

# CAIRN

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AN ERCA RESEARCH NETWORK

**2010/2011 Annual Report**

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## **FORWARD**

While many long-term forces continue to drive agricultural markets, the past year has been eventful creating many new challenges and opportunities for Canadian agriculture. The global economy continues to show signs of recovery with positive growth rates returning to even the hardest hit economies. Commodity prices are nearing or exceeding the record level prior to the crisis. Growing global commodity demand, fueled by the continuing rapid economic growth in Asia, has caused prices to surge as the ability to supply the commodities have been constrained, in some cases by limited extractive capacity, and in other cases by diminishing resource stocks, particularly peak oil. The prospects of climate change and the need for GHG mitigation measures imposes additional challenges to meet the growing aggregate demand.

The short run impacts on agriculture markets have been profound. With over a hundred million tonnes of corn being used annually for ethanol in the United States, a slowdown in agricultural productivity growth in many markets, and surging energy prices, agricultural product prices have surged. With low global grain stocks and record high food prices, food security has once again become an important issue. This is a fundamental change in economic conditions from a decade ago. While periods of high prices occasionally exist in all commodity markets, there is growing speculation that this situation of food insecurity may persist or even worsen in the years ahead.

Higher agricultural prices create tremendous opportunity for the agricultural sector. The ability of the sector to mitigate new risks and capitalize on the opportunities depends on the ability of the sector to innovate or adapt to changing terms of trade in factor markets and output markets. Measured as productivity improvement, innovation allows the sector to generate wealth by producing more with a finite set of resources. In the short run innovation will be achieved by the sector responding to the new price signals using existing technologies and inputs to increase profitability. In the longer term, meeting the growing demand with a finite set of resources will require productivity improvement that is enabled by new knowledge incorporated into new technologies or genetics, successfully commercialized and adopted by the sector.

Productivity improvement is an opportunity to “do good” by “doing well”. Productivity improvement will allow the sector to continue to produce more output for a given amount of input, enhancing profitability, and hence doing well. This productivity growth will also “do good” by helping to address resource use, or food security, or both. Effective innovation policy is about creating policies that will foster innovation and productivity improvement.

Of particular concern for the agricultural sector’s ability to innovate fast enough to address growing demand is the observed slowdown in growth rate agricultural productivity in Canada and other OECD countries, as documented in a recent book by Alston and others. The decline in productivity growth rate has coincided with stagnation in agricultural research investment. The persistent and broadly based high rates of return to agricultural research suggest that underinvestment continues to be an issue for agricultural research. IPRs can be

an effective tool to attract private investment in some forms of research, but it is not a universal solution and there are issues related to market power and the anti-commons. The ongoing work of the Canada Grain Council and other industry groups to find ways to increase agricultural research investment, indicates this issue continues to be of prime importance for the sector.

Regulation continues to be an important impediment to innovation. New food and agricultural products continue to face regulatory hurdles both domestically and abroad. With renewed interest in GM wheat technologies the issue of regulation and market acceptance has once again become important.

While the past year (has)clearly created opportunities for some parts of the agricultural sector, it also created (very) significant challenges. The rapid escalation of energy prices, fertilizer and other commodity prices has increased the cost for producers. The related strong dollar and the lack of exchange rate pass through on many inputs squeezed the margins of many producers. The general increase in the volatility of input and product prices has created challenges for managing the increased risk. Added to the market risk has been record rainfall on the prairies. The new set of relative prices may induce innovation in technology. New institutions and business arrangements may be required in the more volatile economic environment.

The Canadian Agricultural Innovation and Regulation Network (CAIRN) has been established to create a pool of knowledge to improve agricultural innovation policy in Canada. This is a very broad mandate, which is described within the report as a research matrix, which cannot be uniformly comprehensively addressed. Any one of the twelve cells in the matrix could involve a number of studies.

## **EXECUTIVE SUMMARY**

Fostering innovation in the agricultural sector has become a prominent goal for private firms, industry groups and virtually all levels of government. There is an economy-wide interest in innovation and science policy. In the agricultural sector, significant investments continue in genomic technologies, variety development and value added processes. The increased demand for grains and oilseeds from the growth in the global biofuel industry has stimulated additional interest in innovation as a means to increase productivity in the agriculture sector and the Canadian economy as a whole.

With renewed funding from Agriculture and Agri-Food Canada through the Enabling Research for Competitive Agriculture (ERCA) program CAIRN (The Canadian Agricultural Innovation and Regulation Network) has expanded its focus to include regulation and has rejuvenated its membership to bring in new views and ensure quality research is generated for the purpose of aiding in the development of public policy. CAIRN is one of five agricultural policy research networks currently funded under ERCA.

CAIRN is a multidisciplinary network of thirty-three researchers representing nineteen academic, government and private institutions. Our objective is to bring researchers together to study the processes of agricultural innovation while proactively engaging government, industry and the public in an effort to improve the agricultural innovation system in Canada. More specifically, however, CAIRN will identify and resolve obstacles to innovation, build a body of knowledge, train graduate students and increase the understanding of the agricultural innovation system in the context of its regulatory environment. CAIRN II will build on its previous accomplishments (CAIRN I 2005-2009) and utilize its capacities in further advancing effective and sustainable innovation policy.

Thus far the network has already committed support to seventeen graduate students at both the M.Sc. and Ph.D. levels. The students funded through CAIRN work with their supervisor (CAIRN member) to receive broad training in how innovation and regulation co-exist and influence the economy. In addition, research efforts by CAIRN are further leveraged through the ongoing research of network members and the development of proposals for several synergistic projects funded from other sources.

CAIRN was able to generate a significant amount of research and networking in the 2010/11 fiscal year. In addition to the fifteen graduate research projects, CAIRN has committed funding to three multi-year research projects dealing with innovation and regulation in the agri-food sector. CAIRN also provided funding for policy briefs and working papers on innovation and regulation relevant research. Network members participated in a very successful “Future of Food and Farms in Canada” conference and CAIRN workshop in January 2011. Future plans include trying to build on the successes of the well attended “Future of Food and Farms in Canada” policy workshop. Cairn is hoping to host another “Future of Food and Farms in Canada” policy workshop in the winter of 2011-12.

In addition to these network activities, CAIRN continues to develop its website to provide easier access to innovation-related documents and presentations. The website contains a

variety of innovation related information including policy briefs, working papers, and links to other websites and events.

This report is organized into three sections. Section 1 contains a description of CAIRN and its research areas. Section 2 is the core of the report and describes graduate student research projects with some CAIRN funding that were initiated in 2009-2010, for 2010-2011, and other CAIRN research and activities including policy briefs, publications and participation in conferences and workshops. Section 3 contains a partial list of members research activities, publications and presentation based on the member's report received to date.

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## **INTRODUCTION**

The Canadian Agricultural Innovation Network (CAIRN) was established in December 2004 by Agriculture and Agri-Food Canada (AAFC) as one of four Agricultural Policy Research Networks. Funding was renewed by AAFC under the Enabling Research in Competitive Agriculture (ERCA) program for the period October 1, 2009 to March 31, 2013. CAIRN altered its name to Canadian Agricultural Innovation *and Regulation* Network. This report covers the period April 1, 2010 to March 31, 2011.

### ***1.1 Background and CAIRN Objectives***

A number of economic, demographic, and environmental forces are converging that will fundamentally change the face of agriculture over the next few decades. As a result of forces like the concern over greenhouse gas emissions, food safety, and energy security, society will increasingly be looking to agriculture for solutions. Agriculture is well positioned to contribute to environmental sustainability, the provision of bio-energy and bio-products, and other goals. In providing these solutions, agriculture must be economically sustainable in an increasingly competitive global market place. Innovation is vital to effectively respond to these challenges.

Despite the recognition of the importance of innovation, developing the best innovation regulations and policies for facilitating adoption and market growth remains a challenge. Agricultural innovation is often constrained by a lack of public and private research funding, cumbersome regulation, jurisdictional disputes, freedom to operate, trade constraints, inappropriate commercialization vehicles and other aspects of the innovation system. Policy work is needed to deal with these issues.

