Alberta Innovates
FOOD INNOVATION PLAN
2014-17

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EXECUTIVE SUMMARY

The **"Alberta Innovates Food Innovation Plan" (FIP)** is a guide to focus Alberta Innovates future food and beverage research and innovation investments. It is intended to accelerate food innovation, to meet challenges, and take advantage of opportunities for Alberta to increase value-added food production for local, domestic and export markets.

With focused investments and partnerships, jurisdictions such as South Australia have been able to double their gross food and beverage revenue in 15 years.[1] Alberta Innovates aims to foster research and innovation in Alberta that would have a similar substantial impact on this province's agriculture and food sector.

Food Innovation

MARKETS

Alberta has depended on export markets for business growth in agri-food, particularly the United States, China, Japan and Mexico. However, Canada's net trade deficit in value-added processed food is growing. This began with a deficit of $1 billion in 2004 and has deteriorated to $6.8 billion in 2012.[2]

Food businesses face growing competition from low-cost producers in developing countries and from high-value producers in the developed world.[3] Countries such as China have a competitive advantage with their favourable exchange rate and access to a large cheap labour force.

New markets are opening for Alberta food manufacturers. The signing of the *Canada-European Union Comprehensive Economic and Trade Agreement* (CETA) presents both opportunities for exporting Canadian value-added food and beverage products that are safe and of high quality, as well as challenges as European Union (EU) companies will also be competing for market share in Canada.

Alberta businesses continue to grapple with the following issues:

- Minimizing costs of inputs, including labour, energy and transportation
- Plant efficiencies and scale
- Market access
- Product differentiation
- Access to capital
- Access to water
- Reduction of water consumption and production waste.

CONSUMERS

Food innovation is often driven by changes in the consumer market—demographic changes affect consumers' food requirements and evolving preferences. These shape what people will buy and consume. A market must exist or be created for innovations to achieve commercial success.[4]

Products and new technologies must keep pace with consumer expectations. Just as consumers are learning more about food and developing preferences related to ethical, environmental and other social concerns, their expectations with respect to safety, nutritional value, quality (including taste) and price have become entrenched.[5] Consumers are demanding healthier formulations, traditional products and indulgence options. These trends create opportunities for businesses to satisfy both entrenched and emerging preferences.[6]

An increasing demand for food and beverages by a growing global population can be addressed through a multitude of solutions:

- Development of high-nutrient and innovative food and beverage products
- Innovations to enhance yields of primary agricultural commodities
- Ethical and sustainable agricultural practices
- Automation and innovation in food and beverage processing and production
- Reduction of food waste.

OPPORTUNITIES IN FOOD INNOVATION

Based on extensive analysis done by the Conference Board of Canada for Alberta Innovates, several areas of focus have been chosen as the most promising investment opportunities. Additional internal analysis of market demand, Alberta's core strengths in agriculture, and Alberta's research and industry capacity confirmed the following areas for future investment:

- **Ingredients, food and beverages** that add value to Alberta's agricultural commodities
- **Functional foods and nutraceuticals**
- **Food safety with a focus on meat safety**
- **Genomics, metabolomics, other "omics," and food nanotechnology** are emerging technologies in which Alberta has considerable strength. These can be applied to food innovation.

WHERE TO FROM HERE?

Alberta needs an effective food innovation system that fosters tighter connections and a commercialization pathway between the research community and industry. To facilitate the development of a more globally competitive food industry, Alberta Innovates may need to:

- Improve links between industry and the research community
- Facilitate a leadership role for industry in determining research, innovation and growth objectives
- Leverage programs that support industry growth.

In 2014–15, we will:

- Commission a report to better **define high-yielding markets** and competitive advantages for specific Alberta food and beverage products.
- Use the **Agriculture Funding Consortium** to identify and invest in projects that align with the Food Innovation Plan's objectives.
- **Develop a targeted call** that requires significant food company involvement/leadership to accelerate research and innovation in the areas identified in section 7. Alberta Innovates is willing to facilitate industry/research partnerships.

With the right mix of investments and Government of Alberta policy, Alberta Innovates can help industry realize benefits from accelerated food and beverage innovation. Albertans will benefit through economic growth and diversification and access to healthier food and beverage products.

1. INTRODUCTION

The "Alberta Innovates Food Innovation Plan (FIP)" is a tool to focus Alberta Innovates future food research and innovation investments. For the purposes of this document the word food is meant to include food ingredients, food products, and food beverages. The recommendations in this report may lead to investments that can accelerate the development of globally competitive food products, create economic growth and diversification for Alberta's food and agriculture sectors, and foster social benefit through developing healthier food. Through appropriate investments by companies and government, Alberta could double revenues from value-added food production by 2030.

This plan was informed by:

- Analyzing domestic and global market trends, industry drivers and trade barriers
- Analyzing science and technologies impacting food innovation
- Assessing Alberta's academic and industry capacity
- Assessing similar international and domestic initiatives.

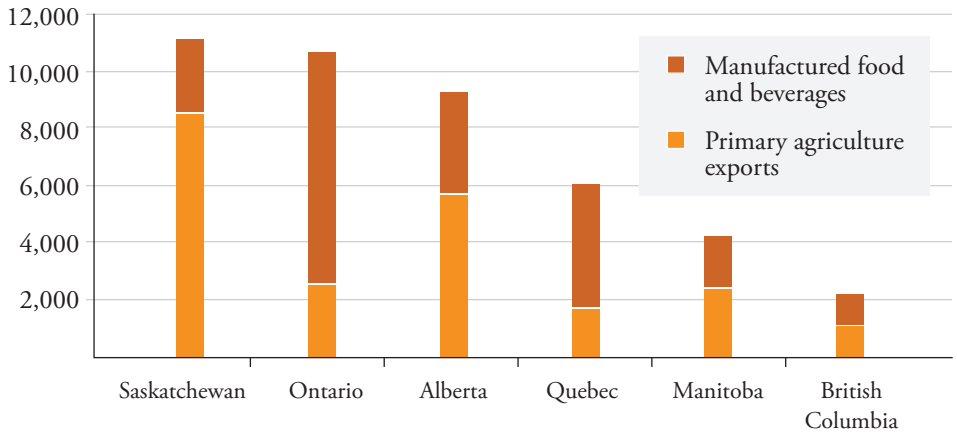
AI Bio commissioned the Conference Board of Canada to assist in this process and has considered its recommendations outlined in *Alberta Unbound—Research and Innovation Opportunities in Alberta's Food Sector.*[7] The Conference Board's work is based on interviews with business leaders and managers in the food industry, including CEOs of large multinational companies as well as small and medium-sized enterprises, industry associations, researchers, government officials and international experts.

Consideration has also been given to the report: Alberta's *Agriculture Advantage, An Evidence- Based Guide to the Sector's Strengths and Innovation Options.*[8]

2. MARKETS

CHART 1

Agricultural, food, and beverage exports of leading provinces, 2012 ($ millions)



Source: Statistics Canada; World Trade Atlas.

Opportunities exist for Alberta processors to supply local, domestic and international markets with new, innovative ingredients and food products where Alberta has a competitive advantage. These value-added products take advantage of Alberta's core strengths in agricultural production, the entrepreneurial spirit of Alberta's agriculture and food producers, and food production and processing innovation.

