



BRAED-Camrose

Value-Added Agriculture Cluster Project - Phase 1

REPORT



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Executive Summary

This report summarizes the research that was conducted by Outlook Market Research and Consulting (OMR) with assistance from Acornhill Partners Inc. (Acornhill) and Shambrock Consulting Group Inc. (Shambrock) to identify the top processing opportunities for the BRAED region for crops that are currently grown or could be grown in or near the region including but not limited to:

- Canola (including value-added processing of meal streams);
- Hemp;
- Wheat, barley and oats; and
- Pulses and other crops

Methodology

The consulting team developed four different versions of interview guidelines for this project and conducted interviews with representatives of each of the four groups across the Prairies. The four guidelines were very similar except for specific questions that were tailored for the specific interviewees. The four groupings of interviewees were:

- Agricultural associations including provincial and pan-prairie or national
- Agricultural companies including local and national
- Agricultural researchers including product and process developers and innovators
- Government and other quasi-government officials

The total number of interviewees totaled 25. A detailed breakdown of the interviewees is shown in Section 2 – Methodology and Sample Characteristics in the table “Interviewee’s Characteristics”.

The interview data is augmented with information and analysis from an extensive literature review by the consulting team. The team are strategic advisors to SMEs and organizations in the agriculture; agri-food and agri-fibre; value-added agri-processing and supplying of inputs and services to agriculture producers throughout Western Canada and beyond for over 25 years. Many of the sources for this project are referenced throughout the report and listed in the Appendices.

Key Insights

The key insights that are shown below under a series of relevant headings were identified from summarizing the results from all twenty five interviews and combining those insights with those gained from the compilation of secondary research.



Two top value-added agriculture opportunities for the BRAED region

1. Plant-based protein opportunities for human consumption including:
 - a. Protein isolate and concentrate production from pulses (especially from yellow peas).¹

¹ Further relevant information regarding the market potential for these protein isolates and concentrates is presented in Appendix 4.3 – Beyond Meat and other meat substitutes and in Appendix 4.6 – (human) health benefits of yellow pea fibre consumption

- b. Protein extraction from cold-pressed canola meal to produce “golden tofu”, dairy substitutes, etc.²
- 2. Milling and fractionation of peas, fababeans and other pulses including:
 - a. Production of protein concentrates and isolates for use in livestock and aquaculture feeds (aquaculture markets are still largely export oriented). The co-product streams could be used in livestock feeds, another way of adding value to crop production.
 - b. Pulse flour production for inclusion at higher utilization rates in pastas and breads to increase fibre and protein (e.g. China is quite interested in a small inclusion rate of pulse flour in their 40 million tonne wheat flour market).
 - c. Fababean fractionation:
 - i. An AB company is working with Nestlé on fababean protein extraction (have been looking at it for a while).
 - ii. Fababeans - Sask Pulse has funded research on faba utilization. There are tannins (in the faba seed coat) and vicine and convicine – Mediterranean people lack an enzyme needed to digest these amino acids in faba protein. Seed size and agronomic issues make seed coat removal challenging.



How well is the BRAED region suited to these two opportunities?

The BRAED region is very well suited for production of plant-based protein (opportunity 1 shown above) and pulse flours and starches (opportunity 2) because:

- There is ample production of peas and canola in the BRAED region and in regions that are within reasonable transportation distances from which to draw feedstock supplies. As displayed in Figure 1, BRAED region has extensive highway and rail transportation infrastructure to move feedstock to processing facilities within the region and to move finished product to markets.³

BRAED region’s over 2.5 million acres of field crops can be moved via its extensive highway and rail transportation infrastructure.

² Further relevant information is presented in Appendix 4.9 – Technical brief – golden tofu canola meal milk

³ Please see Appendix 4.1 – BRAED region maps for details of the highway system and rail lines and Appendix 4.2 – selected BRAED region profile 2016 for information by Census Division for population age and income levels; and workforce numbers and characteristics including education levels.

Transportation

BRAED
BATTLE RIVER ALLIANCE
FOR ECONOMIC DEVELOPMENT

High Load Corridors *

- * Existing - Nil Fee (Red line)
- * Existing (Pink line)
- * Other - Nil Fee (Blue line)

Major Highways (11)

Secondary Highways (111)

Gravel Roads (111)

CN Rail (Red dashed line)

CP Rail (Blue dashed line)

Battle River Railway (Green dashed line)

Airports (Airplane icon)

SPECIAL AREAS 4

BRAED region crop acreages in 2016

Crop	Acreage	Crop	Acreage
Wheat	930,306	Lentils	15,832
Canola	895,182	Flaxseed	11,448
Barley	332,670	Rye	9,431
Dry field peas	207,448	Other dry beans	8,471
Oats	99,482	Triticale	7,470
Mixed grains	40,472	Forage seeds	1,748
Corn	22,232	Total field crop acres	2,582,232

- Despite having several canola crushing plants in and nearby the BRAED region (including Cargill's plant at Camrose, Bunge's plant at Fort Saskatchewan and ADM's plant at Lloydminster), there is still ample canola production available to supply several smaller scale cold-press canola crushing plants that could supply the growing demand for cold-pressed canola meal from which to extract proteins with aqueous and other innovative extraction technologies. These are the types of processes that are being commercialized by Botaneco in Calgary ⁴ and Merit Functional Foods ⁵ in Winnipeg. Both these companies are likely to be expanding their production facilities in the future and, while Merit plans to maintain its roots in Manitoba, both companies may find the BRAED region to be a very attractive location in which to expand in the future.
- The BRAED region is well suited to production of fababeans and other pulse crops.
- The support that is available from Protein Industries Canada ⁶ to support the development of new plant-based protein production could be instrumental in the BRAED region's development of new crop production and processing businesses.



Third top value-added agriculture opportunities for the BRAED region

Whole plant utilization of hemp to produce oil, food, fibre and fractions (including CBD) including: ⁷

- Production of cold-pressed oil and meal. The meal could be further processed to extract protein isolates.
- Production of hemp flour or hemp kernels/nuts/hearts from the seed.
- Production of CBD and other cannabinoids and polyphenol compounds from the flower parts and chaff. Chaff has been collected in 2019 during the seed threshing operation for extraction of CBD.
- Hemp fibre production from the straw. A biocomposites group located in Drayton Valley is taking the fibre that's produced at both Bruderheim and Innotech (Vegreville) and using it to make composites.
- Hemp chaff residuals will likely be used for livestock feed, but this use is not yet approved. Livestock feeding approvals will also create markets for off-grade seed and eventually the use of immature hemp for grazing. More research is needed to determine what may be contained in the plant at that early life stage.

Hemp chaff processing plants needed every 50 to 150 km from Edmonton to Lloydminster plus more in the Peace River area and southern Alberta.

⁴ Please see Appendix 4.4 for information about Botaneco.

⁵ Please see Appendix 4.5 for information about Merit Functional Foods.

⁶ Please see Appendix 4.13 – Protein Industries Canada (PIC) for further details about their support programs and industry support initiatives.

⁷ Further relevant information regarding the products from hemp whole plant utilization is presented in Appendix 4.7 and 4.8 - CBD, and Appendix 4.9 - Just BioFiber.

- a. The Canadian Hemp Trade Alliance (CHTA) expects the main production areas in AB to be the irrigation area in Southern AB, the area along and north of Hwy 16 and also in the Peace River. Ideally, there would be a chaff processing plant every 50 to 150 km from Edmonton to Lloydminster plus one or more in the Peace River area and one in southern Alberta. Each hemp chaff processing plant could potentially include a cluster of spinoff businesses to process chaff for CBD extraction, plus pelleted residuals, graphene or biochar production. The True North at Oyen is currently pelletizing residue from hemp processing and using it in a co-generation power plant.
- b. If there are significant economies of scale for residual processing, larger amounts of residuals could be collected from several plants at a central location for more efficient processing.
- c. Ekoterre plans to build a world-scale decortication plant located within 100 km of Edmonton, but the site hasn't been chosen yet.
- d. Breeding and approval of better hemp varieties bred for specific uses – i.e. seed only, dual purpose and fibre only.



How well is the BRAED region suited to hemp production and processing?

The third opportunity (hemp whole plant utilization) is very well suited to this region because Dr. Jan Slaski and others have shown that the area along and north of the Yellowhead Highway is among the best areas in Canada for hemp production. If Dr. Slaski's vision (and one that is shared by the Canadian Hemp Trade Alliance) of a hemp chaff processing facility every 50 to 150 kilometers from Edmonton to Dauphin were to come to fruition, BRAED could potentially see several of these plants (and their aligned spinoff businesses extracting CBD and processing residues) located in the region.⁸



Other noteworthy opportunities

Many other opportunities were mentioned less often. Some are innovative, but likely are several years from commercialization. Others may not be as innovative or new as the three opportunities noted above. However, they may be of interest to local groups or companies, potentially as an add-on to an existing seed cleaning plant or other type of grain handling business. These opportunities are shown in rank order from most-often to least-often mentioned.