CAIRN's objective is to bring researchers together to study the processes of agricultural innovation while proactively engaging government, industry and the public in an effort to improve the agricultural innovation system in Canada. More specifically, however, CAIRN will identify and resolve obstacles to innovation, build a body of knowledge, train graduate students and increase the understanding of the agricultural innovation system in the context of its regulatory environment. CAIRN II will build on its previous accomplishments (CAIRN I 2005-2009) and utilize its capacities in further advancing effective and sustainable innovation policy.

### ***1.2 Description of Network Research Program Areas***

The Innovation and Regulation Network defines its research areas as a matrix. There are three main areas of agricultural innovation; primary agriculture, functional food and food processing, and bio-energy/bio-product - and four areas of policy analysis; innovation, regulation, coordination and commercialization, and impact measurement. The matrix represents the interdependency of the agri-food sector and the need for multi-faceted public policy, which supports the innovation process, including the commercialization process.

Table 1.0 CAIRN Research Matrix

		Areas of Policy Analysis			
		Innovation Systems Analysis	Regulatory Systems Analysis	Industry Coordination & Commercialization	Innovation Impact & Measurement
Areas of Agricultural Innovation	Primary Competitiveness & Productivity				
	Functional Food & Food Processing Development				
	Bio-Energy & Bio- Product Development and Environmental Stewardship				

*Area 1: Primary Competitiveness and Productivity*

Agriculture is very large economic sector in Canada. Farm sales alone exceeded \$41 billion in 2008. With upstream providers of inputs and downstream processors of products, the sector makes up 8% of the GDP in the Canadian economy. The sector is not only a major source of economic activity; it also generates foreign exchange and contributes to the well being of Canadians through the production of healthy food, bioproducts and environmental amenities.

Innovation is critical to the sector's future well being. Innovation enhances total factor productivity, thereby lowering per unit production costs. Given the size of the sector, even a 1% productivity gain generates an additional \$400 million per year in value added at the primary level alone. These gains also allow the sector to profitably compete in the global market place. New organizational structures and regulations can create greater synergies in R&D activity and create incentives for new products and processes to be developed.

Despite the documented high rates of return, productivity enhancing innovation faces many policy challenges. For instance, while conventional breeding served the industry well for many years, a lack of property rights has limited investment in the rapidly expanding field of genomics. Similarly, over the last two decades we have seen a slowdown in essential public research funding for productivity enhancing activities (e.g., wheat breeding) and a shift towards industry research funding (e.g., check-offs administered by Western Grain Research Foundation as well as large multinational funded private research [e.g. canola]). These shifts in public and private funding have been accompanied by a shift in research agendas (e.g., greater concern for environment stewardship, food safety/food quality, etc), which further contribute to policy challenges.

In crop research, large private research firms have focused their effort on canola, corn and soybeans. While these efforts have stimulated private research, they have also raised issues over freedom to operate and the role of the public sector. Regulations and trade barriers have impeded gains in biotechnology. Despite high returns, genetic research for other crops suffers from chronic underfunding. While successful models of levy funded research do exist in Canada and abroad, most crops continue to be underfunded. Despite large economies of scale, much of the productivity enhancing research remains fragmented because of a lack of co-operation and coordination among numerous jurisdictions and players. As an independent

network of policy researchers, CAIRN plays an important role in helping the sector improve the system for this area of agricultural innovation.

### Area 2: Functional Food and Food Processing Development

The food processing industry is a large employer and an important potential source of economic growth. Consumers are increasingly demanding a wider range of convenient, safe, nutritious, and high quality food, demands that are being met through rapid innovations in food systems. Innovations in functional food and nutraceuticals not only satisfy consumer demands, but may also have the additional benefit of lowering health care costs, something that is increasingly of national importance given the aging population and burgeoning health care costs. Food innovation is also essential to remain competitive in an increasingly global trading environment. Innovation in the food sector faces many challenges, particularly with respect to commercialization. In some cases, incomplete property rights impede research. Regulatory product testing and labeling requirements for new products are often viewed as costly and cumbersome, and also discriminatory compared to those in competing countries. Food safety requirements can be onerous and complex, particularly given the jurisdictional differences that often exist. Regulatory issues are especially difficult policy issues, given the need to maintain consumer confidence in the system. Innovation is particularly complicated for health related food products because many of the economic gains from adoption accrue to savings in public health care costs, which are not fully reflected in consumer demand.

The economies of scale in product development and processing, combined with a limited domestic market in Canada, make access to the larger global market imperative for successful commercialization. The harmonization of standards and international agreements is vital to access larger markets and to provide adequate returns to research investments. By addressing these issues, CAIRN research can help to improve the innovation system for functional food and food processing development.

### Area 3: Bio-Energy/Bio-Products Development and Environmental Stewardship

There is a growing recognition that with innovation, agriculture can play a very important role in providing new energy sources and in reducing greenhouse gas emissions through renewable energy, bio-products and carbon sequestration. In the areas of bio-energy and bio-product development, the industry is still in the very early stages of development and appears to be under-performing relative to its potential, especially compared to conservation technologies (e.g. zero tillage). Unlike the situation in the U.S. and the E.U., Canada's policy with respect to bioproducts is undeveloped. Canada has enormous biomass resources but no real strategy to build an industry on that potential. This includes technologies like first and second generation biofuels, the biological co-generation of fuel and electricity, biomass burning, wind and solar technologies, as well as bio-products like fiber (used for industrial products) and crop biocontrols (used in insect, weed and disease management). The range of products and activities is broad and innovations in this industry will not only affect the products that society uses, but also the processes by which products are produced and the nature of the interactions between farmers, food firms and the environment.

Among the specific challenges facing the bioenergy/bioproduct sector is the notion that the markets for many of the end products do not yet reflect the environmental benefits that they confer on society. Until policies can create more complete incentives, environmentally

friendly products are undervalued but yet are forced to compete directly with conventional products, despite their high initial research costs. In many cases, since these products are new, an industrial base to fund the research is not yet present. Other challenges include a substantial testing and regulatory approval process, as well as tariff and non-tariff trade barriers. While better-defined property rights are important in creating commercialization incentives, it is also important that these new rights do not limit access for new industry players. Similarly, defining trade rules that can govern the international exchange of these products is important.

For those products that contribute to reductions in greenhouse gases, development of a market-based approach to limit GHG emissions is essential to create the economic incentives for innovation in these emerging technologies. Valuing carbon in the marketplace will help the industry achieve its potential but there are many policy questions related to price discovery and the impact that carbon markets might have on both industry and the environment. CAIRN will work with emerging industry and public institutions to develop policies required to support an effective system for this area of agricultural innovation.

#### *Policy Area A: Innovation Systems Analysis*

This area of research explicitly examines innovation as a system, where governments, industry organizations and the private sector interact to provide a conduit for flows of new knowledge to be translated into innovation. While the other CAIRN areas of innovation policy analysis are each important components of innovation systems, researchers in this group will explicitly examine innovation as a system to help identify successful strategies.

The scope of analysis will include international, national, regional and local cluster systems of innovation. While some of the analysis will deal with innovation on a broad scale, attention will be paid to working with industry groups to examine innovation for a particular sector and its products. Other analysis will look specifically at mechanisms of international knowledge flows and innovation. Descriptive and comparative analysis will help identify those systems that are most effective in dealing with different areas of innovation. Theoretical and empirical analysis will help reveal weaknesses in existing systems. Particular attention will be paid to how government policy driven by jurisdictional dynamics is impeding innovation processes in Canada.

#### *Policy Area B: Regulatory Systems Analysis*

Regulation is a major factor in determining the success and impact of innovation in Canada's agriculture and food sector. Regulation affects all facets of the agricultural supply chain including research and development, commodity production, processing and packaging, commercialization, marketing, and trade. As new technologies are developed, it is important to ensure that they are consistent with the regulatory regime of Canada and its trading partners. Similarly, regulatory frameworks need to anticipate the type of innovation that is likely to occur and be responsive to Canadian firms so as to encourage new product development and facilitate commercialization, while at the same time protecting consumers and the environment. Institutions and regulations in any future innovation strategy must therefore account for how emerging technologies will fit into the market place but also how they will impact safety and the environment.