To reap the full benefits, Alberta should focus on serving the domestic market, replacing imports, and take advantage of emerging global market opportunities.

Chart 1, above, illustrates that opportunities exist for Alberta to significantly increase sales of value-added products. Note that other jurisdictions within Canada, such as Ontario, have been able to obtain a 3:1 ratio of sales of food and beverages versus sales of agricultural commodities.[9]

The following information on Alberta's situation is based on the most recent statistics available. In 2012, Alberta's food manufacturing sales reached $11.9 billion. In 2011, beverage manufacturing sales reached $942.7 million. (At the time of this report, the 2012 statistics for the beverage industry were unavailable.) The leading food sub-sector was meat manufacturing ($5.9 billion), which accounted for half of provincial food sales. In 2012, Alberta had international agri-food export sales of $9.2 billion, which included $5.5 billion in primary agricultural commodities and $3.7 billion in value-added products.[10] While total agri-food exports have more than doubled over the past decade, growth in primary commodity exports is more than triple the growth for value-added exports.

Of Alberta's 2012 total agri-food exports, 32.2 per cent went to the United States (U.S.), an increase of $948 million over the last decade. Only 52 per cent of the exports to the U.S. were manufactured food products, which highlights the opportunity for Alberta businesses to add value to a significant portion of the remaining 48 per cent of shipments moving across the border.

Between 2003 and 2012, nearly all growth in Alberta's primary commodity exports came from growth in wheat and canola exports. Exports of live cattle were stagnant.

In the value-added category, exports of meat products declined from $2.1 billion to $1.6 billion. Brazil, Australia and the U.S. have been successful in capturing traditional Canadian market share in specific international markets. While meat remains very important to Alberta's export mix in both the primary and value-added categories, wheat and canola are now the province's top export. Most of Alberta's export increases have come from agricultural commodities moving to China, Japan and Mexico.

As an example, Alberta's agri-food exports to China are valued at $1.6 billion in 2012, up 75.7 per cent from 2011, and are 5.1 per cent of China's agri-food imports.[11] None of Canada's top exports to China are in the value-added category.

Top Export Products to China	Millions
Canola seed	$673.1
Canola oil, crude	$565.0
Raw hides and skins	$132.0
Dried peas	$75.6
Wheat	$74.3
Oilseed cake and meal	$56.4
Barley	$40

Although it may seem difficult to compete with China, there is an opportunity to access the growing wealthy Chinese middle class with foods that meet their evolving consumer preferences for quality, safety, traceability and environmental sustainability.

Other markets in South Asia are becoming increasingly important. Indonesia and Bangladesh, with populations of 240 million and 160 million respectively, could become destinations for quality Alberta products.

India, with a population of over 1.2 billion, also has an expanding middle class and is a key market to watch. Although most consumers in India are Hindu and currently vegetarian, the demand for higher protein foods, including meat, is growing.

The Government of Alberta (GOA) is committed to supporting the export of value-added Alberta products. One example of this commitment is the formation of the Asia Advisory Council.

In addition, through its ministry of International and Intergovernmental Relations (IIR), GOA has identified a number of strategies to improve market access.

Alberta's International Strategy 2013, Building Markets report indicates that "job one for our government is reaching international markets, to get the fairest price possible for our products, resources, and services."[12]

The IIR report estimates that Alberta's agriculture sector could gain $1 billion per year if Alberta were to develop new markets. These new markets would not only grow Alberta's economy but would contribute to improved quality of life as well.

The GOA goes on to identify six key regions: United States; Greater China (China, Hong Kong, Taiwan); Northeast Asia (South Korea, Japan); Southeast Asia and Oceania (Australia, Indonesia, Malaysia, Singapore, Thailand, and Vietnam), and Emerging Markets (including India and Brazil).

The author of the report recognizes the heavy reliance that Alberta has on trade with the U.S., as 87 per cent of all Alberta exports, including oil and gas, go to this market.

As part of the IIR objective to diversify markets and to expand the economy, the IIR strategy references an initiative to support businesses in creating new relationships in strategic markets, and support other GOA ministries in their efforts to expand market access. Alberta Innovates may also be able to partner with ministries, such as Alberta Agriculture and Rural Development to deliver some of their programs.

Alberta's 2012 top agri-food export markets and manufactured products values are listed in the following table.[13] Agri-food exports include both commodities (animals and crops, crude animal and plant products) and value-added products ("products of manufacture"). "Products of manufacture" is a subset of "agri-food exports"; however, these statistics have been highlighted as an opportunity for Canada to add value to existing exports.

Market	Agri-food Exports (Millions)	Products of Manufacture (Millions)
United States	$2,967	$1,543
China	$1,646	$63.65
Japan	$1,345	$45.24
Mexico	$633	$14.12
South Korea	$17	$ 8.94

See Chart 2, below, for an illustration of Alberta's agri-food export trends.

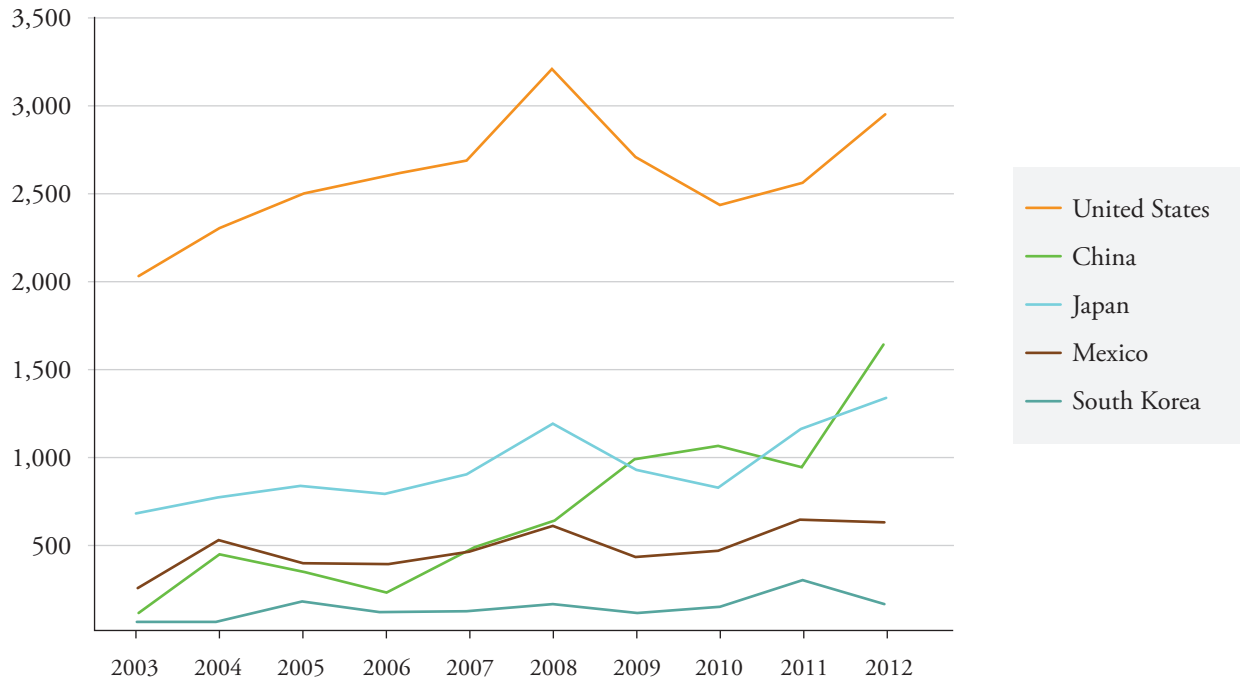
Countries such as the United Arab Emirates, Indonesia, Iraq, Sri Lanka and Venezuela make up the balance of Alberta's top 10 agri-food export markets.