- Canola-related opportunities including:
 - Additional canola processing locally to compensate for the loss of canola seed markets in China
 - Biodiesel produced from canola oil. A mandate requiring increased use would really increase potential market demand
 - Canola varieties with higher protein without sacrificing oil yield
 - Digestible fibre products from canola

⁸ See Appendix 4.7 for the Canadian Hemp Trade Alliance's (CHTA's) \$1 billion blueprint for the Canadian hemp industry

- Other opportunities include:
 - Wheat-related opportunities:
 - Specialty wheats including purple (high anthocyanin)⁹ wheat and high-amylose wheat¹⁰ for niche markets. These markets could take container lots of specialty wheats.
 - High-yielding wheat for ethanol production
 - Permolex (Red Deer) buys between 100,000 and 150,000 tonnes of wheat per year. They extract the gluten before processing the rest into ethanol.
 - Barley-related opportunities:
 - Malt barley to meet the growing demand for specialized malt for the craft brewing industry
 - Extraction of bioactive compounds from craft breweries' spent grains
 - Oat-related opportunities:
 - Oat processing - to produce ingredients for oat milk and cosmetics¹¹
 - Oats - Tate & Lyle (major ingredient company) produces an oat protein and has demand that they can't fill¹²
 - Co-product stream opportunities:
 - Capturing more co-product value from pea fractionation (fibre, starch, etc. for innovative uses)
 - Capturing more co-product value from phenols and other bioactive compounds in hemp and other crops for use in pharma, food and cosmetics
 - Production of resistant starch from pea starch and maybe for its prebiotic benefits (similar to Manitoba Starch's MSPrebiotic natural health supplement using potato starch (this was mentioned by two food development centres)
 - Other opportunities were identified and are shown in the report under the heading "Miscellaneous other opportunities" in Section 3.1.



Suitability of these other opportunities to the BRAED region

The fourth opportunity (canola) is very well suited to this region. As mentioned earlier, canola is a crop that Alberta farmers will produce to meet market demands. Additional local processing facilities would increase the financial incentive for BRAED farmers to increase canola production.

Some of the other opportunities shown above may be of interest to existing BRAED region companies or may be investment opportunities for new players. In some cases (e.g. oat fractionation), the

⁹ Anthocyanins and phenols are examples of highly beneficial bioactive ingredients. There is significant interest in expanding the supplies of food ingredients that contain higher levels of these bioactive ingredients. Research and development work is progressing in Saskatchewan and Ontario with support from several large companies (personal communication with David Shambrock, Executive Director, Food and Beverage Manitoba).

¹⁰ High amylose wheats are high in dietary fibre whereas wheats generally are high in non-digestible fibre.

¹¹ See Appendix 4.12 for one company's (Chobani's) oat milk and oat-based snack offerings

¹² Research and development work is being completed by at least two major companies in western Canada now. Projects are underway at the University of Saskatchewan and at the University of Manitoba. WE understand that the Saskatchewan Food Industry Development Centre also looking at this for clients (personal communication with David Shambrock, Executive Director, Food and Beverage Manitoba).

technologies are fairly well developed and proven. In other cases, extensive work would be needed to more precisely define the opportunity (e.g. capturing more co-product value from phenols and other bioactive compounds in hemp and other crops) and to identify potential technologies to extract the compounds from the crop.



Benefits to the BRAED region

Farmers; processors/investors; local community residents; the general public/consumers; and governments/the economy would benefit from an increase in agriculture value-added processing in the BRAED region.

Farmers would hopefully share in the increased value that would be created from new demand for existing crops and/or from opportunities to grow new crops, which would diversify their cropping options. Having increased cropping options and local demand for their crops would be expected to increase market diversification and price stability. Some farmers may become investors in new processing businesses, thereby diversifying their operations and potentially creating new revenue/profit streams.

Processors would create new revenue, employment and profits by establishing or expanding their processing operations to meet new market needs for ingredients or products. Each new processing operation creates the potential to stimulate a cluster of related businesses. For example a new hemp chaff processing operation may support not only chaff processing, but a co-stream operation that would use the crop residues to make biochar or other valuable products. These businesses, in turn, would create new demand for trucking and other services in the local area.

The general public would benefit from increased employment opportunities and the economic impact of those activities through the multiplier effect of the related spinoff employment and tax revenues that would be created.

Consumers¹³ would benefit by having new ingredients and products available for them to utilize. Two of the most significant beneficiaries may be those consumers that believe plant-based ingredients/products are more sustainably produced than animal-based products or those that have allergies to soy protein, peanut protein or gluten for which a pulse or oat ingredient might be substituted. Many consumers may believe that CBD produced from hemp is more sustainable than CBD produced from greenhouse-raised cannabis and would have very low levels of THC.¹⁴

Governments and the economy would benefit from the increased economic activity that would be created by the new production and processing activities. The resulting new tax revenues would support continued expansion of services that the citizens value.

¹³ Consumers would get these benefits regardless of whether the ingredient production and processing activity takes place in AB. The group of consumers that will benefit the most is those that care about their food being both grown and processed locally. Fortunately this portion of the population is growing. These are the shoppers that go to Coops, Sobeys, and other specialty retailers, farmers markets, etc.; not those who primarily shop at Walmart or Superstore.

¹⁴ The maximum level of THC that is allowed in CBD in Canada is 0.7%.



Crop, ingredient or end-use markets enhanced by value-added agriculture opportunities

The end products listed above include a diverse list of end uses for plant-based:

- Proteins:
 - o meat substitutes and meat/plant-product hybrid products
 - o milk substitutes and
 - o supplementation/substitution for wheat flour in breads and pastas
- Starch:
 - o modified starch for prebiotic and other food uses or industrial uses
 - o bioplastic products
- high quality oils from hemp and flax
- bioactive compounds including CBD and other cannabinoids, phenols, etc. extracted from hemp and flax
- and fibre:
 - o soluble fibres such as mucilage from flax
 - o industrial fibres from hemp for textile and composite use



Research needed to move to commercial scale

The research needs are somewhat diverse. Many of the research needs relate to process development, testing and scale-up. Others are related to genetic improvements to attain better ingredient characteristics and processing efficiencies. A third type of research and development is focused on gaining market acceptance by end users (e.g. for biodiesel).

The research capabilities of the research and food processing development centres are also diverse when combined with the internal capabilities of the processing industry companies and the university-based research community.

There is an encouraging interest among the individual food development centres to work together to move projects forward as quickly as possible to commercialization. Each centre tends to excel at a different aspect of development (e.g. the Alberta Food Processing Development Centre is noted for its high pressure processing capabilities and its meat research unit; FPDC in Saskatoon is very strong in extrusion, Food Development Centre in Portage is mainly known for its fractionation and formulation expertise).



Facilities or organizations that would be best suited to conduct research

There is a large number of research and food development centres distributed across the Prairies. Each one has an area of specialization and multiple centres often work in collaboration on a development project. This may happen concurrently or sequentially.

No one expressed a need for more research capabilities. However, it is challenging for new start-ups to fund the development work that they need to complete while simultaneously building a company, funding working capital, etc. in order to commercialize new technologies and products.



Need for pre-competitive market development work

In most cases, the interviewees believe that the pre-competitive research that is/was needed has been largely completed and that companies will now have to drive the commercialization of those opportunities that are feasible.



Facilities needed to commercialize the identified opportunities

Except for the need for new processing facilities to meet demand for protein isolates and hemp-based products the only other serious infrastructure needs that were noted were for increased numbers of:

- Co-packing and toll processing facilities and
- Cold storage capacity



Interest from farmers and local investors to invest in processing businesses

Generally, there is expected to be cautious support for, and interest in investment in value-added processing opportunities among farmers, local businessmen and existing companies. This is due to awareness that there have been some unsuccessful projects in the past where local investors lost all or most of the money that they invested. That is not to say there isn't money available to invest in good opportunities that are identified – but it likely will be challenging to persuade groups of farmers and investors to bankroll new ventures if they are not soundly planned and effectively managed right from the start.



The most significant barriers in pursuing the opportunities

The most significant barriers in pursuing the commercialization of the identified opportunities include:

- Lack of critical support infrastructure including: toll processing and co-packing; human resources and management expertise; water and wastewater treatment capacity; and capital equipment;
- Lack of funding for start-ups to undertake product development; research (especially for genetics); and private sector investment;
- Trade and regulatory issues including: tariffs/trade barriers; lack of predictable markets and regulatory environment (especially for protein products and hemp-based CBD); and dealing with provincial and local governments regulations;
- Market access issues including: consumer skepticism regarding proteins extracted from GMO crops; trucking and equipment manufacturers skepticism about biodiesel and consumers' concerns about using food products to produce a fuel additive;

- Logistics issues including: rail service (many locations are captive to a single railway company); and challenges of collecting enough co-product at a central location to make processing feasible; and
- Attracting interest from large processing companies to pursue opportunities (especially for barley fractionation). It has been proven that large players can be attracted to invest in processing – e.g. Roquette’s new pea processing facility is currently being completed in Manitoba. Richardson International and Paterson Global have both invested in oat processing capacity in recent years. We understand that multinational firms such as Unilever are interested in creating a western Canadian beachhead from which to expand their Canadian processing presence – where better to do that than in the BRAED region?



Other noteworthy points to consider

The most significant other noteworthy points to consider include:

- Co-product synchronization (balancing markets for multiple co-product streams)
- Market and market development issues
- Processing issues and
- Research and promotion needs and activities (genetic improvement, PIC funding support, food development capabilities)

Recommendation

The consulting team recommends that the BRAED region focus on developing opportunities in protein ingredient production (e.g. protein isolates and concentrates) from pulses (and possibly cold-pressed canola meal) combined with value-added uses of the co-product streams (starches, fibre, etc.) for human, aquaculture or livestock feed ingredients.

Protein Industries Canada continues to launch calls for proposals that seek projects to support additional plant-based protein production. They require local groups or SMEs to be part of each project. This creates an opportunity for groups like BRAED and local businesses to collaborate with other larger industry players.

At the same time, monitor progress of the hemp production and processing industry to gauge the size of the opportunity that may develop in that area. Within the next five to ten years there may be potential for the development of several hemp chaff processing plants along the northern edge of the BRAED region. However, this industry will face some growing pains and the early entrants may not flourish while the markets (and the related regulatory framework) are still being developed.¹⁵ Therefore, caution in the area (e.g. CBD production from hemp) is advised.

