Investing in Innovation and Commercialization: AAFC's role in preparing for a different agri-food future

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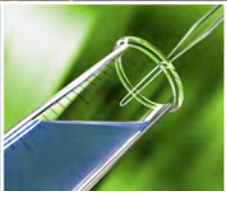

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EXECUTIVE SUMMARY

Innovation, creating economic (or social) value from new ideas and new technologies, is primarily a business activity. Innovation implies taking risks and investing in projects where success is far from certain. Should AAFC invest its funding and policy resources in innovation, particularly beyond the farm gate? A review of the knowledge base on innovation provides compelling reasons why such investments are critical for the future of Canada's agri-food industry, as well as guidance on innovation investments.

Canada's agri-food future will be science based - Canada's agriculture and food industries are entering a new era as the industry expands into health, energy and the environment. Major future developments will be science based, but their economic, social and environmental impacts will depend on how well that science is commercialized and used by Canadian businesses.

Publicly funded research provides significant gains, but investment in innovation goes beyond funding basic research – Investments by governments matter; returns to research are both positive and significant. Future success will depend on a solid foundation of scientific research, but also on support for moving technologies through the pre-commercialization gap and for helping companies scale up and market the products developed from those technologies. These investments are often made into profit-seeking businesses since they are the vehicles for creating economic impact.

Agricultural policy is national, but innovation is regional - Although national policies create the environment in which innovation can either flourish or flounder, innovation tends to be regional and the impact of regional clusters is significant. Proximity to competitors, suppliers and knowledge providers, particularly universities, has a positive impact on innovation and competitiveness. Consequently, programs designed to spur innovation projects are generally best administered at a local/provincial level.

Innovation intermediaries play key roles in creating and supporting innovation networks and knowledge transfer – Networks and collaborations spur innovation and can be supported by innovation intermediaries, government and industry sponsored organizations that connect ideas, technologies, people, businesses and investors.

Much of the innovation will occur beyond the farm gate - Value and opportunities to innovate are shifting up the value chain. Since opportunities for agri-food innovation extend beyond agricultural commodities, investments by governments should as well. Although many benefits are economic, some are public goods – healthier populations, reduced greenhouse gases and improved environment – so public investment is appropriate.

Grants or loans – the choice depends on risk and time – For early stage projects, grants and forgivable/convertible loans allow organizations to take on riskier projects than they might otherwise undertake. Matching grants ensure that the entrepreneur and government share the risk associated with a new technology. For less risky projects, loans are most attractive from a public perspective.

INTRODUCTION

Canada's agriculture and food industries are entering a new era as their role and impact expands beyond food into health, energy and the environment. It is an era where the major developments will be science based, whether they are new biofuels or functional food products, and the ultimate economic and social impact will depend on how that science is employed in Canadian businesses. Agriculture and Agri-Food Canada (AAFC) and its provincial ministry partners have responded to the changing environment by taking a more strategic approach to agri-food policy, one designed to address the pressing issues of the day, but also to act as partners in transforming the industry to prepare for the opportunities and challenges of the future.

This paper considers the factors driving change in the agri-food industry and the possible roles for agri-food policy in the future. It is meant to provoke discussion and priority setting among policy makers, rather than as a prescription for future policy. The paper will address the following questions

1. What changes are occurring and what are the implications to Canada and the industry?
2. How important is innovation to the industry and is there a role for public investment in science and innovation?
3. Should AAFC invest in innovation beyond primary agriculture?
4. What roles can governments play and what kinds of investment should AAFC make in the industry? Should any of those investments be in profit seeking companies?

TRENDS AND IMPLICATIONS

Investment in innovation will occur within the context of the rapidly changing global agri-food industry. The analysis begins in Table 1 below, examining the global drivers of change in the industry and then moving to local issues and implications.