Although the EU countries do not currently make the top 10, export to these countries is expected to increase with the signing of CETA.

See Appendix C for an overview of the opportunities and challenges for exporting Alberta products to key markets.

CHART 2

Alberta Agri-Food Exports – Top Five Destination Countries ($ millions)



Source: Government of Alberta

COMPETITIVE CONTEXT

Alberta companies will need to be aware of and overcome some of the following challenges in order to enter new markets successfully:

- Strong global-manufacturing and retail competition (e.g., Wal-Mart, Target, etc.)
- Need for product differentiation
- Relative value of Canadian currency
- Pressure on profit margins brought on by:
  - customer price sensitivity
  - increase in input costs, including labour, energy and transportation costs
  - plant efficiencies and scale;
  - high capital costs for technology adoption
- Access to adequate supplies of water
- Reducing production waste and water consumption
- Access to capital
- Regulatory issues that limit or impair innovation. (Canadian approvals are too slow compared to other jurisdictions.)[14]
- Trade issues such as sanitary and phytosanitary barriers and high import tariffs.

CONSUMER DEMOGRAPHIC AND SOCIETAL TRENDS

Population growth: Global population is projected to be 9.6 billion by 2050. Growth will be concentrated in Africa and Asia (India, 1.57 billion; China, 1.46 billion). Although markets may exist, some countries may choose to be self-sufficient in a key commodity or food product (e.g., rice in Japan).

Ethnic diversity: Increasing size and diversity of ethnic populations in North America and other jurisdictions will increase demand for ethnic foods and flavours by new entrants and long-term residents. Emerging generations will consider this mosaic the norm.

Aging population: Aging populations in the developed world are driving demand for protein and products with extreme flavours but fewer calories. Anti-aging products are entering the mainstream, using "aging well" as a platform.[15] There is a greater consumer understanding of the role that a healthy diet can have in extending an individual's active years.

Rising middle class: Middle classes in China and India are expected to demand increasing amounts of high-quality protein, higher-value foods and fewer starch-based foods.

Time and family constraints: Longer work days and more dual income families will create demand for convenient ready-to-eat or on-the-go meals.

Population health: Nutrition is now recognized as one answer to health care budget crises around the globe. Some big food companies are looking into all areas of health and developing a more holistic approach by providing nutritious food and beverage solutions to consumers.

A continued societal concern with health care costs and pressure to prevent chronic diseases through improved diets will present new opportunities for food companies.

Food security: 1.345 billion people currently live on less than $1.25/day and experience chronic malnourishment.[16] This is an issue for global peace and stability.

Sustainability and environmental issues: There is increased focus on climate change. Water as a scarce resource will result in a growing demand for sustainable, environmentally friendly agriculture and food production practices.

Cutting food loss during production, reducing food waste by both retailers and consumers and using waste streams to create valued products are all considered critical areas of improvement.

Reductions in packaging and the use of raw materials are leading to innovation in edible films and more sustainable ingredients.

CONSUMER MARKET TRENDS

Food safety and traceability: Consumers continue to expect companies to be transparent, credible and accountable. They are asking about the ingredients in their food and its origin. Food-safety recalls are contributing to this trend, and companies are working to regain or improve consumer trust. Many companies are seeking solutions to trace food from farm to fork to ensure safety at all points in the supply chain.

Health and wellness: Consumers are increasingly more knowledgeable about food, value and health. A new group of consumers aged 12 to 25 are more concerned about their health than previous generations have been.

Consumers are more aware than ever of the natural health properties of specific berries, grains and vegetables.

Consumers are increasingly interested in protein for its benefits of muscle building, exercise recovery, weight loss, satiety and healthy aging. Protein benefits the entire age spectrum, from babies to seniors. Dairy and meat play a critical role as do alternative proteins such as pulses.

Demand for products delivering a slow release of energy (controlling blood glucose levels) or a sustained release of energy, are increasing. Food companies are turning to slowly digestible carbohydrates such as oats and barley.

Weight management is no longer about a special category of foods, but is included as a part of everyday food choice and as a way of maintaining wellness. There is a trend towards simpler foods and a shift towards home cooking.

"Free-from" claims are becoming more prevalent. "Gluten free" is well established. Other claims like freedom from lactose, dairy and wheat are evolving. "No" products can also encompass reduced fat, sugar free, salt free, vegetarian or "meat free" choices. Companies are also reformulating by substituting healthier ingredients in their traditional recipes.

Sugar is being demonized even more so than salt. Companies are quietly reformulating products, reducing their sodium, sugar and fat content. Sugar is being reduced through combinations of new technologies and sweeteners. Natural sweeteners such as stevia and monk fruit allow for innovative products.

Product innovation is focused on both budget and super-premium spaces. Small innovators are developing high quality and distinct products that target niche markets but have big trend potential. Popular products are being spliced together into new hybrids to entice consumers hungry for new experiences.[17]

Indulgence trends: There is a counter-trend to wellness by introduction of super indulgent, high fat, high sugar and salt products. Consumers are looking for premium treats or small pleasures. Fun foods can provide a moment of escapism. Development is focused on texture, flavour and enhanced taste experience. In confectionery, two flavours can be combined for a totally different flavour or fizz can be added.

FOOD AND BEVERAGE MARKET DEMAND

In 2011, Canadian consumers spent $181 billion on food, beverages and tobacco from stores and restaurants. Food, beverages and tobacco account for 18.4 per cent of total personal spending.

To better understand the national demand for Alberta based products, it is helpful to understand the interprovincial sales of Alberta based foods. However, since 2008 these statistics are no longer available from Statistics Canada.

The following information on local consumption, national consumption and exports of Alberta beef was available.

- *Alberta beef production, consisting of carcass and boxed beef, was an estimated 668,835 tonnes in 2012.*
- *About 16.9 per cent of this beef was consumed in the province. The majority was shipped out of province, with 57.1 per cent going to other provinces in Canada, 18.9 per cent exported to the United States and 7.1 per cent to other countries.*[18]

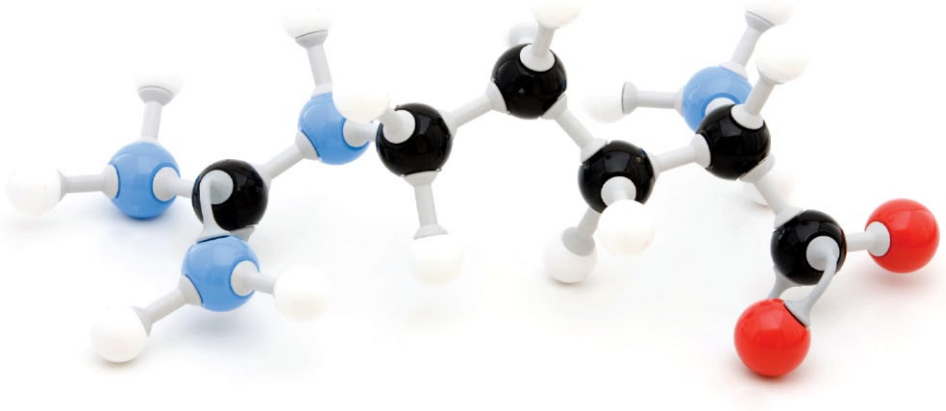
Additional detailed competitive information is needed to determine potential target markets for Alberta food products in local markets, the Canadian market and internationally. In the 2014–15 fiscal year, Alberta Innovates will commission a study to better define the types of Alberta based value-added products that would be best suited for success in specific markets.

