



Alberta Agricultural Research Institute

Strategic Business Plan 2008-2013

*Growing Innovation*

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# Introduction

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Alberta's agriculture and agri-food industry is a significant contributor to Alberta's economy and an integral part of our social fabric; however, the competitiveness of Alberta's agriculture industry is being impacted by numerous factors that are evidence of an increasingly complex global market. This strategy is designed to maintain and grow the economic contribution of this important sector for the benefit of all Albertans.

In the last five years, agriculture has become a focal point for the intersection of several global drivers: climate change, increasing demand for energy (including renewable forms), energy security, environmental sustainability, food and health, geopolitics, world trade and technology innovation. As our world becomes more interdependent, the benefits of agriculture research will directly affect producers and consumers in all corners of the globe.

With a growing world population, many countries facing environmental pressures that will limit increases in agricultural production, Alberta with its relatively small population size, yet with water and land resources to support expansion has huge opportunities for biomass production for food, feed and industrial uses. Probably no other country in the world except for Russia is in this position.

New products, new uses, and value-added processes that appeal to consumers will create additional demand-driven need for agricultural production, thus providing more opportunities for agricultural producers and businesses. The cornerstones for all of these advances are the timely, relevant, and quality research activities that form the foundation on which new products are developed and the outreach activities that help establish these new products in both the domestic and foreign marketplace.

The Alberta Agricultural Research Institute (AARI) provides leadership by setting strategic direction for agricultural research in Alberta, and funds numerous projects each year that play a significant role in advancing Alberta's global position. The Institute recognizes the remarkable opportunities that exist for Alberta to take advantage of the research revolution in biotechnology, genomics, information handling and nanotechnology, and to build on our current strengths to create new opportunities. It will achieve its vision for the future of the agricultural sector through focusing on three areas of strategic priority relating to industrial biorefining, agri-food solutions to health issues, and the sustainable production of agriculture products.

## AARI's Role

AARI was established in 1987. The Institute is governed by the *Alberta Science and Research Authority Act* and supports ASRA's mandate to enhance the contribution of



science and research to the sustainable prosperity and quality of life of all Albertans. The Minister of Advanced Education and Technology, on behalf of the Government of Alberta, appoints the AARI Board to provide strategic technical, policy and other advice and assigns AARI staff to put into operations the strategic directions of the AARI Board. AARI is the primary agency in Alberta for funding, coordinating and promoting strategic agricultural initiatives in research, development and technology transfer for the agriculture and agri-food sector. Since its inception, AARI has invested in excess of \$180 million in the development of new technologies for the agriculture industry. AARI is responsible for the overall strategic direction of agricultural research through *Alberta's Agricultural Strategic Research and Innovation Framework*.

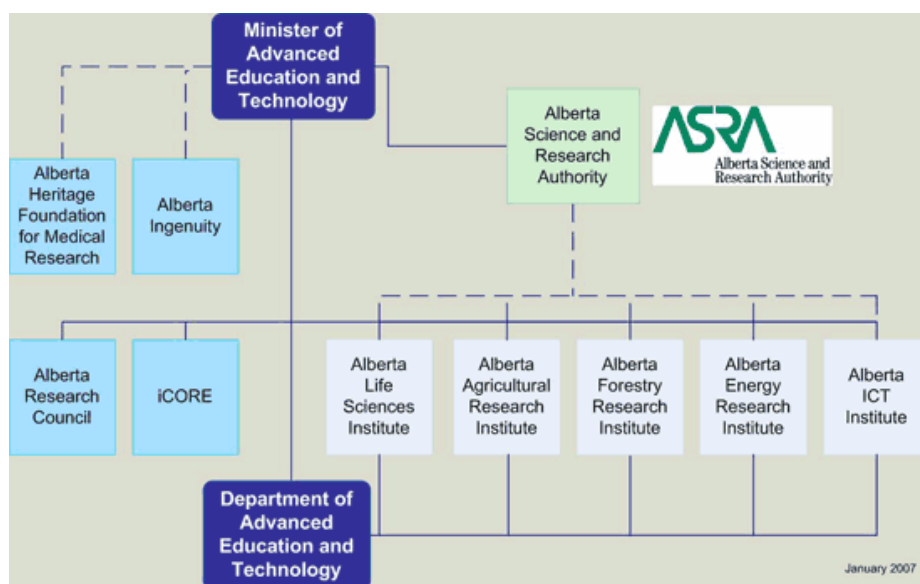


Figure 1: Organizational Structure of AARI within Alberta Advanced Education and Technology

AARI has 3 key roles:

*Leading*—working with industry, academia, government and the public to set direction and advance relevant research and development of prospective new technologies and processes.

*Coordinating*—working with the province’s research, development and deployment partners to ensure delivery of innovative solutions.

*Funding*—investing in research and technology to support short-term goals and long-term outcomes.