¹⁵ Please see Appendix 4.8 for details about the US FDA’s recent prohibition of CBD for use in dietary supplements because an application has been filed to classify CBD as a drug.

Next Steps

The main deliverable of the BRAED - Camrose Value-Added Agriculture Cluster Project, Phase 1 is this detailed report summarizing all primary and secondary research. The report will serve as the building block for a potential second phase of the project: Developing the Value Proposition.

Phase 1 Completion: Supporting Communications/Marketing Tools

- Synthesizing the results of this Cluster project with the BRAED Value-Added Agriculture Phase 4 project that has just been completed by Serecon Consulting with provide BRAED with a wide-ranging foundational step to expanding investment opportunities in the sector. OMR will work with Serecon to develop tools like PowerPoints and Fact Sheets to help communicate the results of these two projects with BRAED membership in Spring presentations. OMR will also integrate these tools and project results into the BRAED website.

Phase 2: Developing the Value Proposition

- A second phase would capitalize on the in-depth knowledge and contacts from Phase 1 to form a value proposition of what Camrose and the BRAED region has to offer investors in the value-added agriculture and the Pan-Prairie Protein Industries Supercluster. These projects are the platform of which to build a true investor outreach program that will attract new value-added agriculture business to the BRAED region.
- Understanding the precise assets in each community to match the opportunities identified in Phase 1 will be a cornerstone of Phase 2. Working with each community to identify natural, human, capital, and infrastructure resources is essential to understanding where new investment should be researched and promoted. Developing an Opportunity-Asset Matrix will be an objective of Phase 2. See table below:

OPPORTUNITY-ASSET MATRIX - <i>Sample</i> E.g. Plant-Based Protein Opportunities for Human Consumption					
	Agriculture Inputs	Labour	Transportation	Water	Power
Community 1	<ul style="list-style-type: none">• Assets• Ranking	<ul style="list-style-type: none">• Assets• Ranking	<ul style="list-style-type: none">• Assets• Ranking	<ul style="list-style-type: none">• Assets• Ranking	<ul style="list-style-type: none">• Assets• Ranking
Community 2	<ul style="list-style-type: none">• Assets• Ranking	<ul style="list-style-type: none">• Assets• Ranking	<ul style="list-style-type: none">• Assets• Ranking	<ul style="list-style-type: none">• Assets• Ranking	<ul style="list-style-type: none">• Assets• Ranking
Community 3...	<ul style="list-style-type: none">• Assets• Ranking	<ul style="list-style-type: none">• Assets• Ranking	<ul style="list-style-type: none">• Assets• Ranking	<ul style="list-style-type: none">• Assets• Ranking	<ul style="list-style-type: none">• Assets• Ranking

1. Objectives

The objectives of the primary research were:

- To gain a better understanding of the support available to the industry from the Protein Industries Canada supercluster initiative; and
- To focus on processing opportunities for crops that are currently grown or could be grown in the BRAED region including but not limited to:
 - Canola (including value-added processing of meal streams);
 - Hemp;
 - Wheat, barley and oats; and
 - Pulses and other crops.

2. Methodology and Sample Characteristics

OMR developed four different versions of interview guidelines for this project and conducted interviews with representatives of each of the four groups across the Prairies. The four guidelines were very similar except for specific questions that were tailored for the specific interviewees. The four groupings of interviewees were:

- Agricultural associations including provincial and pan-prairie or national
- Agricultural companies including local and national
- Agricultural researchers including product and process developers and innovators
- Government and other quasi-government officials

The number of people interviewed in each category and in each province is shown in the table below.

Interviewee's characteristics:

Interviewee Type	Location			Sphere of operation & influence		
	AB	SK	MB	Local*	National*	International*
Ag associations*	3	4	3	7	8	
Ag companies	0	0	2	1	1	
Ag researchers*	1	3	2	4	4	1
Government & quasi-government officials*	3	1	3	3	4	
Subtotals*	7	8	10	15	17	1
Totals	25			33		

* Some interviewee's organizations are included in multiple categories

3. Key Insights

The key insights that are shown below under a series of relevant headings were identified from summarizing the results from all 25 interviews and combining those insights with those gained from the compilation of secondary research.

Generally, the key insights under each heading are shown in rank order from most-often to least-often mentioned.

3.1. Top rated opportunities for the BRAED region

The section below shows the summarized responses from interviewees regarding the top agriculture value-added opportunities.

1. Plant-based protein opportunities:
 - a. Protein isolate and concentrate production from pulses (especially from yellow peas) and from canola meal for plant-based food ingredients and end-use markets .
 - b. Protein extraction from cold-pressed canola meal to produce “golden tofu”, dairy substitutes, etc.
2. Fractionation of peas, fababeans and other pulses:
 - a. Livestock and aquaculture feeds from pulses (aquaculture markets are still largely export oriented). Livestock is also a way of adding value to crop production.
 - b. Higher pulse flour utilization in pastas and breads to increase fibre and protein (e.g. China is quite interested in a small inclusion rate of pulses in their 40 million tonne wheat flour market).
 - c. Fababeans:
 - i. An AB company is working with Nestle on fababean protein extraction (have been looking at it for a while).
 - ii. Fababeans - Sask Pulse has funded research on faba utilization. There are tannins (in the faba seed coat) and vicine and convicine – Mediterranean people lack an enzyme needed to digest these amino acids in faba protein. Seed size and agronomic issues make seed coat removal challenging.
3. Hemp and cannabis processing to produce oil, fibre and cannabinoids including CBD:
 - a. Utilization of the whole plant to produce oil and protein from the seed; CBD from the flower parts and chaff; and fibre from the straw.
 - b. Hemp seed processing for production of cold-pressed oil, protein isolates/flour, soluble fibre and for extraction of CBD oil and other cannabinoids and polyphenol compounds.
 - c. Extraction products of cannabis seed (e.g. THC, CBD and other cannabinoids) using non-solvent processes for use in cannabis-based edibles. Food development centres are already working on formulations for drinks and gummies.
 - d. Hemp fibre processing. A biocomposites group located in Drayton Valley is taking the fibre that’s produced at both Bruderheim and Innotech (Vegreville) and using it to make composites.

- e. Extraction of CBD oil from hemp flowers/pollen/maybe leaves. Chaff is being collected during the seed threshing operation for extraction of CBD.
 - f. Hemp chaff residuals will be used for livestock feed but this use is not yet approved. Livestock feeding approvals will also create markets for off-grade seed.
 - g. Use of immature hemp for grazing, but there is concern because it is not known what may be contained in the plant at that life stage.
 - h. Canadian Hemp Trade Alliance (CHTA) expects the main production areas in AB to be the irrigation area in Southern AB, the area along and north of Hwy 16 and also in the Peace River. Ideally, there would be a fibre processing plant every 50 to 150 km from Edmonton to Dauphin plus one or more in the Peace River area and one in southern Alberta.
 - i. Each hemp fibre processing plant could potentially include a cluster of spinoff businesses to process chaff for CBD extraction, plus pelleted residuals, graphene or biochar production. The True North at Oyen is currently pelletizing residue from hemp processing and using it in a co-generation power plant.
 - j. If there are significant economies of scale for residual processing, larger amounts of residuals could be collected from several plants at a central location for more efficient processing.
 - k. Ekoterre plans to build a plant in Alberta; potentially a world-scale decortication plant. The Ekoterre plant will be located within 100 km of Edmonton, but the site hasn't been chosen yet.
 - l. Better hemp varieties bred for specific uses – i.e. seed only, dual purpose and fibre only.
4. Canola-related opportunities including:
- a. Additional canola processing locally to compensate for the loss of seed markets in China.
 - b. Biodiesel produced from canola oil. A mandate requiring increased use would really increase potential markets.
 - c. Canola varieties with higher protein without sacrificing oil yield.
 - d. Digestible fibre products from canola.
5. Other opportunities include:
- a. Wheat-related opportunities
 - i. Specialty wheats including purple (high anthocyanin)¹⁶ wheat, high-amylose wheat¹⁷ for niche markets. These markets could take container lots of specialty wheats.
 - ii. High-yielding wheat for ethanol production.
 - iii. Permolex (Red Deer) buys between 100,000 and 150,000 tonnes of wheat per year. They extract the gluten before processing the rest into ethanol.

¹⁶ Anthocyanins and phenols are examples of highly beneficial bioactive ingredients. There is significant interest in expanding the supplies of food ingredients that contain higher levels of these bioactive ingredients. Research and development work is progressing in Saskatchewan and Ontario with support from several large companies (personal communication with David Shambrock, Executive Director, Food and Beverage Manitoba).

¹⁷ High amylose wheats are high in dietary fibre whereas wheats generally are high in non-digestible fibre.