The following table describes the various market segments for food and their estimated global market size. See Appendix A for definitions of the various market segments.

Market Segments	Potential Size of Global Markets
Ingredients	An accurate assessment of the global size of this market segment is unavailable. The category includes sensory (colours and flavours, natural and synthetic) and textural (emulsifiers, modified starches, gelling agents, and fat mimetic and fat replacer) food ingredients. Trends are focusing on "natural," health and wellness (sugar or salt replacements, ingredients with proven health benefits), lower cost, clean labels and sustainability. New technologies, such as nanotechnology, to enable encapsulation of bioactives for optimal delivery are being integrated into traditional and new products.
Value-Added Food and Beverages	An accurate assessment of the global size of this market segment is unavailable. Value-added food processing includes any step in the production process that improves or "adds value" to the food and results in a higher value product (e.g., processing beef into sausages; turning cows' or goats' milk into cheese, barley into beer, etc.). Traditional value-added foods include the following: • Meat products (e.g., sausages, beef jerky) • Bakery (e.g., bread, baked goods) • Fresh chilled (e.g., beef, pork, chicken) • Frozen foods (e.g., meat pies, pizza, vegetables, meals, diet meals) • Dairy products (e.g., yogurt, cheese, drinkable yogurt, ice cream) • Baking (e.g., bulk, holiday baking, regular baking) • Gourmet meals, delicatessen products • Grocery (e.g., canned goods, cereals, crackers, snack foods) • Hot and cold beverages • Organic food and beverages Alberta companies may also import ingredients and combine them with Alberta commodities to make value-added products (e.g., confectionary, chocolate). Products can be branded or private label for large retailers, such as Loblaw's President's Choice.
Beverages	Industry analysts expect the global beverage (alcoholic and non-alcoholic drinks) industry to reach $1,347 billion by 2017 with a 4.6 per cent compound annual growth rate (CAGR) for 2012–17.[19] In 2012, beer was the most popular alcoholic beverage in Canada with a market share of 44 per cent. Water is the most popular beverage worldwide. Tea is gaining popularity as additional options become available. Trends include increased production of health and wellness drinks, addition of fruit and vegetable ingredients, Asian specialty drinks, replacement/reduction of sugar, functional additives, energy drinks combined with sports drinks, adding probiotic fibres to dairy drinks, and new packaging concepts.

Market Segments	Potential Size of Global Markets
Halal/Kosher Diets	The global halal food industry has grown to US$632 billion in 2010, and represents close to 17 per cent of the global food industry. This market segment continues to expand.[20]
Snacks and Indulgence Foods	The world snack food market is predicted to reach almost $335 billion by 2015. In 2009, the Canadian snack food manufacturing industry was 2.5 per cent of total food manufacturing. From 2000 to 2010, imports of snack foods have increased 148.7 per cent from $154.7 million to $384.7 million. The bulk of these imports come from the U.S. The trend is toward snacks that are both nutritious and satisfying and includes high-protein snacks (e.g., jerky) and meal replacements.
Naturally Healthy and Organic	The "naturally healthy" global market was valued at $241.4 billion in 2010, and total sales are estimated to reach US$316.1 billion by 2015. The global organic food and beverages industry was US$24.4 billion and is expected to grow to US$36.1 billion due to increased consumer health awareness and broader distribution. Canadian sales were $8.3 billion in 2010.[21] The Canadian organic food market is valued at $1.1 billion. Strong products in organic include dairy products, bakery products and ready-meals.[22]
Reformulation, "Better-for-You"	Global "better-for-you" sales in 2010 were US$160.3 billion. North America is the largest market with $57.9 billion in sales while Europe represents 67 per cent with $50.7 billion in sales. Both of these markets have governments that are actively promoting healthier eating.[23]
Functional Foods	The global functional food market is projected to nearly double from US$127.4 billion in 2010 to $244.6 billion by 2015. Expect greatest demand for foods that contain glucosamine, whey protein, plant sterols, probiotics and omega-3 fatty acids.[24] Compared to other countries, Canada's market is still relatively young for functional foods. The current value of the Canadian market is $4.9 billion, and it is expected to increase to $5.8 billion by 2015.
Intolerance Foods and Special Dietary Needs	Globally, the food intolerance market reached US$9.1 billion in 2011, and it is projected to reach $13.2 billion in 2015. Top food intolerance categories worldwide are gluten free (29.4 per cent), lactose free (39.1 per cent), diabetic foods (16 per cent), and milk alternatives (15.5 per cent). Deloitte estimates that the gluten free market in the U.S. is US$2.7 billion and will reach US$6.0 billion by 2015.[25] The Canadian market is valued at US$161.3 million.

3. INNOVATIONS IN TECHNOLOGY



Agri-food businesses in Alberta are well positioned to benefit from adopting or integrating emerging platform technologies into product development. Of note are nanotechnology and food biotechnology (which includes genomics, metabolomics, proteomics, etc.) and, to a lesser extent, fractionation and extraction technologies. Innovative new manufacturing processes such as high-pressure processing are being evaluated for adoption by Alberta companies. Innovation and continuous improvement are hallmarks of automation (i.e., robotics).

NANOTECHNOLOGY

Nanotechnology refers to the science of manipulating matter at extremely small scales. This technology has had a great impact on other sectors and is slowly being adopted by the food industry.

Nanotechnology is currently being used in the following areas:

1) **Nano devices and intelligent packaging**
   Nano detection systems are being used for:
   - Detecting microbial pathogens, contaminants or spoilage bacteria
   - Monitoring temperature fluctuations of a product during transport
   - Monitoring storage times
   - Monitoring product attributes (e.g., ripeness)
   - Identity preservation.

2) **Flavour, colour and taste enhancement**
   Interactive food refers to food products containing nanostructures that can modulate the release of bioactive compounds that impact flavour, colour or taste. Unique nanoparticles made of proteins can be used to decrease the use of fat or salt while preserving taste and the product's appearance. Incorporating nanoparticles has become more common as companies seek to improve the "healthful" attributes of their food products.

3) **Enhancing nutritional qualities**
   Nanoparticles are used to deliver nutritional elements when there are nutritional deficiencies (e.g., calcium) and to improve how nutrients are delivered and absorbed by the body.

