

Knowledge Insider

Where business meets opportunity | **Bioeconomy**



Farm Credit Canada
Advancing the business of agriculture

Canada





The evolving bioeconomy

Early production methods

Pre-1700s

- Animals and plants domesticated
- Yogurt and cheeses made with lactic acid bacterial cultures
- Grafting techniques for plant breeding developed by Greeks

Pre-1900s

- Pasteurization and immunization discovered
- The microscope was invented
- Yeast and fermentation used in Canada's first brewery in Quebec City

Biotechnology era

1900 – 1949

- The term "bio-technology" coined by Hungarian agricultural scientist
- The term "genetic engineering" coined by Danish microbiologist
- The first antibiotic, penicillin, discovered

1950 – 1989

- Canola developed by two Canadian scientists using biotechnology
- Petunias became the first whole plant grown from a biotechnology process
- Naturally occurring bacterial enzymes used in Exxon Valdez oil spill cleanup

1990 – 1999

- The term "bioeconomy" coined at the American Association for the Advancement of Science meeting
- Genetically modified organisms (GMOs) introduced
- Some pharmaceutical and agricultural companies merged into life science companies
- Canadian genome project launched
- First genetically engineered potato sold in Canada
- First cloned mammal, Dolly the sheep, created using somatic cell nuclear transfer

Life sciences era

2000 – present

- Full human genome sequenced by Human Genome Project
- Canada ranked fourth in the world for total biotechnology crop coverage
- Biodiesel and ethanol mandates put in place in Canada
- Rice became the first crop to have its genome decoded

This timeline was developed using information from common reference works and the following specialized sources: Agriculture and Agri-Food Canada, BioteCanada, National Research Council, United States Food and Drug Administration.

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Business insight from FCC

Make better decisions with better information. Use Knowledge Insider to help track global shifts and industry trends. For more knowledge that you can use to plan for success in your business, visit www.fcc.ca/learning.

Farm Credit Canada is proud to present Knowledge Insider, a semi-annual publication offering thought-provoking information to producers and other agriculture entrepreneurs. Trends described in this document are supported with facts and figures and examined in the context of what's on the horizon for Canadian agriculture.

Please direct questions and comments to FCC's Customer Service Centre at 1-888-332-3301 or email csc@fcc-fac.ca.

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DEFINITIONS:

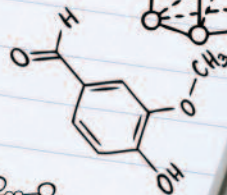
Bioeconomy:

economic activities related to the development and commercialization of products and processes - in whole or in part - using renewable biological sources from agriculture, forestry and marine



Biotechnology:

the manipulation of biological systems through seven component technologies - genetic engineering, cell culture, cell fusion, bioprocess, immobilization, enzyme and bioinformatics - to produce commercial goods and services (from Biotech 101 class in Vancouver)



Life sciences:

the study of living systems or anything connected with living things that uses cross-disciplinary thinking from disciplines such as virology, biology and immunology to develop applications for multiple industries



Hybrid economy:

economic activity that derives value from a mixture of chemistry-based and bio-based products and processes



The changing bioeconomy

The bioeconomy has existed since farmers started breeding plants and animals for selective traits. It continued to evolve as agribusinesses used fertilizers to grow crops and food manufacturers started adding active ingredients such as yeast to processed foods.

Today, there is rising interest in its ability to enhance profitability and productivity through providing sustainable solutions to global issues such as water and food shortages, soil nutrient depletion and the need for affordable products and energy. Your agribusiness is likely already involved in the bioeconomy, whether you produce bioproducts, grow genetically modified (GM) crops, use biological fertilizers or use enzymes to manufacture food.

Both biotechnology and traditional crop breeding have enhanced productivity and increased yields through new products such as drought-resistant crops. Today, resource shortages and rising oil prices are driving the search for bio-based alternatives that reduce dependence on petroleum. Future advances in science and technology will generate more possibilities. As the bioeconomy grows, what role will the agriculture industry play? How will agribusinesses contribute to its growth?

This edition of Knowledge Insider offers insight from industry experts and Canadian agribusiness owners to help broaden your understanding of key considerations for success in the bioeconomy.

In this edition:

- While the term “bioeconomy” was not widely used until the 1990s, the bioeconomy is not new. It has existed since farmers started breeding crops and domesticating animals. Modern uses of biotechnology marked a new era in the bioeconomy, further improving profitability and productivity.
- Interest and activity in the bioeconomy is growing, driven by scientific advances such as the manipulation of genes and the search for sustainable solutions to global resource shortages.
- The economy has always derived value from a hybrid of chemistry-based and bio-based products and processes, with petroleum-based solutions being predominant in recent decades due to the availability of oil.
- Some industry experts suggest that bio-based options will not simply replace petroleum-based ones. Instead, hybrid solutions will continue to be found.
- Factors such as the price of oil, access to capital, the pace of scientific innovation and changing regulations and infrastructure will determine how quickly the bioeconomy grows.
- Agriculture will continue to be a key player in the bioeconomy.

ASK THE EXPERTS – Bob Ingratta



I think algae biorefineries will create bioproducts and bioenergy.

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While humans have used yeast and fermentation to bake bread for thousands of years, modern technologies for thermal processing, cooling and packaging facilitated the move from small bakeries to large-scale, commercial production. The Canadian International Grains Institute works with businesses to innovate new processes in laboratory settings such as the bagel baking facility shown here.



Monitoring trends in a hybrid economy

Economic value has always been derived from a hybrid of chemistry-based and bio-based products and processes. In the past few decades, easy access to oil has made petrochemical solutions generally more profitable than bio-based ones.

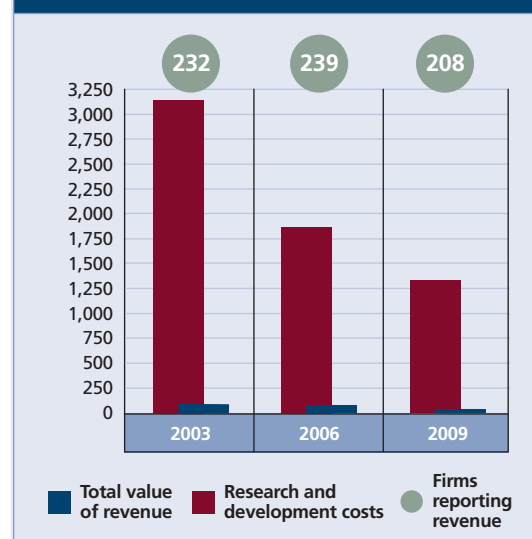
Recent concerns over environmental degradation and shortages of conventional oil, water and food supplies have led to increased awareness of and interest in bio-based solutions.

Controversy has accompanied growth in the bioeconomy. Bans of biotechnology products in the European Union have come from concerns around the need for containment measures to ensure that GM crops and other genetic materials are not transferred to non-GM varieties. Other concerns include public perceptions about the safety of genetically modified organisms (GMOs), their effects on natural ecosystems and the unknown impacts of new technologies. Despite these concerns, the Organisation for Economic Co-operation and Development (OECD) predicts continued growth in the bioeconomy, suggesting that by 2015, biotechnology will be used to produce the majority of new drugs and nearly half of the world's major crops.¹

The findings of Statistics Canada's 2009 Bioproducts Development Survey suggest that the bioeconomy in Canada is in its early stages and continues to adjust, as shown by a decrease in activity and revenue since 2003 (see Figure 1). A report on this survey from the Richard Ivey School of Business points out that the bioproduct industry has been challenged by undeveloped regulations,

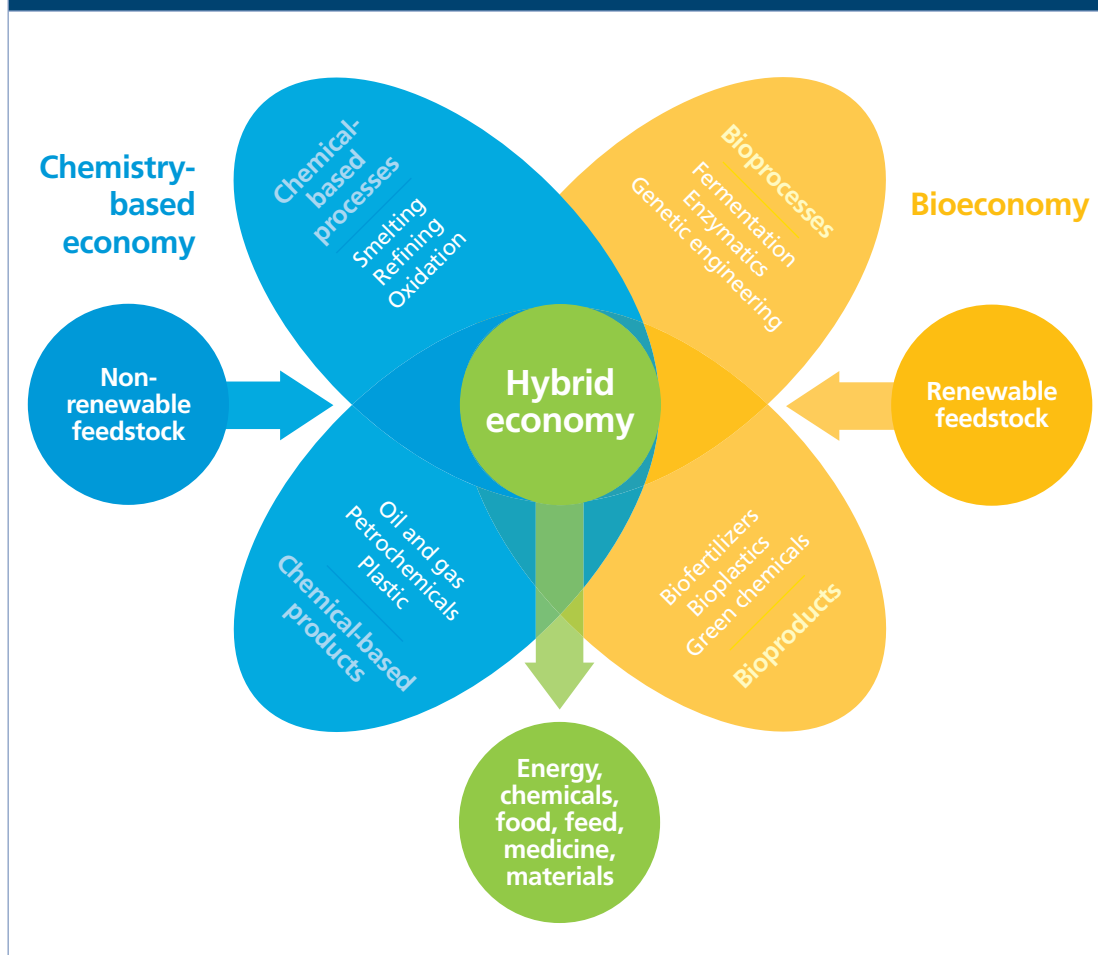
declining research and development expenditure following the 2009 financial crisis, inadequate capital and recent increases in the cost of biomass. BioteCanada's 2011 forecast states, "The question is whether the Canadian industry will emerge from the recent economic turmoil as a smaller but stronger sector and strengthen over time as commercial success continues to be realized."²