- b. Barley-related opportunities:
 - i. Malt barley to meet the growing demand for specialized malt for the craft brewing industry.
 - ii. Extraction of bioactive compounds from craft breweries' spent grains.
- c. Oat-related opportunities:
 - i. Oat processing - to produce ingredients for oat milk and cosmetics.
 - ii. Oats - Tate & Lyle (major ingredient company) produces an oat protein and has demand that they can't fill¹⁸.
- d. Co-product stream opportunities:
 - i. Capturing more co-product value from pea fractionation (fibre, starch, etc. for innovative uses).
 - ii. Capturing more co-product value from phenols and other bioactive compounds in hemp and other crops for use in pharma, food and cosmetics.
 - iii. Production of resistant starch from pea starch and maybe for its prebiotic benefits (similar to Manitoba Starch's MSPrebiotic natural health supplement using potato starch - this was mentioned by two food development centres).
- e. Miscellaneous other opportunities:
 - i. Increased volumes of gluten-free and organic products and ingredients.
 - ii. There are likely several commercially viable ingredient/product streams that will be commercialized by Merit Functional Foods using Burcon's large portfolio of patents. These are primarily protein extraction patents but may also include extraction/purification of other plant-based compounds.
 - iii. Advancing agriculture technologies and food processing/packaging technologies.¹⁹ This has been identified as a high priority by government of Canada. For example, remote sensing and driverless vehicles have been developed for the petroleum industry, but not so much for agriculture.
 - iv. Higher value oils from hemp and flax; mucilage which has potential as a substitute for other ingredients; and proteins.
 - v. Extraction of bioactive compounds from many different crops.
 - vi. Farmers in the BRAED region will likely have the opportunity to grow more yellow field peas to supply the Roquette plant in Portage la Prairie, Manitoba. It is reported that there are not currently enough peas grown in Manitoba and Saskatchewan to supply the new processing plants requirements. This may also create opportunities for local large-capacity seed plants to contract pea production that they could clean to remove weed seeds and other foreign matter from the peas in order to minimize freight costs of shipping the peas to Manitoba.

¹⁸ Research and development work is being completed by at least two major companies in western Canada now. Projects are underway at the University of Saskatchewan and at the University of Manitoba. WE understand that the Saskatchewan Food Industry Development Centre also looking at this for clients (personal communication with David Shambrock, Executive Director, Food and Beverage Manitoba).

¹⁹ This could include robotics, sensor technology and other types of automation in general, blockchain technology for product tracking and traceability, etc.

Summary – top value-added agriculture opportunities for the BRAED region



The BRAED region is very well suited for the first (plant-based protein) and second (pulse milling and fractionation) opportunities shown above because:

- There is ample production of peas and canola in the BRAED region and in regions that are within reasonable transportation distances from which to draw feedstock supplies. The BRAED region has extensive highway and rail transportation infrastructure to move feedstock to processing facilities within the region and to move finished product to markets.
- Despite having several canola crushing plants in and nearby the BRAED region (including Cargill's plant at Camrose, Bunge's plant at Fort Saskatchewan and ADM's plant at Lloydminster), there is still ample canola production available to supply several smaller scale cold-press canola crushing plants that could supply the growing demand for cold-pressed canola meal from which to extract proteins with aqueous and other innovative extraction technologies. These are the types of processes that are being commercialized by Botaneco in Calgary and Merit Functional Foods in Winnipeg.²⁰ Both these companies are likely to be expanding their production facilities in the future and while Merit plans to maintain its roots in Manitoba, both companies may find the BRAED region to be a very attractive location into which to expand in the future.
- The BRAED region is well suited to production of fababeans and other pulse crops.

In addition to meeting the existing market requirements, farmers have shown their ability and willingness to expand pea acreage to meet increased demand (as they have done in the case of canola). The table below shows the acreages of the main crops grown in the BRAED area based on the 2016 Census.



²⁰ Please see Appendix 4.4 for information about Merit Functional Foods and Appendix 4.5 for information about Botaneco

BRAED region crop acreages in 2016

Crop	Acreage
Wheat	930,306
Canola	895,182
Barley	332,670
Dry field peas	207,448
Oats	99,482
Mixed grains	40,472
Corn	22,232
Lentils	15,832
Flaxseed	11,448
Rye	9,431
Other dry beans	8,471
Triticale	7,470
Forage seeds	1,748
Total field crop acres	2,582,232

The third opportunity (hemp and cannabis) is very well suited to this region because Dr. Jan Slaski and others have shown that the area along and north of the Yellowhead Highway is among the best areas in Canada for hemp production. If Dr. Slaski's vision (and one that is shared by the Canadian Hemp Trade Alliance) of a hemp processing facility every 50 to 150 kilometers from Edmonton to Dauphin were to come to fruition, BRAED could potentially see several of these plants (and their aligned spinoff businesses extracting CBD and processing fibre and residues) located in the region.

The fourth opportunity (canola) is very well suited to this region. As mentioned earlier, canola is a crop that Alberta farmers will produce to meet market demands. Additional local processing facilities would increase the financial incentive for BRAED farmers to increase canola production.

Some of the other opportunities shown above may be of interest to existing BRAED region companies or may be investment opportunities for new players. In some cases (e.g. oat fractionation) the technologies are fairly well developed and proven. In other cases, extensive work would be needed to more precisely define the opportunity (e.g. capturing more co-product value from phenols and other bioactive compounds in hemp and other crops) and to identify potential technologies to extract the compounds from the crop.

3.2. Benefits to BRAED region

Based on the interviews, the ways in which benefits would be created within the BRAED region and in the surrounding area would include those shown below.

- a. Farmers would (hopefully) benefit from:
 - i. New market demand and the need for more production and/or higher crop values paid to them to fill new markets for protein and other ingredients
 - ii. Biodiesel production = new demand for canola oil and hopefully farmers would share in the added value

- iii. Increased market diversification and stability
- iv. New extraction businesses and more predictable markets
- v. Increased acreage of hemp seed production and hopefully a better price to farmers (with this new alternative to existing crops)
- vi. Increased acreage of chickpeas and/or lentils, which would mostly be grown in SK and AB and hopefully a better price to farmers
- b. Processors would benefit (otherwise they wouldn't invest):
 - i. Companies that make investment in pulse processing to fill the demand for human and pet markets will be expected to benefit. There is expected to be high and increasing demand for plant-based protein in the coming years. Currently demand seems to be outstripping supplies²¹
 - ii. Profitable extraction of high-value compounds for specialized medical and food/beverage end-use markets
- c. The general public would benefit from:
 - i. Higher employment, especially near the new processing plants and (hopefully) in rural areas through direct and indirect spending (e.g. transportation, supplies, etc.)
 - ii. New CBD production (from hemp) would meet new demand from Millennials and seniors for CBD's benefits
 - iii. Consumers with allergies would benefit from a wider range of products made with oat ingredients (e.g. oat-based dairy products, especially those with soy allergies)
 - iv. Consumers who believe that oats (and other crops) are raised more sustainably than livestock would feel better about buying plant-based products
 - v. Consumers may see this as a more sustainable source of bioactive ingredients (such as prebiotics) compared to animal-based alternatives
 - vi. Consumers may see CBD from hemp as a more sustainable source than from cannabis produced in greenhouses
 - vii. Consumers may see more convenience, less red meat, more sustainability
- d. Governments would benefit through additional economic development and increased taxes
- e. Our economy would benefit from replacing imports with locally grown and processed products

²¹ **Caution:** If there is a backlash against the number of additives that are used in making plant-based products, this could (perhaps significantly) slow the growth of this market sector. For example, the Beyond Meat burgers have 26 ingredients compared to a beef burger that typically has one ingredient (or very few more if flavours are added).

Summary – benefits created and for whom in the BRAED region

Farmers; processors/investors; local community residents; the general public/consumers; and governments/the economy would benefit from an increase in agriculture value-added processing in the BRAED region.

Farmers would hopefully share in the increased value that would be created from new demand for existing crops and or from opportunities to grow new crops, which would diversify their cropping options. Having increased cropping options and local demand for their crops would be expected to increase market diversification and price stability. Some farmers may become investors in new processing businesses, thereby diversifying their operations and potentially creating new revenue/profit streams.

Processors would create new revenue, employment and profits by establishing or expanding their processing operations to meet new market needs for ingredients or products. Each new processing operation creates the potential to stimulate a cluster of related businesses. For example a new hemp fibre processing operation may support a chaff processing facility and a co-stream operation that would use the crop residues to make biochar or other valuable products. These businesses, in turn would create new demand for trucking and other services in the local area.

The general public would benefit from increased employment opportunities and the economic impact of those activities through the multiplier effect of the related spinoff employment and tax revenues that would be created.

Consumers²² would benefit by having new ingredients and products available for them to utilize. Two of the most significant beneficiaries may be those consumers that believe plant-based ingredients/products are more sustainably produced than animal-based products or those that have allergies to soy protein, peanut protein or gluten for which a pulse or oat ingredient might be substituted. Many consumers may believe that CBD produced from hemp is more sustainable than CBD produced from greenhouse-raised cannabis and would have very low levels of THC.²³

Governments and the economy would benefit from the increased economic activity that would be created by the new production and processing activities. The resulting new tax revenues would support continued expansion of services that the citizens value.

²² Consumers would get these benefits regardless of whether the ingredient production and processing activity takes place in AB. The group of consumers that will benefit is those that care about their food being both grown and processed locally. Fortunately this portion of the population is growing. These are the shoppers that go to Coops, Sobeys, and other specialty retailers, farmers markets, etc.; not those who primarily shop at Walmart or Superstore.

²³ The maximum level of THC that is allowed in CBD in Canada is 0.7%.

3.3. Crop, ingredient or end-use markets enhanced by value-added agriculture opportunities

The end uses that were mentioned by the interviewees included a wide range of possibilities as shown below. Virtually all of these end uses dovetail well with the top opportunities that were identified for the BRAED region.