## Our Vision

*AARI envisions a thriving agriculture sector and bioeconomy through innovation in agriculture.*

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## Our Mission

*To align the direction and priority for strategic research in bioproducts, sustainable production and food for health. Successful innovation in research, development and deployment will serve to improve the quality of life for all Albertans.*

## Linkages

The Government of Alberta's 20-year strategic plan released in 2004—*Today's Opportunities, Tomorrow's Promise* identifies “Unleashing Innovation” as the first pillar of strategic opportunity. That direction is echoed in Alberta's 20-year economic development framework, *Securing Tomorrow's Prosperity*, which targets building the capacity of the province's innovation system through cooperation and collaboration.

AARI's mandate to provide strategic leadership for science and research, and facilitate technology commercialization and development supports the Government of Alberta's direction, and is set out in the *Alberta Science and Research Authority Act*.

Our priorities are also synchronized with the strategic priorities identified by the Alberta Science and Research Authority (ASRA) and each of the organizations under the ASRA umbrella. AARI recognizes that its programs will play a critical role in making ASRA's Life Science Strategy a reality.

AARI provides strategic direction for the Life Sciences Branch of the Ministry of Advanced Education and Technology (AET). *Alberta Prospers Through Innovation*: the 2007-2010 AET Business Plan identifies AARI's link through Goal 5: “Accelerate innovation in the life science sector.” Strategies within that plan mirror what AARI has identified as key priorities, such as aligning current investments, developing networks that promote industry collaboration and increasing investment in research and in the development of a bioenergy strategy.



Alberta Agriculture and Food's mandate to encourage industry growth and facilitate rural and environmental sustainability is also directly supported by AARI's goals and strategies in this plan.

In addition to maintaining close relationships within the government's research organization structure, AARI has developed and nurtured partnerships and relationships with other organizations including:

- National Agriculture and Food Organizations
- Academic Institutions (e.g. University of Alberta, University of Calgary, University of Lethbridge, Olds College School for Innovation)
- Funding Agencies

## Long-term Outcomes

AARI is focusing on developing internationally leading research, development and deployment capacity in strategic areas to help achieve the following industry outcomes:

- A \$15-billion value-added food industry (*2006 value: \$9.6 billion*)<sup>1</sup>—Value-added areas include processed meats and grains, functional foods and with the potential for enhanced economic activity, in both rural and urban communities.
- A \$2.5-billion bioproducts industry (*2006 value: \$105 million*)—Biorefining of several biomass opportunities to generate chemicals, heat, electricity, transport fuels, materials and bioactive extracts.
- A \$2.5-billion health and nutrition industry (*2006 value: not available*)—Natural pharmaceuticals and bioactive ingredients, such as edible oils, fats, emulsifiers, fibres and probiotics.
- A \$10-billion crop and livestock production industry (*2006 value: \$7.8 billion*)—Crop and livestock production for commodity markets globally and for feedstock for the value-added industries.
- Appropriate research, development and deployment capacity to fulfill Alberta's research, development and deployment goals—An effective and efficient agriculture-based research, development and deployment system.

The timelines for achieving these goals will be aligned with the Growth Strategy being developed by the Ministry of Agriculture and Food.

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<sup>1</sup> 2006 data provided by the Ministry of Agriculture and Food



A significant portion of this growth will take place in rural areas, which should provide new businesses, improved farmer profits, new jobs and improved economic vitality. Research and development will provide solutions and technologies to the challenges of agriculture's growth and prosperity, and will help the industry to capture new markets as the face of agriculture changes.

## Investing in Success

Toward achieving our long-term outcomes, in the past five years AARI has made significant investments in research areas that are anticipated to build a platform for continued research success in the province. Some of these include:

- *Alberta Bovine Genomics*—This group has participated in a number of globally-recognized research initiatives including the first bovine genome map. Alberta has become a recognized centre for leading new efforts in finding commercial opportunities by establishing the genetic basis of economically important traits.
- *Alberta Lipid Utilization*—Investments have led to a greater understanding of the industrial potential for canola and flax oils. International companies have been attracted to invest in the program due to the unique approach to understanding and engineering new lipid-based products.
- *Canadian Triticale Biorefining Initiative*—AARI's early investment in the triticale program has led to significant interest by both industry and other levels of government. The use of triticale as a platform crop for the new bioeconomy will create opportunities for Alberta producers and processors to benefit from this national initiative.
- *Value Added Meats Program*—In recognition of the substantial value addition occurring outside of Alberta, and based on products that originated in the Alberta meat industry, significant resources were invested by AARI and the Government of Canada to address the issue. This has resulted in successful recruitment of the scientific expertise which is leading the development of new technologies that will strengthen Alberta-based processing companies.
- *Building a Better Canola* —AARI has made substantial investments to address the challenges and opportunities presented by a burgeoning canola industry. Research to modify fatty acid composition (including reduction of saturated fats) and better understand seed oil deposition in the seed will create new ways of producing canola oil that delivers the needs of end-users in the food and energy business. Additional projects on clubroot, fusarium wilt resistance and seedpod weevil will ensure that canola remains a viable cropping option in Alberta.
- *Alberta Poultry Utilization Centre*—The Poultry Research Program consists of a dedicated, interdisciplinary team of scientists who conduct research aimed at benefiting egg and poultry producers and processors in Alberta as well as



nationally and internationally. Our research spans the entire range of the poultry value chain from reproductive efficiency of chicken and turkey breeders, egg incubation and applied embryology, poultry nutrition, and production efficiency and economics to value-added product development, food packaging and safety.

