CAIRN

The Canadian Agricultural Innovation Research Network

2005/2006 Annual Report

Forward

The 2005/06 fiscal year was a busy and productive year for the CAIRN. The network initiated seven collaborative graduate student based research projects dealing with innovation in the agri-food sector. This research effort was further leveraged through ongoing research of network members and the development proposals of several synergistic projects funded from other sources.

Fostering innovation in the agricultural sector has become a prominent goal for the private firms, industry groups and virtually all levels of government, creating a large demand for knowledge generated by the CAIRN. As evidenced in this report, members of CAIRN have contributed to, and participated in, policy making processes in very many ways. In addition to the CAIRN sponsored IPR workshop held in Toronto, network members have made more than a dozen presentations at industry and government sponsored meetings. Several members continue directly participate in organizations and decision making bodies, such as CAPI, CFA, drawing on their knowledge and the knowledge of other CAIRN members to contribute to policy making process.

The next year will be an equally important year for CAIRN. The flow of new knowledge from network research activities will accelerate as more student projects are completed. The challenge will be to disseminate this increased flow of knowledge in policy relevant channels. Perhaps a greater challenge will be to integrate aspects of agricultural innovation policy into larger formats of a Canadian Science and Innovation Policy and the development of a Canadian Agricultural Policy. The later will require will require more interaction a collaboration with other APRN networks, and continued work with various stakeholders to integrate appropriate innovation policy into the vision for the sector. We have developed a workplan with many exciting projects to explore important policy relevant knowledge gaps. CAIRN is partnering with the CAES to organize sessions at the Joint CAES/CEA meeting in Montreal. By organizing sessions, at these joint meeting we will draw in and create awareness CAIRN among our economist brethren working on innovation in other sectors of the economy. CAIRN also organizing a one-day workshop prior to Joint CAES/CEA present the research results and discuss areas of further research.

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Area1:

Research Proposal

Area: Innovation and MNE Investment Decisions

Project Title: Innovation in the agri-food sector and the presence of foreign equity

Location: Saskatoon

Project Leader: Hartley Furtan and Pascal Ghazalian

Project Members and Affiliations: Mark Partridge, Murray Fulton, others possible.

Duration: September 1, 2005 – June 30, 2007

Amount Requested: $10,000 per year

Use of Funds: Fund a MSc student

Brief Project Description:

Foreign direct investment (FDI) is an important source of investment and innovation in the Canadian economy. The linkage of FDI to the growth of the overall Canadian economy has been well documented. However, one sector where little to no

research has occurred in measuring the relationship between growth and the level of FDI is the agriculture and food sector. The purpose of this research is to start to fill the gap in our knowledge as to the relationship between FDI, innovation and growth in the agriculture and food sector.

In terms of ongoing research in the area of FDI in the Department of Agricultural Economics there are currently two projects that would support the proposed research. First, Pascal Ghazalian is completing his doctoral dissertation examining the question of how FDI impacts the measured 'border effects' between two countries. He has completed some fairly original theoretical research and is currently testing the hypotheses which fall out of the model. To date his results look very promising. Second, Olfert and Furtan have a short paper on Canada-U.S. economic integration, which formally incorporates the role of FDI. This paper is limited by the paucity of data on the quantity of FDI in the Canadian agric-food sector. Thus all of our work to date has focused on the linkage between the level of trade and FDI. This proposal would model explicitly the role of FDI in increasing the level of innovation in the food processing sector, using the network survey data.

The links between innovation and foreign equity can take various forms and have influences in different directions. The internal presence of foreign equity may reallocate the innovation activities (such as research and development) to the parent multinational enterprise (MNE). In this case the innovation outcome developed by the parent MNE has a public good aspect and is supplied to the foreign affiliate at lower cost. Yet, it can be argued that the presence of the foreign capital may also boost the research and innovation activities as the foreign ownership brings access to a wide range of skills associated with innovation activities. Further, the presence of foreign equity and associated innovation can generate external economies in the industry through spillovers. Development and adoption of innovation by local firms, in this case, can be the result of simple observation, information leakages, or cooperation. Clusters of innovation may develop. Spillovers may be strongly influenced by geographic proximity.

The potential spillover resulting from the presence of foreign capital has inspired a massive literature. Previous literature has mainly described firms' performance by productivity. Görg and Greenaway (2002) provide an excellent overview of the empirical evidence of spillover. The evidence of spillover in the developed countries is mixed. Some literature has found positive effect at industry level (e.g. Caves, 1974; Liu et al, 2000; Driffield, 2001) and at the firm level (e.g. Ruane and Ugur, 2001). Other literature finds inconclusive results (e.g. Grima *et al*., 2001; Grima and Wakelin, 2001; Harris and Robinson, 2001; Barrios and Strobl, 2002). Some literature searches the spillover effect of the foreign affiliates on the exports and the propensity to export by the domestic firms (e.g. Sousa *et al.*, 2000; Barrios *et al.*, 2001).