Figure 1: Profile of Canada's bioproducts sector (millions CAD)



Adapted with permission from Statistics Canada using data from three separate point-in-time profiles of the Canadian bioproducts sector: the 2003 Bioproducts Development Survey and the 2006 and 2009 Bioproducts Production and Development Surveys.³

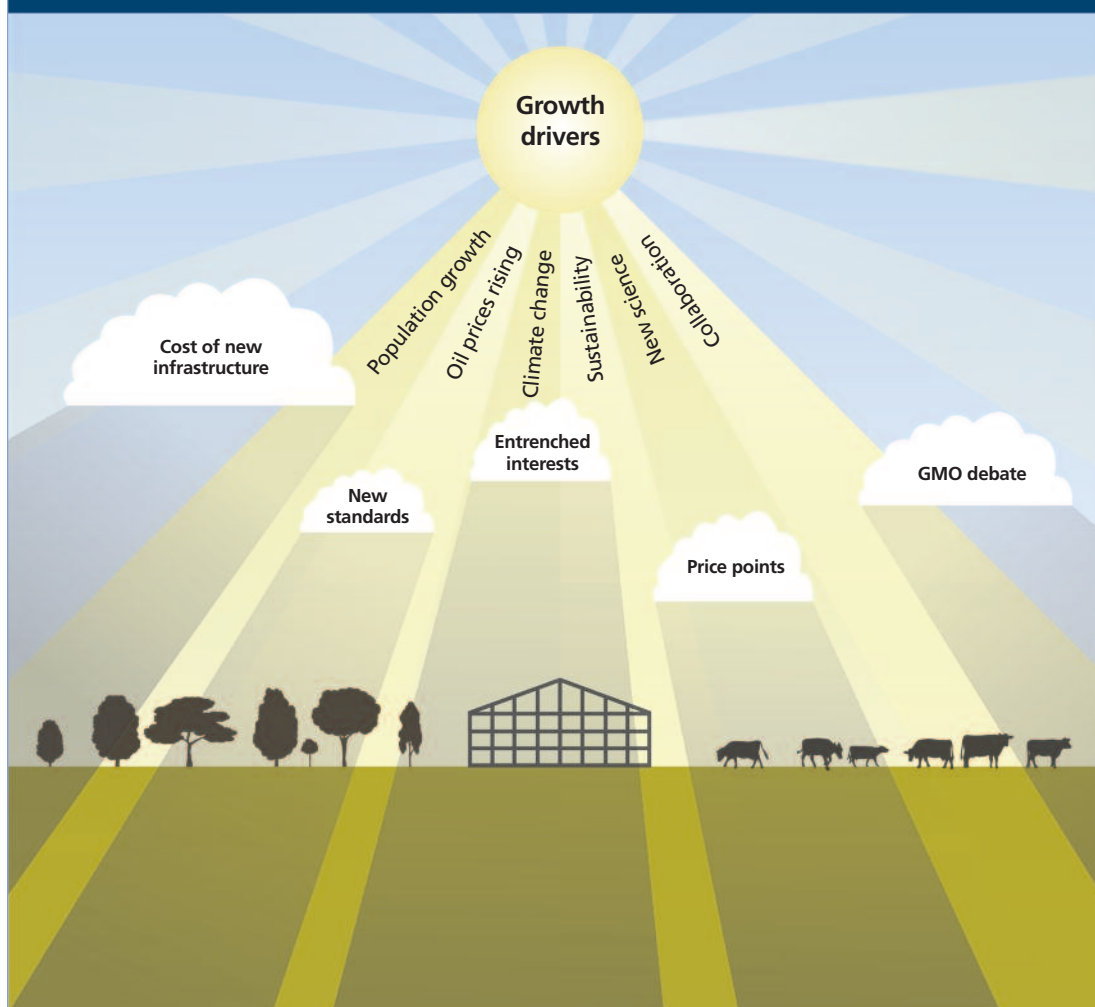
Figure 2: A hybrid of chemistry-based and bio-based options



Some industry experts suggest that options in a hybrid economy, as shown in Figure 2, will help businesses remain profitable and prepare for growth. Paul Barran, Industrial Technology Advisor with the National Research Council Canada's Industrial Research Assistance Program, believes that the economy will grow gradually as a hybrid and remain that way. "A lot of what we can do with biological processes is already transformational, but it's not going to replace everything. Scientists are looking for economically viable biological solutions to problems."

Some hybrid products and processes already offer cost savings by building on existing infrastructure and scientific platforms. Murray McLaughlin, President and CEO of the Sustainable Chemistry Alliance, says that the interaction of chemistry and life sciences integrates the best of both disciplines. "As oil prices continue to rise, we'll see more opportunities for commercialization and the development of a hybrid, bio-based chemistry industry in Canada and elsewhere. Many of the early products will be a blend of petroleum products and green products that create improved

Figure 3: What drives bioeconomy growth and what holds it back?



end products such as foam for car seats that's made of petroleum and soybean oils."

A complex variety of factors drive growth in the bioeconomy or hold it back (see Figure 3). Energy

security concerns may prompt investment in alternative energy sources to help meet growing global energy needs. Regional water scarcity, food shortages and rising prices may push scientists to develop solutions such as new plant and animal traits and irrigation technologies.

ASK THE EXPERTS – Murray McLaughlin



Sustainable rubber offers opportunities for the future.

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You already monitor trends in energy, transportation and globalization to identify opportunities and mitigate risks. What are the risks of not understanding an evolving bioeconomy?



In the bioeconomy, researchers are finding new ways to use renewable sources to create products such as pharmaceuticals, foods, fuel and plastics.

Key considerations

Interviews with industry experts and Canadian agribusiness owners who are finding success in the bioeconomy uncovered five key considerations for your agribusiness:

- 1 Monitor supply and demand**
- 2 Focus on competitiveness**
- 3 Understand changing infrastructure**
- 4 Forge strategic relationships**
- 5 Keep up with scientific advances**

1 Monitor supply and demand

Monitoring supply and demand can help you anticipate and avoid risks associated with developing new bioproducts and bioprocesses. Much can be learned from ethanol plant closures in the United States and early biomass projects in Canada that struggled with inconsistent supply and markets that were not ready for premium-priced bioproducts.

Monitoring how supply and demand interact and connect within value chains can help you make more strategic decisions. Your business may supply products to one partner while requiring supply or feedstock from another. While your value chain ultimately works together to meet end-user demand, it is important to understand how supply and demand at different stages in your value chains vary based on factors such as feedstock availability, price fluctuations and transportation costs. For example, widespread adoption of GM crops could lead to an increase in supply. At the same time, consumer concerns in markets such as the European Union may limit demand for these crops.

Monitor supply

It is critical to ensure a reliable stream of feedstock of consistent quality so that products are ready

when value chain partners need them. According to FCC Senior Agriculture Economist Jean-Philippe Gervais, "There are many challenges on the supply side such as financing and venture capital in agriculture, biomass availability, competing and supporting technologies and the need to be innovative."⁴

A consistent supply of biomass is needed to commercialize a broad range of bioproducts from vaccines to industrial materials and biochemicals. Agriculture and Agri-Food Canada (AAFC) has an interactive, online tool that provides data on Canadian biomass feedstock supply. The Biomass Inventory Mapping and Analysis Tool includes thematic maps that show users the types and amounts of feedstock that are required and available for their processing plants.

Gord Surgeoner, Executive Director of Ontario Agri-Food Technologies, suggests that consistency becomes more important when supplying feedstock to a large company producing for world markets. "Meeting the consistent supply requirement may be different for farmers who are used to markets where they can change their customers on a regular basis."

How would short- or long-term contracts affect your ability to provide a consistent supply to customers or get the supply you need? Do risks created by changing weather patterns, oil price fluctuations and other unforeseen factors affect your ability to provide or access a consistent supply?

Monitor demand

Demand already exists in the bioeconomy for alternative energy, bioproducts that replace traditional products such as plastics, and sustainable processes such as carbon sequestration. Your success depends on a range of variables from consumer readiness to the maturity of scientific platforms and the approval of new

regulations. While consumer interest in purchasing alternatives to petroleum products may be high, purchasing behaviours are driven largely by price. Monitoring trends in demand can help you anticipate possible risks such as consumer concerns linked to trans-species gene transfer and genetic markers.

The winter 2011 Knowledge Insider highlights the investment in time and resources that is often needed to grow an idea from concept to commercialization. By monitoring trends, some

businesses identify future opportunities and invest a decade or more in commercializing new bioproducts. Others are finding short-term opportunities that meet current demand. "In Canada's life sciences sector and to some extent globally, businesses in agriculture and pharmaceuticals are looking for short-term opportunities where markets are already established," Paul Barran explains. "There are existing products that they can benchmark against, which helps with managing risk."



Chatham Biotec uses patented processes to produce active ingredients for pharmaceutical applications, including cancer drugs, from regionally harvested Canada yew, pictured here.