- a. New (or new to Canada) ingredient/product combinations:
 - i. An example of a value-added pulse end-use would be a product called dhal, which is similar to hummus, but made with pureed lentils
 - ii. Hybrid products using plant-based proteins with either meat or dairy (e.g. chicken fingers and burgers). One of the benefits would be if there's a need for a clean label replacement for methyl cellulose which is used as a binder in food products
 - iii. Plant-based protein/meat hybrids that offer convenience (e.g. Jerky-type products or bars)
 - iv. Boutique (niche) foods using plant proteins
 - v. Faba, oat, or hemp protein and fat emulsions for use in milk and meat analogs – almond and coconut milk are high in fat/oil content. Faba, oat and hemp would be more moderate
 - vi. Hemp protein is easy to puff to make snack products
 - vii. Consumer products (golden tofu or “milk” products) from canola protein
 - viii. Meat and snack products from plant-based ingredients
 - ix. Wheat and pulse flour blends for pastas and breads
 - x. Oat protein is a good binder for use in meat analogues. The protein is similar to pea protein but has a neutral flavour and neutral smell.
 - xi. Health products (e.g. CBD and other compounds derived from cold-pressed hemp oil)
 - xii. CBD oil for edible products from hemp (perhaps a more sustainable production system with minimal THC)
- b. New (or new to Canada) markets:
 - i. Plant-based protein ingredient markets initially from peas and canola and maybe in the future from hemp and other crops
 - ii. Flax (and hemp) fibre to make composite materials; these could be used in everything from cell phone covers to auto and equipment parts and other products²⁴
 - iii. A lot of markets for plant-based protein including high value aquaculture & livestock feeds; meat analogs; and sports drinks
 - iv. Beyond Meat uses protein isolates and pea flour in their products. However, pea flour is a generic term that may contain any combination of protein and starch to meet the formulators' requirements

²⁴ Composite innovation centres in Manitoba and Alberta have been working on this type of new product development for years and some adoption has occurred with industry players (e.g. Buhler in Winnipeg has used natural fibre in composites to make hoods for tractors and other equipment).

- v. Beyond Meat is the tip of the iceberg. Huge opportunity to blend plant-based protein with animal protein e.g. lentil and meat protein together in a meat product
- vi. Bioplastics using starch from fractionation plants (some European bioplastics²⁵ companies are making enquiries about sources of starch in Canada)
- vii. Perhaps egg white substitutes (especially with chickpea and other legume protein)
- viii. Bioactives from spent grains sourced from the craft brewers
- ix. Fermented products (e.g. sourdough products are growing in popularity as Michael Pollan is promoting them)

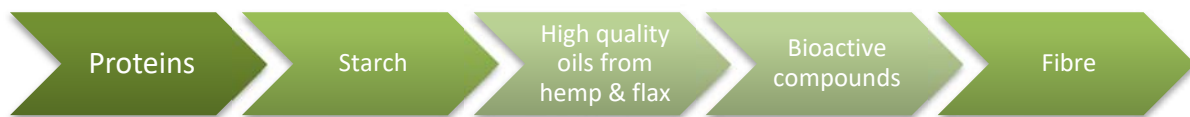


²⁵ Winpak, a major consumer packaging manufacturer with its head office in Winnipeg and plants located throughout North America, targets having all of their products being recyclable or derived from sustainable, renewable resources by 2025 (2019 Winpak Sustainability Report).

c. Increase of existing markets:

- i. Biodiesel for farm equipment & transportation industry; heating oil (east coast & north)
- ii. Functional foods and natural health products
- iii. Higher value protein markets for healthy foods
- iv. A new locally sourced prebiotic / resistant starch for healthy food products and supplements

Summary – crop, ingredient or end-use markets that would be enhanced by these new value-added agriculture opportunities



In summary, the end products listed above include a diverse list of end uses for plant-based:

- Proteins:
 - meat substitutes and meat/plant-product hybrid products
 - milk substitutes
 - supplementation/substitution for wheat flour in breads and pastas
- Starch:
 - modified starch for prebiotic and other food uses or industrial uses
 - bioplastic products
- high quality oils from hemp and flax
- bioactive compounds including CBD and other cannabinoids, phenols, etc. extracted from hemp, flax,
- Fibre:
 - soluble fibres such as mucilage from flax
 - industrial fibres from hemp for textile and composite use

3.4. Research needed to move to commercial scale

The research needs that were identified during the interviews included those shown below. Many of these research needs can be provided by Alberta-based research and food process development centres working with their counterparts across the Prairies.

The research needs that were identified included:

- a. Food development research or scale-up process development:
 - i. Increased equipment & resources for food development centres²⁶
 - ii. More sophisticated dry-milling techniques & equipment
 - iii. Research that reduces the processing industry's environmental footprint – this could enhance Canada's production advantage (which needs to be clearly enunciated and promoted)
 - iv. Production of protein isolates is a well-established technology, but there may be room to develop more sustainable processes to reduce large water and energy usage that is currently required; this would be a big advantage
 - v. Protein isolate and concentrate production needs process optimization, product application/formulation R&D and market feasibility research
 - vi. Increased starch research to optimize desired benefits (e.g. particle size and form needed to suit various application requirements)
 - vii. Need for research on interactions of CBD when combined with things like chocolate in edible products
 - viii. Co-product research to determine processing technologies, feasibility (both market demand and market development) and logistics
 - ix. Characterization of ingredients for specific types of physical functionality (e.g. solubility, gelling, sheeting, etc.)
 - x. Formulation work to develop ingredients and product formulations for plant-based products that are acceptable to consumers. For example, Beyond Meat spent millions of dollars and years of development to modify proteins to get rid of off flavours and aftertaste issues
 - xi. Development of new extrusion products (e.g. burgers, nuggets, etc.)
 - xii. Hemp protein may be the best for making milk substitutes because of its higher solubility
 - xiii. Test lentil and chickpeas as source for protein isolate and determine applications for which the resulting isolates are best suited
 - xiv. Scale up work needs to be done on aqueous extraction of canola protein
 - xv. Basic research is needed to determine what could be available from spent brewers grains
 - xvi. A lot of research is needed to determine the technical and commercial feasibility of CBD production from hemp. Much of this research is being done by the companies that are in the cannabis processing sector (e.g. Canopy Growth which recently purchased KeyLeaf Life Sciences in Saskatoon). The

²⁶ At the current time, the food development centre facilities are generally not strong in fractionation and separation of components to high levels of purity (e.g. protein concentrates and isolates). They focus on traditional food and beverage products formulations. A lot of the protein and bioactive ingredient opportunities that have been described in this report would require these core extraction technology capabilities and competencies. This was the work that POS Biosciences in Saskatoon provided in the past. Now they are part of Canopy Growth and are focused on cannabis and hemp research and development. There is a western Canadian gap in this kind of research and scale-up capabilities. The Food Development Centre in Portage la Prairie is adding equipment for protein extraction as part of the Manitoba Protein Advantage initiative and likely other centres in Alberta and Saskatchewan will as well.

food development centres across the Prairies either are currently, or will soon be gearing up to undertake formulation research for creation of CBD-infused edibles. The Cdn Hemp Trade Alliance is very interested in pursuing CBD extraction and has asked that CBD not be included under the same Cdn permits/regulations that cover THC (in the US they are not).

xvii. The FPDC (Saskatoon) specializes in extrusion technologies and they are doing extensive formulation development and scale-up on product with pulses (e.g. tofu products with 30% pea or faba protein). FPDC is also working on improving fractionation of pulses, hemp and cereals.

xviii. FPDC (Saskatoon) is working on development of some meat/plant-protein hybrids and some development of fermented meat products.

b. Genetics research and development:

- i. Pulses and hemp with improved amino acid profiles
- ii. More sophisticated seed genetics and selection
- iii. Ongoing need for variety development with improved processing and end-use characteristics

c. Other research and development needs:

- i. Biodiesel research/testing to persuade the trucking industry and machinery makers that it is good for (or at least won't harm) engines
- ii. Market development work on resistant starch / prebiotics; there is low knowledge among consumers of the benefits of dietary fibre and the ability of these compounds to provide the same benefits as dietary fibre



Summary – research needed to move these value-added agriculture opportunities to commercial scale



In summary, as shown above the research needs are somewhat diverse. Many of the research needs relate to process development, testing and scale-up. Others are related to genetic improvements to attain better ingredient characteristics and processing efficiencies. A third type of research and development is focused on gaining market acceptance by end users (e.g. for biodiesel).

The research capabilities of the research and food processing development centres are also diverse when combined with the internal capabilities of the processing industry companies and the university-based research community.

There is an encouraging interest among the individual food development centres to work together to move projects forward as quickly as possible to commercialization. Each centre tends to excel at a different aspect of development (e.g. the Alberta Food Processing Development Centre is noted for its high pressure processing capabilities and its meat research unit; FPDC in Saskatoon is very strong in extrusion, Food Development Centre in Portage is mainly known for its fractionation and formulation expertise).

3.5. Facilities or organizations be best suited to conduct research

- a. CBD extraction:
 - i. Extraction work at multiple centres (e.g. Food Development Centre (Portage); Richardson Centre for Functional Foods and Nutraceuticals (Winnipeg); and other provincial food processing centres). The Canadian Centre for Agricultural Research in Medicine (Winnipeg) can do testing of CBD effects. Israel has some of the best research on CBD.
- b. Canola research:
 - i. POS (KeyLeaf Life Sciences) had been the key R&D facility for canola. Now that it is owned by Canopy Growth it has changed focus to cannabis and hemp research for that company.
 - ii. Science cluster at U of M including Dr. Rob Duncan canola breeder.
- c. Fractionation and milling research:
 - i. Buhler (a dominant flour milling equipment manufacturer and service provider).
 - ii. PAMI (e.g. field equipment testing).
- d. Pulse crop utilization research:
 - i. Health research - Dr. Jenkins at U of Toronto (e.g. lentils to reduce blood sugar) – pulses are well-established as healthy products.

