
Supporting Cross-Cutting Research: The Agricultural Bioproducts Innovation Program

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I was asked to talk about the Agricultural Bioproducts Innovation Program, which was established in order to coalesce research in Canada on bioproducts. I will begin with background on how that program came into existence.

CANADA'S BIOECONOMY

Canadian interest in the bioeconomy isn't driven primarily by energy-related considerations. Canada is a net energy exporter, producing many forms including hydro, nuclear, oil and natural gas. The main reasons for interest in bioenergy are environmental and social, with the development of rural economies and improvement of farm incomes as desirable outcomes. The Canadian agriculture and agri-food industry is characterized by the production of commodities with very little transformation; participants are largely price-takers. With the emergence of developing economies such as India and China, which have significantly lower labor costs, Canada's competitiveness in commodity markets is at risk. The need to add value to Canadian agricultural products is becoming increasingly obvious.

The federal government has identified a few major priorities, including:

- Human health
- National security
- A strong economy
- The environment

Of these four priorities, agriculture plays a direct and significant role in three. It is recognized that food, which is produced by agriculture, has an important impact on health.

Agriculture is already a strong part of the Canadian economy, responsible for one job in eight. And agricultural practices can make contributions to the environment, for instance in carbon capture. As biofuel development was gaining momentum, the Canadian government recognized the opportunity to have a positive impact on the environment while using technology to develop new markets and enhance the agricultural economy.

At the same time, the government was developing a new *Strategy on Science and Technology*. Research in Canada is conducted mostly in the public sector; the private sector lags behind that in other countries in terms of tangible contribution to R&D. Too little of the knowledge resulting from Canadian R&D is translated into innovative commercial products. Therefore, the *Strategy on Science and Technology* focuses on translating research into innovation by forming multi-partner clusters, including government, universities and industry, to move technologies out into the marketplace.

The government has mandated efforts in renewable energy, with the following targets:

- An annual average renewable content of 5% ethanol in gasoline by 2010 and 2% in diesel fuel and heating oil by 2012.
 - This will require 2.3 billion liters of renewable ethanol, compared to the current 600 million liters.
 - It will require 500 million liters of renewable diesel compared to the current 100 million liters.
- It is estimated that biomass could provide up to 20% of Canada's energy supply by 2030 since the country has:
 - 7% of the world's land area,
 - 10% of the world's forests,
 - 68 million ha of farmland.

AGRICULTURE'S ROLE

The forestry sector is already a strong contributor to biofuels and is in a good position to diversify its bioproduct output. The agricultural industry is interested in increasing its share and decided to step up and be players. However, bioenergy is challenging in the Canadian context. The country has a fairly cool climate and many ecozones with long distances between them. The crops that are being considered as bioenergy sources on a world scale, such as sugar cane and corn, will not be major contributors to Canada's bioenergy portfolio for climatic reasons. Also, the population is small and urban, concentrated in five major cities spread across the country. Transportation between these cities or from production points to urban centers is a major challenge. And, as mentioned, there is relatively little private-sector investment in R&D. Many of the large companies that are players in the Canadian economy are subsidiaries of large multinationals—US- and EU-based—with little R&D performed in Canada.

On the other hand, Canada has the advantage of being a major producer of agricultural crops and forestry biomass. Farming occurs in diverse environments and on various scales.

There are large farms in the western prairie region, but there are also specialized, much smaller-scale farms in the eastern regions particularly in the Maritimes and on the coast in British Columbia. This provides flexibility to meet various markets. In general, the economic and regulatory climates are open to technologies such as genetically modified organisms, which are widely grown. There is general acceptance of the manipulations that are likely to be necessary to achieve a significant bioeconomy. Finally, industries that are important to the economy—automobile, construction, aerospace, *etc.*—are open to the potential improvements that bioproducts could bring.

IMPORTANCE OF CO-PRODUCTS

It is recognized that energy on its own will not be economically viable in most aspects of the Canadian context. Neither ethanol nor biodiesel will provide major economic opportunities for Canadian agriculture; cost of production versus cost of transportation to market make it less competitive than in other countries. Value must accrue from biorefinery co-products. Canadian agricultural industries will need to extract all possible value before using what amounts to the waste stream for energy production. If at least some of the extraction and processing occurs in rural environments, it will provide new employment opportunities in the agricultural sector. The hope is to create high-skill jobs in areas such as engineering in addition to those that will help to keep family farms viable.

At the same time as the federal government was developing its *Strategy on Science and Technology*, Agriculture and Agri-Food Canada's research branch (somewhat analogous to the US Agricultural Research Service) was developing its own *Science and Innovation Strategy* through extensive consultations; seven priority areas were identified for future research:

- Enhancing human health and wellness through food and nutrition, and innovative products
- Enhancing the quality of food and the safety of the food system
- Enhancing security and protection of the food supply
- Enhancing economic benefits for all stakeholders
- Enhancing environmental performance of the agricultural system
- Understanding and conserving Canadian bioresources
- Developing new opportunities for agriculture from bioresources

Developing new opportunities for agriculture from bioresources is, in essence, developing the bioeconomy, *i.e.* making the transition from being a supplier merely of food and feed to a supplier of many value-added products.