Our proposed research is in the spirit of the previous literature yet it focuses on the effect of the internal and external foreign equity on the innovation performance of firms. The effect of internal foreign equity may be measured by the innovation adoption by the firm, either from its' locally generated research and development, or that transferred from the foreign parent company. The effect of the external foreign equity on the firms' innovation activity reflects the spillover aspect. When studying the effect of the external foreign equity, particular interest is directed toward the domestic firms that are exporters or recipients of foreign direct investment. Evidence of positive spillover effects

implies enhancement of domestic firms' global competency that becomes self-reinforcing.

We provide additional detail by disaggregating the innovation into product innovation and process innovation and by disaggregating the innovation activities into six sub-categories: intramural R&D, extramural R&D, acquisition of machinery, equipment and software, acquisition of other external knowledge, training, market introduction of innovations and other preparations.

Agricultural Policy Research Network: Innovation
April 1, 2005-March 31, 2006 Proposal

Research Proposal

Area: Regional Incidence of Innovation and Impacts

Project Title: Regional Dimensions of Innovation in the Canadian Food Processing Industry.

Location: Saskatoon

Project Leader: Mark Partridge

Project Members and affiliations: Richard Gray, James Nolan, and Rose Olfert (all of University of Saskatchewan)

Duration: April 1, 2005-March 31, 2006

Amount Requested: $20,000

Use of Funds: To fund MSc student Jill McDonald

Brief Project Description:

Using the draft food-processing innovation survey developed in the first quarter of 2005, this project will assess the regional dimensions of innovative activities. Goals of this project include an assessment of the input-output linkages of technological change and the resulting economic impacts on the various regional economies. Empirical techniques will include geographical information system analysis using the C-RERL lab and database, survey analysis, and spatial econometrics.

While the survey has not been completed and there will be constraints in its size, our goals will be to answer the following questions:

- Identify innovative capacity in the Canadian food processing industry.
    - Does it differ by firm size, by region/province, and by rural/urban location?
    - How have government policies supported or constrained innovation, including technology transfer?

- How can Canadian food processors be encouraged to export their products?
    - Enhanced entrepreneurship.
    - Improved market intelligence regarding potential foreign and domestic markets.
    - Changing U.S. trade barriers.
    - Identifying partners in other foreign markets for distributing the product.
    - Improved quality and availability of transportation infrastructure. (e.g., on the Prairies, north-south rail and highway transport is limited.)

- Identify constraints in adopting best-practise technology such as lack of information technologies and out-dated capital stock.
    - Lack of knowledge or understanding of new technology (suggesting a need for a government outreach/extension to disseminate best practise).
    - Lack of financing. (Does government need to better promote their efforts to broker or provide venture financing?)
    - Regulatory, taxation, and business-climate constraints. Difficulties in attracting a qualified workforce as there are looming labour-shortages?

Using these findings, what can cities, municipalities, provinces, and The Government of Canada do to promote future innovation, competitiveness, and export success in the knowledge economy.

During this one-year period, we want to support the administering of the survey instrument and to support the data entry process. The student hopes to have preliminary analysis completed by at the end of period and to have completed a literature survey of innovation in food processing and related industries.

Area3: Alternative Management of Public Intellectual Property Rights

Governments have historically played a large role in agricultural research. During the 20th century, most crop research was undertaken by public institutions and the products of the research were held in the public domain (Huffman and Evenson 1993). At the very root of support for agricultural research was the notion that the innovator could not capture all of the benefits from research (Alston and Pardey 1999) as benefits "spilled over" to adopters. The lack of private incentive created from these spillovers resulted in public investment in research. More recently, the introduction of modern biotechnology and improved Intellectual Property Rights (IPRs) has conferred monopolistic rights to the inventor, leading to increased private investment in agricultural research. Despite the considerable growth in private investment, the government continues to make large public investment in research, especially in basic research which creates a positive spillover to private firms as many successful industries are based on break through innovations created in the public sector.