Table 1 The Changing Environment for Canadian Agri-Food Industries

Driver of Change	Implications for Canadian agriculture
Globalization and consolidation	Canada's agri-food industry is competing on a global scale with supply chains that span the globe. Price is only one aspect of competition. The simultaneous consolidation of food retail and distribution means that Canadian farmers and processing companies have fewer options for marketing their products. However, there will be new opportunities to sell both commodities and high-end products in emerging economies, particularly in Asia as incomes rise and protein consumption increases. Consumers are also becoming increasingly concerned with food safety.
Global food demand	Demand is increasing and changing. A global food price crisis created uncertainty over agriculture's ability to feed the world and also meet new obligations in energy and environment.
Global financial crisis and the availability of capital	Canada has always lagged far behind the U.S. in investment in new technologies from both public and private sources. Access to capital for firms commercializing new technologies has been difficult but the recent global financial meltdown has further restricted the availability of capital for financing innovation.
Changing consumer demands	Markets for food products are becoming more segmented on dimensions of health, nutrition, quality, and brand, but also on new dimensions such as organic, local, sustainable, fair trade. There will be more opportunities for companies to differentiate products, particularly processed and manufactured food products.
Food and health	Advances in nutrition science are illuminating the close relationship between the foods we consume and our health. Agriculture and food scientists are working to ensure that the crops and products that Canadian farms and processing firms produce contain more of those healthy ingredients and properties. Their success in developing and commercializing healthier food and nutraceutical products will not only affect the economics and employment in the agricultural and food processing industries, it can also affect health of Canadians and Canadian healthcare expenditures.
Climate change and the bioeconomy	Global warming, concerns over energy and the environment provide dramatic incentives for transforming to a bio-based economy. Agriculture is considered one contributor to the problem, but agricultural biomass is viewed as an important element in the solution. Agriculture can be a larger carbon sink. The industry will also have to adapt to a new warmer and more variable climate.

Environment and Sustainability	Developing sustainable production processes and products throughout the entire agri-food industry will be a high priority in the future. There will be markets for carbon credits and aspects of environmental goods and services.
Energy	Concern over energy availability, security and role of petrochemicals in global warming has created the impetus for moving to alternatives, including biofuels from agricultural and forestry biomass. This also creates new business opportunities for farmers and the need for new specially designed energy crops.
Converging technologies	Nanotechnology, genomics and improved traditional breeding methods dramatically extend biotechnology capabilities to enhance crop productivity and components. They also create new risks and management challenges.
Acceptance of new technologies	There is a need for better understanding of the role of new technologies and consumer response to those technologies. Agricultural biotechnology investment and focus will continue to vary by nation.
Farm income dominates the agricultural policy agenda	Farm income support will continue to be the major expenditure under any policy framework. Risk management programs, while necessary to help farmers stay in business, compensate for past performance. Since they are backward looking, they reinforce past behavior and, because they apply only to select major commodities, they can slow change and adoption of new opportunities. Investment in risk management is not an investment in developing a more profitable and sustainable future for farmers.
Importance of food processing	A significant percentage of farm production is processed before it is sold or exported (ie. 70% in Ontario). A healthy processing sector is vital to the prosperity of farmers and rural communities, but processing makes a major economic contribution to Canada's economy. The recent recession has made it even more apparent how important a diversified and somewhat recession proof industry is to the country. Canada's food processing industry is lagging behind competitors in terms of productivity growth, reducing its competitiveness.
Interest in local food	Although the industry is becoming more global, many consumers are looking for local solutions to their concerns over food quality and nutrition and the impact of the industry on the environment.

THE FUTURE OF CANADA'S AGRI-FOOD INDUSTRY

The global trends make several facts evident when looking to the future.

- The agri-food future will be science based. Not only is scientific change inevitable, the rate and impact of scientific change will continue to increase.
- Innovation and the ability to adapt to changing technologies, climate, consumer demand and competitive environments will be critical to success.
- Competition will be global but competitive responses and solutions will often be local.

- Competition will be between value chains. The value captured in the industry is shifting further up those chains. The opportunities for the agri-food investment in innovation extend far beyond agricultural commodities, so investments by government programs should as well.
- Food and bio-processing capabilities will be essential components of the industry's future success.
- To realize its full potential, the agri-food industry will need partnerships with new industries and new types of organizations, from medical to automotive.
- Some of the benefits from investment in the agri-food industry are public goods – healthier populations, reduced greenhouse gases and improved environment – so public investment is appropriate to create and capture those public benefits. While governments recognize this value, the current emphasis at every level appears to be on innovations that will create economic activity and employment for Canadians.