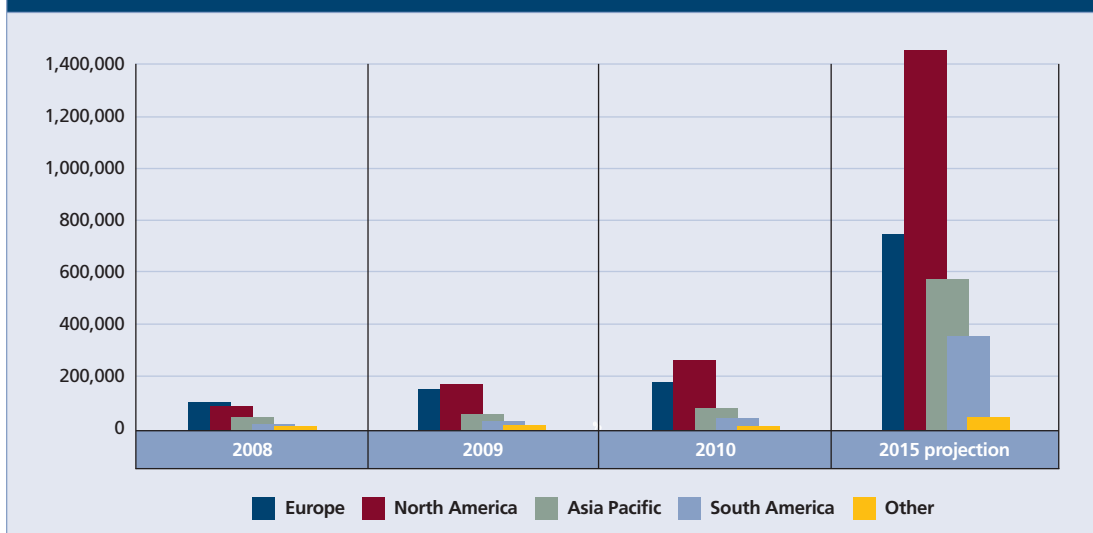
Photo courtesy of Chatham Biotec Ltd.

Making it work – Chatham Biotec Ltd. Chatham, N.B.

Chatham Biotec Ltd. produces active ingredients from North American plants for use in products such as fruit powders, nutraceuticals and pharmaceuticals. Chatham's patents allow it to process the natural ingredients into a value-added format to meet strong demand from the pharmaceutical industry. President Ryan Smith recognizes that this demand is a key reason for

Chatham's success in commercializing an active ingredient from wild Canada yew, also called ground hemlock, to treat cancer. Smith sees future opportunities to meet new demand for extracts from wild Canadian plants that can be sustainably harvested such as wild berries, fiddleheads, mushrooms and salal. "The future involves tailored drugs and customized nutrients. There's a lot of value in matching needs with products, and there are untapped attributes in Canadian wild products."

www.chathambiotec.com

Figure 4: Use of bioplastics by global region, 2008-2015 (metric tons)

Source: BCC Research, 2010

Recent successes in the bioplastics industry may be linked to consumer demand, affordable technology and the rising costs of petroleum-based resins. Figure 4 shows global demand growth forecasts for bioplastics. A 2011 market research report by BCC Research estimates the global market for biodegradable polymers, which are mainly used to make packaging, to be over 900 million pounds in 2011 and forecasts its growth to 2.5 billion pounds by 2016.⁵

Craig Crawford, President and CEO of the Ontario BioAuto Council, is partnering with multinational industrial companies in biotechnology, chemicals and agribusiness to accelerate the commercialization of new technologies, build viable value chains and grow global market demand for bioproducts. "Demand is really driven by the buyer, in this case, the auto sector, which is interested in bio-based materials because of what's happening with oil prices." Crawford explains that rising resin prices have made bio-based plastics a more viable option for controlling costs in recent years. Who could your business work with today or in five years who will help you find profitability through the bioeconomy?

According to Trevor Kloeck, Program Leader with the Alberta Biomaterials Development Centre, demand from Asia and Europe for bioproducts made from forestry and agricultural biomass residues will drive future collaborations between Canada's forestry and agriculture industries. "Hybrid products are most likely in the initial years. They'll help to mitigate some of the risks with variable supplies and performance while we're developing the sector to get to completely bio-based products."

ASK THE EXPERTS – Paul Barran



Nutrigenomics will allow for self-customized diets.

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Consider how consumers, governments, industry groups, value chains and multinational corporations influence supply and demand. Working with your value chain partners, you may find ways to bridge the gap between consumer intentions and purchasing behaviours by adjusting price points or raising awareness about product attributes and environmental impact. How can you

Solegear received the Best Green Business award in 2010 from the Canadian Youth Business Foundation for its work in developing non-toxic, compostable plastics. CEO Toby Reid believes that high-performance engineering and environmental responsibility do not need to be mutually exclusive in the world of specialty materials.



and your industry partners better understand how multinationals influence supply and demand when they set research priorities, influence policy development and analyze consumer trends? Could you meet current demand by selling bioproducts as substitutes for traditional products into existing value chains?

2 Focus on competitiveness

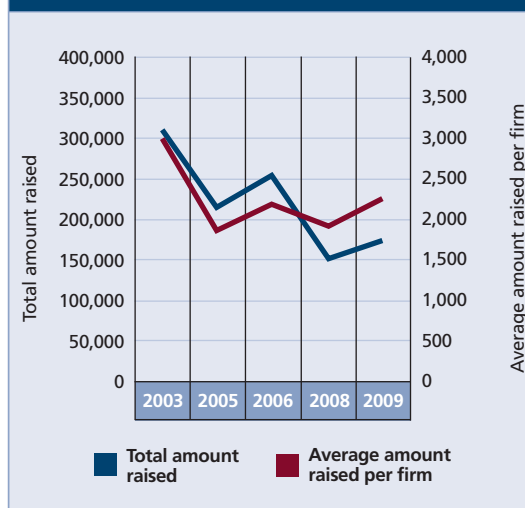
As you focus on remaining profitable in today's competitive marketplace, consider how to best finance your business, monitor changing regulations and ensure cost competitiveness.

Financing your business

To remain competitive, you may need to further finance your business, especially if it is growing or developing new products or processes. Traditional term funding sources may be less accessible than venture capital in the early stages of a growing bioeconomy due to uncertainty or high-risk profiles for new, untested bio-based products and processes. The 2009 Bioproduct Development Survey showed that the average amount of money raised per bioproduct firm in Canada declined between 2006 and 2008 (see Figure 5). David Sparling of the Richard Ivey School of Business co-authored a report that states, "A dwindling number

of funding sources and a strong reliance on government programs has resulted in a thin distribution of funds to a larger pool of companies."⁶

Figure 5: Declining funding in Canada's bioproduct industry (CAD)



Source: Statistics Canada Bioproducts Development Surveys 2003, 2006 and 2009 as cited in "Not enough green in Canada's bioproduct industry," Sparling, Cheney and Cranfield, 2011

Making it work – Solegear Bioplastics Inc. Vancouver, B.C.

Solegear Bioplastics Inc. has developed non-toxic, compostable plastics for making products such as packaging, toys and cosmetics cases. Founder and CEO Toby Reid says he initially looked at the footprint of traditional plastics in the materials industry. "Traditional plastics are made from oil, and many contain chemicals that we wouldn't want our kids to be around. They also require a lot of intense energy to produce." According to Reid, Solegear generated just under \$50,000 in revenue in 2010, its first

commercial year, and forecasts \$500,000 in revenue for 2011. Reid says that as awareness of bioplastics increases, consumers will expect many different bioplastic products in the marketplace. "Hybrids and pure compostables will do well, with more widespread adoption in compostables as the related technologies continue to develop." He believes that demand for Solegear's products will continue to rise as health and safety issues around petroleum-based plastics continue to become better understood and fossil fuel supply and costs become less predictable.

www.solegear.ca

Sixty per cent of respondents to BioteCanada's Canadian Life Sciences Industry survey believe that raising capital will be the most challenging issue for their organizations over the next two years, and 84 per cent believe that the ability to access capital is the top challenge for the Canadian life sciences industry to become a stronger global competitor.⁷

Jeff Schmalz, President of Soy 20/20, sees many future opportunities for value-added, bio-based soybean products, while recognizing that financing barriers must be overcome. "Obstacles such as an inconsistent supply of identity-preserved feedstock, the need for more specialized processing capability and the lack of funding for the bricks and mortar infrastructure are currently holding back this potential."

Sparling suggests that several factors have made financing a significant challenge for developers of Canadian biotechnologies. "The long time to market, which is partly due to regulatory approvals and challenges around intellectual property, has contributed to a dearth of venture capital for the industry." Even when venture capital is available, challenges such as scalability can require unanticipated funding during pre-commercialization, as going from a pilot to full-scale production often requires additional financing.

There is a limited supply of venture capital in Canada for any sector, according to Jim Taylor, a partner with Avrio Ventures – a firm that manages FCC's venture capital investments. "Many investors are still cautious about the return prospects for companies in the bioeconomy as they haven't seen the types of profitable exits common to other sectors. This is beginning to change as successful companies begin to emerge." Since venture capital has not historically funded capital needs for infrastructure, government programs may help fund necessary fixed assets. "Companies could seek venture capital funding and non-traditional strategic relationships with larger players in the sector," Taylor says. "Small companies could find workable partnerships for product testing, sharing research and development costs and initial production runs to help move ideas forward." How can successful bioeconomy

ventures showcase their successes to further raise funder confidence? How can you find out more about what potential investors are looking for? Who could you partner with to expand your possibilities?

Did you know?

Scientific Research and Experimental Development is a federal tax incentive program administered by Canada Revenue Agency that encourages Canadian businesses of all sizes and in all sectors to conduct research and development in Canada.
www.cra-arc.gc.ca/txcrdt/sred-rsde/menu-eng.html

Monitor changing regulations

Innovations in the bioeconomy are already prompting changes in regulations in areas such as labelling, access to health safety data and traceability. In the future, new products could require more stringent certifications to ensure safety or facilitate consumer adoption. Monitoring and anticipating changes in regulations ranging from packaging and processing to employee training and advertising can help you make more strategic decisions.

Regulations may be perceived as barriers when the number of regulatory bodies or a lengthy process slows progress toward commercialization. They may also be seen as enablers of growth when they are perceived as boosting a new industry or clarifying information for consumers. A favourable policy framework can help advance the bioeconomy.

Mavis McRae of Solanyl Biopolymers Inc. in Carberry, Man. suggests that technology has moved faster than regulations in the bioplastics industry, making it challenging for consumers to understand the nuances between biodegradable, bio-based and compostable products. McRae explains that there is currently no standardized way to identify and differentiate biodegradable plastics, which means that petrochemical products that break down into smaller parts are lumped in with biodegradable, bio-based products. "Since there are price

Making it work – Integrated Grain Processors Cooperative Ethanol Inc. Aylmer, Ont.