Public IP and research spillovers have important implications on the research intensity, industry structure and the distribution of research benefits. A number of studies show that while IPRs create incentives to invest, they may create market power and efficiency losses (e.g., Lindner 1993, Perrin 1994, Moschini and Lapan 1997, Fulton and Keyowski

1999, Alston and Venner 2000, Gray and Malla 2003). Moreover, the inherent non-rival nature of agricultural research output tends to create a concentrated private industry as firms move to capture economies of scale and scope (Fulton and Giannakas 2001). A further push toward integration occurs as firms adopt strategies, such as vertical integration, mergers, acquisitions and joint venture arrangements, to preserve their own *freedom to operate* (e.g., Kalaitzandonakes and Bjornson 1997, Lesser 1998, Lindner 1999, Falcon and Fowler 2002). Finally, the concentrated nature of the research industry, and the exclusive ownership of key pieces of IPRs give research firms some degree of market power, which through higher prices reduces the incentive for product innovation and adoption downstream (e.g., Mochini and Lapan 1997, Malla and Gray, 2003)

Furthermore, the introduction of single genetic trait into a product of biotechnology can require the use of many separate pieces of IP. Before the innovator can have 'freedom to operate' the innovator must reach an agreement with each of the other IP owners (Kowalski et. Al 2002). If the ownership of the IP is dispersed, negotiating 'freedom to operate' agreements to share the proceeds from the innovation is an expensive, time consuming process, and can be subject to hold up by any of the parties involved. (Falcon and Fowler, 2002). For example, the commercialization of Golden Rice involves at least 70 process and genetic patents (e.g., Rafi Communiqué 2000) which represents a hold up problem. Hence, the high transaction costs associated with the exchange of intellectual property have adversely affected the structure of the private and public research industries and have created an economic barrier for the commercialization of second generation GM crops.

Many policy makers and economists have begun to examine the 'freedom to operate' issues related to IP ownership. They have developed proposals that focus on improving 'freedom to operate' for public institutions and for innovators working on smaller crops in lesser developed countries. Many US land grant Universities, and public have formed a new organization called PIPRA, (Public Intellectual Property Resource for Agriculture). Richard Jefferson of CAMBIA has proposed the use of *open source* IP agreements similar to the one used to develop *Linex*, the open source computer operating system Broothaerts et al., 2005 and Philipkoski, 2005). In this model, new users can use existing IP on the condition that any improvement to the IP is made available on an open source basis.

In Canada, meaningful progress on this issue has been very limited to date. Agriculture and Agri-Food Canada have indicated they will withdraw from commercial varietal development, however, the process they will use to transfer IP to private firms remains unclear. Public breeders in Universities and other public institutions often avoid using proprietary IP, and only protect their own knowledge on a case by case basis.

The objective of this study is to examine alternatives for the management of public crop related IP in Canada. This will include a comparison of: existing structures, "PIPRA" type models, open source models, and quasi-public models. Each management structure will be evaluated for its impact on freedom to operate, revenue generation, and impacts

on downstream users. The research will focus research two or three crops with that differ in scale, IP, and private sector involvement.

The research will be undertaken as part of a Master Thesis. The methodology will require several steps including:
1. a review the literature,
2. the development of theoretical tools for analysis,
3. the development of a proposed structure for each management alternative,
4. a preliminary analysis of each management alternative,
5. solicitation of advice from industry experts who will discuss the preliminary analysis and provide their insights into the viability of each management alternative, and,
6. a revision and refinement the analysis of management alternative.

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- The Economist, Feb 10, 2005 (Forwarded by Roger Kalla)

The computing industry has been transformed by open-source software, threatening business models while creating lucrative opportunities for some firms. Might the same happen in biotechnology? In a paper published in NATURE on February 10th, a group of researchers describe a way to transfer genes into plants that bypasses the now most commonly used technique, agrobacterium transformation, which is protected by hundreds of patents. The new process may provide an alternative method of modifying certain types of crops in order to, say, improve harvests. But what makes the invention particularly notable is that the authors, affiliated with CAMBIA, a non-profit biotech research group in Australia, have made the procedure free for use under a novel "open-source" licence.

This licence allows people to commercialise products based on the procedure. All that is required is that improvements to the technique itself be shared, to the benefit of all users. This should make it easier for companies and researchers in poor countries to use agricultural gene-transfer technology, which today's patent-licensing approach impedes.

"The idea is to try to craft a system so that we have a different way to do business," says Richard Jefferson, the head of CAMBIA and a co-author of the paper. "This is a demonstration of a way forward for an innovation business model," he says, which could help unleash creativity in poorer countries. This week, the group also unveiled a website, BioForge.net to help biotech researchers to

collaborate, much as SourceForge.net is a nexus for open-source software development.