- *Food Safety*—AARI has made investments in basic and applied research to provide a greater understanding of how to overcome diseases and pests that could reduce the quantity and quality of sustainably produced crops and livestock. The Institute has partnered with researchers within the province and beyond (such as the support for vaccine development for key livestock diseases with the Veterinary Infectious Diseases Organization in Saskatchewan) to develop new technologies to ensure efficacious vaccines are developed to mitigate new and emergent micro-organisms that present a significant threat to Alberta's agricultural industry.



## Strategic Context

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Alberta's agriculture and agri-food industry is an integral part of our economy and an important contributor to Alberta's social fabric. The competitiveness of Alberta's agriculture industry is being impacted by numerous factors that are creating an increasingly complex global market. The high costs of energy and fossil fuel-derived input chemicals and the emergence of new, lower cost suppliers, especially in Latin America, have combined to put pressure on the industry's competitive position. Growing global concerns over the contributions of greenhouse gases (GHG), especially CO<sub>2</sub>, to global climate change have created pressures to shift energy supply away from fossil carbon. Additionally, consumers are becoming increasingly health conscious and environmentally aware, seeking more from their food, and examining the relationship between agricultural production and the environment. At the same time, technological advances are creating unprecedented potential for growth.

Circumstances facing agriculture continue to change; this reality poses challenges, but also offers opportunities. Innovations in agriculture will be instrumental in helping Alberta adapt and compete.

## Global Competition

Agriculture the world over has seen dramatic productivity and production increases. Since the 1950s, global food production has increased 250%, outpacing a global population increase of 135% over the same period. For many major commodities, developed countries have continued to expand production while competitors from developing countries, spurred by lower production costs, have entered international markets. For example, the unit cost of oilseeds production in Argentina is less than half that of oilseeds produced in Canada.<sup>2</sup>

Technological change, ranging from increased mechanization of agriculture to advances in biotechnology, has increased the efficiency of world agricultural production and has allowed both existing farm operations to improve their yields and new operations to begin production in areas previously thought to be unsuitable for farming. This increasing global supply has put downward pressure on prices. As a net exporter of agri-food products and the third largest exporter in the world, Canada is significantly impacted by these industry transformations.

This intense competition in the global marketplace (including currency fluctuation) emphasizes the need for the Alberta agriculture sector to pursue and market higher value agricultural products. We have an abundant source of renewable agricultural raw material for value-added food, fibre, industrial products, and fuels.

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<sup>2</sup> Agriculture and Agri-Food Canada (2006), *A Discussion Paper: The Canadian Agriculture and Agri-Food Industry*



## Changes in Consumer Demand

*Industrial Biorefining*—Consumers are showing a preference for purchasing renewable products to reduce pressure on the use of non-renewable resources.

*Sustainable Production*—Consumers above all want safe and nutritious food. After this they want to see minimal usage of chemicals or additives and the food to originate from farming systems that will not result in environmental degradation.

The movement for sustainable agriculture began in the 1930s in Canada, but is recently garnering increased attention, support and acceptance. Not only does sustainable agriculture address many environmental and social concerns, but it offers innovative and economically viable opportunities across the entire food system. Globally, producers and consumers are looking for drought- and disease-resistant crops, inexpensive production systems, and environmentally sound methods that meet high standards for safety and quality.

*Food for Health*—Increasingly, consumers want better quality products and production processes that provide safe and nutritious food. High health care costs have been associated with illness and premature death, which can result from poor diet choices (e.g. heart disease, cancer, stroke, diabetes). Producing healthier foods will provide consumers with the choices that they desire, either to become healthier or at least prevent the development of chronic illnesses. Healthier foods can also help reduce the province's health care costs.

## Energy Challenges

Growing global energy demand, coupled with growing environmental and climate concerns, are driving the need to explore more efficient and renewable energy supplies. As in most countries, Canada's total energy demand is expected to continue to climb. Canada's GHG emissions are also projected to rise. Biorefining projects provide opportunities to build on our existing energy strengths and address these important global issues.



The drivers for biorefining development vary by region. For example, US efforts are led mainly by concerns over energy security, coupled with a strong agricultural lobby. Europe is similarly concerned over energy security, and initial growth in biofuels was also related to support for agriculture; however, the drivers in the EU have shifted somewhat towards more ideological views on reducing environmental impact and sustainability. Other regions such as China, Southeast Asia, and Brazil view biorefining as an opportunity for economic development.