INNOVATION, COMPETITIVENESS AND GOVERNMENT INVESTMENT

Innovation in products, processes, relationships and organizations will be necessary for the industry to thrive in a very different and rapidly changing future. However, innovation is primarily a business activity, creating economic (or social) value from new ideas and new technologies. Is there a role for governments? Is that role necessary? A number of conclusions may be drawn from the literature about the role of governments in innovation and competitiveness in Canada's agri-food industry.

1. Publicly funded research provides significant gains

The importance of public support for R&D is well documented and supported (for a review see, for example, Goldstein 2006). According to Goldstein "*The basic argument for public support of R&D is that innovation is a critical factor for growth…, but a well functioning market economy cannot generate by itself the optimal levels of R&D. There are two main sources of market failure with respect to R&D5: (1) partial appropriability (due to spillovers), which does not allow inventors to capture all the benefits of their invention, and (2) information asymmetries, for example, the difference between the information that an inventor looking for financing has about an invention and the information that the potential financier has, which leads to a 'funding gap.' "*[1] Some form of public support for R&D is vital.

In their review of the literature on returns to basic research, Salter and Martin (2001) conclude that publicly funded basic research has major economic benefits either directly or through spillovers, and there are local effects in the impacts. They also conclude that "no nation can 'free-ride' on the world scientific system". Returns to research come only to those countries which invest in research.

Basic research provides an essential foundation for innovation, but creating value from new technologies and ideas, is not built purely on scientific discovery. It has to be based applying new ideas and scientific discoveries to improve the profitability of the agri-food industry and its impact on the economy and population of Canada. The role of government and public institutions in the innovation process has changed. For example, a recent study of award-winning U.S. innovations had two key findings. First, collaborations matter - the proportion of innovations coming from firms acting alone has decreased, while the proportion developed as a result of collaborations with spin-offs from universities or government laboratories has increased. The flow of intellectual property from universities to industries has increased dramatically (Narin, 1997). Innovation has become more collaborative because technology life cycles are shrinking, the complexity of emerging technologies is beyond the internal

[1] Goldstein et al. 2006 page 8.

R&D capabilities of even the largest firms and R&D capacity is expanding and becoming more dispersed across industries (Tassey 2007).

Their second finding was that the number of innovations that are federally funded has increased (Block and Keller, 2008). They found that federal funding is particularly important for small to medium-sized enterprises (SMEs). The number of award winners from SME's increased dramatically after the introduction of the Small Business Innovation Research program – from 4% of winners in 1984 to 20%-25% in 2002-2006. (Block and Keller, 2008).

2. Investment in innovation goes beyond funding basic research and into the private sector

Creating economic success from investments in research and development requires looking beyond basic research and investing in more applied development research, funding for pre-commercialization activities and investments in commercializing the new technologies. Many of these investments must be made into profit-seeking businesses, since these are the organizations that will ultimately create the economic impact. The so-called pre-commercialization gap between basic research and early-stage products in private or public companies is significant. Many promising technology opportunities are lost in the gap between university research labs and successful business products (Gitelman, 2005). This stage is too early for venture capital, too risky for lending institutions, too far along the development continuum for basic research funding and too expensive for university researchers. Angel investors fill part of the gap, but the level of funding is far too low to fully exploit the promising technologies.

However, once a commercial product has been created, businesses require considerable funding for production scale-up and marketing related to the new products. Lack of capital has been consistently identified as one of the top obstacles to innovation in Canada (Van Dusen, 2009, Sparling et al., 2006).

In a study of university start-ups, Cooper found that spin-offs that had received government funding through the Industrial Research Assistance Program (IRAP) had outperformed non-IRAP funded spin-offs in both employment and sales. This could be attributed partly to the funding support. Cooper concluded that the higher rates of success did not appear to be a result of the IRAP screening process.