With regard to the agriculture sector, innovation and regulation impact each other in two

distinct ways: (1) existing regulations can constrain or stifle welfare improving innovations; and (2) new innovations will dictate the need for new regulations, which can, in turn, better guide innovation in emerging areas. While regulation is very important to maintain consumer confidence, it also often represents a major impediment to innovation as a source of costs and delay in the innovation process. In addition, many industries choose to self regulate through use of private standards.

CAIRN is dealing specifically with the relationship between regulatory processes and innovation by examining the interface between regulation and private standards to ensure that regulations give strong incentives for appropriate types of private standards to emerge. Working with industry, CAIRN will study the economic impact of Canadian and foreign regulations from a social benefit and cost perspective. This could lead to recommendations for change in specific regulations or in regulatory frameworks for new technologies. CAIRN researchers will also examine various national and international regulatory systems that could allow regulation to be flexible, more compatible with other jurisdictions, and more responsive to new products. The research could also examine issues of standards harmonization and international data sharing.

### *Policy Area C: Industry Coordination and Commercialization*

Innovation activities are shared by governments, producer organizations and private research firms through a wide range of contractual and institutional arrangements. There is significant evidence of the role and value of public/private collaborations in enhancing innovation and commercialization success. Research funding structures, intellectual property (IP) right laws, the ownership and management of IP and mechanisms for commercialization are inextricably entwined and play a critical role in successful innovation.

Recently, new domestic laws, international agreements and technological improvements have significantly enhanced the ability of private industry to protect IP resulting in significant private investment. While basic research has continued to be undertaken mainly by public institutions, the public sector has also moved to protect and actively commercialize IP. For products of biotechnology the exclusive ownership of key pieces of IPRs give research firms some degree of market power. The resulting freedom to operate issues can strain long-term relationships, fragment knowledge, and impede innovation.

International flows of capital, knowledge, and other inputs, along with access to markets, are critical to remain globally competitive. The management and commercialization of IP continues to evolve in many jurisdictions around the world, as public institutions strive to act in the public interest by developing policies to facilitate revenue generation and commercialization, while the producer associations and the private research sector strive to find better arrangements for commercialization.

It is evident that the commercialization of many forms of new knowledge continues to be a complex issue in Canada and abroad. This area of policy research will examine how innovation activities in the agri-food sector are funded, coordinated and commercialized, including the complex process of moving innovations between research institutions and commercial firms, and the role that IP plays in this process. CAIRN will continue to work with industry to identify successful commercialization strategies and to examine other barriers to commercialization, including size of market issues, financing issues, and regulatory and jurisdictional issues. From an international perspective CAIRN research will analyze the role

of migration, direct foreign investment, non-tariff trade barriers, and other factors that impact commercialization.

*Policy Area D: Innovation Impact and Measurement*

As the chief indicator of innovation system performance, there is an ongoing need to measure the economic costs and benefits to research and development (R&D). One of the prerequisites for investment in R&D is an expected high rate of return. While high returns to R&D have been well documented in the past, they cannot be taken for granted. Recent studies suggest lower investments in R&D are part of the reduced rate of productivity growth in farm level productivity.

Research is an incentive driven process that is impacted by the needs of individual groups who undertake it. For the public sector, the benefits, costs and distributional effects for the entire country are important. For producer groups, support for research levies is dependant on expected grower returns. Similarly, private research firms need to see an expected return on their investments. Each innovation system will have implications regarding how much research is done, its effectiveness, as well as who will pay for the research and who will benefit.

The measurement of R&D impacts is often complex. The returns to innovation may not be reflected in a specific output, but are evident in measures of total factor productivity, or in the case of basic research, downstream innovation benefits. International, spatial and cross commodity research spillovers are often important. Transformative innovation can lead to outcomes that are not anticipated at the time of investment. Long lead and lag times further complicate the analysis. Finally, research decisions are made ex ante meaning that the returns cannot be directly estimated but have to be anticipated based on past relationships. Given these complexities, a rigorous approach is needed to obtain reliable estimates. CAIRN will work with public and private institutions to provide these estimates and to develop knowledge that will improve the understanding of the returns to research, and importantly, what seems to be working and what does not.

### **1.3 CAIRN Membership (2010-2011)**

Julian Alston – University of California-Davis  
Henry An – University of Alberta  
Derek Brewin - University of Manitoba  
Ryan Cardwell - University of Manitoba  
Richard Carew – Agriculture and Agri-Food Canada  
Stephen Clark - Nova Scotia Agricultural College  
John Cranfield - University of Guelph  
Murray Fulton - University of Saskatchewan  
Hartley Furtan - University of Saskatchewan  
Viktoriya Galushko - University of Regina  
Pascal Ghazalian - University of Lethbridge  
Greg Graff – Colorado State University  
Richard Gray - University of Saskatchewan  
Jill Hobbs - University of Saskatchewan  
Wilf Keller – Genome Prairie  
Kurt Klein - University of Lethbridge  
Bill Kerr - University of Saskatchewan  
Bon Koo - University of Waterloo  
Andréanne Léger – Agriculture and Agri-Food Canada  
Stavroula Malla - University of Lethbridge  
Anwar Naseem – University of McGill  
Rose Olfert - University of Saskatchewan  
Peter Phillips - University of Saskatchewan  
Cammy Ryan\* - University of Saskatchewan  
Grace Skogstad – University of Toronto  
David Sparling - University of Guelph  
Stuart Smyth – University of Saskatchewan  
Bodo Steiner – University of Alberta  
Shelley Thompson – SJT Solutions  
Kien Tran\* – University of Lethbridge  
Jim Vercammen - University of British Columbia  
Crina Viju – Carlton University  
Simon Weseen – IBRG Consulting

\* New member 2010/11

## 2.0 CAIRN FUNDED PROJECTS

### 2.1 Graduate Student Projects Continuing or Initiated in 2010/11

#### 2.1.0 Overview

During 2010-11 CAIRN funded 13 projects that involved graduate student research. Some of these projects were initiated in the 2009/10 and most were initiated in 2010/11. These projects are all co-funded *in-kind* through supervisory roles, and other University support. Most of these projects also receive a significant amount of additional financial support through fellowships and scholarships, and project funding. Members are encouraged to seek additional funding sources even after CAIRN funding has been awarded with the understanding that unused CAIRN funds can be reallocated to fund additional research and support additional students. This approach has worked very well in leveraging the limited funding available in CAIRN to undertake a large body of innovation related research and to train a large pool of graduate students.

A list of graduate projects that were funded by CAIRN during 2010/11 is found below in Table 2, by alphabetical order of student surnames. These projects are briefly described in the remainder of the section in the same order.

Table 2.0- List of Graduate Student Research Projects Funded\* By CAIRN during 2010/11

#	<i>Students and Degree</i>		<i>Supervisor(s)</i>	<i>End Date</i>	<i>Topic</i>
2.1.1	Awada, Lana	Ph.D	Fulton	Jul-11	Adoption of Conservation Tillage Technology
2.1.2	Bartlett	M.Sc	Clark/Thomson	Jul-11	Regulatory Regimes for <i>Buy Local</i> Markets
2.1.3	Boland, Bill	Ph.D	Phillips	Mar-12	Role of P3s in PGR R&D
2.1.4	Bolek, Katarzyna	Ph.D	Gray/Alston	Oct-12	GRDC/EPR Seed Industry Models
2.1.5	Covey, Caalen	M.Sc	Gray	Jun-12	Cooperative Variety Trails
2.1.6	Galli, Fabrizio	M.Sc	Naseen	Aug-11	Returns to Genomics Research
2.1.7	Lassoued, Rim	Ph.D	Hobbs	Oct-12	Interface - Regulation and Private Standards
2.1.8	Ogochukwu, Albert	Ph.D	Hobbs	Mar-13	Adoption of Traceability Technologies
2.1.9	Pavleska, Marija	Ph.D.	Kerr	Dec-12	Regulatory Failure-GM Wheat
2.1.10	Torshizi, Mohammad	Ph.D	Gray	Mar-11	Dynamics of Hybrid Seed Pricing
2.1.11	Zhuhua, Xiao	Ph.D	Fulton	Oct-12	R&D Decisions by Producer Groups
2.1.12	Zubchenko, Anna	M.Sc	Vercammen	Dec-11	Time Inconsistent Innovation Competitions

\* These projects are all co-funded *in-kind* through supervisory roles, and other University support. Most of these projects also receive a significant amount of additional financial support through fellowships and scholarships, and project funding.