In Canada, biorefining is seen as an opportunity to diversify our economy and address environmental concerns. The federal government has supported this opportunity through:

- \$1.5 billion in funding over 9 years to boost Canada's production of renewable fuels;
- A five-per-cent average renewable content requirement in Canadian transportation fuel by 2010;
- \$200 million toward projects to help farmers construct or expand biofuel production facilities;
- \$10 million of expanded funding to help agricultural producers develop business proposals or undertake feasibility studies to expand biofuels production capacity; and
- \$500 million over 8 years to invest with the private sector in establishing large-scale facilities for the production of next-generation renewable fuels.

Alberta has committed \$239 million over the next five years toward alternate bioenergy. This will help position Alberta as a leader in producing renewable energy from organic materials, producing environmentally friendly products and creating markets and process opportunities for Alberta's agriculture industry. Alberta has significant existing infrastructure in petrochemicals, as well as the capacity for high quality diversified crop production, and the potential to integrate forestry and agricultural fibre processing.

## Technological Advances

Science, the root of agriculture, is evolving at a furious pace. Technological advances are altering the global economy. It's a new business world in which everything is changing, with each new technology or innovation begetting another whole series of possibilities. There is significant opportunity for the agricultural sector to participate in and grow through these advances in technology.



There has been accelerated development of the various techniques and technologies involved in genomics, and notably the fields of metabolomics and nutrigenomics.

Metabolomics provides a detailed description of human pathways and their workings, and is increasingly being used in a variety of health applications including pharmacology, pre-clinical drug trials, toxicology, transplant monitoring, newborn screening and clinical chemistry. Researchers at the University of Alberta have catalogued and characterized 2500 metabolites, 1200 drugs and 3500 food components that can be found in the human body. Further progress in this area will lead to improved disease identification, prognosis and monitoring; insights into drug metabolism and toxicology; linkage between the human metabolome and the human genome; and development of software tools for metabolomics.

Throughout the 20th century, nutritional science focused on finding vitamins and minerals, defining their use and preventing the deficiency diseases that they caused. As the nutrition related health problems of the developed world shifted to overnutrition, obesity and type two diabetes, the focus of modern medicine and of nutritional science changed accordingly. In order to address the increasing incidence of these diet-related-diseases, the role of diet and nutrition has been and continues to be extensively studied. Nutrigenomics focuses on the effect of nutrients on the genome, proteome, and metabolome. Genome Alberta is pursuing a Nutrigenomics Initiative that will investigate how nutrition can optimize and maintain cellular, tissue, organ and whole body homeostasis.



## Areas of Focus

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AARI will continue to set strategic direction for, and recommend investment in, agricultural research that will provide a competitive advantage to the province's agricultural sector. To do so, we will work with our partners to ensure that great ideas can be developed within Alberta that will produce new technologies and innovations for the benefit of the Alberta agricultural sector.

AARI's recommendations to support Alberta's research sectors will be based on a set of criteria:

- Is there a significant market opportunity?
- Does the opportunity build on existing Alberta strengths in innovation?
- Are there unique jurisdictional advantages to develop the idea in Alberta?
- What biological and production issues need to be addressed?
- What regulatory barriers currently inhibit commercial development of the potential technology?

The three strategic areas of focus for agricultural research identified by AARI are:

- 1) **Industrial biorefining**—New technologies and economies of scale are creating exciting opportunities for how the agriculture, forestry and energy sectors use their resources and integrate their efforts to produce the molecules, products and services that will be needed in the next century.
- 2) **Food for health**—AARI can make a difference through supporting the development of technologies that deliver safe, healthy food and food ingredients.
- 3) **Sustainable agriculture systems for crops and livestock**—The biological nature of products and pests, as well as constantly changing market demands, means that there will be a continually-evolving set of new issues that must be addressed if Alberta is to remain globally competitive.



AARI will achieve the goals identified for each of these strategic areas by using tactics within its three key roles to advance agricultural research in Alberta.

## Leading

AARI's strategic plan will only be as good as the sector's environmental scanning capability. Its consultation, networking and gap analyses locally, nationally and internationally will position Alberta as a leader in agricultural innovation.

- Develop an agriculture research, development and deployment strategy for the next 20 years and identify any potential leap-frogging technology to advance innovation in the province;
- Collaborate with Institute boards, other ministries and industry on emerging technologies; and
- Search for global reports on nanotechnology, genomics, and clinical trials on health initiatives and incorporate knowledge at the board level and within strategic planning and research investments.

AARI will also work with industry to determine the greatest innovation needs for the agriculture sector and share these with stakeholders and the research funding community. by:

- Aligning a competitive and robust strategy for biorefining in Alberta;
- Extending Alberta's competitive advantage in primary production to the processing sector through innovative products;
- Engaging the health community to ensure development of innovative products and processing (based on Alberta commodities) as an avenue to promote good health; and
- Advancing agricultural production in the province through innovation in platform technologies such as nanotechnology and genomics.