3. Innovation intermediaries play key roles in creating and supporting innovation networks and knowledge transfer activities

In recent years, there has been a rise in the use of innovation intermediaries, who provide networking and knowledge transfer services to the agri-food industry. These organizations play many roles in connecting researchers, businesses and finance (Van Dusen 2009). While there is evidence that these intermediaries create value, they have challenges extracting that value for their role in the innovation process. The experience in the Netherlands points to the best approach being to support these intermediaries through government funding so that they can focus on building networks and helping connect new opportunities and organizations (Klerkex 2008).

4. Agricultural policy is national but innovation is regional.

Although national innovation systems create the environment in which innovation can either flourish or flounder, innovation tends to be regional and the impact of regional clusters is significant. Proximity to competitors, suppliers and knowledge providers, particularly universities, has been repeatedly shown to have a positive impact on innovation and competitiveness (Branscomb 2002 or see Salter 2001 for an extensive review). Garrett-Jones (2004) noted that there has been a "*strong rebirth of regionalism (at least at the State level) as far as government support for science, technology and knowledge-based industries in Australia is concerned.*"[2]

[2] Garrett-Jones (2004) page 14.

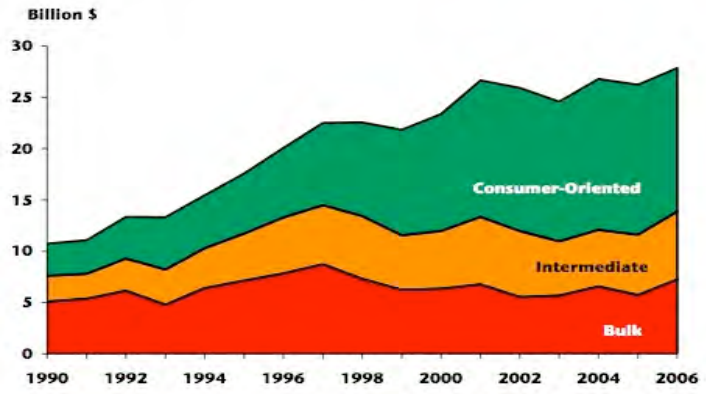
The regional nature of innovation, combined with the inherent regional differences of agri-food production across Canada, has implications for implementing innovation related policies and programs. Programs designed to create an environment conducive to innovation, such as research and development tax credits and science policy, should be delivered at a national level. However, to achieve maximum impact, programs designed to spur individual innovation and commercialization projects should be administered at a local level. Proposed changes to the delivery ACAAF programs are a disturbing reversal of previous attempts to encourage regional innovation through programs administered at a provincial level with significant industry involvement. The concept that individual agri-food innovation initiatives will be best promoted through programs where decisions are made through a bureaucracy administered nationally, runs counter to most literature on the importance of dynamic regional innovation.

Innovation implies taking risks and investing in projects where success is far from certain. As Rosa and Rose report "*sometimes failures are a necessary evil, causing firms to grow and learn regarding commercialization.*"[3] Will AAFC personnel really be prepared to invest in projects that have a chance of failure? Do they have sufficient local knowledge to make the best decisions on local innovation projects? There is an impression in the industry that AAFC has become more risk averse in recent years rather than more open to taking risks and facing possible failure.

5. Much of the innovation will occur beyond the farm gate

Value and opportunities to innovate are shifting up the value chain. By their very nature, commodity products have limited capacity for innovation or value added. Value is added by processing, supplementing, packaging, and distributing products in local or foreign markets. These are the areas where opportunities to innovate abound, and where many Canadian companies are making their mark. Over the years, there has been a steady shift in value from farm level to processing and distribution. This is reflected in the significant shift in trade from raw commodities to semi-processed and processed products (Figure 1) – more of the value is created and retained in Canada.

Chart B2.3
Canadian Agriculture and Agri-Food Export Sales (BICO), 1990-2006



Source: Statistics Canada and AAFC calculations.

[3] Rosa (2007) page 22.

Productivity gains in agriculture have resulted in a steady decrease in employment in the sector. Since the land base is shrinking, the long term trend toward lower employment in agriculture will continue. Further employment gains will come from new developments in industries that use the products from Canadian farms - in food processing, biofuels and bioproducts. For example, Canadian employment in food processing grew by 2/3 between 1990 and 2003. In 2006, Canada's food processing employed about 268,000 people with sales of $68 B. The beverage industry employed another 32,000 with sales of $10B[4].