2.1.1 The Economics of Innovation: The Adoption of Conservation Tillage Technology

**Research Area:** Area 1 – Primary Competitiveness and Productivity

Policy Area A – Innovation Systems Analysis

**Location:** University of Saskatchewan

**Project Leader:** Murray Fulton

**Graduate Student:** Lana Awada, Ph.D. Student

**Funding:** Partially funded by CAIRN

**Status:** Estimated date of completion July 31, 2011

Lana is examining the adoption of conservation tillage technology on the Canadian Prairies in an attempt to understand the economic and social factors that have affected farmers' decisions in adopting this technology. Specifically, this research focuses on two objectives. The first objective is to determine the welfare implications of the switch from traditional tillage (TT) to zero-tillage (ZT) technology on participants in the spring wheat industry. To do this, an equilibrium displacement model will be constructed. Preliminary results from this model indicate that:

- The switch from TT to ZT increases the return to land, machinery, and herbicide suppliers
- The switch from TT to ZT decreases the return to farm-owned labour and to fuel suppliers
- A 1.0% increase in the efficiency of land in the long run increases the return to the suppliers of this input by around \$1.17 per acre
- The aggregate change in the return to the industry is positive
- Most of the increase in the industry returns accrue to land owners

The second objective is to empirically examine the impact of economic and social factors on farmers' adoption decision of conservation tillage technology in Saskatchewan and to understand if, in addition to economic factors, social factors such as farmers' interactions and farmers' membership in conservation tillage associations have influenced the rate of ZT adoption. To meet this objective a spatial model of interdependent preferences in a binary choice decision introduced by Yang and Allenby (2003) is used. The model assumes that a person's choice behaviour is not only influenced by economic factors but also by social factors such as geographic and demographic networks. The geographic network includes people who live in close proximity to one another and is measured as geographic distance between two individuals. The demographic network includes people who share characteristics such as education, age, household income, and membership in associations. To develop the database, data by agricultural census sub-division (CSD) for Saskatchewan from 1991 to 2006 are required. Tillage practices, age, education, farm size, soil types and sales data are available from the Canadian Agriculture Census and Census of Population; soil type data are available from the Department of Soil Science at the University of Saskatchewan; and farmer membership in conservation tillage association data are obtained from the Saskatchewan Soil Conservation Association (SSCA).

Lana presented a poster entitled "The Impact of the Switch from Traditional to Zero Tillage Technology on the Spring Wheat Industry on the Canadian Prairies" at the CAES conference "The Future of Farms and Food in Canada" in Ottawa, January 13-14, 2011.

2.1.2 Regulatory Regimes for “Buy Local” Markets

**Research Area:** Area 1- Primary competitiveness and innovation  
Policy Area B (Regulatory Systems Analysis)  
Policy Area C (Industry Coordination and Commercialization)

**Location:** Nova Scotia Agricultural College

**Project Leader(s):** Steve Clark, NSAC and Shelley Thompson, SJT Solutions

**Graduate Student:** Bartlett, M.Sc. Student

**Funding:** CAIRN Funded

**Status:** Ongoing; Estimated completion date July 31, 2011

**Project Description:**

“Buy local” has become more mainstream with bestsellers such as “The 100-Mile Diet” and “The Omnivore’s Dilemma” extolling the virtues of consuming locally produced food. “Locavore” has been introduced into the English language. Cities, such as Toronto, have seen the emergence of large-scale local food programs.

If buy local simply meant the desire to buy local foods on the part of the consumer, then there would be little need to study it as a separate entity because it could easily be incorporated within existing supply chains. Modern supply chains with existing mechanisms for food safety and identity preservation could easily incorporate buy local with minimal cost and little market disruption.

However, in one very important sense, the buy local phenomenon is a misnomer. It means more than a simple desire on the part of consumers to purchase locally grown food, it also implies a simplification of the food supply chain: getting to know your supplier. Many times sustainability is also coupled with buy local.

From this perspective, the buy local phenomenon can be viewed as much as the development of a set of food preparation skills and marketing value added chains as well as a geographic indicator of where food is produced. In fact, this seems to be the most important philosophical underpinning of the buy local phenomenon.

If buy local implies a simplification of the marketing chain, then it can no longer be easily incorporated into existing marketing structures. Historically, these simplified marketing structures have given way to the rise of the large scale marketing chains needed to facilitate modern agricultural production and distribution systems. They have traditionally been under the radar screens of policy analysts. If the buy local phenomenon implies a reversal of this trend, it does not in itself eliminate the issues involved in the marketing of agricultural products, especially those related to food safety and asymmetric information. Food safety and asymmetric information issues are fundamental to consumer confidence in food marketing systems, local or otherwise.

The purpose of this study is to analyze regulatory regimes for local marketing chains. If the buy local phenomenon gains momentum and grows to be a significant part of the marketing chain, there are several reasons why it is important to study the implications of this growth for regulatory regimes.

The objective of this study is to analyze existing local markets to identify the types of

regulatory regimes (including self regulatory schemes such as certification) that are used and to determine types that may be appropriate for these markets. Part of study will be devoted to analysis of existing informal and formal regulatory structures. How these markets deal with health and information asymmetries will be determined. Other issues that will be studied will include how well existing standards/certification such as HACCP, ISO14000 and Organics are incorporated into these markets. In this way, information with regard to how these standards may evolve if there is growth in buy local markets can be deduced.

The project will be undertaken in two phases. The first phase will use a case study method. One food cooperative and one local food market will be selected for intensive study. The first phase is intended to be a pilot for the second phase, where a set of surveys will be designed and a more formal set of data on local markets and food cooperatives will be collected and analyzed.

### 2.1.3 Plant genetic resource (PGR) management through public private partnerships

**Research Area:** Area 1- Primary competitiveness and innovation  
Policy Areas A, B, D

**Graduate Student:** Bill Boland, PhD.

**Location:** University of Saskatchewan

**Supervisor:** Peter Phillips

**Funding:** CAIRN

**Timelines and Progress to date:** Expected completion March 2012

**Student Profile:** Under University of Saskatchewan rules for outstanding graduate students, I was able to transfer from the MA to PhD program this year. Thus, while I am entering my first year of a PhD program in Political Studies, I am in my third year of graduate study. I have completed my last graduate class and am in the middle of my comprehensives. I have undertaken a significant portion of the research: I have completed an extensive critical analysis of the literature, investigated and tested a number of models and developed a number of unique data sets to use in the scholarly work. This work is discussed further in the context of three research articles in the objectives section. My supervisor is Peter W. P. Phillips, Professor of Public Policy in the Johnson-Shoyama Graduate School of Public Policy and former Head, Political Studies.

**Research Question:** Plant genetic resource (PGR) management refers the R&D intensive process of plant-breeding using biotechnology, genomics and molecular biology. Public-private partnership (P3) refers to the collaborative efforts of the public, private and voluntary sectors to collectively achieve specific policy objectives. Many models of the combined PGR-P3 exist at the local, national and international levels of operation. However, there is both a paucity of theory and a dearth of empirical analysis in evidence. I intend to advance the theory, analysis and policy review of the PGR-P3 by asking how do PGR-P3s contribute to the formation and operation of science and technology oriented agrifood R&D networks, specifically, how do they facilitate knowledge generation and technology transfer.