As the agriculture lead in the province, AARI will ensure performance measures are in place for investment as well as its research community and partners by:

- Developing consensus for and implementing a clear and effective governance structure for Alberta's agricultural research, development and deployment system;
- Ensuring a process for effectively reviewing governance roles of the funding consortium, IFASA and other stakeholder groups; and
- Ensuring funding initiatives have a detailed plan for deployment through extension to producers or commercialization of technology or products.



## Coordinating

AARI's role is to equip industry advocates who will market Alberta with materials and resources to do the job well. AARI will also participate in leading this conversation with various stakeholders. We:

- Lead a collaborative effort to broadcast the impact of innovation in agriculture research throughout the province;
- Commit resources to advocacy and board training on advocacy; and
- Plan and execute a marketing and communications plan, with materials promoting Alberta as a top global location for agricultural research, development and deployment.

## Funding

AARI has participated with all members of the Alberta Funding Consortium to provide the resources to establish significant research initiatives in these areas. Now is the right time to consider where the next set of major investments need to be made, which will contribute to the long-term prosperity of the Alberta agricultural industry. Clarity on long-term priorities will create the opportunity to align the vision and activities of stakeholders within the province across the spectrum of funding agencies, research providers and industry partners. AARI will determine priorities for innovation needed within the sector, and position its funding efforts to get initiatives started. We will:

- Advance innovation in industrial biorefining through seed funding to create momentum and security for co-funders so they see value and commit research investments in priority areas;
- Create a robust proposal for biorefining to be presented as the next accelerator project with the Alberta Ingenuity Fund; and
- Fund innovative programs developed by IFASA and all research institutes relative to AARI's priority areas.

The targets set within each new opportunity will necessitate work to establish baselines on what is currently happening in the agricultural sector. This will require substantial effort in some cases, but will create the opportunity to measure and monitor our success.

## Industrial Biorefining

### The Challenge

*Does it provide diversity in markets and revenue streams?*

The bioeconomy describes all industries and economic sectors that produce, manage or otherwise exploit biological resources (agriculture, forestry, fisheries, textiles and other bio-based industries). Biorefining describes integrated unit operations producing important molecules which go beyond



the traditional processing (threshing, weaving or sawing) of our biological resources. These building blocks can be used directly or developed into transport fuels, heat, electricity, chemicals, materials and food. New technologies and economies of scale are creating exciting opportunities for how the agriculture, forestry and energy sectors use their resources and integrate their efforts to produce the products and services that will be needed in the next century. Biorefining technologies have the capability to enhance current total values anywhere from doubling to a thousand-fold, depending on product value and volumes.

### ***Alberta's strengths***

Biorefining is based on three elements: biological feedstocks (also known as biomass), conversion technologies and product development. Competing jurisdictions throughout the world are pursuing a bioeconomy agenda and finding that they do not have the biomass available to meet their needs (the Netherlands government has stated that, to meet its goals for the use of renewable feedstock to meet its transportation fuel and electricity targets, it will need to import 60-80% of the required biomass). Alberta has a large land base, and a wealth of biomass resources that have provided the basis for our existing agriculture and forest industries. Biorefining presents a growth opportunity for the agricultural sector that cannot be ignored.

Biorefining enterprises would benefit from our existing infrastructure for the energy sector that currently uses hydrocarbons for feedstock and produces multiple fuels and other products. Alberta has already had some success in developing products (such as electricity from Alberta forestry processors) based on by-product streams.

Agriculture has the ability to tailor individual crop characteristics using existing research streams through both genetic and management approaches. Market signals will also drive production of specific crops which are of interest in biorefining applications. Recent investments in this sector include the development of the Alberta Lipid Utilization Program, which has created new polyols with functionality in bioplastic, as well as food, applications. New bioconversion technologies are being developed to create new products such as fire retardant foams from animal co-product protein streams. Alberta's research infrastructure includes capability in fermentation (and other bioconversion technologies) as well as material engineering of bioproducts such as fibreboard. The Integrated Manure Utilization System (IMUS) has been developed to address both environmental and economic opportunities in turning animal manure into electricity, fertilizer and other products.



Alberta has access to the building blocks of a bioeconomy. Stakeholders must parlay Alberta's existing strengths, working with existing and new industry partners, regulatory agencies and consumers, to create new economic opportunities and increased sustainability as industries move toward a zero-waste scenario.

## Food for Health

### The Challenge

*Does it address healthy food for a healthy population?*

In Canada, Europe, the U.S. and Japan it is estimated that over 300 million adults are overweight or obese. Alberta is not immune from what the World Health Organization calls a "global epidemic", with the number of overweight adults more than doubling here since 1985. Awareness of this dangerous and costly trend is causing people here in Alberta, and around the world, to become more health conscious. People are looking for tools to manage their own health and prevent disease. At the same time, scientific and medical researchers know more about the factors that contribute to disease—and nutrition is on the top of the list.