As President of Integrated Grain Processors Cooperative Ethanol Inc. (IGPC), Jim Grey closely monitors ethanol mandates that are intended to help grow the industry by requiring blenders and refiners to purchase ethanol, thereby expanding ethanol markets. IGPC started when a small group of farmers took advantage of provincial and federal programs to help farmers invest in processing downstream. Since going commercial in 2008, Grey has

helped shape Canada's ethanol policy framework. He sees future bioeconomy opportunities beyond ethanol and plans to diversify into an agriculture processing company that uses bioprocesses to produce new food and industrial products. "All ethanol companies operate in a commoditized market, meaning that one unit of ethanol can be replaced for another. Many companies are looking for what to grow in the future without turning their backs on what got them here, which is fuel." Grey says ethanol mandates are beneficial market access tools that will help advance a more hybrid economy.

www.igpc.ca



IGPC was founded in 2002 by a group of farmers looking to add value to Ontario's agricultural production. The co-operative opened its new facility in Aylmer, Ont., in the fall of 2008.

Photo courtesy of Integrated Grain Processors Cooperative Ethanol Inc.

differences between petroleum-based and bio-based biodegradables, many consumers are confused, don't know that these nuances exist and take the labels at face value. There's still a lot of work to be done to regulate this industry."

Did you know?

The OECD has a Working Group on Harmonisation of Regulatory Oversight in Biotechnology that is aiming to increase efficiency, avoid duplication and reduce trade barriers by ensuring that the type of information used in assessing biosafety and the collection methods for this information are as similar as possible among countries.⁸

Mandates can enable growth in the bioeconomy. By requiring a specified level of biodiesel or ethanol to be blended with diesel or gasoline, they allow early entrants to capture excess profits. Recent mandate examples include the 2010 five per cent federal ethanol mandate, the 2011 two per cent federal biodiesel mandate and various provincial initiatives. Mandates ensure that there will be a market for corn grown for ethanol, for example, whether or not the product is competitively priced compared to petroleum.

Mandates boost some industries. They may also pose risks by creating short-term demand or temporarily affecting prices. Mandates can have unanticipated impacts in value chains, as with the higher feed costs experienced by the livestock industry in response to ethanol mandates. How can you prepare for a future in which ethanol or biodiesel mandates may no longer exist?

Mark Stumborg, Head of Applied Science at AAFC's Research Centre in Swift Current, Sask., points out that Canada is furthering ethanol and biofuel opportunities by developing policies that

link with the forestry sector. "Policies are being developed to provide assistance to the forestry sector as it adapts and moves toward a more economically and environmentally sustainable position. New technology additions and improvements will facilitate the production of value-added chemicals and energy and improve

Making it work – Valbio Canada Inc. Magog, Que.

Valbio Canada Inc. helps farms, municipalities and the agri-food industry produce bioenergy through anaerobic digestion, which converts organic residues from industrial effluents, food processing, municipal solid waste and agricultural biomass into methane-rich biogas. "In addition to producing renewable energy, anaerobic digestion systems provide other benefits such as on-site disposal of organic waste with no outside costs and high-quality fertilizer from the remaining biomass, digestate," says Marc Hubert, Vice-President of Business Development. The company understands the importance of monitoring changing regulations. "We believe it's critical to keep abreast of new regulations and programs to ensure that our projects meet customers' needs," Hubert says. In addition to one on-farm installation in Ontario, Valbio Canada has four installations in operation and three being installed in cheese plants in Quebec. Hubert believes feed-in tariffs are an important support scheme to promote renewable energy. "By guaranteeing the purchase of electricity from renewable sources, feed-in tariff programs increase project revenues and make them more financially attractive. Along with other support programs, feed-in tariffs help accomplish a government objective, which is increasing the amount of renewable energy consumed within the province. They also help renewable energy gain a foothold to compete with established energy sources."

www.valbio.ca

ASK THE EXPERTS – Mark Stumborg



Distributed biorefineries will improve the environmental performance of first-generation biofuels.

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Valbio Canada's anaerobic digestion processes include phytotechnology systems from John Todd Ecological Design, which use plants and micro-organisms to process organic materials that remain in wastewater following methanization.

Making it work – GreenField Ethanol Inc. Varennnes, Que.

Recognizing future opportunities in renewable energy, GreenField Ethanol Inc. strategically positioned and branded itself as a renewable fuel business in the 1980s. Since then, GreenField has grown to have multiple facilities in Ontario, Quebec and the United States, and has become Canada's largest producer of fuel ethanol. President and CEO Robert Gallant knows the risks that come with producing ethanol. "When an agricultural input commodity such as corn is sold in a crude oil, gasoline-driven commodity segment, the market is profitable. Risk management strategies need to be employed to remain profitable when corn prices are high and

gasoline prices are low." Gallant says that risk management programs were critical in GreenField's development. GreenField worked closely with government officials to develop unique and beneficial Canadian programs. The company developed sophisticated risk management and hedging systems internally to maintain profitability today and in the future. Gallant believes that the Canadian government learned from the challenges the United States experienced with its boom in ethanol plant construction in the early 2000s. "Government risk management and support programs help new industries that provide opportunities for the entire value chain so that they can weather the early stages and eventually be able to run on their own."

www.greenfieldethanol.com

the output of conventional forestry products." What other industries could connect with agriculture to create solutions in the bioeconomy? As more bioproducts and bioprocesses are introduced, what new regulations and regulatory bodies will be needed?

According to David McInnes, President and CEO of the Canadian Agri-Food Policy Institute, "Canada can take advantage of the bioeconomy because we're good collaborators. To do so, we need to fully leverage the collaborative potential of our food systems, including value chains and input suppliers, by advancing common objectives. Our research and innovation machine across the country can benefit from new collaborations involving sectors such as agri-food, health and environment." McInnes says that the bioeconomy plays a role in each sector. "Governments can support this by further aligning policies and regulations."

Ensure cost competitiveness

In 2011, FCC conducted a survey on the bioeconomy with 987 producers from the FCC Vision Panel – a 9,000-member research advisory

group representing small to large Canadian producers and agribusinesses across all sectors. Forty-one per cent of respondents identified the challenge of remaining cost competitive as a barrier to involvement in the bioeconomy.⁹

Craig Crawford, President and CEO of the Ontario BioAuto Council, believes that bio-based solutions have the potential to offer efficiencies and cost savings. "If you take industrial biotechnology as an example, you can create a chemical that's either the same as, or similar to, what you get when you take oil out of the ground, but you can do it in fewer processing steps, using less energy, water and waste streams. A lot of these chemicals and resins used to be more expensive when compared to petroleum – the opposite is becoming true today."

While measuring cost competitiveness can be complex, it may prove worthwhile. On its website, California-based Mendel Biotechnology, Inc. points out that biomass yield drives the economics of the bioeconomy, using U.S. metrics to show the importance of measuring yield. "[F]or renewable energy to be commercially viable in a zero-subsidy world, biomass feedstock costs will need to be \$55-\$60 per dry ton [...] to compete with hydrocarbon

In addition to the 600 million litres of fuel ethanol GreenField produces annually, it also produces industrial and beverage alcohol, and distillers grains for use in livestock feed.



fuel sources. In order to achieve these cost targets, energy crop yields will need to be at least 10 dry tons per acre with minimal energy inputs.”¹⁰ What metrics or expert advice could help your business analyze cost competitiveness?

3 Understand changing infrastructure

In the bioeconomy, agribusinesses may need to change existing infrastructure, including systems, equipment, facilities and scientific platforms. Fifty-three per cent of producers surveyed in the 2011 FCC Vision Panel survey identified high costs to change infrastructure as a barrier to entering the bioeconomy.

John Oliver, President of Maple Leaf Bio-Concepts, believes that, along with logistics and financing, the need for new infrastructure is a key barrier to growing the bioeconomy in the near term. “We need to fit bio-based products into existing systems and infrastructure. This includes working with the petroleum and traditional fossil fuel industry.”

In some cases, using current infrastructure can be profitable. Chemical engineers at the University of Massachusetts Amherst have found a way to use existing infrastructure to produce high-volume chemical feedstock, which may reduce or eliminate the need to use fossil fuels to make industrial chemicals such as pesticides and fertilizers. “Thanks to this breakthrough, we can meet the need to make commodity chemical feedstock entirely by processing pyrolysis oils,” Associate Professor George Huber explains. “We’re making the same molecules from biomass that are currently being produced from petroleum, with no infrastructure changes.”¹¹

Cyrille Neron, director of innovation and growth for Quebec’s Coop Fédérée, sees opportunities for short-term gains. “Using existing infrastructure to develop bio-based solutions such as ethanol, biochemicals or green rubber can help businesses find quick wins.”

The case for diversified biorefineries

Biorefineries, which use bioprocesses to create energy, fuels, chemicals and industrial materials, are one type of business model that could support long-term bioeconomy development.

Biorefineries are based on principles such as sustainability, co-location, efficiency and the amalgamation of chemical and biological processes to capture the full value streams of renewable feedstock. Developing a biorefinery model often requires infrastructure changes.