**Theory:** As the theory of the research P3 in general and the PGR-P3 in particular, are undeveloped, a number of theories are needed to contextualize the PGR-P3. New public management (NPM) seeks to lower taxes and government expenditures by the application of private sector management techniques and objectives to the provision of government services. This includes the use of technology to reduce labour and increase productivity. P3s are both a

policy option and a tool for government to privatize public or collective pool goods. The theory of knowledge development suggests that the process of knowledge generation has changed from an institutional and mono-disciplinarian hierarchal process driven by academic enquiry to an inherently collaborative process where heterogeneously organized networks form around problem-focused and solution-oriented P3s. Industrial organization theory posits that knowledge development is a public good, where the returns on investment are insufficient to warrant private investment in basic research and development. Therefore, for cost sharing and commercialization reasons public and private collaboration may offer one solution to the public goods failure. Transaction costs theory hypothesizes that organizations, over time and without external constraint, organize in a manner that produces the lowest cost of contract management and enforcement.

**Methodology:** As the PGR-P3 challenges existing theory I have developed a unique methodology based upon on a deductive framework in combination with social network analysis and statistical analysis. The deductive framework is based upon the theory and methodology of international political economy (IPE), which is a family of political and economic theories and research tools. This will permit a component-level analysis of the PGR-P3. The overall study will be grounded in methodological individualism of public choice theory. Social Network Analysis (SNA) is a tool that illuminates the previously invisible relations between individuals and institutions in a networked environment. With SNA it becomes possible to graphically identify and quantify the relative power relations and functions between individuals and organizations within a network or sub-networks. SNA utilizes three unique measures of centrality. First, degree centrality measures the ability of a single actor to influence communications over a network providing that actor with relative control over the flow of information. Second, betweenness centrality measures how often an actor is positioned between the shortest paths linking other actors. Third, eigenvector measures power by measuring the relative strength of one actor's connections to other well-connected actors'. Put simply, a high eigenvector rating implies relative power in a network is derived from the relative importance of an actor's connections, not the quantity of connections. Statistical analysis permits the researcher to investigate causal factors that influence the outcome of relationships.

**Research Objectives:** This research is directed to producing three interrelated articles on the role of P3s in PGR research and development.

The first article examines the role of the PGR-P3 in managing the global pulse-crop breeding network. Pulse crops, which include peas, beans, lentils, chickpeas and faba beans, are a major export commodity for Canada. A preliminary analysis has identified and coded 248 actors in the global pulse network, consisting of 42 PGR-P3s, 107 government agencies, 83 universities and 16 private entities. The PGR-P3 represents 17% of the actors in the global network, but occupies 7 out of 8 top positions in all three SNA centrality measures. Furthermore, the global pulse network actually consists of three functioning sub-networks, each centered on at least one PGR-P3. One sub-network is focused on Europe, one in the Developing World, and one consists of Canada, Australia and the United States. If one were to remove two key PGR-P3s from each sub-network, all three would cease to exist in a recognizable network format. This article uses theory and SNA to explore the institutional and relational factors that provide the PGR-P3 with the characteristics critical to the formation and management of science and technology oriented agrifood R&D networks.

The second article reviews all Agriculture Canada (AAFC) peer-reviewed and published scientific canola articles from 1981-2007 to examine the role of collaborative research in improving the quality of research as measured by relative citation rates. During this period, canola research was transformed from a public process to a collaborative public-private venture involving government, the private sector and PGR-P3s. During the 1981-1996 period, AAFC collaborated on 21% of its published articles resulting in a citation rate lower than solely-AAFC authored articles. During the 1997-2007 period, AAFC collaborated on over 50% of its canola papers resulting in a substantially higher relative citation rate than non-collaborative AAFC papers. Research indicates an increase in research partners leads to an increase in citation rates. These articles have been coded by source of funds, research field and institution, and these variables will be examined further as potential explanatory variables. This article uses theory, SNA and statistical analysis to examine the role of collaboration in improving the efficacy of public-private research as measured by relative citation rates.

The third article focuses on developing a comprehensive typology of P3s, ranging from the uncomplicated contractP3 to the sophisticated science and technology research P3. P3s will be delineated by theory; new public management; theory of knowledge; industrial organization and transaction costs theory. The primary objective of this article is to provide a working PGR-P3 typology to define the institutional, relational and research characteristics associated with PGR-P3s that will fill a large void in the literature.

**Contribution to the advancement of knowledge:** Given the focus on knowledge-based growth, there is a need to examine further the microeconomic governance challenges of creating and exploiting new knowledge. My research aids the advancement of knowledge in the following six areas. First, this research advances the theory and analysis of the PGR-P3, which is currently deficient. Second, this research aids in the advancement of the generalized theory of P3s. Third, this is the first attempt to publish a comprehensive and multi-disciplinary typology of P3s. Fourth, the combined SNA and statistical methodology can easily be transferred to examine and review other commodity and research networks. Fifth, the methodology can be refined to provide a tool to analyse complex governance systems. Sixth, my research will modestly improve the knowledge of collaborative research.

**Suitability to the CAIRN Research Matrix:** This research proposal meets the requirements of the Primary Competiveness and Productivity area of CAIRN research in three of the four Innovation Policy areas. The first article, which as noted, examines the global pulse innovation network and sub-networks, is closely aligned with the research criteria of CAIRN'S Innovation Systems Analysis and the requirements of the Industry Coordination and Commercialization section. The second article, which examines the role of collaboration in improving the quality of scientific articles as measured by relative citation rates, meets the needs of the Innovation Impact and Measurement section. Overall, the methodology developed for this research is suitable for expansion for the analysis and review of complex governance systems used to regulate agrifood innovation.

**Research Output to Date:** My research is directed to the production of three inter-related articles on the PGR-P3. The first article uses social network analysis to demonstrate that the PGR-P3 provides the structural integrity for the global pulse breeding R&D network of 248 actors. The global pulse system consists of three independent regional networks, which are constructed from various national breeding programs. The PGR-P3 anchors the national programs and links these programs into the three regional networks. The PGR-P3 then

connects the three regional networks into the global system. This article was presented at the Triple-Helix Conference in Madrid Spain in October by Peter Phillips; by myself at the VALGEN Conference in January and was a part of Peter Phillips presentation at the same VALGEN Conference.

The second article utilizes a regression analysis on 490 AAFC peer-reviewed scientific canola articles published over a 10 year period to demonstrate that the PGR-P3, when financing and managing research, can lead to increased rates of knowledge development and technology transfer as measured by citation rates. The objective is to determine the factors that led to a 60% increase in citation rates between the two five-year intervals of 1997-02 and 2003-07, in which the citation rate improved from .66 to 1.11 when compared to the global average of 1.0. The regression analysis indicated that the use of a PGR-P3 as a funding source and/or the use of the AAFC Matching Industry Initiative (MII) as a funding source lead to a doubling of citation rates.

The third article fills a void in the literature by developing a typology for the PGR-P3 based upon the type of knowledge developed, the organizational structure employed and the objective/output of the PGR-P3 by integrating the three theories with the different variables associated with research such as type of knowledge and the mode of research. The typology will provide the basis for an article/literature review of the PGR-P3, designed to be a landscape analysis of the state of the art in both the PGR-P3 and the R&D-P3.

**Status and Timelines:** As of Sept. 2010, I had six tasks remaining: completion of the three articles and the completion of the three comprehensives. I completed my first comprehensive, written and oral, in November 2010. I anticipate completion of my second comprehensive by May 2011. I have begun the literature review for my third and final comprehensive with a target of August 2011 for completion. My first article on the role of the PGR-P3 in the pulse industry is complete and is being formatted for publication to Research Policy for publication. The second article on the PGR-P3 and canola is 70% complete and I anticipate sending it out for publication in July. The third article the typology of the PGR-P3 is 50% complete and I anticipate a completion date of September 2011. In September, I submitted a poster of my first article at the 10<sup>th</sup> annual Agricultural Biotechnology International Conference (ABIC) in Saskatoon. As earlier noted, I presented this article at the recent VALGEN Conference.