The health sector increasingly recognizes the role food plays in disease prevention and illness attenuation. Population health efforts recognize the importance of affordability, accessibility and consumption of healthier foods. The food industry is attempting to produce products that contribute to an individual's ability to attain health and lifestyle goals. The agricultural sector can make a difference through functional foods, and delivers food ingredients that have been seen as contributing to health (soluble fibre, essential fatty acids) or adding to the problem (trans fats).

AARI will serve as a catalyst to facilitate a conversation between food processors, agri-food researchers, health researchers, farmers and other groups that can have an influence on the successful development of new ideas to reduce obesity. We recognize that the participants will be motivated by differing goals, but the intent is to explore opportunities to align the interests of the various groups to realize a shared vision and outcome.

### **Alberta's strengths**

Food processing industries produced products valued at approximately \$8 billion in 2005. The Government of Alberta invested in the Food Processing Development Centre and the Agrivalue Processing Business Incubator to



enhance the ability of Alberta companies to develop product concepts and grow their businesses.

Investments have been made in several concepts that advance specific health agendas. The CLA Network has investigated the potential for conjugated linoleic acid as a “good trans fat” for a variety of food applications. Lipid research and development has created strong industry-academic linkages to develop new opportunities based on canola oil profile and processing. Research funding has also built substantial expertise in cereal fractionation, with the resulting commercial development of companies. Research has been conducted on a number of possible diversification opportunities represented by plant species that have a potential health benefit (ginseng, rhodiola, anti-oxidant rich berries).

Alberta’s nutritional science capability has played a useful role in linking the opportunities coming from the agricultural sector with healthful applications. The province has made a significant investment in recruiting new scientists to the province to work with industry to develop new meat products, which transcend our usual emphasis on commodity export. New technologies led to the recent announcement by a University of Alberta research team of the first draft of the human metabolome (the full listing of all chemicals and constituents that occur within our bodies, such as amino acids, sugars, fats and cholesterol).

Alberta has a number of initiatives and collaborations underway that are addressing food for health goals. They include the Pulse 2020 and Flax 2015 initiatives, establishment of the Alberta Livestock Genomics Centre, and establishment of the Alberta Oils and Lipids Utilization Centre.



The Government of Alberta is currently developing a Food and Health Innovation Framework, which is designed to increase innovation that allows food, food products and natural health products to improve health outcomes and drive increased economic growth in Alberta's agriculture/food sector. The strategy emphasizes bringing together key members of Alberta communities to test the idea of a new R&D mechanism for developing food products that capture health and economic benefits for the province.

## Sustainable Agriculture Systems

### The Challenge

*Is there economic and environmental sustainability?*

Agriculture has always represented a balance between increased productivity and long-term stewardship of resources. Prosperity in the agricultural sector is interdependent on both environmental and economic sustainability of production systems. New technologies have led to the remarkable growth of yields in the past five decades. Improved livestock and crop genetics have been made available using tools which include classical plant and animal selection, molecular biology and, more recently, the family of genomics, transcriptomics and proteomics (to name but a few of the family of rapidly evolving technologies). Livestock nutrition and management have led to increased performance of individual animals and greater efficiency in producing larger numbers of animals. Breakthroughs in plant nutrition, protection and irrigation have led to the development of fertilizers, herbicides, insecticides, fungicides and water delivery which provide the platform for full expression of a crop's genetic potential. Agricultural engineering has developed new infrastructure and equipment to maximize production capacity (greenhouses, feed handling, intensive livestock operations) and protect soil (reduced tillage seeding systems).

Sustainable agricultural productivity is the platform of new opportunities for the sector, whether the end intent is food, feed or industrial biomass, and each end use will have specific production requirements.



## ***Alberta's strengths***

The importance of agriculture in Alberta has led to significant investments in research. Alberta has been a leader in the development of new animal and plant genetics, plant and animal nutrition, reduced tillage, water management, integrated pest management and diversification of production. Recent investments have been made in efforts to characterize the bovine genome to understand and enhance traits of interest to the industry. The need to shift away from being a commodity supplier was the underlying reason a decision was made to recruit new scientific capacity to enable research on value-added meat products. The Alberta Funding Consortium has provided resources for the research community to address key questions in animal and plant disease and abiotic stresses to ensure that our production base is maintained. New programs such as the Alberta Prion Institute and the Water for Life Strategy are targeted to deal with specific issues that have a direct influence on Alberta's agri-industry.

The research success that has been achieved has led to greatly enhanced productivity, but should not be seen as a one-time investment, which can now be channeled into new areas of enquiry. The biological nature of products and pests, as well as constantly changing market demands, means that there will be a continually-evolving set of new issues that must be addressed if Alberta is to remain globally competitive.

## Summary

Alberta cannot address all of these issues independently, nor can we afford to invest in everything. Alternatively, should we choose to do nothing, we would watch our industry's profits erode as other progressive jurisdictions adapt and flourish in a constantly changing environment. We must make good business decisions for those research investments that will achieve the greatest benefit to Albertans in the future.