   Nanoencapsulation allows a bioactive (biologically active component) to be delivered to the parts of the body that will benefit the most.[26] Of interest is the use of protein-based nanostructures to encapsulate compounds. Proteins possess unique functional properties and high nutritional value. They are also less controversial when applied in the food industry.

Applications of nanotechnology to food are still emerging and evolving. Some estimate the global market for food containing nanotechnology to have reached $5.8 billion in 2012, representing a growth of 1,400 per cent over the previous six years. Other estimates put this number as high as $20 billion.[27]

One major concern is that the properties of many common elements and compounds change with decreasing size. Thus, small/nano particles have the potential to overcome the effectiveness of natural biological barriers. The use of nanomaterials in the food industry could increase concern about accumulation in human body tissues resulting in unknown health impacts.

For nanotechnology applications to be fully realized and accepted by regulatory authorities and consumers, toxicological research and risk assessments will need to be completed on the health, safety and environmental impacts of the use of nanomaterials in food and food packaging. Extensive transparent communication of this information to consumers may be needed once the safety of nanoparticles has been established to avoid negative backlash similar to current consumer attitudes toward genetically modified organisms (GMO).

BIOTECHNOLOGY

The manipulation of various crops and animal traits through multi-generation cross-breeding has been practised for thousands of years. In the last few decades, the science of biotechnology has developed, allowing scientists to add or remove genes with much greater precision. Applying biotechnological techniques has allowed for improvements in food nutrition, safety and crop yields. However, societal concern about the health and safety of food derived through biotechnology, particularly genetically modified crops, has escalated in the last decade.[28]

Biotechnology involves a wide variety of gene expression technologies such as genomics, proteomics (protein expression analysis) and metabolomics (metabolite analysis) but also genetic transformation and cloning.

Biotechnology has made it possible to more easily modify the content of macronutrients, micronutrients and phytochemicals in foods. For example, genes for synthesizing essential nutrients such as flavonoids, iso-flavonoids, biotin, thiamine and vitamin E can be incorporated into traditional crops.[29] Nutrients that are candidates for production in plants through genetic modification include:

- Carotenoids, such as lycopene in tomatoes and lutein in kale and spinach to promote eye health
- Glucosinolates such as glucoraphanin in broccoli and broccoli sprouts for cancer prevention
- Phenolics such as resveratrol in red wine and red grapes for enhanced immunity
- Phytoestrogens such as genistein and diadzein in soybean products to lower risk of osteoporosis and heart disease
- Inulin, a high-fiber natural sweetener found in potatoes.

Vegetable oils are an important element of human nutrition. Biotechnology has made it possible to tailor the composition of plant-derived lipids to enhance desired food functionality and human dietary needs. These modified oils have decreased concentrations of linolenic and palmitic acids. More importantly, they have increased levels of linoleic acid, which gives oil its resistance to rancidity.

The use of biotechnology in food production provides innovative possibilities for feeding a growing world population by increasing agricultural production as well as by improving the nutritional content of many staple crops.

An industry report indicates that biotechnology companies have grown by eight per cent from 2011–12, with $89.8 billion in global revenues.[30]

Although biotechnology is used extensively in food innovation, there are increasing consumer concerns (particularly in North America and Europe) about the health and safety of biotechnology-derived foods, especially GMO's. These consumer concerns can partially be addressed through risk assessments that demonstrate safety to both the environment and human health. Although it will take some time, transparency and availability of credible information will be essential in changing consumer perspectives about genetically modified foods.

OTHER EMERGING PROCESSING TECHNOLOGIES

1) **Extraction** is a process that separates a substance from a matrix. **Fractionation** is a process in which a mixture is divided into its smaller components or fractions.

   Some Alberta researchers have conducted work in **super-critical fluid technologies**, which allows for extraction and fractionation. Work in this area contributes to the development of functional foods, ingredients and other value-adding opportunities, including delivery systems for bioactives.

2) **High pressure processing (HPP):** HPP uses compressed cold water to subject foods to extremely high pressures—up to 4,000 times atmospheric pressure—to reduce and deactivate pathogens, denature proteins and increase the shelf life of products.[31]

   HPP technology was first commercialized in Japan in the early 1990s, with companies in other parts of the world following thereafter.[32] Since 2000, there has been an almost exponential uptake of HPP around the world.[33] In 2010, Canada was estimated to have the third-largest number of HPP installations in the world (after the United States and Mexico).[34] Although the exact market share of HPP around the world is unknown, in 2011 it was estimated to fall between US$2 billion and US$3 billion.[35]

3) **Irradiation:** Irradiation is a well-established practice that could reduce food safety risks. However, consumer concerns regarding potential health impacts are a challenge to widespread adoption.[36]

   Irradiation is presently used in food production by more than 40 countries, including Canada, where it is permitted for use only on potatoes, onions, wheat, flour, spices and dehydrated seasonings.

4) **Other food processing technologies** that are being explored for application in Alberta include:

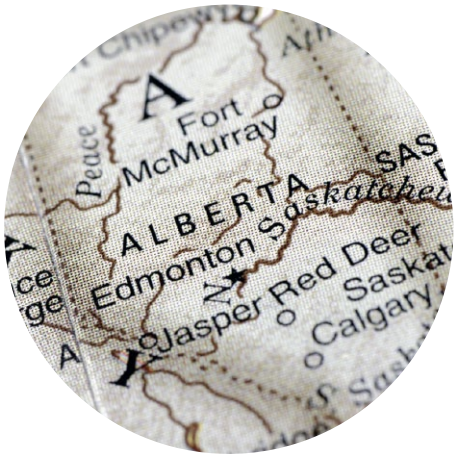
   - Microwave technology
   - Ohmic heating (using a charge to cook)
   - Pulse electric field (for fluid type products)
   - Shock wave (for meat tenderization).

5) **Automation of food manufacturing facilities:** Many companies are looking to automate their food processing facilities with production capacity robotics to drive down labour costs and improve efficiencies. Robotics are generally developed in other countries and adapted to meet Canadian regulatory and consumer expectations.

4. ALBERTA CAPACITY

The following section reviews Alberta's research and industry capacity. Success in developing a stronger value-added food manufacturing sector will depend on alignment between market demand, research knowledge, and industry capacity in developing innovative new products.

As work on innovation in other sectors has demonstrated, businesses that select opportunities that align with their existing capacity are more likely to succeed than those who pursue opportunities beyond their experience and expertise.[37]



ALBERTA RESEARCH CAPACITY

Alberta possesses strong capacity in food research and innovation. There are approximately 55 researchers across the University of Alberta, University of Calgary, University of Lethbridge, Olds College, Alberta Agriculture and Rural Development (ARD), and Agriculture and Agri-Food Canada's (AAFC) Lacombe Research Centre.

In addition to Alberta Innovates organizations, there are at least 10 funding bodies, most of which are part of the Agriculture Funding Consortium. The province is home to approximately 15 centres, institutes and teams that play important roles in Alberta-based food research and innovation. These include:

- ARD Food Processing Development Centre and Agri-Value Incubator
- AAFC Lacombe Research Centre
- National Institute for Nanotechnology (NINT) located at the University of Alberta
- University of Alberta's Agricultural, Food and Nutritional Sciences laboratories
- University of Alberta's Agricultural Genomics and Proteomics (AGP) Unit
- The University of Alberta's Agri-Food Discovery Place (AFDP)
- University of Alberta Metabolomics Innovation Centre (TMIC)
- Alberta Innovates Phytola Centre (core funding provided by Alberta Innovates Bio Solutions (AI Bio))
- Alberta Innovates Livestock Gentec (core funding provided by AI Bio)
- Portage College's Food Sciences Centre.