Although open-source approaches have already been used in biotech-related computing (called bioinformatics) and database sharing, CAMBIA's licence represents an actual technique being provided in an open-source form. It is part of a broader push towards open practices in the life sciences. For example, Science Commons, an offshoot of Creative Commons (which provides less restrictive copyright licences to authors), is preparing to develop open licences later this year.

CAMBIA's technique, and its open-source licence, "is a potentially huge deal for people working in minor crops, on humanitarian projects, and even for smaller companies working with the major crops," says Lisa Lorenzen of Iowa State University. Calestous Juma of Harvard University's Kennedy School of Government believes the approach is viable because "you have the incentive to invent, but you also have the raw materials--information--with which to invent."

The dominant patent holder in agrobacterium transformation, the most widely-used means of plant gene-transfer, is Monsanto, a big agricultural firm. The firm says that, although it is not very familiar with open-source approaches in the life sciences, the technology seems to complement, not threaten, its business model.

In information technology, some firms, including mighty Microsoft, are severely threatened by open source. Yet

other firms, including big ones such as IBM, have evolved business models to embrace open source, which contributes greatly to their revenues. The question is, can open-source biotech also find its way into drug development, where the costs are higher and potential profits greater?

Pedants will note that CAMBIA's approach is not pure open source, since the group relied on grants from foundations to develop the technology rather than on volunteers. Moreover, the licence itself is not completely unique, in that royalty-free, non-exclusive technology agreements that stipulate sharing improvements have existed before. But these are quibbles. The open-source-like approach may not revolutionise the biotech industry, but it is a notable step in a new direction.

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Genetically Modified IP Launched

- Kristen Philipkoski, Wired, Feb. 09, 2005
http://www.wired.com/news/medtech/0,1286,66545,00.html

A paper appearing in this week's edition of Nature is antiseptically entitled: "Gene transfer to plants by diverse species of bacteria." But the information that lies within may herald a revolution in biology.

The paper describes two new technologies: TransBacter, a method for transferring genes to plants, and GUSPlus, a method of visualizing where the genes are and what they do. Behind the research, which was funded by the Rockefeller Foundation, is a team of scientists who want to provide the technologies as a "kernel," modeled on the Linux movement, as the beginning of perhaps the first practical offering in open-source biology.

Researchers who want to develop technologies based on this kernel can use it as they wish if they agree to a flexible license issued by Biological Innovation for Open Society, or BIOS. The initiative is being spearheaded by Richard Jefferson, also founder of Cambia, an agricultural life science institute in Canberra, Australia.

"My own hope is that seriously disadvantaged people who have a sense of disenfranchisement and neglect can take great heart from our work, and ultimately can find means to dig out of poverty and despair," Jefferson said. "There are millions of creative people who must be crushed to find they have no means to leverage their commitment into advancing their well-being and quality of life."

But how will poor farmers benefit from a technology published in a fancy science journal like Nature? Jefferson calls it "representational technocracy."

In other words, local entrepreneurs, universities and other institutions in impoverished locales need to get on board with BIOS for Jefferson's open-source biology plan to work. He hopes the initiative will help new enterprises, as well

as existing nonprofit organizations charged with improving conditions in poor nations, to take advantage of the BIOS program.

"(Institutions in the public sector) need to be much more effective, and the BIOS initiative will (help them) do that," Jefferson said. "Ultimately, as broadband expands, more and more decentralized participation can be envisioned."

For the vision to become reality, BIOS plans to reach out to these entities with its BioForge website, which it launched Wednesday. Scientists can deposit and obtain scientific information on the site.

The open-source biology movement has been bubbling to the surface for years, and enthusiasts are heartened by the first technologies finally becoming available.

"This is important, fundamental agricultural technology moving into the commons," said John Wilbanks, executive director of Science Commons, a group working to make it easier, and legal, to share scientific data. "This is the type of tool that, in increasing numbers, is being patented. To use the operating system metaphor, this is Print-F for plant genomics. Imagine trying to build any piece of software if the print function required a patent license."

The biotech industry is officially not opposed to open-source biology projects, and is interested in studying them further, said Lisa Dry, a spokeswoman for the Biotechnology Industry Organization. Dry also pointed out that infrastructure, not patent licenses, are often the impediment for implementing new technologies in developing countries.

"The judicial system, the culture, the regulatory regime ... there are many hurdles to overcome before you even get to the question of, 'Is intellectual property an issue here?'" Dry said.

Jefferson is interested in seeing small-time farmers, rather than big companies, benefit from his efforts. And it seems logical that agricultural biotech companies like Dow Chemical and Monsanto, whose business plans are centered on patent protection for genetically modified plants, would not welcome the concept of open-source technology relating to genetically modified crops. Monsanto has brought several lawsuits against farmers for using their technology without a license. (A Monsanto representative referred inquiries for this story to BIOS.)