Figure 6: Model of a glucose biorefinery

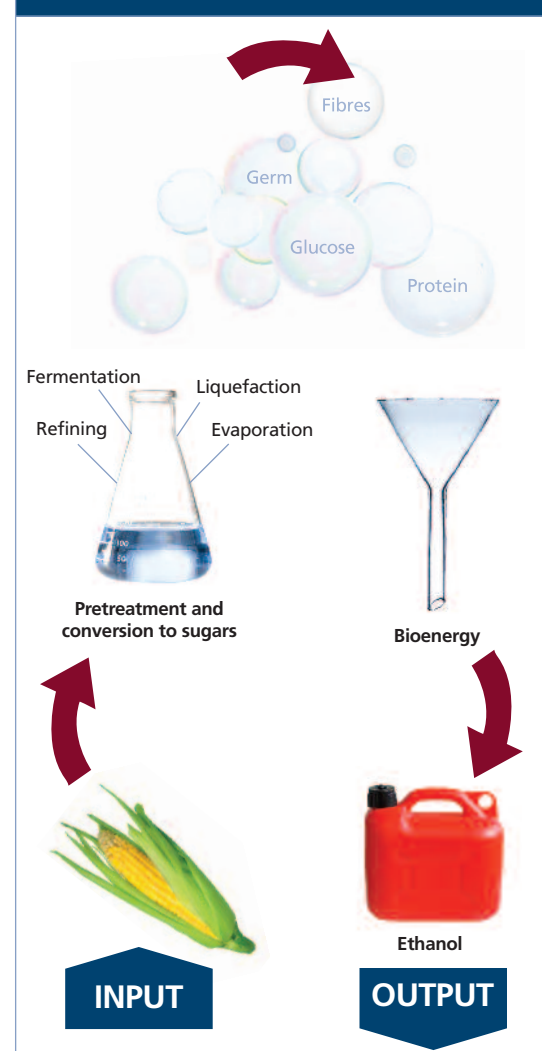
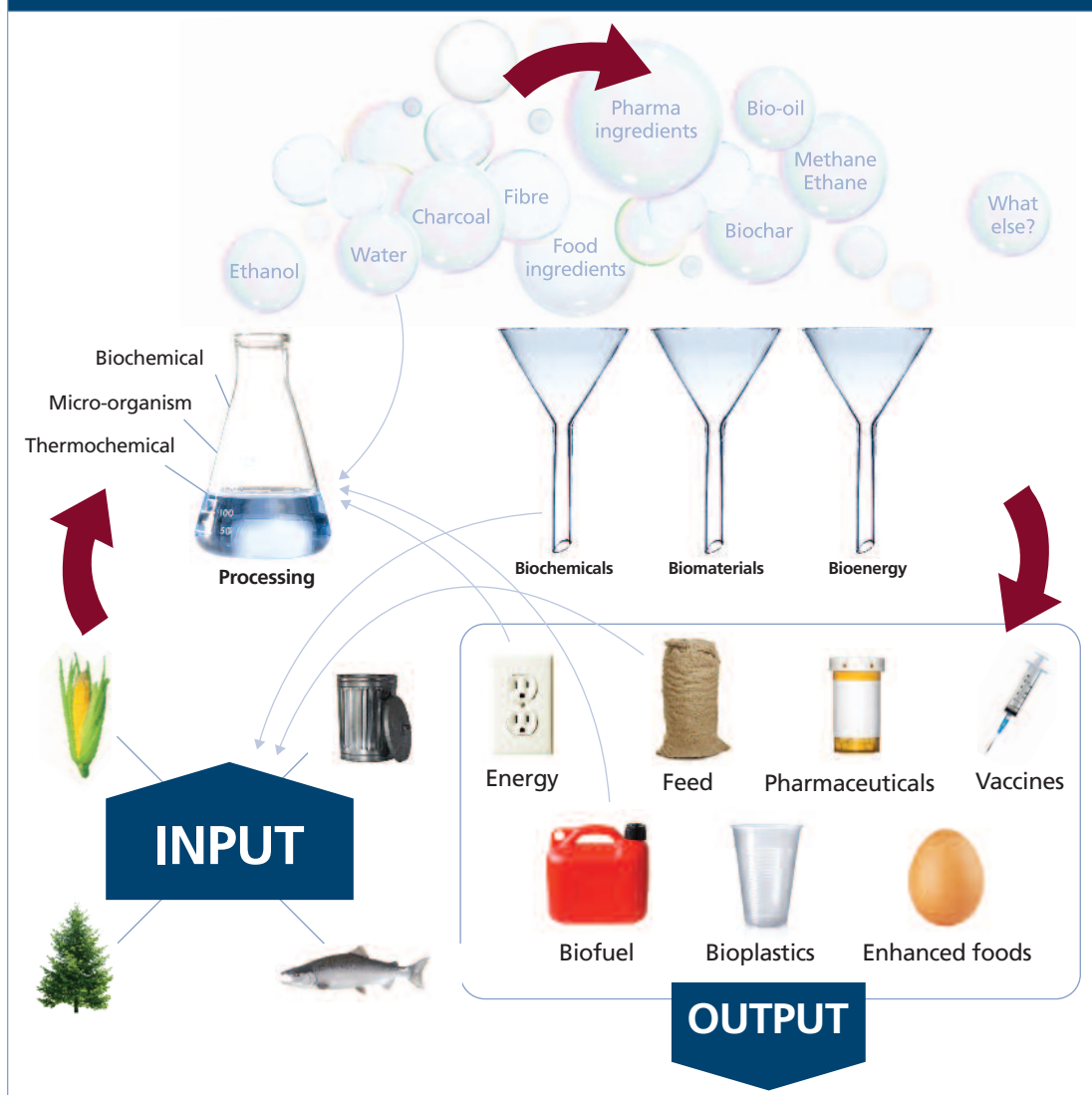


Figure 7: Model of a diversified biorefinery



Many recent biorefinery projects have used a single sugar-based biomass feedstock and a single bioprocess – the fermentation of sugar from biomass – to produce bioproducts such as ethanol and feed grains (see Figure 6 on page 20). In the United States, ethanol biorefineries were initially successful when feedstock prices were low and fuel prices were high. In 2008 and 2009, rising feedstock prices and falling fuel prices resulted in wide-scale bankruptcies in the U.S. ethanol industry.

Diversified biorefineries may address changing market conditions by using multiple feedstock such as biomass, oilseeds, fats, oils and greases to produce multiple bioproducts such as ethanol, biodiesel, butanol, chemicals and feed (see Figure 7). Examples of large-scale, diversified biorefinery projects that emphasize both biopower and biofuel can be seen in Brazil, Georgia, the United Kingdom, the United States, Ghana, Kenya and France.¹²



After visiting poultry farms in the United States, René Gélinas changed his on-farm energy processes to save money. He also sourced an insulated pipe from Denmark to efficiently move heated water between buildings.

Photo courtesy of Ferme Tomchyrs Inc.

Making it work – Ferme Tomchyrs Inc. Saint-Boniface, Que.

On a 2008 business trip to poultry farms in the United States, René Gélinas discovered that production costs were significantly lower than on his operation, Ferme Tomchyrs Inc. With a large portion of his production costs coming from energy, mainly propane, Gélinas researched solar energy and wood pellet stoves. He purchased a wood chip boiler, commonly used in greenhouse operations, that could produce the four million BTUs (British thermal units) required presently and up to 40 million BTUs for future needs.

Tomchyrs saved on propane costs and, as side benefits, its poultry barns now have drier air with more available oxygen and grain can be dried quicker. Gélinas can also reset the boiler and monitor its water temperature, oxygen and carbon dioxide levels from his smartphone. “I believe we have saved two-thirds of our former propane costs. Although the installation was a lot of work, it’s a good step forward. I’m considering a future trip to Europe, starting in France, to find other best practices.” In Gélinas’s opinion, knowledge is key and choosing the right bio-based solution depends on your operational needs and geography.

Stan Blade, CEO of Alberta Innovates, sees efficiencies in the fundamental concepts behind biorefineries. “By taking a feedstock and breaking it down into its component parts, then manipulating it through biological, thermal or chemical processes, Canadian firms are producing molecules that have value as biomass or specialty ingredients. They’re then turned into multiple product streams, including energy, industrial matting or car parts.” Blade also suggests that partnerships between agriculture and forestry present opportunities, as forestry pulp mills have been operating like biorefineries for years.

Could greenhouses offer another biorefinery model? They harness the sun’s energy and use conventional and alternative fuel sources. Some have co-located with other industries to capture their waste as a fuel source. What parts of your operation can be modified, using ideas from the biorefinery models in Figures 6 and 7, to take better advantage of the sun’s energy, reuse waste or otherwise increase your productivity and efficiency?

GreenField Ethanol, featured on page 18, is planning to turn its core ethanol infrastructure into a biorefinery. “One part of the model will gasify the inorganic portion of municipal waste to produce ethanol,” CEO Robert Gallant explains. “The second will use anaerobic digestion to convert the remainder of the municipal waste that can be biodegraded into a natural gas replacement and ethanol if we choose.”

In 2008 and 2009, the World Economic Forum suggested that industrial biorefineries could mitigate climate change impacts while meeting growing demand for energy, chemicals, fuels and materials.¹³ What risks or challenges could hold back the development of biorefineries in Canada? Would a biorefinery model enhance your operation?

4 Forge strategic relationships

Broadening your value chains to include new partners in forestry, plastics, automotive, manufacturing, petrochemicals and other industries could help you find value in the bioeconomy. You may also benefit from working with technical experts within and outside of your industry.

Forging new relationships is one of five key themes of AAFC’s proposed bioproducts strategy. The framework for this strategy was approved in May 2011 and includes four other themes: feedstock availability and quality, technology development and adaptation, public policies and regulation, and market opportunities. Nicole Howe, AAFC Acting Chief of Bioeconomy, encourages agribusinesses to become involved. “Engagement on the next policy framework (Growing Forward 2) is ongoing, and this provides an opportunity for stakeholders to give input on how to support a modern agriculture sector that is innovative and adaptive, including the development of bioproducts.”

Geography is not always a barrier to forming business relationships. To ensure the steady supply of high-quality seed that is needed to create sprouted products such as lentil, flax, berry, omega and chia powder for Saskatchewan’s BioEssential Botanicals, owner Dennis Barker relies on his relationship with a producer in Ontario. Leicht Farms ships the seeds from Spalding, Sask., and BioEssential does the germination and processing in Stirling, Ont.