What are our options?

- Survey the world science community and examine potential technologies that have value for Alberta;
- Build on our existing industry strengths by making further investments in areas where Alberta will have a competitive advantage in both domestic and international markets; and
- Identify areas of research investment that address new areas of commercial opportunity, which may require recruitment of new research skills, development of new infrastructure and creation of a new market channels.



# Goals

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## **Goal 1**

Increasing Alberta's agricultural sector to respond to new opportunities in industrial biorefining

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### **What it Means**

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Energy is in the headlines. Its availability, cost and use influences geopolitics, economic performance and the environment. A significant proportion of global energy demands (79%) are currently met by non-renewable sources; their value today is based on light captured millions of years ago.

The bioeconomy describes all industries and economic sectors that produce, manage or otherwise exploit biological resources (agriculture, forestry, fisheries, textiles and other bio-based industries). In 2005, Alberta produced 40+ million tonnes of grain and biomass from crops. The forest industry harvested 24 million cubic meters of wood. The total value for crops and forestry was less than \$6 billion.

Biorefining builds on Alberta's energy strengths. Biological feedstocks represent a logical progression to be incorporated into the current energy supply chain. Biogas (produced from animal waste) is identified by pipeline companies as "renewable natural gas". The transferability of skills, expertise and experience currently in Alberta (infrastructure development, energy marketing, financial/investment) will provide the foundation for the province's success in bioeconomy initiatives.

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### **Intermediate Outcomes**

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- More products are made in Alberta using biomass as a feedstock
  - Agricultural industries adopt zero-waste technologies
  - Alberta increases the quantity and quality of its biomass
  - New technologies increase the options for converting biomass to molecules.
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### **Strategies**

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- **Developing new biological feedstocks**
  - **Creating new molecules from biomass through conversion**
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technologies

- **Creating new bioproducts for the marketplace**

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## Major Initiatives

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### 1.1 Biological Feedstocks

AARI has made multiple investments in increased commodity production during its history. The two elements that control this increased productivity are the development of higher biological (or economic) yield potential and reducing the influence of yield limiting elements. The bioeconomy presents opportunities to produce biomass that will have different end-uses beyond food and feed. This will require a different research approach. AARI has recently made an investment in the Canadian Triticale Biorefinery Initiative to develop the crop as a feedstock for western Canada, which addresses opportunities for delivering other traits that will enhance its bioindustrial value. Additional investments could be made in specific crop platforms or technologies (drought tolerance, enhanced biomass from current and new crops), as well as enhanced utilization of livestock industry co-products (manure, processing by-products).

**Target:** Increase Alberta's agricultural biomass production potential by 25%

### 1.2 Bioconversion

The bioeconomy's economic potential will be realized by developing new methods of converting biomass into economic products. We currently use hydrocarbons for many of these products, but bioconversion will require new technologies to break down biomass into its valuable components. Breakthroughs in systems biology will create the potential for designing new enzymes, which will enhance the efficiency of (or replace) other industrial process such as combustion, pyrolysis, gasification or fermentation.

**Target:** Develop three new processes to create value-added products from biomass

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### 1.3 Zero Waste

Agricultural production systems produce co-product streams. These may include animal manure, crop residue and food processing by-products. Technology and economics are creating new opportunities for capturing value of assets that were

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previously viewed as waste. We need to develop the next generation of zero-waste technologies that will create new value for the province's agricultural sector.

**Target:** Develop two new technologies that enhance the value of co-product streams by a multiplier of 20

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## Goal 2

### Creating new opportunities in food for health

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#### What it Means

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Newspapers, magazines, neighbourhood conversations, peer-reviewed journals, national reports, international think tanks—no matter what the source, food is being identified as a key solution to global health issues.

Discoveries of specific components in food that reduce the risk of disease provide an opportunity for the agri-food sector to play a key role in improving the health of Albertans. At the same time, it opens a market for new products. The challenge is to develop a made-in-Alberta mechanism for creating agri-food solutions to health issues.

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#### Intermediate Outcomes

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- Alberta producers market safe products
  - Increased demand for Alberta agricultural products due to safe production practices and nutritional advantages
  - Displacement of global foods and ingredients by Alberta products
  - Increased value-addition of Alberta-grown products
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#### Strategies

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- Develop enhanced technologies for traceability
  - Understand the biology and management of pathogens
  - Support innovation in value-addition
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#### Major Initiatives

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##### 2.1 Natural Health Products (for humans and livestock)

Natural sources can deliver an array of molecules that may have significant health benefits. Traditional medicine is based on the principle of using the functionality of these active ingredients. Companies are focusing on the economic opportunities associated with products that can address specific disease concerns or enhance overall vitality in both humans and animals. Other bioactive molecules can be produced through new crop development or modification of current species that positively influence human and/or animal health.