But Jefferson says he has had "fairly productive" conversations with agri-biotech executives, and he believes there is a way they can actually make money by adopted the BIOS approach, at least for developing some technologies.

"Even large companies, if they embrace a very different business model, can make serious money -- probably more than current earnings -- by decreasing costs of accessing

technology, litigation and developing early-stage innovation," Jefferson said.

The companies will likely need to see a clear synergy in order to invest, said Stephen Maurer, an attorney and lecturer with the Goldman School of Public Policy at the University of California at Berkeley, who proposed an open-source approach for developing tropical disease drugs in a paper published in the December issue of the Public Library of Science.

"IBM funds open-source software," Maurer said. "Why? Because IBM sells hardware. You have to tell the same story about why people out in the world would invest in research to develop this kernel."

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World's Hungry are Denied Benefit of Biotech Foods

- Alan Mchughen Taiwan News, Feb 6, 2005
http://www.etaiwannews.com/Opinion/2005/02/06/1107660252.htm

Whether gold or grain, humans don't give it away.

Globally, a thousand people die of hunger every hour. More than 800 million of us are chronically malnourished. Yet studies consistently conclude that the world actually produces enough food for everyone; if only it were more evenly distributed we could eradicate hunger.

This is a major plank in the argument against using modern farming methods to increase food production, "There's already enough food, so we don't need modern technology."

All we need do, according to this simple argument, is to redistribute the surplus grain from those who have it to those who don't.

But humans have been starving for eons, even as the world has been producing grain and other food surpluses all along. Clearly, if redistribution were as simple a solution as some suggest, hunger would have been eradicated long ago.

As with global food production and hunger, society has always had poor people living in a world filled with bountiful riches. And the simple solution is to redistribute wealth from those who have to those who haven't.

But complex problems are not solved with sound bites. Hunger persists, and the simplistic solutions simply don't work. Worse, they actually impede the development of

realistic solutions to reduce, if not eradicate, hunger and poverty.

Biotechnology and other techniques of modern farming offer a practical means to provide more nutritious food to more people, and do so in an environmentally sustainable manner.

Yet these methods are under attack by some of the very people who claim to represent the hungry and impoverished.

Biotech crops and foods have now been grown by farmers, and eaten by hundreds of millions of consumers, for 10 years. In that time, farmers report a dramatic drop in pesticide usage, increases in yield and higher quality grain with less insect and microbial damage and contamination.

In developing countries, crops under-perform largely due to devastation from weeds, insects and disease. When whatever's left of the crop is finally harvested, as much as a third spoils before humans can eat it.

These are exactly the problems that judicious use of biotechnology can overcome, and a large reason biotech crops have been so enthusiastically embraced in developing countries.

But let's return to the redistribution scenario and question its feasibility. Is it realistic to expect

American farmers to deliver that excess, uncompensated, to the hungry overseas? Will our productive farmers continue to grow surpluses if they have to give away the excess grain?

Having the world's poor and hungry fed by American farmers does nothing to stimulate self-respect and self-sufficiency. In banning biotech crops and foods, we deny the hungry a means to overcome both, and continue the cycle of dependency on charity handouts.

American farmers have overwhelmingly adopted biotech crops. Because the grain surpluses come mainly from these biotech crop farmers, redistribution faces another roadblock.

The people spouting the redistribution argument have succeeded in banning biotech grain in many hungry countries. Since biotech grain forms the bulk of the surplus, redistribution to those countries will be prohibited, and the people will continue to be hungry.

One of nature's immutable laws holds that simple solutions to complex problems don't work. Let's reject this redistribution fallacy and focus on real solutions.

Alan McHughen is a biotechnology specialist and geneticist at the University of California at Riverside.

Area 4:

January 2, 2006

Progress Report & Budget Projections (April 1, 2005 to March 31, 2006)
CAIRN, Area 4 (The Structure of the Agri-food Sector and Innovation)
Project Leader: Jim Vercammen
Other Members: Grant Isaac, Jill Hobbs and Murray Fulton

The $20,000 budget for Area 4 during the April 1, 2005 to March 31, 2006 period was originally earmarked to fund a U. of Saskatchewan MSc student, who would work under Grant Isaac while in the Interdisciplinary MSc program. This student informed Grant in May 2005 that he would not start the program. The $20,000 was then reallocated to two UBC students.