- ii. Commercial development is largely driven by companies working with food development centres in general and the one in Saskatoon specifically. Saskatchewan Pulse donated \$750,000.00 to the Saskatchewan Food Industry Development Centre in Saskatoon for equipment. Pre-competitive work has largely been done except for pulse flours.
 - iii. Food Development Centre in Portage will likely soon have pilot plant capability for protein extraction work.
 - iv. RCFFN, other food development centres (e.g. Richardson's corporate food facility (Winnipeg), centres in Saskatoon and Leduc). Each centre has its unique strength and clients often use multiple centres to do different types of development work.
- e. Cereal crop utilization research:
- i. Dr. Chen at U of A and also Dr. Ames at AAFC in Winnipeg (most of her work has been on noodles). Dr. Chen has been working on an oat beverage for cancer patients that are having nausea problems, sensitive stomach, etc. Prairie Oat Growers Association funds some utilization research. The Alberta Crop Industry Development Fund (ACIDF) funded this type of work, but it doesn't exist anymore. There is no provincial funding from AB for oat research. There is some from SK and MB governments.
 - ii. Dr. Hassan (U of S) is working with dietary surveys. Haven't shown any correlation between refined carbs and BMIs.
 - iii. The Healthy Grains Institute existed in the past, but disbanded and promotion and research related to cereal health benefits was taken over by Cereals Canada.
 - iv. The Alberta Wheat & Barley Commission funds breeding all across Canada. The main barley breeding programs are in Brandon, Saskatoon and Lacombe. The main wheat breeding programs are in Lethbridge, U of A, U of S and AAFC at Swift Current.
 - v. Dr. Temelli; Dr. Vasanthan at U of A.
 - vi. University of Manitoba, Innovate Alberta (varietal development and trials).
 - vii. Likely U of M and private sector research facilities/companies.
- f. Formulation and other research:
- i. Formulation research and recipe development – perhaps Paterson Global Foods Institute at Red River College, in Winnipeg
 - ii. The Saskatchewan Food Industry Development Centre (Saskatoon) collaborates with U of Alberta, U of Saskatchewan, U of Manitoba, AAFC at Lacombe, U of Guelph, and AAFC, St Hyacinthe on both meat and crops research projects

Summary – particular research facilities or organizations that would be best suited to conduct research for the identified opportunities

In summary, the list above shows that there is a large number of research and food development centres distributed across the Prairies. Each one has an area of specialization and multiple centres often work in collaboration on a development project. This may happen concurrently or sequentially.

No one expressed a need for more research capabilities. However, it is challenging for new start-ups to fund the development work that they need to complete while simultaneously building a company, funding working capital, etc. in order to commercialize new technologies and products.

3.6. Need for pre-competitive market development work

- a. Associations are trying to support innovation as much as they can, but often their efforts get diverted to more pressing issues (e.g. royalties payable to genetics companies, etc.). It's good that many of the commodity groups have amalgamated to be more efficient.
- b. Economic and market feasibility studies.
- c. Market development.

Summary – need for pre-competitive market development work for the identified opportunities

In most cases, the interviewees believe that the pre-competitive research that is/was needed has been largely completed and that companies will now have to drive the commercialization of those opportunities that are feasible.

3.7. Infrastructure needed to commercialize the identified opportunities

- a. Fractionation, milling and extraction:
 - i. Buhler has invested \$20 million to develop a pilot plant for pea processing in Minneapolis.
 - ii. Moving from animal feed use to food grade use = upgrades to plants and lots of new equipment for protein extraction; possible need for identity preserved system.
 - iii. Logistics efficiencies are critical in a commodity market where movement of large volumes at lowest cost is essential, but in a more specialized/niche market meeting customer demand for consistency, quality and timeliness are often more important than low-cost.
- b. Collection, transportation and processing:
 - i. There is a need for significant hemp seed processing facilities for new food ingredients in AB and SK. Examples of companies involved include Aliment Trigone, MB Hemp, and Aurora Hemp (in Edmonton area).
There will be a need for chaff collection and processing every 50 to 100 kms from northwest of Edmonton to Dauphin, MB. Chaff has to be processed quickly as it comes off the field (collection, drying and conditioning). There are two operating facilities now for chaff: True North in Oyen, AB and Canopy Growth in Yorkton, SK. There have to be SOPs and they'll have to meet CFIA



- and Health Canada standards because this is ultimately producing CBD and other cannabinoids that will be for human consumption.
- ii. Merit Functional Foods plans to purchase its raw ingredient supplies through established grain companies and brokers to minimize the need for a large procurement staff.
 - iii. Rail service is a high priority for Alberta because they're so export oriented.
 - iv. There's generally good rail service but very few locations that have more than one railway serving them (i.e. captive shippers in terms of rail). One exception is Camrose – has both CN and CP serving their area.
 - v. Trucking has expanded to meet the needs.
 - vi. Calgary and Edmonton airports have focused on air transport with more direct freighter flights and are capturing some business because of that.
 - vii. There's a Vanhorn institute in Calgary that is Canada's leading think tank on transportation issues.
 - viii. Water supplies and wastewater treatment may limit suitable locations for processing plants.
- c. Handling and storage of processed ingredients and products:
- i. There is a serious shortage of cold storage infrastructure.
 - ii. There is a very serious lack of co-packing capacity and toll processing (a lack of toll processing capacity was mentioned as a critical issue by many interviewees).
- d. Varietal research and selection:
- i. Moving towards higher protein pea varieties. For pulses generally, increasing protein quantity and quality.
 - ii. Genetic improvement may improve protein quantity/quality and reduce fibre content – this would reduce water use during processing (e.g. breeders have developed soy varieties that are well suited to tofu production).

Summary – infrastructure needed to commercialize the identified opportunities

In summary, except for the need for new processing facilities to meet demand for protein isolates and hemp-based products the only other serious infrastructure needs that were noted were for increased numbers of:

- Co-packing and toll processing facilities and
- Cold storage capacity

3.8. Interest from farmers and local investors to invest in processing businesses

- a. Farmers:
 - i. Most associations, especially Alberta-based ones, said they would not be allowed by their charters/legislation to invest in a processing opportunity; they would leave it to their members to decide individually whether or not to invest in a new venture.
 - ii. Most associations said they would encourage (or at least allow) proponents to publish articles in their association's newsletters where these proponents could inform members of new technologies and opportunities and could invite members to attend meetings at which new business opportunities would be promoted.
 - iii. They would be cautious about seeming to endorse any business venture and, in many cases, they are forbidden by law to own any processing or grain handling assets.
- b. Universities and development centre:
 - i. The university may patent some process technologies and license them to private sector.
 - ii. The food processing development centres have not taken ownership of intellectual property that they have developed in the past, but may be interested in doing so in the future as they are being encouraged to operate in a more self-sustaining way. The centres outside Alberta suggested that it may be more common for Alberta-based businesses to take an ownership interest in processing technologies that they develop.
- c. Companies:
 - i. They are certainly willing to consider taking an ownership position in viable opportunities with the right partner(s). They would evaluate each case on its own merits and look at the quality of the strategic alliance partners that are proposed or already engaged.
 - ii. Merit Functional Foods feels that it is well positioned to capitalize on these opportunities without needing additional financial resources or partners other than Burcon.
 - iii. Paterson Global Foods would consider the merits of each opportunity and the team that is developing it.

Summary – interest from farmers and local investors to invest in processing businesses

Generally, there is expected to be cautious support for, and interest in investment in value-added processing opportunities among farmers, local businessmen and existing companies. This is due to awareness that there have been some unsuccessful projects in the past where local investors lost all or most of the money that they invested. That is no to say there is not money available to invest in good opportunities that are identified – but it likely will be challenging to persuade groups of farmers

and investors to bankroll new ventures if they are not soundly planned and effectively managed right from the start.

3.9. The most significant barriers in pursuing the identified opportunities

- a. Infrastructure and human resource issues:
 - i. Lack of toll processing was mentioned several times. There might be a facility in BC that does toll processing, but it may not be logistically feasible for some processors to use it.
 - ii. Water and waste water treatment capacity.
 - iii. A senior government of Alberta (GOA) official commented that the heavy domination of small and medium sized enterprises (SMEs) in Alberta sometimes hampers product development and scale up because of a lack of resources and awareness as mentioned below.
 - iv. SMEs tend to have a lack of managerial talent and lack of knowledge of export markets (true for all of Canada). The percentage of SMEs that export processed products is low.
 - v. SMEs tend to utilize less automation and achieve less productivity improvement than larger businesses in the same sector. It is also true that Canadian companies do less well on this measure compared to US and European counterparts.
 - vi. HR resources for processing plants may be a limitation, especially for process engineers and other technical staff to conduct basic technical research and testing of output products); lab technicians can likely be sourced in Canada or through immigration.
 - vii. Fababean processing challenges. The seed size and the somewhat irregular seed shape make de-hulling somewhat difficult. On the other hand, it has the benefit of being whiter, blander and higher protein level than peas.
 - viii. Funding for capital equipment costs.
- b. Funding issues:
 - i. Lack of funding for small companies to make needed investments in new technologies.
 - ii. Funding for research (especially for genetics) is something that's lacking.
 - iii. There is a lack of capital funding for groups that have strong hemp market connections.
 - iv. Western Diversification is tapped out (except maybe for totally new technology) and many joint federal/provincial programs are as well. Financing is always hard unless principal has deep pockets and can proceed with or without grant support.
 - v. The caution that's been caused by previous disasters (e.g. the plants that tried to make straw board out of wheat straw) has caused potential investors to be gun-shy of investing in new processing opportunities, but there is local money available for the right idea and lots of farmers looking for farm diversification opportunities.