#### 2.1.4: The Economics of Seed Industry Ownership Models

**Research Area:** Area 1. Primary Competitiveness and Productivity,  
Policy Area A (Innovation Systems Analysis)  
Policy Area C (Industry Coordination and Commercialization)

**Location:** University of Saskatchewan

**Graduate Student:** Katarzyna Bolek (Ph.D.)

**Researchers:** Richard Gray and Julian Alston

**Funding:** Cairn Funding

**Introduction:** The crop research system in Australia has undergone major transformation since the introduction Grain Research Development Corporation (GRDC) more than a decade ago. The GRDC, funded by a research levy and controlled by producers, has become the major funder of crop research in Australia. Committed to working with the public and private sector the GRDC has a complex and evolving relationship with other players in the seed sector. In some crops the GRDC has committed to license germplasm to the private seed industry who

develop, propagate and sell seed for new crop varieties. In other cases the GRDC has partnered with the private sector and state governments to create corporations that make direct investments in the seed industry. The result is an evolving mix of new institutions that play a critical role in crop innovation.

The inherent non-rival nature of knowledge and economies of size in seed production creates economic forces for market concentration and market power, which in turn, can distort incentives and the efficiency of the innovation process. Understanding the roles of the producer directed GRDC within this inherently non-competitive environment and the economic impact of these alternative ownership and control structures can inform producer funded research organizations in Canada and elsewhere. These implications are not only important for the future direction of the GRDC but also for Canada and other jurisdictions that are contemplating new crop innovation systems.

**Objective:** The objective of this project, which will feed into a broader Ph.D. dissertation, is to develop the knowledge and begin to model the economic incentives within the GRDC vertical ownership and IP management structures. The inherent non-rival nature of knowledge and economies of size in seed production creates economic forces for market concentration and market power, which in turn, can distort incentives and the efficiency of the innovation process. Understanding the roles of the producer directed GRDC within this inherently non-competitive environment and the economic impact of these alternative ownership and control structures can inform producer funded research organizations in Canada and elsewhere. These implications are not only important for the future direction of the GRDC but also for Canada and other jurisdictions that are contemplating new crop innovation systems.

These GRDC structures will be compared to existing models in the industrial organization (IO) literature dealing with producer and cooperative organizations within vertical market structures. Where applicable IO models exist, they will be used to describe how the producer involvement should alter incentives, behavior, and economic consequences. Where models do not exist, existing IO models will be modified to reflect the incentives and structures found within the GRDC structures.

The economic models of the GRDC structures will be used to compare these structures to counterfactuals of pure public and pure corporate ownership structures. This theoretical comparison will help identify the key features of these structures, where they are likely and unlikely to work better than the counterfactuals. If there are GRDC models that show promise they will be identified as candidates for further study and analysis. This preliminary exploration will increase the understanding of producer-controlled check-offs, the role they can play in the emerging bioeconomy, and the gaps in knowledge where more research is needed. The results will be described in a policy brief.

**Proposed Timelines and Progress to Date:** The proposed research has commenced as part of Ph.D. Dissertation. Ms. Bolek has completed all class requirements and is qualified to write her dissertation. She has travelled to Australia, and helped interview officials in the GRDC, DAFWA, InterGrain and Australian Grain Technologies and has collected data from Western Australia on wheat variety pricing and adoption. She has co-authored a policy brief and an AAFC report (see publications below). Subject to the approval of her committee she hopes to defend her dissertation by the end of 2012.

2.1.5: The Economics of Cooperative Variety Trials

**Research Areas:** (1) Primary Competiveness and Productivity and in Innovation Policy Areas  
(C) Industry Coordination and Commercialization  
(D) Innovation Impact and Measurement.

**Location:** University of Saskatchewan

**Graduate Student:** Caalen Covey (M.Sc.)

**Project lead:** Richard Gray

**Funding:** CAIRN Funding – other funding will be applied for

**Duration:** April 1, 2011 to June 30, 2012

**Use of Funds:** The funds will be used to support Caalen Covey during his thesis research. Caalen's family farms at Beechy, Saskatchewan. Caalen has worked three years with Dow AgriSciences as a summer student and has earned an 80% average during his first term of studies.

**Background:** In Western Canada new crop varieties are compared in side-by-side tests in several locations throughout the region via co-operative research trials that are supported by public funds. Based on these tests, an annual crop variety guide is produced, which publishes the relative yield of crop varieties and other agronomic information such as days to maturity, lodging resistance, disease resistance etc. These reports are used extensively by producers in deciding which varieties to grow, speeding the adoption of superior varieties. Reducing the information asymmetries between those selling the varieties and producers that purchase them, the cooperative variety trials play a potentially crucial role in the crop innovation system.

**Research Impact:** While there are many studies of the returns to agricultural research there are very few studies that have examined the returns to public knowledge generation in the context of technology adoption. Despite the current support for the variety testing system, governments often face pressure to reduce funding for these trials, and some parts of the seed industry are sometimes reluctant to participate in these trials. A Benefit /Cost analysis will serve to quantify the economic impact of this public/investment to better inform the process of resource allocation.

**Research Objective:** The objective of this research will undertake a benefit/cost analysis to quantify the economic benefits and cost of cooperative research trails, to calculate the social return to these activities. The goal is to produce a Thesis, a Policy Brief and a Journal article from this analysis.

**Research Methodology:** The theoretical aspect of this problem utilizes the economics of information to develop a model for adoption. More than 30 years of variety testing and adoption data will be used to econometrically estimate role of information in the adoption process. The estimated parameters from the model will be used to simulate adoption with and without variety testing. Using a partial equilibrium framework these simulations will be used for a Benefit/Cost analysis.

**Timelines:**

April 15, 2011- Class completion,

June 1 – Background Review and proposal completion

August 1 – Literature and Methodology

December 1- Data and Econometric analysis completed  
Feb 1,2012 – B/C completed  
June 15, 2012 – Thesis defended

2.1.6 Analysis of Economic Returns to Genomics Research on Crop Breeding

**Research Area:** 1. Primary Competitiveness and Productivity,  
Policy Area A (Innovation Systems Analysis)  
Policy Area C (Industry Coordination and Commercialization)

**Location:** McGill University

**Graduate Student:** Galli, Fabrizio (Ph.D.)

**Project lead:** Anwar Naseem, anwar.naseem@mcgill.ca

**Background:** The science of genomics has the potential to make important contributions to health, agriculture, environment and related sectors. For example some of the most important avenues of drug development are due to research on pharmagenomics where researchers employ genome markers to predict drug response and safety. Similarly in agriculture the use of molecular markers holds considerable potential in improving the efficiency of the breeding process allowing for genotype based selection over more time consuming phenotypic selection. To appreciate the power of markers to improve backcross breeding consider that for the majority of crops, over “90% of the recurrent parental genotype can be recovered within two generations when a suitable number of markers and an adequate number of progeny is used for backcross selection” (Xu and Crouch, 2008). Relative to conventional backcross this represents a significant saving in time. Genomics has allowed the identification of a large number of markers for economically important species, such as maize. However gaps remain as molecular marker maps for many horticultural and open pollinated crops have been slow to come with only a few QTLs identified.

Over the years, governments and private sector firms have made significant investments in genomics, seeking to sequence and characterize the genomes of a wide variety of organisms. For example, the combined investment of the Japanese and U.S. governments to sequence the rice genome amounted to nearly \$300 million by the time it was completed in 2002. The private sector, led by Syngenta and Myriad Genetics, spent nearly \$50 million using the less expensive shot-gun technique. Although the cost of doing genomics research is considerably less that it was five years ago, estimating the payoffs to these investments has been a challenge. At the macro level, the gains in productivity are one indication that investment in agricultural genomics and plant science research are having in impact. With the exception of maize, yield growth of other crops has been stagnant since the 1990’s at 1% per year and no significant yield change is observable for the last 5 years, when the payoffs to genomics research, especially from MAS breeding, were expected to start registering.