Bioeconomy clusters in Canada

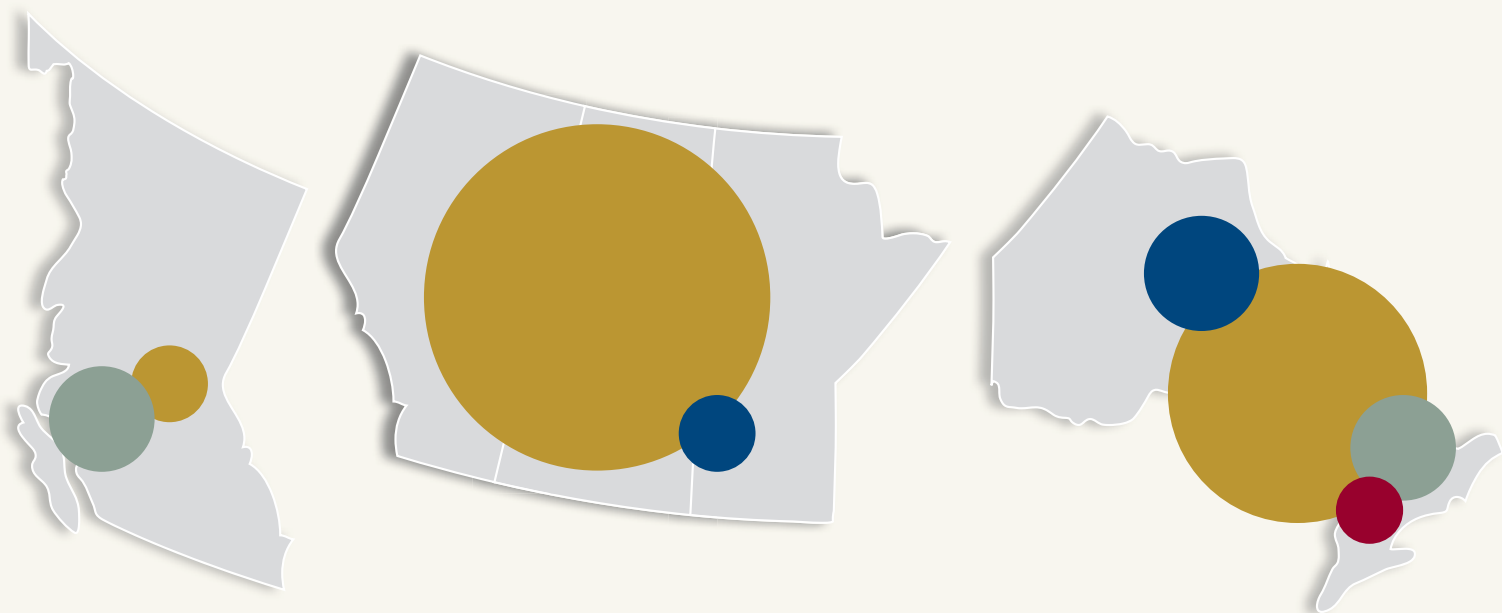
Canadian bioeconomy clusters such as the forestry clusters in British Columbia and Quebec and the auto industry and manufacturing industry in southern Ontario are being developed based on geography and regional industry base. These clusters bring together researchers, funders, businesses, retailers, customers and others.

Agriculture and the bioeconomy

BRITISH COLUMBIA

PRAIRIES

ONTARIO

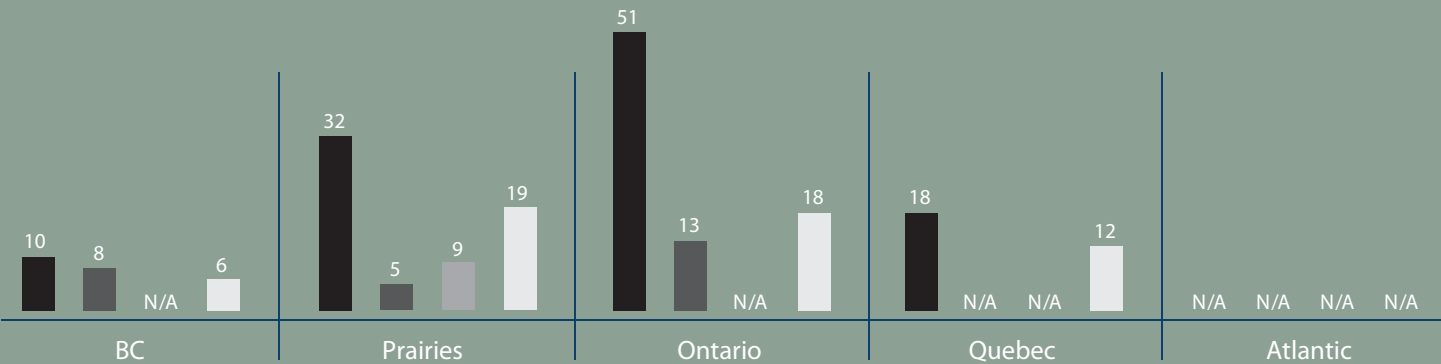


Examples of regional resources

<p>Biomass and Bio Energy Research Group www.biomass.ubc.ca</p> <p>LifeSciences British Columbia www.lifesciencesbc.ca</p> <p>BC Innovation Council www.bccic.ca</p> <p>BC Bioenergy Network www.bcbioenergy.com</p>	<p>Alberta Biomaterials Development Centre www.albertabiomaterials.com</p> <p>Alberta Innovates www.albertainnovates.ca</p> <p>Ag-West Bio www.agwest.sk.ca</p> <p>Go Bio Biofuel and Bioproduct Resources www.go-bio.ca</p>	<p>Life Science Association of Manitoba www.lsam.ca</p> <p>Richardson Centre for Functional Foods and Nutraceuticals (University of Manitoba) www.rcffn.ca</p> <p>Industrial Technology Centre www.itc.mb.ca</p>	<p>University of Guelph Bioproducts www.bioproductsatguelph.ca</p> <p>Ontario Bioproducts www.ontariobioproducts.com</p> <p>Ontario Agri-Food Technologies www.oaft.org</p>
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NUMBER OF FIRMS WITH BIOPRODUCTS (BY TYPE) 2009

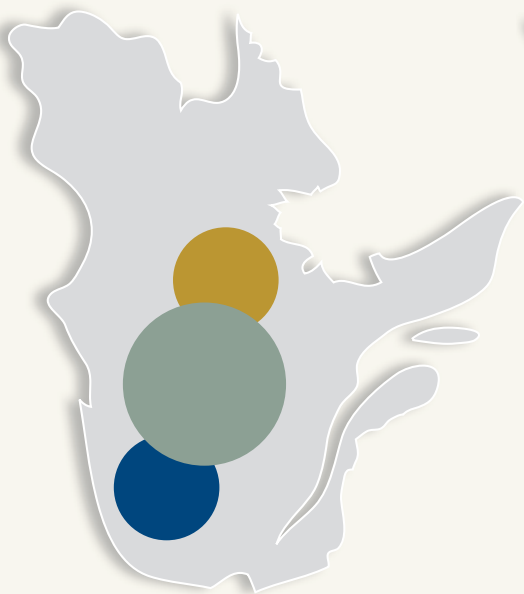
■ Liquid Fuels ■ Organic Chemicals ■ Materials/Composites ■ Other



Note: Bioproducts may be in research and development, proof of concept/product development or on the market.
Source: Adapted from Statistics Canada, Bioproducts production and development survey 2009.

Regional snapshot of Canada

QUEBEC



Le Centre Québécois de Valorisation des
Biotechnologies
www.cqvbc.qc.ca

BIOQuébec
www.bioquebec.com

Research and Development Institute
for the Agri-Environment
www.irda.qc.ca/en/

Centre de développement des bioproduits
www.biopierre.com

ATLANTIC REGION



Atlantic BioVenture Centre
www.atlanticbioventure.com

PEI BioAlliance
www.peibioalliance.com

Bioeconomy Crop Initiative
www.gov.pe.ca/agriculture/bci

BioAtlantech
www.bioatlantech.nb.ca

BioNova
www.bionova.ca

NUMBER OF FIRMS USING BIOMASS (BY TYPE) 2009



Source: Adapted from Statistics Canada, Bioproducts
production and development survey 2009.

ADDITIONAL RESOURCES

Canadian Biomass Innovation Network
www.cbin.gc.ca

Canada's Technology Clusters
www.nrc-cnrc.gc.ca/eng/clusters/index.html

Sustainable Chemistry Alliance
www.suschemalliance.ca

Ontario BioAuto Council
www.bioautocouncil.com

BIOTECCanada
www.biotech.ca

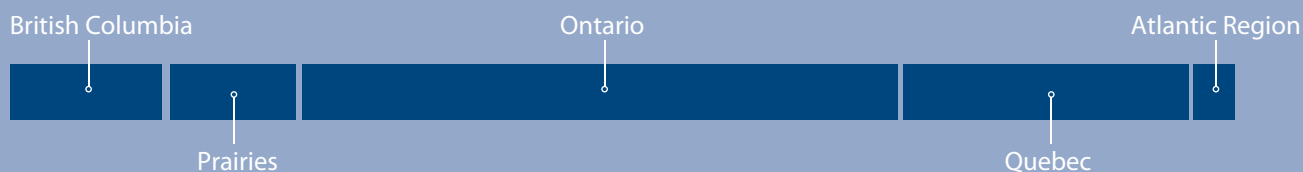
Genome Canada
www.genomecanada.ca/en/centres

Agriculture and Agri-Food Canada
www.agr.gc.ca

CropLife Canada
www.croplife.ca

BIOPRODUCT R&D EXPENDITURES 2009

Bioproduct R&D in Canada \$50,152,000



Source: Statistics Canada, Bioproducts production and development survey 2009

Prepared by: Synthesis Agri-Food Network



Consider what new products will emerge and what existing products will be replaced as the cost of producing bioplastics from renewable resources becomes lower and the science becomes more advanced. Solanyl Biopolymers Inc. already uses bioplastics in diverse applications such as using potato starch to produce these biodegradable clips that hold plant stalks in place.

Photo courtesy of Solanyl Biopolymers Inc.

Federal and provincial organizations such as those featured on pages 24 and 25 are driving the growth of Canadian bioeconomy clusters. They promote innovation, provide funding, attract investment and encourage commercial development in their regions and beyond. Bob Ingratta of LifeSciences BC considers these clusters as knowledge clusters that will be most successful if they include what he calls “market receptors,” which are companies that provide capital, host pilot projects and adopt new technologies.

PEI BioAlliance Inc. co-ordinates the activities of the PEI BioScience Cluster – a group of companies

and research institutions that specialize in bioactive compounds and natural product chemistry, with applications in human, animal and fish health and nutrition. Executive Director Rory Francis explains that PEI BioAlliance partners with companies to successfully move new technologies to market. “As a cluster, we focus on collaborations

ASK THE EXPERTS – Rory Francis



New technologies will minimize water use and carbon footprint.

See page 33

that enable commercialization and revenue growth.” The PEI BioAlliance’s customers include a specialized soybean operation in Ontario, an Edmonton oat extract and cosmetic ingredient company, a specialized oilseed company from North Carolina and a nutraceutical company from India.

Will you forge relationships in your backyard or across the country? Who do you want to be working with in five years that you are not working with today?

5 Keep up with scientific advances

Advances in the life sciences, in particular in genetic manipulation, have opened up myriad possibilities for new bioproducts and bioprocesses. Life sciences applications go beyond biology and

biotechnology applications, including such disciplines as virology and ecology. The bioeconomy already includes new life science solutions such as biologically produced drugs and using photoremediation to treat sewage. Future innovations will require more growth and infrastructure changes and will challenge existing ways of thinking.

The OECD expects three elements to be involved in the emerging bioeconomy: “the use of advanced knowledge of genes and complex cell processes to develop new processes and products, the use of renewable biomass and efficient bioprocesses to support sustainable production, and the integration of biotechnology knowledge and applications across sectors.”¹⁴ Bio-based solutions are being sought to address water shortages,

Making it work – Canadian General-Tower Ltd. Cambridge, Ont.