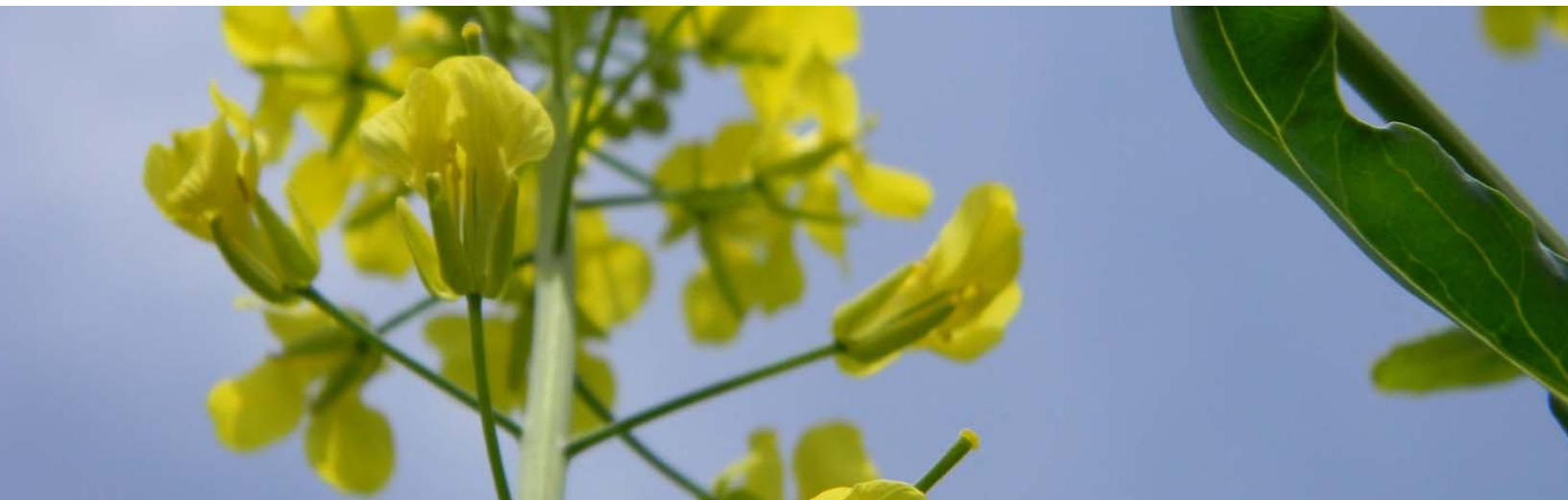
- c. Trade and regulatory issues:
 - i. Tariffs and trade issues are always a threat.
 - ii. Uncertainty about US borders and market access.
 - iii. Market predictability and regulatory environments.
 - iv. Contracting can be somewhat problematic for farmers because companies specify things like non-GMO and other production practices as well as specific quality and agronomic requirements.
 - v. Dealing with local and provincial levels of government for water, power, transportation, etc. (e.g. Cargill's access to water for the Camrose plant was a big issue).
 - vi. For hemp foods, processors need a license to process the seed. Standardization and a grading system may be needed.
 - vii. Regulatory factors as it relates to labeling and evaluation processes – Health Canada is not in step with the needs for plant proteins. Products have to be judged as being equal to meat as far as protein content, etc.; the protein evaluation protocols are outdated.
- d. Market acceptance issues:
 - i. Consumer perception (almost all canola is GMO and GMO is found in the protein); non-GMO varieties have significant yield disadvantage.
 - ii. Resistance from equipment makers & trucking industry officials to using biodiesel.
 - iii. Consumers may resist food product being used for fuel (e.g. canola or soy oil) & cost of production may be too high.
 - iv. With bioplastics there is some skepticism as to whether or not they are really biodegradable. In the current low-cost petroleum feedstock environment, bioplastics are nearly four times higher cost than the traditional materials that they would have to displace.
- e. Logistics issues:
 - i. For pulse shipments, logistics issues are being addressed by AGT and CN – developing a container facility in Regina area. Hopper cars are shipped to Montreal to load onto cargo ships
 - ii. Transportation is a limiting factor, primarily rail; containers have been less of a problem as compared to bulk railcar movement. Rail service from AB into the US is particularly challenging.
 - iii. The logistics to gather enough co-products into one location to process them economically; and the need for market research into the viability of the co-product streams.
- f. Attracting interest from larger processing companies:
 - i. For barley products, it has been challenging getting larger companies to consider commercialization.

Summary – the most significant barriers in pursuing the identified opportunities in the BRAED region



In summary, the most significant barriers in pursuing the commercialization of the identified opportunities include:

- Lack of critical support infrastructure including: toll processing and co-packing; human resources and management expertise; water and wastewater treatment capacity; and capital equipment.
- Lack of funding for start-ups to undertake product development; research (especially for genetics); and private sector investment.
- Trade and regulatory issues including: tariffs/trade barriers; lack of predictable markets and regulatory environment (especially for protein products and hemp-based CBD); and dealing with provincial and local governments regulations.
- Market access issues including: consumer skepticism regarding proteins extracted from GMO crops; trucking and equipment manufacturers skepticism about biodiesel and consumers' concerns about using food products to produce a fuel additive.
- Logistics issues including: rail service (many locations are captive to a single railway company); and challenges of collecting enough co-product at a central location to make processing feasible.
- Attracting interest from large processing companies to pursue opportunities (especially for barley fractionation). It has been proven that large players can be attracted to invest in processing – e.g. Roquette's new pea processing facility is currently being completed in Manitoba. Richardson International and Paterson Global have both invested in oat processing capacity in recent years. We understand that multinational firms such as Unilever are interested in creating a western Canadian beachhead from which to expand their Canadian processing presence – where better to do that than in the BRAED region?



3.10. Other noteworthy points to consider

Interviewees were asked if there was anything else that they felt was relevant to a discussion of value-added agriculture opportunities that we had not discussed. There wide-ranging responses are summarized below.

- a. Co-product synchronization:
 - i. Need to balance markets for protein & starch; in the future pea processing plants will need to segregate their inflow of peas based on protein and starch content.
 - ii. Don't forget that feeding barley (or co-products) to livestock is also a value-added option.
 - iii. Crops and livestock are compatible – if you could locate a processing business in an area with livestock may make good sense.
 - iv. It is surprising to a food development centre manager that processing companies don't focus more resources on co-product value-added research. Sometimes they don't have enough volumes to make extra processing feasible and it's difficult to gather or store large enough amounts to process them.
- b. Market and market development issues:
 - i. Ted Haney (executive director, CHTA) foresees that the US will produce a lot of CBD but there won't be enough market channels/markets (at least in the short term).
 - ii. The Canadian Hemp Trade Alliance is in the process of setting standards for grading criteria.
 - iii. Aurora (a cannabis company) has established a big cannabis production facility near Edmonton airport. Bought an ingredient company called Radient Technologies and Extraction. It is being converted from a fee-for-service company to a producer of cannabis and hemp-based ingredients and formulations. Radient had been set up as a toll processing facility and was really struggling to get enough business to keep it going (ingredients in general, not just hemp – before purchase by Aurora).
 - iv. Protein Industries Canada (PIC) works to support its members to help them both access information and funding.
 - v. PIC is looking for alliances up and down the supply chain. Also looking for IP creation. Best if the owner of the IP and the licensee apply together and even better if they have suppliers and users as part of their application. Eligible costs include IP related costs, scale up and market studies.
 - vi. The Government of Alberta's (GOA's) Investment Attraction department fields incoming requests and they're flexible in responding to those. They have 13 trade offices around the world. Some are totally agricultural (e.g. China and Japan). Others are partially agricultural (e.g. Korea). The department regularly buys data from ROI (a reliable data company) and from other sources. They participate in trade missions (those were on hold in September 2019 because the new government hadn't announced its plans yet – the throne speech and

budget were delivered in late October 2019). The department was facing travel restrictions. “If BRAED comes up with an idea, Dee can arrange for BRAED to work with their trade offices. The government of AB is involved with a trade mission to Asia in March of 2020”²⁷

- vii. Setting the stage comment: Alberta has a high number of companies and a high volume of sales which is the good news. The bad news is they’re dominated by small and medium sized enterprises (SMEs) – this creates some challenges.
- viii. It’s a huge policy issue to encourage/ incentivize research and development.
- ix. Universities are less effective at technology transfer to industry than they need to be, especially compared to universities in the US.
- x. Generally there is less re-investment among companies in R&D and product development than would be ideal.
- xi. Alberta government has pledged to reduce red tape for businesses.
- xii. Over the next four years, the GOA plans to reduce the corporate tax rate to the lowest in Canada for all sizes of companies.
- xiii. The GOA has given RMs freedom to use tax incentives to attract businesses.
- xiv. The GOA has promised to bring in new immigrant attraction program.
- xv. There is another group within Ag & Food that works with domestic processors.
- xvi. The Prairie Biosciences Canada (PBC) membership includes the Biosciences Association of Manitoba, Ag West Bio in Saskatchewan and Bio Alberta. Its funding source is Western Diversification. It assists its members to attend international tradeshows and to upgrade their business skills.
- xvii. PBC targets tradeshows that cover a broad cross section of Canadian cleantech and they subsidize companies to attend these shows (e.g. Expo West in Anaheim and Agritechnica in Hanover, Germany). The Anaheim show is primarily a food show and the Agritechnica show is primarily for equipment. The Clean Tech Forum in San Francisco is coming up in January.
- xviii. Cleantech must have a biological component (e.g. not solar panels but it would include biomass energy). It includes agriculture and industrial biotech, sustainable protein and food production, water remediation, and some applications of IT related to agriculture.
- xix. Exsteaminator – killing of weeds using steam is an example of ag cleantech.
- xx. Demand for plant proteins will continue to increase because of desire for healthy eating and reduced environmental impacts.
- xxi. The Richardson Centre for Functional Foods (RCFFN) is doing ongoing human feeding trials using hemp seed in a semi-frozen smoothie to lower blood pressure.