Although attributing the impacts of genomics is difficult without further analysis, the available evidence (even if somewhat anecdotal) does suggest that the dramatic gains in productivity from genomics have not been forthcoming. There may be a number of reasons that explain this seeming disconnect between the gains that have been made in our understanding of plant genomes and the lack of progress in breeding. First, there exist lags between discoveries in basic research and those that occur downstream suggesting that it may be too early for these benefits in genomics to spillover into breeding. Second, the use of markers in breeding programs is not costless and will require investments to build capacity and infrastructure to take advantage of molecular marker maps. The issue of how much to

invest in MAS breeding is complicated by the fact that MAS and conventional breeding are not direct substitutes, which requires that the research manager make an economic assessment of which method to use. Significant gaps in knowledge remain as to the benefits and costs of alternative breeding methods, which make investment choices difficult. Under certain conditions, phenotypic based selection may be faster and inexpensive offering an advantage over MAS, whereas in other cases MAS may offer enough time saving over conventional techniques that having the benefits arrive earlier would justify the higher cost. Developing a methodology that estimates the cost-effectiveness of conventional and MAS breeding will be useful to researchers and research managers alike.

A third reason that has been suggested as to why MAS breeding may not have been as effective is the lack of integration of plant breeding programs with complementary disciplines (Reece and Haribabu, 2007). Successes in developing crops with desirable traits will require an inter-disciplinary approach that involves molecular biologists, plant scientists (especially breeders), soil scientists, extension specialists as well as social scientists. Such an integration of disciplines is needed especially in resource scarce environmental to allow for a more focused research programs directed towards meeting the needs of the farmers.

We explore these issues within the context of economically important crops for Canada, such as canola, soybean and corn. These crops have quality traits, such as oil content, protein content, and carbohydrates that make it desirable for a variety of uses from human consumption and feed to industrial processes, depending on the combination of traits that are amplified. Given the high cost and time required to build up the infrastructure for a MAS program, identifying costs and benefits of a MAS based breeding program versus a conventional breeding will inform research planners. These costs will, of course, vary based on the particular crop, the genetic complexity underlying the trait, whether markers are already available, and the expertise required in using the markers in breeding. The benefits too will vary, and would also depend on how much time is saved (if at all) with MAS breeding relative to conventional and the value of productivity gains from having new varieties come sooner.

**Theoretical Framework and Methodology:** The most widely used methods in evaluating the economic benefits of agricultural R&D outputs are based on measures of economic surplus. This methodology is preferred because economic surplus concepts underlie the conventional economic rationale for government intervention in providing agricultural research through the public sector (Alston et al., 1995). The economic surplus approach estimates returns on investment by (1) calculating the change in consumer and producer surpluses that results from technological change brought about through research, and (2) using estimated economic surplus together with research costs to estimate the returns to research through NPV or IRR. The economic surplus methods could either be used to project future benefits (*ex-ante*) or current benefits (*ex-post*) from investment in to research or technology. The economic surplus model is also more advantageous than cost-benefit analysis and econometric models since it does not assume either perfectly inelastic or perfectly elastic supply or demand. In addition, the economic surplus calculation incorporates international price effects and distributional effects, unlike the cost-benefit analysis.

Our major focus is to estimate the costs and returns to genomic based breeding research and the pay offs associated with that. Therefore a detailed economic analysis considering

different scenarios, with and without the use of molecular markers associated with single or multiple traits would be considered. In addition, we would estimate both direct and indirect benefits that have wider impact on the overall economy of the region or country in comparison to the rest of the world.

The current study would adopt methodologies outlined by Dreher *et al* (2003); Morris *et al.* (2003); Moreau *et al.* (2000); and Brennan and Martin (2007), which provided economic analyses of MAS breeding. However these studies focused mainly on the cost side of breeding technologies, with less emphasis on quantifying benefits. A recent study by Alpuerto *et al.* (2009) accounted for the benefits of developing and releasing salinity-tolerant and phosphorous-deficiency tolerant rice in Bangladesh, India, Indonesia and the Philippines, and are estimated for marker assisted breeding (MAB) and for conventional breeding (CB) using economic surplus analysis. Here we would modify the approach by Alpuerto *et al* to derive welfare gains for a highly competitive, open-economy like Canada along with its impact in the rest of the world.

We anticipate using a multi-region, partial-equilibrium approach described by Alston, Norton and Pardey (1995) which allows for the exploration of the influence of a broad range of policy, market, technology and adoption factors on the timing, magnitude, and distribution of the economic benefits of R&D. To evaluate the stream of benefits and costs of the genomics research program, net present values (NPVs) and internal rates of return (IRRs) would be calculated for the marker-assisted breeding programs and compared to NPVs and IRRs for conventional breeding. Research costs would include primarily the MAS breeding project costs for specific traits in Canada.

The major outcome of this research would be to develop an economic surplus model to estimate the extent and distribution of gains of introducing MAS based trait technologies to the target crops. This would also estimate the potential gains of such modified varieties, their timing of delivery and the potential of other events and traits that could be bundled of into the existing product.

### **Relationship to CAIRN Network**

The proposal outlined contributes towards CAIRN's objective of measuring the impact of innovation in the area of primary competitiveness and productivity. While the objective, in the first instance, seeks to measure the impact of MAS on breeding for specific crops/traits, the broader objective of the project is to develop a conceptual framework for impact analysis for plant genomics research. As indicated earlier despite the large amount of investments that have been made on genomics research worldwide, and especially Canada, it is important to evaluate the returns to such research in order to sustain policy support and further funding. Careful identification and analysis of the different cost and benefits, will inform policy makers on the ultimate value of genomics research.

### **Timeline:**

The proposed study will be carried out over a period of 16 months, from May 2010 to August 2011.

**Timelines and Progress to date:** Data collection and consultation with canola breeders is ongoing. Data analysis will be completed over the summer.

2.1.7 Co-regulation: Exploring the Interface Between Regulation and Private Standards

**Research Area:** Area 2 – Functional Food and Food Processing Development

Policy Area B – Regulatory Systems Analysis

**Location:** University of Saskatchewan

**Project Leader(s):** Jill Hobbs

**Graduate Student:** Rim Lassoued, Ph.D. Student

**Funding:** CAIRN Funded

**Status:** The research is progressing a proposed. Expected completion date July 1, 2012.

**Project Description:**

Innovation in the food industry brings new products and new technologies to the market and may also change the nature of food distribution systems. Innovative new products and new technologies also generate new challenges in assessing and monitoring safety and assuring the veracity of quality claims. Governments routinely intervene in markets to establish regulatory frameworks for food safety generally and for emerging technologies in particular, and sometimes also for food quality attributes. At the same time, private mechanisms (standards) for food safety control and food quality assurance have become increasingly important as evidenced by the growing array of private and third party quality assurance labels, ‘Good Agricultural Practice’ programs, etc. Thus, public regulation and private standards are often viewed as separate alternatives. As has been noted elsewhere, however, rather than a discrete choice between public and private standards, in practice there is often a continuum between the two (Fearne and Garcia Martinez, 2005; Gunningham et al., 1998). So-called ‘co-regulation’ is an approach which aims to combine public sector regulation with private standards, through a mixture of primary legislation - with its relatively predictable and binding nature - as the governing framework, reinforced by the more flexible self-regulatory approach (Fearne and Garcia Martinez, 2005; Eijlander, 2005). One of the challenges lies in aligning the incentives embedded in private standards with the broader social objective function inherent in public sector regulation.

This project would explore the concept of co-regulation with respect to assuring the safety and quality of innovative food products or those produced with emerging technologies. A comprehensive literature review will form the basis of an examination of the use of co-regulation in other countries and in other contexts (e.g. where relevant, lessons from non-food examples of co-regulation will be explored). The challenges in designing an effective co-regulatory strategy for food safety and quality in Canada, particularly with respect to emerging technologies, will be examined. An economic framework for evaluating co-regulation will examine issues such as the extent to which different co-regulatory approaches are incentive compatible, and the role of public sector agencies and third parties in monitoring compliance with standards. Knowledge gaps will be identified as a component of defining further research needs in this area.