Canadian General-Tower Ltd. (CGT) has gone from making rubber coverings for wagon wheels in 1863 to rubber-coated fabrics for products such as raincoats to becoming North America’s largest producer of flexible PVC (polyvinyl chloride) films and coated fabrics. Today, it continues to sell seat cover fabric to the automotive industry, using bio-based plasticizers from soybean and castor oil. Patrick Diebel, Vice-President Advanced Technology, explains that science helps CGT retain its competitive edge. “CGT uses science and a creative and innovative spirit to keep from becoming a commodity player and to remain competitive against low-cost, offshore competitors.” CGT started looking at renewable options five years ago in conjunction with an Ontario BioAuto Council program launched to help commercialize products made from renewable resources. With the automobile industry’s dependence on crude oil polymers and plasticizers, CGT anticipated

that the investment in science was worthwhile even with the risks it anticipated. “There are performance risks. For example, if you don’t formulate the product properly, you could get cracked leather,” Diebel notes. “New products need extensive testing, and you need to prove how they’ll perform in five years compared to traditional products. You also have to work with engineers to get the products into the car.” Cost competitiveness was another risk CGT anticipated in entering the bioeconomy. With a 15 to 20 per cent increase in cost when substituting bio-based plasticizers for petroleum-based phthalates, CGT understood that a premium would be passed to consumers. Diebel believes that the price premium will become less of an issue. “At the beginning, we saw bio-based plastics as niche products, but we now see tremendous growth potential. As the cost of oil continues to rise over the next five years, we can reduce the cost of bioplastic materials and gain economies of scale, making our bioproducts cost competitive.”

www.cgtower.com

disease, environmental degradation, the need for increased yields and other issues already being experienced or anticipated in the face of growing, changing populations.

Did you know?

Biosensors in agriculture applications use biological materials such as antibodies, enzymes and micro-organisms to detect allergens and pathogens, monitor quality and freshness, and detect viral, fungal and bacterial diseases and microbial contaminants.

While scientific advances already offer solutions to global issues such as food shortages and health concerns, they also present challenges. Containment measures to help with identity preservation for GM crops could require changes to on-farm production methods. Scaling up from the

research stage to fully operational plants may require additional funding. Patent law and ownership rights of new scientific knowledge can be complex. What role do scientific innovations play in your business's strategic plan? What sources could you tap into to keep up-to-date on the rapidly changing world of science and technology?

Did you know?

In March 2011, the federal government invested \$60 million for 16 applied-research projects run through Genome Canada, including research into cattle and pig populations and creating the next generation of wheat. Possible benefits of this investment will be to further develop Canada's international reputation, help identify threats to forests, improve food safety and help develop new treatments for human and animal diseases.¹⁵

Making it work – BioExx Specialty Proteins Ltd. Saskatoon, Sask.

BioExx Specialty Proteins Ltd. is a technology company focused on the extraction of oil and high-value proteins from canola for global food, beverage and nutrition markets. BioExx employs trade secret, patented and patent-pending technologies that use lower temperatures than conventional oilseed processing to enable the improved separation of proteins from oilseeds such as canola. BioExx believes that its technologies and processes have the potential to make a valuable contribution to global food and protein supply, while maintaining an environmentally sustainable footprint. "There are broad-based concerns with the ability and

capacity of traditional animal protein sources to satisfy the protein demands of a growing world. A high-quality plant protein can provide a compelling alternative to meet this growing need," says Chris Schnarr, BioExx CFO and interim CEO. "We believe that our pioneering efforts and investment position us well in global protein markets. We hope that our work in increasing the food value realized from Canadian canola will also have beneficial impacts throughout the Canadian canola industry." BioExx is currently operating a small commercial-scale canola processing facility in Saskatoon, Sask., and plans to facilitate the development of additional and larger processing plants globally.

www.bioexx.com



Using a patented and proprietary process, BioExx is developing value-added products from oilseeds for cosmetic, healthy food, nutritional beverage and nutraceutical markets.

Final thoughts

Agriculture will continue to play a key role in developing bio-based solutions to sustain human, animal and environmental health. By looking at risks and opportunities today, you can anticipate how to best find value in the bioeconomy and decide how you want to be involved.

Stan Blade, CEO of Alberta Innovates, suggests that public sector support and creative thinking by companies will build a strong bioeconomy in Canada. “While some groups have done well getting research funding with breakthrough ideas, it’s critical to collaborate more fully to fund the full value stream, not just the research process. By

drawing the circle a little bit bigger, we can test and bring innovations into the Canadian marketplace.”

There is no single strategy for success in the changing bioeconomy. Monitoring supply and demand, considering infrastructure needs and keeping up with advances in science can help your business retain a competitive edge. Forging strong relationships in Canada’s growing bioeconomy clusters can help you monitor trends to capitalize on future opportunities. What strategies will help you mitigate risk and forge opportunities as bio-based solutions continue to shape tomorrow’s hybrid economy?

Knowledge Insider

Tips, tools and strategies | **Bioeconomy**

ASK THE EXPERTS

FCC asked Canadian bioeconomy experts about future opportunities in the bioeconomy.



Janice Tranberg
Vice-President, Western Canada
CropLife Canada

1. Increasing production – Scientists are improving the genetic makeup of various crops to produce higher yielding varieties. With the world population expanding and available arable land on the decline, producing more on existing land while using fewer resources is imperative.
2. Improving water-use efficiency – Drought is increasingly becoming a challenge in agriculture and the problem is expected to worsen. In 2025, about 1.8 billion people will be living in water scarcity. Biotech-derived varieties of drought-resistant crops will help significantly reduce the water footprint of agriculture and help farmers grow more crop per drop.
3. Tackling climate change – Improved crop genetics are making it possible for plants to grow and flourish in the fluctuating weather conditions and changing growing seasons brought on by climate change. Ensuring optimum production on existing farmland is critical to the long-term sustainability of agriculture.
4. Meeting energy needs – Agriculture biotechnology stands to play a significant role in meeting the world's energy needs. Crops such as corn, sugar cane and soybeans are currently being used to develop ethanol and biodiesel, while new crops designed specifically for biodiesel production are in development.
5. Addressing demographic shifts – With an aging population and a significant portion of the developing world entering the more affluent middle class, dietary demands are changing globally. Biotechnology is helping create higher yielding grain for animal feed and new varieties of crops with improved nutritional value.



Murray McLaughlin
President and CEO
Sustainable Chemistry Alliance

1. Sustainable rubber
2. New plastics
3. Energy from waste
4. Specialty consumer products
5. Hybrid chemistry

ASK THE EXPERTS



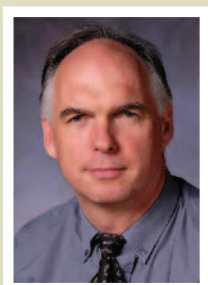
Bob Ingratta
BioEnergy and BioProducts Sector Specialist
LifeSciences BC

1. Biorefineries combining energy and value-added bioproducts
2. Using agricultural waste for renewable products
3. Combining organic and municipal waste from the food industry
4. New agriculture energy production systems using non-food crops systems
5. Using algae biorefineries to create bioproducts and bioenergy



Paul Barran
Industrial Technology Advisor
National Research Council Canada
Industrial Research Assistance Program

1. Nutrigenomics will allow for self-customized diets.
2. Genomics will bring vast improvements to some of the agricultural plants using recombinant technologies instead of GM technology.
3. Ways to replace the need for chemical fertilizers and reduce overall energy requirement to produce them will be found.
4. Uses for animal waste will be developed.
5. Facilities will be co-located to maximize efficiencies.



Rory Francis
Executive Director
PEI BioAlliance Inc.

1. Technologies, including aquaculture, to produce food protein for the world
2. Technologies that reduce water use and carbon footprint in food and biomass production
3. The customization of crop and food animal traits in response to consumer preferences, climate change, pests and manufacturing requirements
4. Products and technologies that can reduce health-care costs and emphasize the prevention of disease and illness
5. Biofuels, though it is still too early to tell which platforms will be successful and competitive

ASK THE EXPERTS



Hervé Bernier

Executive Director

Biopterre – Centre de développement des bioproduits

1. Biomass production for non-food uses: With Quebec having approximately 300,000 hectares of abandoned land, biomass crops could be grown to produce biofuel and industrial fibre and generate energy. Land that is not useful for food production can adequately support less demanding biomass crops such as willows.
2. Environmental protection: In the next 10 years or so, we will no longer be able to dispose of residual organic matter at subsurface containment sites. We will have to identify treatment methods of organic material that are adapted to rural and urban areas. Farms may become partners in recovering the material, as it could be used as fertilizer for bioenergy and agro-industrial crops, among other things. In addition, a variety of incentive programs promote the use of vegetation strips to protect soil and water courses in agricultural areas. Such strips may also be a source of additional revenue, bringing together environmental protection and biomass production.
3. Non-timber forest products: Forests have traditionally been harvested for their wood to produce construction materials and paper pulp. But forests are also home to 500 species of plants – an opportunity for the pharmaceutical, cosmetic, nutraceutical and food industries. Woodlots could provide a diversified source of revenue, as the plants are harvested for use in manufacturing significant value-added products.
4. Bioenergy shortcuts: Municipalities, public utilities and businesses that consume energy are trying to reduce their dependence on oil and are increasingly looking to biomass as an energy source. Rural areas are particularly sensitive to the cost of transporting energy. The concept of producing biomass and biofuel in proximity to users is currently being developed. This shortcut would secure the supply of energy to local users, while boosting economic activity at the regional level. Heating costs for users go down, greenhouse gas emissions are reduced and new revenue is created in the region, since energy payments stay in the region rather than going to oil companies.
5. Molecular farming: The natural health, pharmaceutical and cosmetic product industries use plants in manufacturing their products. Therefore, plants with a high concentration of the molecular complexes used in making such products are in demand. Developing plants that produce biomolecules is another opportunity.

ASK THE EXPERTS



Wilf Keller
President and CEO
Ag-West Bio Inc.