²⁷ Personal interview with Devinder (Dee) Pannu, Director, Investment Attraction, Alberta Agriculture and Forestry, Policy, Strategy and Intergovernmental Relations

- xxii. Protein ingredients could be modelled on how the soybean isolate business has developed (i.e. very specific end user needs are met by tailoring the ingredient specifications to the need).
- xxiii. FDC received funding from Western Diversification (WD) to train entrepreneurs, especially females. Females are at a disadvantage when seeking venture capital funding.
- xxiv. The growth in the plant-based protein market seems like a recent phenomenon but Shaun (Hemp Oil Canada) first saw Beyond Meat's Burgers being promoted at the Anaheim food showcase in 2009 and every year since then. Every year there was tremendous interest in their product.
- xxv. The biggest risk for many companies is that they won't stay focused. They'll try to be all things to all people. This has led to the downfall of many ventures that initially seemed sound.
- xxvi. Kelvin (Paterson Global Foods) was quite open about discussing whether or not they might be willing to work with a local investor group. He said they would entertain an arrangement where they could identify long-term sustainable demand for a product stream. I said they would likely be sought as a "partner" for their international market reach. I mentioned a few specific areas (protein, hemp CBD) as examples of some of the ideas that we are hearing mentioned.
- xxvii. I spoke about how early we are in the process of narrowing down a wide list of possibilities to make sure that we don't miss something that has potential to come up with a small number that are worthwhile doing far more research and feasibility assessment on.
- xxviii. I asked if, in the past, Paterson had worked together with local communities. Kelvin said when he was still with Ernst & Young, Paterson had been part of the Dynamic Pork Network that built several hog barns in southwestern MB. Paterson built the feed mill at Killarney to support the network's feed needs. The network did not survive the downturn in the hog industry. We agreed to speak again when we are further along in our process and looking for specific types of support.

c. Processing issues:

- i. Environmental impact will take on new importance. Sustainability/carbon footprint will become more significant in the future. This will have an impact on wet fractionation (takes a large quantity of water and has some real sustainability implications).
- ii. Different products require different protein content levels; "It's not about feeding the world, it's about supplying what they want and are willing to pay for."; supplying export markets no longer makes sense with increasing trade protectionism²⁸.
- iii. Rocky Mountain Soap – they do some toll processing as well.

²⁸ Personal interview with Gordon Bacon, CEO of Pulse Canada

- iv. Pleasant Valley Oils – a number of Hutterite colonies are producing cold-pressed canola oil and may also be interested in doing some toll processing (of ingredients).
 - v. Hutterites need value-added businesses in order to provide jobs for their people and they currently produce about half of AB's hogs. They are already doing some meat processing. MNP works with almost all of the Hutterite colonies and has good connections.
 - vi. The Plant Protein Alliance of Alberta (PPAA) is running fractionation 101 courses in Southern AB for RMs and counties in November 2019.
- d. Research and promotion needs and activities:
- i. Barley Breeding - the objective is yield. Barley is losing its competitive position compared to other crops such as canola. The Barley Commission funds both malting and feed barley development. It spends about 1.5 million dollars/year, which gets leveraged about 3 to 1 from other sources. The Malting Barley Institute spends about another 100,000 dollars, which also gets leveraged. They're trending towards more focus on malting barley (70 to 90% of most of the programs are dedicated to malt barley research), but are also looking at high yielding feed varieties as well. They're also doing some research on use of barley for distillery and other alcohol products and a small portion goes to food barley varieties. There is no significant private sector varietal development happening.
 - ii. Disease Resistance - Fusarium head blight is huge in MB and SK and spreading to AB so it's a very high priority. 100 million dollars is allocated in the US to controlling fusarium head blight in cereals. Secondary diseases are leaf diseases e.g. scald.



- iii. Prairie Oat Growers Association's (POGA's) board is keen to promote oat production and utilization. AB production is increasing and markets are becoming more diversified (50% of the milling oats are grown in AB). POGA supports oat breeders in Western Canada and in Ottawa (Dr. Beatty and Dr. Dyck at U of S). POGA is hoping to increase the number of oat breeders.
- iv. Wheat - just sequenced wheat genome in 2017. Every geneticist is trying to identify groups of genes and related traits. The biggest advancement is that they can clip a seed and analyze on a breeder chip to identify the traits that are exhibited. Using clip technology they can take seeds from tens of thousands of potential varieties and know before they grow them, what the traits would be. The challenging thing about the wheat genome is while people have two sets of genes related to each trait – wheat has six genes related to each trait.
- v. Wheat has unique characteristics and attributes in food processing. Pulses and oilseeds have a lot of catching up to do. There's a need for gluten that creates less sensitivity to celiac.
- vi. Warburton's has been working with a blend of pea flour and wheat flour to make scones, etc. for the UK market. There's still too much wheat in them to be appropriate for celiac.
- vii. Wheat is contained in most products. Removing allergen would avoid celiac issues.
- viii. Wheat genetic improvements: Yield protection (disease resistance, frost resistance, drought resistance).
- ix. Sask Wheat does not encompass winter wheat.
- x. Varietal registration requires a variety license, which is issued by CFIA and a classification which is designated by the Canadian Grain Commission. New varieties must be equal or better in yield, disease resistance, and protein quality to others in the same class. Varieties that don't meet a class can be grown in a closed-loop system (e.g. for feed, ethanol, or some other special use).
- xi. Taurine – a component in Red Bull – is derived from a seafood source. The only non-aquatic source of Taurine is in wheat protein. If we could breed high taurine content wheat it may be quite valuable.
- xii. Tom Steve, general manager of Alberta Barley, was with Viterra when they bought the Carrington pasta plant in North Dakota. He maintains that there is a healthy skepticism of value-added because of the money he has seen lost with hogs, ethanol, and bio-diesel over the years.
- xiii. Hemp genetics - there are new varieties that need to be registered with low THC, but higher CBD. Right now there are about 20 cultivars registered for production.
- xiv. Protein Industries Canada (PIC) is interested in funding some commodity crop research, but only for those crops that have had less research and development funding in the past (e.g. canola protein, hemp, oats, and flax).
- xv. Work needs to be done to better use byproducts – e.g. soluble and insoluble fibres have dietary benefits that are not generally recognized.

- xvi. Also needs to be research done to extract CBD and other polyphenols from hemp oil.
- xvii. Chlorophyll consumption is good for the microbiome. Hemp seed is a source of chlorophyll, as is broccoli.
- xviii. Distinct peptides can be produced through hydrolysis of proteins. They have high solubility and functionality (enzyme hydrolyzed proteins have been shown to lower blood pressure in rats).
- xix. The Food Development Centre (Portage) makes ingredients at the lab scale but also runs a pilot plant. They do meat products, extruded products, and are licensed for dairy, seafood and honey processing.
- xx. FDC's (Portage, MB) big strengths are extrusion and air classification (all part of fractionation). Maximum protein levels achievable from air classification are approximately 50%.
- xxi. FDC has incubation suites and daily rental facilities available.
- e. General comments regarding opportunities:
 - i. "There's no silver bullet. Cathy and BRAED are very good. The best opportunity is probably to grow an existing business rather than attract someone from outside e.g. there are several seed plants that could build on adjacent businesses. One is at Ryley. Another at Alliance." ²⁹

Summary – other noteworthy points to consider

In summary, the most significant other noteworthy points to consider include:

- Co-product synchronization (balancing markets for multiple coproduct streams)
- Market and market development issues
- Processing issues
- Research and promotion needs and activities (genetic improvement, PIC funding support, food development capabilities)

3.11. Other people we should speak with

Interviewees were asked if they would suggest that we speak with anyone else to gain a more complete understanding of the opportunities and issues. The list below was compiled from these responses.

- a. Chris Vervaet at the Canadian Oilseed Processor Association (COPA) 204-956-9500
- b. Sally Vail (U of A)
- c. LeeAnn Murphy
- d. Steve Pratte
- e. Dr. Sue Arntfield (University of Manitoba - food scientist who retired a couple of years ago)

²⁹ Personal interview with Alan Hall, COO, Plant Proteins Alliance of Alberta

- f. The Ag ministry group. There's a new division titled value-added something or other. Darren Chase – policy head (Alberta Ag)
- g. Protein Industries Canada – Bill Greuel
- h. Jan Slaski – Vegreville (research facility). He sits on the board of the Canadian Hemp Trade Alliance (CHTA).
- i. Keith Jones at Birwin Farms at Taber – they grow 7,000 to 8,000 acres of hemp under irrigation.
- j. Trevor Pizzezy – had been with Permolex and then in SK somewhere
- k. Kim McConnell – did some work with Richardson's related to oat processing
- l. Dr. Vasanthan has launched a company called Grain Frac (a spinoff from the work that he's done on fractionation, particularly oats and perhaps barley)
- m. Dr. Leeyun Chen – chair at U of A in agriculture
- n. Rob Stoddart at Bio Alberta. They're part of the Alberta Cleantech Industrial Alliance.
- o. Mr. Ted Haney, Executive Director, Canadian Hemp Trade Alliance
200, 6815 - 8 Street NE, Calgary, AB T2E 7H7
403-219-6262
ted@hemptrade.ca
- p. Barry Tomiski, Co-CEO of Merit Functional Foods Corp

Summary – other people that interviewees suggested that we should speak with

Additional contacts were suggested that will be useful during the next phase of this project.