In order to get there, the sector will need to innovate in many areas, including the identification of appropriate feedstocks for the climate, and systems for producing feedstocks to the desired standards. High-value multi-use crops will be needed and it would be ideal if they had environmental advantages such as perennial habit and the ability to fix nitrogen. Although that's not necessarily the material that is currently available, research on harvesting and processing technologies must advance.

Work is needed on product diversification and sustainability. For example, a group of researchers has bred lines of oats for particular physical and chemical attributes to facilitate biorefinery processing: hull-less oats that have few hairs are more amenable to separation and are usable, because of their specific chemical composition, in several applications including specialty foods, specialty feeds, cosmetics and cosmeceuticals. But we also need to know how much of a feedstock crop can be removed from the field in order to avoid a negative effect on soil organic matter, and we need to understand the energy inputs that are required to extract the various products. Research on these issues is in progress within Canadian universities and the federal system using various models including flax, triticale, and brassicas.

FOCUSING RESOURCES

It is interesting to compare work being done in the ARS¹ to that being done in Canada with about a tenth of the population. A small economy has to be strategic. Canada must focus its public resources, but also encourage industry to be more of a research contributor and collaborator early in product development. It will have to take advantage of technologies created elsewhere while maintaining capacity for research, in order to remain attractive as a research collaborator.

Canada has developed several collaborative models. For example, the Canadian Biomass Innovation Network involves all of the federal departments that have an interest in biomass and bioenergy. It is led by the Department of Natural Resources, and it provides funding to other departments to carry out research that supports the overall objective of supporting bioenergy development and within the recipient department's mandate. There are other networks of centers of excellence, for example the Green Crop Network, which is comprised mostly of universities that collaborate to create the critical mass and complementary skill set required for larger comprehensive initiatives; the funding supports the networking activities rather than the research itself. In another initiative, the National Research Council (NRC)—a special operating agency of the Department of Industry—has designed a program of research with participation of the Department of Natural Resources and AAFC; it is anticipated that each department will bring its expertise as well as its stakeholders to the same table. The NRC works with the automotive, forestry, construction, *etc.*, industries that are potential users of bioproducts supplied by agriculture and forestry. By bringing these departments and their stakeholders together, we believe we can achieve a better match between the supply and demand sides of research.

ABIP

AAFC developed the Agricultural Bioproducts Innovation Program (ABIP) with the aim of bringing entire value chains together in research, development and commercialization. ABIP's core concept is to develop valuable nontraditional products from agriculture through interdisciplinary research with innovation all along the chain. Eligible areas of focus areas are:

¹Reported by Robert Fireovid, pp. 83–87.

- Better feedstocks—The development of crop platforms and cropping systems relevant to production of raw materials suitable for conversion to bioproducts.
- Better processing—The development of effective and efficient technologies for converting biomass into intermediates that can subsequently be converted into new products and fuel.
- More products—Product diversification through technologies relevant to production of a range of co-products that can increase the feasibility of biorefinery development.

The goal is to encourage the formation of networks that can focus on comprehensive projects. Therefore, ABIP is designed to support projects, portions of which may be carried out within federal government departments and other portions may be done outside of government, in universities or the private sector, according to need. The ability to support work in this range of organizations is unusual because of the rules governing the administration of federal funds. Program administration is, predictably, demanding, but is believed to be worth the effort particularly if we can set successful precedents.

A single call for proposals was issued. Selection criteria were designed to favor projects that were likely to have a transformational impact on the sector. Of course, scientific merit and return on investments were among the evaluation criteria, as was degree of collaboration. More value was placed on networking that was likely to be effective and was likely to ensure that all the pieces were in place to bring the product to market. Consideration was given for the ability to draw industry into the research and to get it sufficiently involved to start taking more of the initiative. Consideration was also given for the likelihood of creating high-skill employment.

A panel of a dozen international experts evaluated about a hundred proposals; because of the size of the networks only a small number could be recommended for funding. Some networks that had common interests joined together to form more comprehensive and robust projects. Some networks will develop bioproduct platforms based on specific crops. Some are developing platforms based on animal products. For some networks, the focus is on developing biobased materials including energy and composites, from various crops. Funding ranges from \$1 million to \$23 million per network, amounting to approximately \$100 million over the next 3 years.

In order to get as much benefit as possible from this program, a twinning exercise was instituted with the European Community where their Seventh Framework Program had identified similar objectives. At a workshop, the principal investigators from ABIP networks got together with those from the EU networks to discuss issues of common interest. In cases where they discovered their overseas counterparts had a particular, useful technology or methodology, networks committed to exchange information, to exchange personnel or use common methodologies. Thus, benefit accrues to both sides through coordination with very small incremental investments.



CHRISTIANE DESLAURIERS'S training and interests are in plant breeding and biotechnology. She has worked within Agriculture and Agri-Food Canada (AAFC) in regulatory, research and management roles. Most recently she has focused on the bioeconomy and on research policy and planning.

Dr. Deslauriers has spent much of her career in Atlantic and Central Canada. She is currently responsible for AAFC's Charlottetown and Saskatoon Research Centres. She is working within a collaborative agreement between the University of Prince Edward Island, the National Research Council's Institute for Nutrisciences and Health and AAFC, developing more effective models for the delivery of cross-cutting multi-disciplinary research.