An example of how researchers have built on Alberta's strengths can be found at NINT and Agricultural, Food and Nutritional Sciences laboratories at the University of Alberta. Researchers are actively developing nanoencapsulation technologies and their applications. This research may support the ability of other researchers and companies to develop and commercialize nutraceuticals that add value to the province's agricultural commodities, such as barley, oats and other field crops.

Alberta is also well positioned in livestock and canola-based genomics research aimed at enhancing meat and oil quality. The AAFC Meat Quality Program in Lacombe has a unique facility that allows researchers to determine the impact of various livestock production adjustments on meat quality. One example is genomic work in livestock that is targeted at improving feed efficiency and examining the potential impacts on meat quality.

The University of Alberta Agri-Food Discovery Place, Meat Safety and Processing Research Unit is a Containment Level 2 biosafety facility that allows for testing new strategies to eliminate food-borne pathogens.

Other ongoing research initiatives in the province include developing healthy food products, functional foods, nutraceuticals, snack foods and value-added foods and ingredients; improving fortification and food safety; and evaluating new processing techniques.

ALBERTA INDUSTRY CAPACITY

Alberta has a moderate food and beverage manufacturing sector by Canadian standards, with 1.17 per cent of the province's GDP from food and beverage manufacturing. This is lower than the Canadian proportion of 1.7 per cent. However, Alberta's agriculture commodities account for 2.93 per cent of GDP—nearly twice the Canada-wide average of 1.6 per cent.

Alberta revenues from commodities continue to grow at a faster rate than those from value-added products.[38] The value-added products subsector in Alberta is dominated by meat processing (47 per cent) and grain and oilseed milling (14 per cent).

The majority of Alberta's food businesses, 774 in 2010, are small companies, with very few companies (approximately 38) in the over 100 employees' category. Approximately 120 companies have between 26 to 100 employees. Alberta could benefit from placing a greater emphasis on helping mid-size companies take advantage of federal and provincial industry programs.

Many of Alberta's larger food companies are branch offices and research and innovation investment decisions are made by their head offices. Head offices, especially for multinationals, are more likely to be located in Eastern Canada (Ontario, Quebec), the U.S. or other countries than in Alberta.

Although Alberta is an attractive province for investment and is ranked first in Canada in terms of investment climate (corporate income tax, fiscal prudence, personal income tax, labour market regulation, and burden of regulation), it competes with other jurisdictions to attract businesses and has experienced relatively low levels of investment in its agri-food businesses.[39]

One reason is the availability and cost of labour. Alberta's agri-food industry competes with high-paying jobs in other sectors such as the oil industry. Ontario has an advantage over Alberta due to its large population base, existing expertise and food manufacturing base, which drives further innovation. Its more temperate climate allows greater access to more diverse agricultural products for value addition. Other provinces may simply appear more attractive for investment in agri-food than Alberta.

In addition to low levels of investment, results from the Conference Board of Canada's Food Industry Survey reveal that Alberta food businesses are among the least motivated in Canada to pursue product, process or input innovation, but they do show greater interest in food safety innovation. Further investigation into the reasons why Alberta companies are less motivated is required.

5. LESSONS FROM INTERNATIONAL INITIATIVES

Alberta trails global leaders in applying strategies to grow the food and beverage manufacturing sector. There are many countries that have had significant success by establishing specific growth strategies. They target small and medium-sized businesses, which have the potential for growth, greater risk tolerance and flexibility to embrace new technologies and processes.

Two examples can be found in the **Netherlands and Australia (specifically South Australia)**. These two countries have very differing food sectors. The Netherlands is the second-largest global exporter of fruits and vegetables, with much of its production in greenhouses. On the other hand, Australia is a relatively small exporter on the global scale, with most of its production in the open field. Both jurisdictions have managed to grow their food and beverage sectors substantially over a short period of time by establishing an organization solely for the purpose of growing the agri-food sector and by maintaining focus on national and provincial goals.

Food South Australia (Food SA) was established in 2010 through the merger of industry associations Food Adelaide and Flavour SA. This merger brought together memberships, roles and staff, domestic and international marketing and business development expertise into a single focal point for industry.

Food SA's role is to support and develop the sustainability and profitability of the food industry in South Australia. Through its programs and services, Food SA:

- Helps food companies increase market options, increase profitability and be sustainable
- Supports the growth of entrepreneurial capacity and best-practice processes
- Fosters connections between South Australian food companies and domestic and international buyers
- Acts as the voice for industry
- Assists in strengthening brands and developing connections.

The Netherlands Food Valley (NFV) was established in 2004 and consists of a small office that supports more than 60 companies that participate in collective activities. Their focus is on food, health and nutrition. The NFV is a region serving 500 million Europeans and is home to a large number of multinational food companies. About 15,000 professionals are active in food-related sciences and technological development. The NFV was created to:

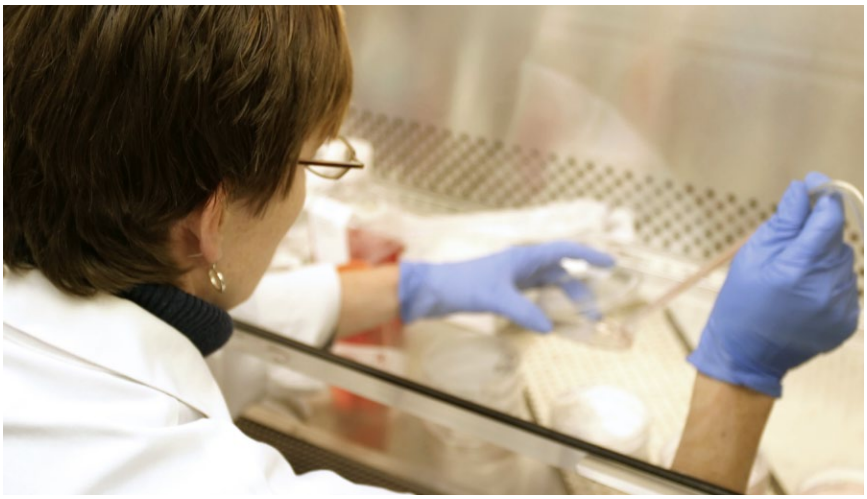
- Create a network for innovation and business
- Provide solutions for the knowledge paradox
- Create flexible responses to changing market dynamics
- Develop new markets for knowledge application
- Create new jobs.

Alberta has the opportunity to consider the strengths and best practices of other jurisdictions and develop a model for an industry growth and diversification strategy underpinned by innovation. A critical success factor is the creation of a centralized point of access to ensure a consistent approach is implemented; provide information to industry; and act as a bridge between industry, academia and government.

Innovation is the key to driving growth. A stronger voice for businesses in identifying research priorities can help close the gap between research that is rigorous and research that is rigorous, relevant and results in improved performance across the globe.