At every level of Canada's agri-food chains there has been recognition of the need for closer relationships between retail and food service, food processing and agriculture to drive innovation and competitiveness.

WHAT ROLES CAN GOVERNMENTS PLAY AND HOW CAN THEY INVEST RESOURCES?

Discussions of the role of government often begin with the question of whether governments should be involved at all. If there are benefits to research, commercialization and innovation then markets should dictate whether and how those investments are made. Proponents of this view also argue that governments are notoriously bad at picking winners and the costs of reporting are too high.

There is a great deal of evidence that, with respect to investing in research and commercialization, there are market failures that make government investment necessary. Investments by governments do matter, particularly in the areas of science and technology. Studies of the returns to research point out clearly that returns are both positive and significant. OECD studies, in particular, repeatedly point to value of investment in science and technology.

However, investments by governments should match the opportunities. Canada's agricultural policy framework provides vehicles for investing in the industry. With the array of opportunities facing the agri-food industry - everything from food, health, energy, bioproducts and the environment - it seems difficult to justify committing only a small percentage of total expenditure to innovation. The industry's future depends on its ability to develop new ideas, technologies and products, efficiently and effectively.

There are several ways in which AAFC can make investments to support innovation in the agri-food sector and along agri-food value chains.

1. Supporting basic research in the entire range of agriculture, food and bioeconomy research
2. Supporting engineering research into new bio-processing technologies and into new Canadian products and technologies
3. Investing in proof of principle studies and early stage development of new products and technologies
4. Information, market intelligence and research – analyzing and understanding the implications of industry trends and statistics, assessing new industry directions and the implications for future innovation and research
5. Investing in productivity, new production methods and new business models

[4] http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1171288446081

6. Investing in the formation of both knowledge networks and value chains to help the adoption of new ideas and technologies and creating the infrastructure to fully develop new market opportunities
7. Investing in the intermediary organizations needed for knowledge transfer and network formation
8. Creating supportive policy/regulatory environments
9. Investing in dissemination projects to spread the lessons learned from earlier work

Grants or loans – What's best?

When considering funding commercialization activities, particularly for profit-seeking companies, there is often a question about whether the appropriate model is to fund though repayable loans or through grants. The ultimate answer depends on the program objectives and the riskiness of the projects funded. Loans are often viewed as most attractive and fair from a public perspective. If a project is successful, the organization will be in a position to repay the loan and the public will receive economic and possibly social benefits in return for some interest forsaken for the period of the project. If repayment is mandatory, then the level of risk increases for the entrepreneur and they are less likely to take on risky projects. Forgivable loans or loans that can convert to grants, on the other hand, allow organizations to take on riskier early stage projects than they might otherwise engage in. While the ultimate returns are uncertain, the grants may allow risky technologies to be developed to the point where other investors, or government loan programs, may be prepared to invest, and where companies are confident enough in their projects to take on a loan or equity investment to continue developing and marketing a product. Matching grants ensure that the entrepreneur and government share the risk associated with commercializing new technologies.

CONCLUSIONS

Innovation will be a vital to the agri-food industry as it expands the scope of its activities and its impact on health, energy and the environment. That innovation will be driven by changing consumer demand and societal expectations at one end and by scientific advances at the other. A supportive policy and regulatory environment and investments by AAFC and provincial governments are essential factors supporting that innovation. Those investments need to be along the entire knowledge and value chain, from basic research to supporting investments in innovative but risky new products, in new technologies and productivity and in the intermediaries supporting innovation. The report highlights several key implications for innovation and commercialization policy for Canada's agri-food industry.

- **Canada's agri-food future will be science based**
- **Publicly funded research provides significant gains, but investment in innovation goes beyond funding basic research**
- **Agricultural policy is national, but innovation is regional – policy should support regional flexibility**
- **Innovation intermediaries play key roles in creating and supporting innovation networks and knowledge transfer**
- **Much of the innovation will occur beyond the farm gate**
- **Grants or loans – the choice depends on risk and time**

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