Project 1: "Using Matlab for Stochastic Dynamic Programming" (Seena Mortazavi working under the supervision of Jim Vercammen)

Seena is pursuing a MSc in Economics at Queens University. He was taking classes at UBC from May – September, 2005. He was hired to work with Jim Vercammen from May 15, 2005 to August 14, 2005 to program MatLab for solving stochastic dynamic programming problems. The specific application was a model of direct payments and farm investment. Vercammen is now in a position to use MatLab to solve stochastic dynamic programming problems that are applied to agricultural innovation.

Project 2: "Producer Associations, Check-off Schemes and Innovation" (Zoe Campbell, working under the supervision of Murray Fulton and Jim Vercammen)

Zoe is currently in the first year of a MSc program in AgEcon at UBC. She began work on this project on August 1, 2005 and has been working on the project for 20 hours per week since that time. She will complete the project by March 31, 2006.

Zoe developed a questionnaire and a set of interview notes that she is currently using to obtain information from a comprehensive set of Canadian agricultural producer associations. She conducted a set of face-to-face interviews with several Saskatchewan-based producer associations in December, 2005. She is currently conducting telephone and e-mail interviews with producer associations from other provinces.

Zoe's first objective is to compile a database of precisely how producer associations use the money raised via member check-offs. Of particular interest is the extent that producer associations use check-off money to fund research and development. Zoe's second objective is to better understand how producer associations make check-off funding allocation decisions. Zoe's third objective is to better understand producer associations' perception about the comparative usefulness of the various sources of R&D (e.g., private versus public).

Zoe intends to have a first draft of the report completed by March 31, 2006. Fulton and Vercammen will take the lead in using the draft report to write an academic paper, that will be presented at a future workshop or conference.

Budget to December 31, 2005

Salary for Seena in Project 1:	$3,000
Salary for Zoe in Project 2:	
5 months @ $1,333/month	$6,665
Expenses for Zoe in Project 2:	$1,800
Total	$11,456

Projected Budget from January 1, 2006 to March 31, 2006

Salary for Zoe in Project 2:	
3 months @ $1,333/month	$3,999
Expenses for Zoe in Project 2	$1,500
Total	$5,499

Total Actual and Projected Expenditures ≈ $17,000

Advanced Policy Research Network: Innovation

Research Proposal

Area 5: Entrepreneurship and Innovation

Project Title: Factors Affecting Innovation, Biotechnology and Bio-products

Location: University of Guelph

Project Leaders: David Sparling (UG) and John Cranfield (UG)

Duration: Summer 2005 to Summer 2006

Amount Requested: $20,000

Use of Funds: Funding for 1 M.Sc. student and/or research assistant, as well as supporting expenses.

Brief Project Description: The project will extend a previous research partnership by the researchers with Statistics Canada and AAFC. The project will involve working in the analysis of one or more of three AAFC and Statistics Canada surveys completed in 2003/2004, the Bio-products Use and Development Use, the Agri-Food Innovation Survey and the 2003 Biotechnology Use and Development Survey. The project leaders have held discussions with AAFC and will be collaborating on the analysis of these surveys, the extent will depend on the availability of students or research assistants. The Bio-products survey is a world first in the area and the Biotechnology survey will provide the researchers to extend their previous analyses of the 1999 and 2001 surveys where they focused on agricultural biotechnology and by performed a longitudinal analysis for firms common to both surveys. The biotechnology project will examines the structure and characteristics of innovative biotechnology firms with the objective of understanding characteristics of successful biotechnology companies in terms of product innovation and success in securing the financing required to commercialize the innovations. The opportunity to study the industry and individual firms over three data points is unique and worthwhile, particularly since few studies focus on agricultural biotechnology.

The project will involve the development of an econometric model regressing alternative measures of innovation performance in the different industries and financing success on various firm and industry factors. For the biotechnology survey analysis the previous study, firm level data for firms common to the 1999 and 2001 Statistics Canada's Biotechnology Use and Development Surveys (BUDS), 194 firms. While the sample common to all three surveys will be smaller it will still be sufficient to perform a longitudinal analysis in addition to the comparison for all firms in the three surveys. The 2003 AAFC innovation survey and 2004 bio-products survey both offer new opportunities to gain insight into areas critical to the future of Canada's agri-food sector.

Cross cutting 1:
Canadian Agriculture Innovation Research Network
Cross-Cutting Research Proposal

Topic: Producer Group R&D, Market Structure and Producer Welfare
Researchers: John Cranfield, Murray Fulton, James Vercammen
Budget: $15,000

The following proposal is designed to cut across the structure and intellectual property groups within the network.