Alberta's food and beverage industry should be engaged and speak with a united voice to influence the direction of provincial research initiatives and innovation.

6. LEVERAGING ALBERTA AND CANADIAN INITIATIVES



There are several organizations concurrently working towards developing various aspects of a national food strategy. These include the Conference Board of Canada (CBC), Canadian Agri-Food Policy Institute (CAPI), and Agriculture and Agri-Food Canada (AAFC). Although the level of collaboration between these organizations is unclear, they all recognize the importance of increasing value-added food and beverage production to the prosperity of Canada's agricultural sector and to enhancing population health.

Ontario, British Columbia and New Brunswick have already developed provincial food strategies aimed at growth, adding value and improving the sustainability of the food sector. Although the remaining provinces do not have specific published strategies in place, all have organizations and institutions available to help grow the industry. Of particular note are Winnipeg's Canadian International Grains Institute and Saskatchewan's Food Industry Development Centre and Global Institute for Food Security.

Networks such as Food Tech Canada are also a key resource but lack sustained core funding. Food Tech Canada provides a single source for information on 12 food-and-bio-product technology centres. These include 200 scientists; 250,000 square feet of laboratory, pilot and commercial facilities; and $65 million in analytical, processing and packaging equipment. This information is valuable to companies and entrepreneurs that need to access expertise or equipment for food product development and commercialization.

7. PROMISING RESEARCH AND INNOVATION OPPORTUNITIES

Based on extensive analysis completed by the Conference Board of Canada for Alberta Innovates, several areas of focus have been chosen as the most promising investment opportunities. Additional internal analysis of market demand, Alberta's core strengths in agriculture, and Alberta's research and industry capacity confirmed the following selections for future investment:

- **Ingredients, food and beverages that add value to Alberta's agricultural commodities.** This work will include ingredients, complex food products, potato and pulse-based foods and snacks as well as specialized products that support improved health outcomes.
- **Functional foods and nutraceuticals**, particularly in barley/beta-glucan, functional pulse-based ingredients, poultry bioactives, and possibly dairy proteins.
- **Food safety** with a focus on meat safety.
- **Genomics, metabolomics, other "omics"**, and **food nanotechnology** are emerging technologies in which Alberta has considerable strength. These can be applied to food innovation.

PATH FORWARD

It is important that Alberta work to develop a more effective food innovation system that fosters tighter connections and a commercialization pathway between the research community and industry. To facilitate the development of a more globally competitive food industry, Alberta Innovates may need to:

- **Improve links** between industry and the research community
- Facilitate a **leadership role for industry** in determining research, innovation and growth objectives
- **Leverage programs** that support industry growth.

In 2014–15, we will:

- Commission a report to better **define high-yielding markets** and competitive advantages for specific Alberta food products.
- Use the **Agriculture Funding Consortium** to identify and invest in projects that align with the Food Innovation Plan objectives.
- Develop a **targeted call** that requires significant food company involvement/ leadership to accelerate research and innovation in the areas identified above. Alberta Innovates will play a facilitative role in matching industry interest to academic capacity.

With the right mix of investments, Alberta Innovates can help industry realize the benefits from accelerated food and beverage innovation. Albertans will benefit through economic growth and diversification and access to value-added food and beverage products.

APPENDIX A: GLOSSARY OF MARKET TERMS

Reformulation, "Better For You"

Many companies are reformulating their food products in a market trend referred to as "better for you" (BFY). In some cases, this involves removing ingredients from an established brand that in certain quantities are, or are perceived to be, unhealthy, such as sodium, sugars and harmful fats, or as "unnatural", such as certain additives and preservatives. This work can be challenging for food companies as they try to improve the healthfulness of established products while maintaining taste and functionality. In other cases, reformulation focuses on increasing the presence of ingredients that are, or are perceived to be, healthy, such as fibre, fruit and vegetables.

Intolerance Foods

Food intolerances refer to a broad range of hypersensitivities to a food, beverage or food additive and includes both self-diagnosed and medically confirmed conditions. Adverse reactions can vary from mild to life threatening. Nine substances are most frequently associated with food allergies and allergic-type reactions. These include peanuts, tree nuts, sesame seeds, soy, milk, eggs, fish (including crustaceans and shellfish), wheat and other cereal grains (containing gluten and sulphites).

Functional Foods

Functional food and fortified foods are defined as foods or food components that provide a health benefit beyond basic nutrition. Health Canada defines functional foods as being "similar in appearance to, or may be, a conventional food that is consumed as part of a usual diet, and is demonstrated to have physiological benefits and/or reduce the risk of chronic disease beyond basic nutritional functions." The Hartman Group defines functional foods as an industry term that covers any food or beverage designed and/or marketed with a health benefit (physical or emotional), implicit or explicit. "Functional foods" expands the category that both industry and consumers commonly refer to as "fortified foods."

Naturally Healthy

Naturally healthy refers to foods that are considered to be minimally processed and include ingredients that naturally contain vitamins, minerals and other nutrients essential to a healthy diet. This includes using no hormones or antibiotics, and foods containing a lower percentage of fat, sugar and sodium. High fibre has become a growing ingredient trend within this category, and fibre is considered an ingredient that most consumers look for when shopping for food products. Examples in this category include 100 per cent fruit/vegetable juice, natural mineral water and spring water, green tea and white tea.

Halal/Kosher Diets

There is growing demand for specialty products such as food prepared according to kosher (Jewish) and halal (Islamic) practices. Both types of foods are prepared in a specific manner according to their respective faiths. Demand for halal meats has become so great that they are poised to surpass organic meat markets in popularity. Many non-Muslim and non-Jewish consumers who do not follow these religious dietary guidelines are beginning to buy halal and kosher products as they are considered to be safer and of higher quality, taste and freshness than conventional products. Lactose intolerant consumers are buying kosher certified food products, which clearly indicate if a product is dairy free.

Organic

Organic foods are grown without the use of synthetic chemicals, fertilizers, pesticides, hormones or antibiotics. They are being chosen by those concerned about the environment and sustainable farming. Consumers consider organics to be healthier, more natural, minimally processed and pesticide-free. Organic dairy products, bakery products, ready-made meals and baby food are some of the global top-selling organic items.

APPENDIX B: GLOSSARY OF GENERAL TERMS

Biotechnology

Biotechnology is the use of living systems and organisms to develop or make useful products. Biotechnology is any technological application that uses biological systems, living organisms or derivatives thereof, to make or modify products or processes.

Commercialization

Commercialization is the process by which a new product or service is introduced into the general market. Commercialization is broken into phases, from initial introduction of the product through its mass production and adoption. It takes into account the production, distribution, marketing, sales and customer support required to achieve commercial success. As a strategy, commercialization requires that a business develop a marketing plan, determine how the product will be supplied to the market and anticipate barriers to success.

Genomics

Genomics is a branch of biotechnology concerned with applying the techniques of genetics and molecular biology to the genetic mapping and DNA sequencing of sets of genes or the complete genomes of selected organisms, with organizing the results in databases, and with applications of the data (as in medicine or biology).[40]

Innovation

Innovation is the creation of new or improved products, services or processes for a global marketplace. It is a critical driver of productivity growth in the modern knowledge-driven economy. Innovation is not just invention but any improvement on the status quo, whether in food processing, distribution, retail or marketing.

