and beverage industries were the margins and return on investment are low
    - Long time to obtain investment returns

Section 2: Hypothetical Fractionation Cluster for Value-added Barley Ingredients

Figure 3 illustrates a selection of the extracts, components and valued added ingredients that can be fractionated from cleaned barley. The numbers 1 through 4 represent further processing or manufacturing streams to produce either more refined or additional value-added ingredients/technologies.

Figure 3: Barley Fractionation for Ingredient Feed Stocks



From a cluster perspective each of the orange boxes represents an ingredient, component or extract that can be utilized by a specific company, industry or market segment. For example: ethanol can be utilized by fuel companies for the production of fuel blends or biofuels, and β-glucan can be utilized by bakeries, beverage companies, functional food manufacturers, etc. to create innovative and nutritious food and beverage products.

The components that enter the further processing streams can be utilized in a variety of ways including the following:

Further Processing Stream 1: This stream produces protein enriched flours, which can be used as a feedstock for a variety of applications. For instance protein enriched flours can be utilized in bakery applications to create higher protein baked goods or the flours can provide a feedstock

for the Cereal Protein and Cellulose Program's ($(CP)^2$) platform technologies, such as the micro/nano-encapuslations, emulsifiers or antioxidant or metal chelating peptides. $(CP)^2$'s platform technologies can be customized to meet the specific needs of companies within the food, beverage and personal care industries.

Further Processing Stream 2: Starch enriched flours are produced as the feedstock for this stream. Starches can be utilized for the development of delivery systems, coatings, surfactants, binders, sweeteners, etc. for the food, beverage and personal care industries.

Further Processing Stream 3: This stream utilizes fiber or β-glucan enriched flours. These flours can be utilized to extract β-glucan for use in food or nutritional products or for the production of functional foods that help with preventing cardiovascular disease. B-glucan can be incorporated into supplements, baked goods, functional foods and beverages, etc.

Further Processing Stream 4: Produces wet distillers' grains which are primarily utilized as a feed supplement or as a blending agents within the feed industry. There is a potential to utilize distillers grains as a potential source of extracts for nutraceutical applications.