1. Designer food and feed: Nutrigenomics will contribute to the development of food and feed for optimal nutritional health and well-being. Feed will contribute to superior meat, dairy and egg products. Omega-enriched eggs are an early example of how this sector will evolve. Continuous and effective modifications of food and feed products will differentiate Canadian products in a competitive international market.
2. Sustainable crop production systems: Genomics and biotechnology will pave the way for new crop cultivars (sometimes referred to as climate-ready crops) that have increased tolerance to cold, frost, heat, drought and flooding. These technologies will also contribute to the development of crops with enhanced nutrient-use efficiency, reducing input costs for fertilizers and reducing nutrient-based fouling of the environment.
3. Bioindustrial products: Bioindustrial products, particularly bioindustrial vegetable oils, may become sources of high-value products such as lubricants, polymers, plastics and coatings and could enter niche fuel markets such as jet aviation fuel.
4. Bio-based "greening" of the mining and petroleum sectors: Metagenomic technologies (dissecting and managing complex microbial communities through genomic sciences) will play a big role in enhancing oil recovery from existing wells and improving mining processes, and in the remediation of contaminated sites.
5. Advanced diagnostics for improved human, livestock and environmental health: Rapid advances in DNA technologies and biomarkers will allow for effective, quick and cost-effective diagnoses and accurate treatment strategies. For example, in the next decade, we can expect sequencing of the human genome at a cost of \$1,000 or less (sequencing of the first human genome cost more than \$1 billion 10 years ago). This information will play a major role in the prevention and treatment of a range of diseases, including cancer.

ASK THE EXPERTS

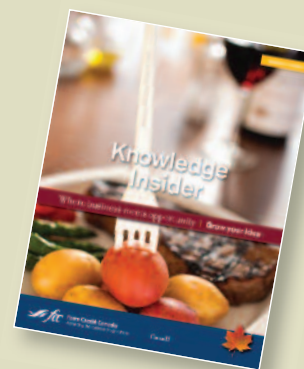


Mark Stumborg

Section Head, Bioproducts and Bioprocesses
Agriculture and Agri-Food Canada

1. **Energy and natural fibre:** With flax or hemp, there is a leftover product (shive or hurd, respectively). This material can be easily combusted, pyrolysed or gasified to produce power, chemicals, heat or a combination of all three. Plastic composites, textiles, fibreglass replacements or structural materials would provide possible markets for the fibre.
2. **Biofuels and chemicals:** When you split second-generation or woody biomass, you end up with three products: hemicellulose, cellulose and lignin. The cellulose can be converted to any fermentation product, including ethanol or biopolymers. The hemicellulose can be similarly treated, often with different microbial organisms and residence times. The lignin, depending upon its purity, has a host of possible chemistries that could be end products. A biorefinery would ideally tailor its output to anticipated economic outcomes to maximize its economic performance.
3. **Distributed processing for thermal conversion to chemicals and energy:** Canada has considerable landscape and biomass that can be sustainably harvested. However, much of our productivity has a low productive density, meaning that the yield on a per area basis is moderate to low. Concentrating the biomass into a value-added product for shipment and upgrading at a central location may make sense. Pyrolysis technologies offer this potential. The resulting products could be converted to energy and chemicals.
4. **Additions to first-generation ethanol and biodiesel fuel production systems:** The co-products from both systems will end up as feedstuff for the beef, dairy, swine and poultry industries, and the manure from all can be used for energy through anaerobic digestion or, potentially, pyrolysis. This type of biorefinery will improve the environmental performance of first-generation biofuels.
5. **Biotechnology applied to output traits:** Whether for food, nutritional improvement or special chemical properties, biotechnologies such as proteomics, transcriptomics and metabolomics can be tied to an output trait specific to end-product quality requirements.

Growing your ideas



Now that you've heard from Canadian experts, you may be considering taking an idea from concept to commercialization. The winter 2011 Knowledge Insider, Grow Your Idea, can help you get started.

List the top five opportunities your business is considering:

1. _____
2. _____
3. _____
4. _____
5. _____



Will you need venture capital financing? Consider this advice from Jim Taylor, a partner with Avrio Ventures.

Attracting investors: best practices

- Look to the marketplace first for possible needs before developing a product. It will not matter how great your product is if nobody has a need for it.
- Ensure that your business is scalable – do not limit yourself to small markets.
- Keep in mind that your business plan must allow for enough growth to generate a return for external investors.
- Diversify your risk – external investors are most interested in companies that have not limited themselves to one channel.
- Expect and plan for an evaluation period by external investors – Avrio takes anywhere from four to 18 months to make a decision on an investment.

Knowledge Insider tools

What you'll find	Web address
Monitor supply and demand	
The George Morris Centre is an independent think-tank that provides industry decision-makers with information on issues affecting the Canadian agri-products sector, including supply and demand and value chain management.	www.georgemorris.org/GMC/Home.aspx
Export Development Canada's foreign market expertise can help businesses monitor supply and demand in export markets.	www.edc.ca
Agriculture and Agri-Food Canada's Biomass Inventory Mapping and Analysis Tool provides information about the biomass feedstock supply, production and harvesting costs, and environmental impacts.	www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1226509218872&lang=eng
Focus on competitiveness	
The Scientific Research and Experimental Development program is a federal tax incentive program administered by the Canada Revenue Agency that gives claimants cash refunds and/or tax credits for their expenditures on eligible research and development work done in Canada.	www.cra-arc.gc.ca/txcrdt/sred-rsde/menu-eng.html
Understand changing infrastructure	
BioteCanada's strategy "The Canadian Blueprint: Beyond Moose and Mountains" focuses on people, capital and the operating environment to capitalize on biotechnology opportunities and builds Canada's competitive edge internationally.	www.biotech.ca/en/policy-matters/beyond-moose-and-mountains.aspx
Forge strategic relationships	
Biotalent is a non-profit national organization that offers human resources tools, information and skills development to ensure that the industry has access to job-ready people.	www.biotalent.ca
CropLife Canada is a trade association representing manufacturers, developers and distributors of plant science innovations such as pest control products and plant biotechnology.	www.croplifecanada.ca

Notes

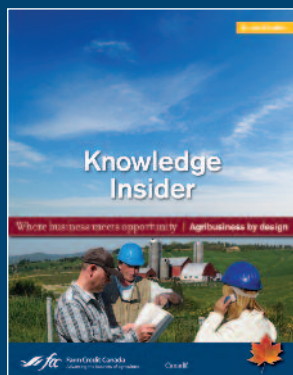
This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Endnotes

- ¹ Organisation for Economic Co-operation and Development, "The bioeconomy is key to tackling many future global challenges, says OECD," June 8, 2009 press release, OECD website, [www.oecd.org/document/12/0,3746,en_2649_37437_42953484_1_1_1_37437,00&en-US\\$_.01DBC.html?wwparam=1315431487](http://www.oecd.org/document/12/0,3746,en_2649_37437_42953484_1_1_1_37437,00&en-US$_.01DBC.html?wwparam=1315431487).
- ² David Sparling, Erin Cheney and John Cranfield, "Not enough green in Canada's bioproduct industry," 2011, p.1, Agri-Food section, Richard Ivey School of Business website, <http://sites.ivey.ca/agri-food/?wwparam=1315432431>; BioteCanada and PricewaterhouseCooper International Limited, "Inflection point: Canadian Life Sciences Industry Forecast 2011," p. 5, PwC website, www.pwc.com/ca/en/pharma-life-sciences/canadian-life-sciences-industry-forecast.jhtml?wwparam=1315431857. "BioteCanada is the national non-profit association dedicated to building the bioeconomy in Canada" (www.biotech.ca).
- ³ Statistics Canada conducted three separate point-in-time profiles of the Canadian bioproducts sector in 2003, 2006 and 2009. The three surveys were not designed to provide a time-series due to changes related to the survey methodologies, to questionnaire content and concept definitions to keep pace with this rapidly evolving sector. While not being recommended, attempts to compare data from these survey iterations should take into account differences in concepts, design and methodology in order to properly interpret the results. For further information on any of the three reference periods, consult the definitions, data sources and methods section for survey number 5073 on the Statistics Canada website. www.statcan.gc.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SDDS=5073&lang=en&db=imdb&adm=8&dis=2
- ⁴ For more insight from Jean-Philippe Gervais on the agricultural economy and other topics see www.fcc.ca/multimedia.
- ⁵ BCC Research, "Biodegradable Polymers - Market Research Report," May 25, 2011, as posted on the companiesandmarkets.com website, www.companiesandmarkets.com/Market-Report/biodegradable-polymers-market-research-report-623880.asp?prk=7c4ed5b510c1ffe12b50d9829eddaba2.
- ⁶ Sparling, Cheney and Cranfield, "Not enough green in Canada's bioproduct industry," p. 24.
- ⁷ BioteCanada and PwC, "Inflection point: Canadian Life Sciences Industry Forecast 2011," p. 6.
- ⁸ Organisation for Economic Co-operation and Development, "Bio-technology Update: Internal Co-ordination Group for Bio-technology (ICGB)," OECD Better Policies for Better Lives, No. 21-31, January 2001, p. 7.
- ⁹ Vision panel respondents were asked to indicate their own involvement in the bioeconomy in an earlier survey question with examples such as growing biotechnology-enhanced crops, using bio-enhanced crop inputs, using biomass to produce bioenergy or using bioprocesses in their operation. A full list of examples is available on request.
- ¹⁰ Mendel Biotechnology, Inc. "Opportunities in the New Bioeconomy," p. 3, Mendelbio website, www.mendelbio.com/bioenergy/opportunities_in_the_new_bioeconomy.pdf.
- ¹¹ "A High-Yield Biomass Alternative to Petroleum for Industrial Chemicals," *Science Daily*, November 26, 2010, www.sciencedaily.com/releases/2010/11/101125202013.htm.
- ¹² Jim Lane, "The Integrated Bio-refinery: the (re)rise of BioPower," *Biofuels Digest*, June 15, 2011, www.biofuelsdigest.com/bdigest/2011/06/15/the-integrated-biorefinery-the-rise-of-biopower/?wwparam=1315455038.
- ¹³ World Economic Forum, *The Future of Industrial Biorefineries*, p. 6, World Economic Forum website, www3.weforum.org/docs/WEF_FutureIndustrialBiorefineries_Report_2010.pdf.
- ¹⁴ Organisation for Economic Co-operation and Development, "The Bioeconomy to 2030: Designing a Policy Agenda," p. 8, International Futures Programme section, OECD website, www.oecd.org/futures/bioeconomy/2030.
- ¹⁵ "Genome Canada investment in applied genomic research strengthens forestry, environment, health and agriculture sectors," March 25, 2011 press release, Genome Canada website, www.genomecanada.ca/en/medias/news.aspx?i=378.



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