Nanotechnology

Nanotechnology is the manipulation of matter on an atomic and molecular scale, sized from 1 to 100 nanometres.[41]

Metabolomics, OMIC's Diagnostics

The emerging field of metabolomics, in which a large number of small-molecule metabolites from body fluids or tissues are detected quantitatively in a single step, promises immense potential for early diagnosis, therapy monitoring and understanding the pathogenesis of many diseases. Metabolomics methods are mostly focused on the information-rich analytical techniques of NMR spectroscopy and mass spectrometry. Analysis of the data from these high-resolution methods using advanced chemo metric approaches provides a powerful platform for translational and clinical research and diagnostic applications. There are many applications in the area of cancer, diabetes, metabolism and cardiovascular diseases.

APPENDIX C:
KEY EXPORT MARKETS

United States[42]

- **Alberta's largest trading partner**
- **In 2012 $3 billion or 32.2 per cent of Alberta's agri-food exports went to the U.S.**
- **Top five exports include:** fresh, chilled, frozen beef; canola oil/mustard oil; live cattle; bread, pastry, cakes, biscuits
- **Three-quarters of Alberta's total beef exports** and 2012 beef exports declined 11.3 per cent to $581 million

OPPORTUNITIES

- **U.S. market remains top priority** due to size, proximity, infrastructure, and trade access
- **Food service and retail demand include:** ingredients, partially prepared products, shelf stable and dry grocery, frozen/convenient ready-meals and appetizers, ethnic foods (new flavours), specialty gourmet foods, natural foods, bakery, functional foods, convenience foods, and snacks
- **Target regions for Alberta: Pacific Northwest** (12 million consumers are a day and half away), **West Coast and South Western States**, and **Upper Mid-West** (Access to major agriculture and food companies such as Cargill, ConAgra, and General Mills)

CHALLENGES

- U.S. Mandatory Country of Origin Labeling
- Parity of the Canadian dollar
- Competition for U.S. market from Asia and Latin America.
- Increased cross-border regulation, inspection and fees

China[43]

- **Alberta's second-largest trading partner**
- Alberta is **5.1 per cent of China's agri-food imports**

OPPORTUNITIES

- Middle class spending more on food, demanding a **wide variety** of foods and **eating out more** often
- Increased demand for **safe, high-quality, branded, processed, and convenience foods**
- **Product price** remains a major factor
- Top growth food areas are **baked goods, soft drinks, fast food, and alcohol**
- Food retailing moving to "**hypermarkets**," convenience stores and fast food restaurants
- **Online shopping** increasing
- **One-child policy** resulting in children, especially males, being very influential in purchasing decisions

CHALLENGES

- Competitors are: U.S. (26.4 per cent of imports), Brazil (16.2 per cent), Argentina (6.8 per cent), Malaysia (6.7 per cent)
- Western food products may not appeal to Chinese tastes (too sweet)
- Issues with protecting intellectual property rights
- Different business customs / language barriers
- Corruption issues / bureaucratic interference
- Distribution and logistical issues (lack of cold storage facilities and transportation systems)

Japan[44]

- **Alberta's third-largest trading partner**
- In 2012, agri-food exports rose 14.9 per cent to **$1.3 billion**
- Exports have grown 100 per cent since 2003
- **Top exports:** $220 million in **wheat**; $537 million in **canola**, $179 million in **pork** (fresh, chilled, frozen), $67 million in **beef**, $48.2 million in **tallow**, and $18.1 million in **processed meats**[45]

OPPORTUNITIES

- Japan relying more on imports for consumer-ready food products
- Consumers demanding a greater variety of functional foods
- Japan recognizes safety standards for Canadian foods
- Well-established health and wellness market is expected to continue to grow
- Increased consumption of pork and beef

CHALLENGES

- Transportation distance
- High cost of marketing
- Complicated labelling laws
- High duties on many products
- Increasing competition from China and other food exporting countries
- Requirement for long-term commitments[46]

Mexico[47]

- **Alberta's fourth-largest trading partner**
- Exports fell 1.2 per cent to **$633 million** in 2012
- **Major exports:** canola seed, wheat, beef, frozen French fries, waffles and wafers
- Long-standing relationship with Canada as part of the NAFTA agreement[48]
- In 2010, 52 million or 46.2 per cent of total population lived in poverty, with 11.7 million people (10.4 per cent of the population) living in extreme poverty[49]
- Has the highest rates of child, adolescent, and adult obesity in the world

OPPORTUNITIES

- More than 10 million Mexicans, over 1/6 of the adult population, suffering from obesity and diabetes[50] and 70 per cent of Mexicans trying to lose weight are changing their diets[51]
- Growing retail sector includes **frozen meals, sauces, bakery and private label**[52]
- Consumers wanting **convenient** and food service alternatives, **packaged food** and **ready-to-eat** meals
- Young professionals driving increased sales of beer and snacks, and consumption in fast-food and dining out

CHALLENGES

- Limited market access for beef and table potatoes hindering exports
- Now signing free trade agreements with more than 42 countries, potentially impacting Canada's future exports to Mexico

South Korea[53]

- Alberta's fifth-largest export market
- Exports fell 41.3 per cent to $174 million in agri-food exports in 2012
- Decline is due to reduced exports of wheat and pork—beef exports grew from $45,000 in 2011 to $7.4 million in 2012 due to South Korea opening its market to Canadian beef
- Sales of manufactured products: $89 million (pork, malt, beef, oils—canola/mustard—other oils).
- Population at 50 million in 2012

OPPORTUNITIES

- Increased demand for western style foods, healthy food and beverages, natural and value-added products, and more wheat and protein
- Recently focused on sourcing healthier edible oils, including canola oil—harmonized tariffs putting canola oil on par with soybean oil
- Increased imports of refined canola oil due to lack of capacity to crush canola seed or to process large quantities of crude canola oil

CHALLENGES

- Market access issues, e.g., South Korea signed bilateral trade agreements with New Zealand, the EU, and the U.S. so Canada at a significant disadvantage to its competitors until similar agreement is reached (e.g., 230 per cent tariff on honey, high tariffs on beef and pork)

India[54]

- Alberta's 18th largest export market
- Recommended key market to watch
- Alberta is India's sixth-largest agricultural import source
- In 2011, Canada agri-food exports to India were valued at $58.3 million, with 98 per cent of exports in dried peas and lentils
- Population at 1.27 billion and is expected to grow to 1.53 billion by 2030
- 72 per cent of population lives in rural areas with 65 per cent employed in agriculture
- Consumption of beef (water buffalo) and veal increased 73 per cent since 2000.

OPPORTUNITIES

- Largest importer of pulses, as India cannot meet its own demand
- Opportunities for Canadian wheat, canola oil, sunflower, and mustard oil
- Demand for meat increasing, although 80 per cent of India's population is Hindu and traditionally vegetarian—non-Hindus account for 20 per cent of population (242 million)
- Enhanced market access in pork, live cattle, live swine and poultry genetics.

CHALLENGES

- Restrictive import regulations
- Sanitary and phytosanitary barriers
- High import tariffs
- Intellectual property rights an issue
- Competition already active in India market
- Limited access to logistics, infrastructure and storage

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