**Target:** Alberta companies are recognized for the development of products based on molecules developed within living



## 2.2 **Nutrigenomics**

Since the discovery of the function of the double helix, we have believed that our genetic code controlled a substantial portion of factors such as body development, susceptibility to specific disease and mental development. New scientific tools that have become available in the past five years are now showing a clear relationship between how nutrition and gene regulation are linked. There appears to be an opportunity to understand how each individual's genetic makeup can be assessed and to identify what nutritional elements can be used to increase positive results while managing potential problems. The evolving science could lead to practical advice for society to follow Hippocrates' advice to "let food be your medicine".

**Target:** Alberta is acknowledged as a global leader in the development of food products to address the needs of the "personalized medicine" industry.

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## 2.3 **Food Safety/Zoonosis**

Current news events have presented agriculture and the food processing sector as primary sources of human health challenges. The frightening scenario of global pandemic is generally linked to the development of disease which originates in animals and is subsequently transmitted to humans. Outbreaks of food-related illness undermine the confidence that society has in the entire food production chain. The organisms which create these problems must be characterized, and new technologies developed to overcome their potentially devastating results. Innovations must also be developed to allow for rapid traceback to ensure that potentially harmful events are quickly addressed.

**Target:** Alberta companies reduce product callbacks by 50% with immediate data availability for implementing necessary product recovery action

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## **Goal 3**

### **Sustainable production of agriculture products**

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#### **What it Means**

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Sustainable agriculture refers to the ability of a farm to produce food indefinitely, while maintaining or enhancing this vital resource base for the long term, and rests on the principle that we must meet the needs of the present without compromising the ability of future generations to meet their own needs. Two key issues are of prime importance:

- Biophysical (the long-term effects of various practices on soil properties and processes essential for crop productivity); and
- Socio-economic (the long-term ability of farmers to obtain inputs and manage resources such as labour).

Alberta's agricultural success has been based on research investments that enhanced production and reduced risk. Since the first agricultural research station was established by the Government of Canada at Fort Vermilion, new ideas have been developed to give producers access to new methods of increasing the productivity and quality of crops and livestock. Alberta's annual farm cash receipts are usually \$7-9 billion, based on cattle and calf inventories of approximately six million cattle and calves, and a farm land base of 23 million hectares, including 8 million hectares of annual crops.

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#### **Intermediate Outcomes**

- Improved water and nitrogen use efficiency of Alberta crops
- Increased competitiveness of the Alberta livestock industry
- Reduced total energy footprint on Alberta farms
- Enhanced revenue from production co-products

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#### **Strategies**

- Improved small grain genetics for the feed industry
- High, sustainable yields for Alberta oilseed crops
- New technologies to delivery high-value livestock market traits

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#### **Major Initiatives**

##### **3.1 Feed Production**

Alberta's competitiveness in livestock production is being challenged due to increasing feed prices. Other jurisdictions have increased calorie and protein yield per unit area at a rate that has



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eclipsed Alberta feed crops. New technologies must be used to increase the total yield of barley, feed wheat, forage and other potential crops in the province.

**Target:** Increase the energy and protein yields (per unit of land) of feed crops by 50%

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### 3.2 Enhanced Production Systems

How can we sustain increased productivity of our agricultural systems in the face of climate change and other pressures? Some areas of the world are going back to “old answers” such as winter, perennial and intercropping systems to expand and increase yields. New research needs to address how we can maximize the time that crops have to be productive. New technologies for the livestock industry must address increased economic and environmental sustainability.

**Target:** Increase the land equivalent ratio of crop production by 30% (based on current productivity of one crop grown in a single spring-summer-fall cycle) without increasing purchased inputs

Increase the net return per animal by 30%

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### 3.3 Water Efficiency

Alberta walks a tight rope when it comes to water availability for agricultural production and development. Increasing demands of existing water sources, and the potential for reduced future precipitation, encourage the development of new ideas to reduce, re-use or recycle water for agriculture.

**Target:** Increase the productivity of crop and livestock (per unit of water) by 20%

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### 3.4 Energy Reduction

The history of agriculture can be linked to energy intensification. Draught animals, water wheels, inorganic fertilizers—all have increased productivity through the capture of additional energy into the system. The current emphasis on biofuels has potentially reversed the trend of agriculture being a net-user of energy, but there can be no debate about continuing increases in energy costs to primary agriculture, as well as to agri-processing industries. The sector needs to develop new ideas to reduce net energy through reduction of: inorganic fertilizers (increased pulse crop, enhanced use of organic nutrient sources), farm equipment fuel

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use, transportation costs and other innovations.

**Target:** Reduce agricultural sector energy use by 30%

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# Performance Measures

The Alberta Agricultural Research Institute has participated in the development of a logic model, which has identified the resources and business practices that the Institute uses to create the outcomes and impacts that we wish to deliver. The business processes within the logic model address the mandates given to AARI by Government of Alberta legislation. The Institute is working with the Life Sciences Secretariat to identify key measures which will be based on elements of the logic model.

## AARI Logic Model