Overview of Proposed Research
Since the early 1990s, producer groups in Canada have emerged as significant players in agricultural R&D. Funded through check-offs on grain and livestock production, groups such as the Saskatchewan Pulse Growers, the Canola Growers of Saskatchewan, and the Western Grains Research Foundation have invested millions of dollars in R&D. Most of this R&D has been targeted towards new varieties with improved yields and other agronomic characteristics – i.e., the R&D has been directed at process innovation at the farm level.

Recently, a number of producer groups have been considering R&D directed at product innovation at the processing and further processing level. A good example of this type of activity is the involvement by the canola industry in bioproducts. This investment is intended to create new markets for producers' products, and thus to benefit producers through increased product demand, particularly for niche and/or differentiated products.

The economics of R&D directed at farm-level process innovation are reasonably well understood. Alston, Norton and Pardey provide an extensive survey of the research in this area. The focus of much of the literature that they review is the public provision of R&D; the impact of R&D funding by producer groups is very similar to the case when R&D is publicly-funded research. Moschini and Lapan show that R&D undertaken by private companies and directed at the farm sector can have very different impacts, depending on the market structure of the industry in which the firms operate.

The economics of R&D directed at processing-level product innovation and undertaken by producers are much less well understood, in large part because of the complex impact that this R&D can have. The development of new products can lead to new markets for producers' products, thus potentially benefiting producers. The extent to which producers will benefit, however, will depend on a number of factors. One important factor is the degree to which producers can limit the supply of any new product that is supplied at the farm level. If supply cannot be limited, then the benefit to producers may be limited.

There may also be market structure impacts that need to be considered. As Sutton shows, R&D activity undertaken by firms in the processing or further processing sectors is likely to influence the market structure (e.g., the number of firms) of these sectors. Depending on the nature of the underlying technology, greater R&D can lead to more a concentrated sector or to a sector that supports a large number of firms producing highly differentiated products. A key economic variable affecting the market structure is the sunk costs that the firms incur when they undertake R&D.

The structural impact of producer groups undertaking R&D directed at the processing or further processing sector has not been investigated. Given the key role that sunk costs play in determining industry structure, the impact of producer-funded R&D on market structure will likely depend on the effect the R&D has on sunk costs. For instance, if R&D funding by producer groups does not affect sunk costs in the processing sector (producers incur the sunk costs rather than the processors); then concentration may fall or remain constant, which in turn has implications for the price they are willing to pay for the producers' product.

The sunk costs that the firms in the processing sector have to incur will depend on the manner in which producer groups exploit their new technology. For instance, if the producer group is successful in generating a new product, then it has to decide how this product will be produced – i.e., will the producer group try and produce it themselves or will they license it to another firm. If they choose the licensing option, then they also

have to decide the price at which the product should be licensed. The sunk costs incurred by the processors will depend on the price paid for the license.

Given the lack of understanding of the impact of producer-funded R&D directed at the processing sector, the purpose of the proposed research is to examine the consequences to producers of their direct investment in product innovation at the processing and further processing level. Specifically, the research will examine the following questions:

(1) If producer groups are not constrained by R&D fund availability, what is the optimal amount of processing-level product innovation R&D to undertake?
(2) Given that producer groups have a limit to the amount of R&D that they can undertake, what is the optimal split of R&D spending between farm-level process innovation and processing-level product innovation?
(3) Will producer groups be better off producing the new product that they have developed, or should they license the technology to a third party?
(4) If the producer group licenses the technology, what form should the license take? What price should be charged?
(5) What impact does the choice of technology exploitation mechanism have on the optimal amount of R&D to undertake?

Methodology

The proposed research will have both a theoretical and empirical component. The theoretical component will involve an examination of the incentives faced by producer groups to undertake R&D at different stages in the supply chain. The basic model will consider a standard Betrand differentiated products oligopoly that utilizes a common input (e.g., canola). The literature normally considers the incentive of one or more of the oligopolists to conduct R&D in order to create a less elastic demand for its product. The impact of this R&D on the selling price of canola needs to be traced. Within this framework, we then ask what happens if the suppliers of canola come up with an innovation that either: (a) makes one of the final product demand schedules less elastic; or (b) creates an entirely new product (i.e., adds a new player to the game). The analysis should also be able to answer the question of whether it is best to for producers to sell the product themselves or license it.

The analysis will consider at least two situations. In the first, the number of processing firms will be kept fixed, so that the direct impact of R&D investment on the industry can be determined. In the second situation, the number of firms will be endogenized so that the impact of R&D activity on market structure, and subsequently on the prices paid, can be investigated.

The empirical portion of the research will consider a case study of a producer group that is involved in R&D activity of the type outlined above. The research will examine the issues considered by the producer group as they undertook R&D activity in this area and will attempt to obtain some idea of what the producer group hopes to accomplish with its R&D. Given the lack of data on R&D activity of this type, a case study represents the only method of being able to empirically study this phenomenon.

The theoretical work will be carried out by the three researchers, as well as by a graduate student that will be employed under this project. The graduate student will be largely responsible for the development of the case study.

The budget will be used to fund the graduate student and to provide travel funds for the researchers and graduate student to meet at a common location where they can work on the theoretical model.

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Moschini, G. and H. Lapan. "Intellectual Property Rights and the Welfare Effects of Agricultural R&D." *American Journal of Agricultural Economics* 79(November 1997):1229-42.

Sutton, J. "Technology and Market Structure." *European Economic Review* 40(1996):511-30.

Crosscutting 2:
Agricultural Policy Research Network: Innovation
April 15, 2005-March 31, 2006 Cross Cutting Proposal

<u>Research Proposal</u>

Areas: Regional Incidence of Innovation; Knowledge Economy and Innovation; and Entrepreneurship and Innovation.

Project Title: Regional and Individual Human Capital Effects on Innovation

Location: Saskatoon

Project Leader: Mark Partridge

Project Members and affiliations: Derek Brewin (University of Manitoba), Mark Partridge, (University of Saskatchewan), and Daniel Monchuck (University of Southern Mississippi).

Duration: April 15, 2005-March 31, 2006

Amount Requested: $20,000

Use of Funds: To fund an MSc student at the University of Saskatchewan and travel funds to facilitate collaboration.

Brief Project Description:

This research proposal is presented as a cross-cutting part of the Canadian Agriculture Research Network on Innovation. It includes rural and entrepreneurial elements in an exploration of the location of innovation and its link to human capital. The proposal is to fund a student at the University of Saskatchewan with participation in the research by Mark Partridge, Daniel Monchuk, and Derek Brewin. The focus of the research will be the link between human capital and innovation. The current plan is to use the survey suggested by the rural team in this network and focus on firm and regional human capital capacities as a driver in innovation among those firms surveyed.

There is a clear body of evidence linking the growth of a regional or national economy to education levels (see Goetz and Hu, 1996, Barro and Sala-i-Martin, 1992, Partridge, 1997, and Carlino and Mills, 1987). Solow's theory was that this education is a type of capital stock that saves labor in the production process or as Lucas suggested in 1990, it effectively raises the labor supply. As endogenous growth models have grown in use and tractability (Romer, 1986 and Lucas, 1988), there is a new view of investments in human capital as part of continuing cycle of innovation, profitability and obsolescence. A key goal of this research would be to compare the importance of two human capital processes that could sort through both effects. Education rates for a regional labor supply can impact the effective work force, but firm level measures of human capital could capture impacts on the cycle of innovation at the firm level.
This research would use data already being collected as part of the "Innovation Survey" described by Mark Partridge in the Calgary meeting of the Innovation network. In sections 10 through 13, the survey asks questions to measure the level of innovation incorporated by the firm in the last three years. Human capital factors are also collected within the surveys that identify low levels of educated workers as a possible impediment to innovation.

Human capital is a complex and important construct. Berkowitz (2001) wrote:

> "[K]nowledge is now the most versatile and the most important of all the factors of production, whether we can measure it or not. Knowledge has now become the real capital of a developed economy. A computer wizard with a bold new program in mind can walk across a border with no tariff, carrying more capital assets within her head than might be contained in a thousand cargo ships."

As Berkowitz suggests, human capital, or knowledge as used above, is very important but difficult to measure. The foundational work by Schultz (1961) suggests investment in human capital can take the form of anything from direct investment in factors like education and health to the less obvious use of leisure time to improve skills and obtain additional expertise in the field. It is difficult to capture much beyond and average education rate in regional data, even though the theory of learning by doing suggests significant impacts from experience. Three possible measures are suggested in this research; the first is a regional education level, likely the percentage of a local population with a college education, the second would be firm level education stocks measured as the average education level of employees or the manager of a firm or the highest

education level of any employee; and the third would be the years of experience of the manager or most experienced employee.

These impacts could be compared to the incidence of innovation already captured in the survey to help sort out the contrasting effects of human capital on firm level innovations and regional productivity.

The survey offers us a unique opportunity to explore the effectiveness of human capital investments towards innovation at the firm level as well as the contribution of regional factors innovation and productivity.

References:

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