2.1.8: Exploring the Adoption of Traceability and Food Quality Verification Technologies

**Location:** University of Saskatchewan

**Graduate Student:** Albert Ugochukwu, PhD student

**Researcher:** Jill Hobbs

**Funding sources:** CAIRN

*Objective or Abstract:*

The food industry operates in a highly competitive global environment with products differentiated on the basis of numerous quality dimensions, many of which are credence attributes. Consumers are increasingly interested in where their food comes from and how it was produced. This creates an information challenge for the food system in credibly communicating credence quality attributes to consumers. Assuring the veracity and credibility of quality claims is, in essence, an information problem. Potential solutions to this information problem arise in the form of new technologies and innovations in the food sector and the extent to which these technologies will be adopted and integrated into supply chain relationships within the food sector. The project draws upon the economics of information and signaling literature to examine the role of food industry innovations in delivering credible quality signals, combined with insights from the supply chain economics literature. A conceptual model will be developed exploring the factors affecting traceability and quality verification technology adoption within a multi-level supply chain.

**Progress to Date:**

Literature review underway. Concepts for three thesis papers under discussion. Basis of conceptual model under development. Student completing coursework in April 2011. Project still underway with continued funding in 2011-12.

*2.1.9 Regulatory Failures and Risk in Innovation – The Case of GM Wheat*

**Research Area:** Area 1 – Primary Competitiveness and Productivity

Policy Area B – Regulatory Systems Analysis

**Location:** University of Saskatchewan

**Project Leader(s):** William A Kerr

**Graduate Student:** Marija Pavleska (PhD student)

**Funding:** CAIRN Funded

**Economic Issue:** World population is expected to grow by at least 2 billion people over the next 25 years. Wheat has the potential to be a major contribution to satisfying this increased demand – but productivity must be increased. The rate of increase in improvements to wheat productivity in Canada (and elsewhere) has declined over the last decades. A new, some would say transformative, technology is, however, available that has the potential to considerably boost wheat-growing productivity. The science is sufficiently encouraging that significant investment in research would be forthcoming – but regulatory failures abound. As a result, productivity-enhancing investments are inhibited. The regulatory failures are manifest both domestically and abroad. It is a “fact of life” that Genetically Modified (GM) products will not be accepted by all consumers or in all markets. This means that GM varieties must be segregated from non-GM products on the land and through the domestic supply chain. Co-existence is the term used for segregation on the land. In Canada, as yet, there is no regulatory regime to ensure that non-GM crops can co-exist with GM crops – a regulatory regime to control contamination. Thus, there is no way that Canadian wheat producers can be assured that they can produce wheat that can cater to the specific demands of consumers with different preferences and markets with different requirements – it is simply too risky to allow the licensing of GM wheat. Internationally, regulations surrounding import tolerances are supposed to be based on science and risk assessments. While these criteria have been enshrined in the World Trade Organization for 15 years, they are clearly not working – they do not provide a sufficient guarantee of market access for non-GM wheat if GM wheat were to be licensed. It is expected that this degree of regulatory risk inhibits investments in

wheat and distorts the investment that is undertaken. These regulatory failures are recognized but they are poorly understood – which leads to considerable frustration in the innovation community, among farmers, in regulatory institutions and in governments. A better understanding of these market failures, and hence their mitigation, would be an important contribution to innovation policy.

**This Research and CAIRN Objectives:** This research fits solidly in a range of CAIRN objectives: identify and resolve obstacles to innovation, build a body of knowledge, train graduate students, and increase the understanding of the agricultural innovation system in the context of its regulatory environment. The research will be undertaken by a PhD student, it is centered on a better understanding of regulatory failure, market access risk has not been studied to any great extent so the thesis will help build a body of knowledge.

**Research Timeline:** Full time work on the thesis should commence in the spring of 2011 and be wrapped up by the end of 2012 or early 2013. The thesis will follow the three-essay mode that is now common in Economics and Agricultural Economics. I would expect that it will result in three Policy Briefs for CAIRN with the first one – based on the first essay’s work – near the end of 2011.

**Theoretical Framework:** PhD theses in agricultural economics often take the form of three essays tied to a general theme – and ideally should illustrate various desirable facets of a student’s abilities – (1) the ability to make a theoretical contribution; (2) empirical competency and (3) the ability to analyze a policy problem. The research objective of the first essay would examine the nature of the current failure of the WTO science-based/risk assessment criteria in the context of market access risk. Science based decision-making was enshrined in the WTO’s SPS agreement but instead of improving security of market access it has increased market access risk. This will be a theoretical contribution that examines the current science paradigm – the Risk Analysis Framework – within the context modern economic-based risk theories. The second essay will empirically examine the relationship between international market access risk and investment that would enhance wheat productivity – both levels and emphasis. The third essay would examine the factors that affect economic feasibility of co-existence in the context of prairie agriculture – how to reduce the risk of contamination – the latter has been identified by the Canadian Wheat Board as a primary area of interest.

#### 2.1.10 The Dynamics of Hybrid Seed Pricing: Lessons from the Canola Industry

**Research Areas:** (1) Primary Competitiveness and Productivity  
(C) Industry Coordination and Commercialization  
(D) Innovation Impact and Measurement.

**Location:** University of Saskatchewan

**Graduate Student:** Mohammad Torshizi, Ph.D. student

**Project Lead:** Richard Gray

**Funding:** CAIRN for proposal development

**Duration:** Feb. 1, 2011 to March 31, 2013

**Use of Funds:** The CAIRN funds were used to support M. Torshizi, a Ph.D. student during his final term of classes, to develop a research proposal for his Ph.D. studies. Mohammad is an excellent student with the highest average grades in his cohort. In April 2011 Mohammad was awarded a Ph.D. fellowship.

**Brief Project Description:** The purpose of this dissertation is to explore the dynamics of seed research, seed pricing, and economic impacts in hybrid crops, informed by economic theory and an empirical study of hybrid canola seed industry. The dissertation will explore how the resulting dynamic economic impacts of private hybrid seed industry will be affected by technological assumptions and research policy.

**Research Impact:** The issue of the hybridization of seed pricing is very important in today's economics climate. In some crops, notably corn and canola, the introduction of hybrid technologies has stimulated significant private investment, which has displaced public variety development. The result has been an acceleration of yield increases with producers paying a significant share of gross revenue for seed each year. As governments increasingly face other budget demands, hybrid systems and other legal mechanisms, such as end point royalties that annually reward private investors, are becoming more important in policy development. A study of the impacts of hybridization will inform policy makers about investments in hybrid technologies and about policies for stronger intellectual property rights.

**Research Methods:** The following process will be modeled dynamically: A farmers' decision to purchase a hybrid would be based on a comparison of yield and seed cost per acre for hybrid and inbred. Relative yields are not fixed over time. If research on inbred seed varieties are halted or diverted, inbred seed yield will decrease over time due to pressures from diseases and pests, while the hybrid varieties will benefit from research investment. Therefore, one would expect the ratio of hybrid yield to inbred yield to increase over time. As the relative yield changes in favour of the hybrid, the inbred line seed becomes less attractive to farmers and willingness to pay for hybrid increases. With market power the seed producers could take advantage of this opportunity and increase the price of hybrid seed year after year. This in turn generates more money for research, more investment and higher seed prices. Based on the theoretical model an empirical model will be developed to examine Canola hybrid and estimate the model with pricing data from Canada and France. A dynamic partial equilibrium will then be used to simulate the evolution of the industry, to be able to simulate the welfare impacts over time across a range of policy and technology scenarios.

**Expected outputs:**

- Ph.D. dissertation
- Policy Brief

**Timelines:**

- December 31, 2011 theoretical model
- May 31, 2012 Empirical model
- Sept 30, 2012 Simulation model
- Dec 31, 2012 Dissertation Draft completed
- March 31, 2013 Ph.D. Defense

2.1.11: R&D Decisions by Producer Groups

**Research Area:** Area 1 – Primary Competitiveness and Productivity  
Policy Area C (Industry Coordination and Commercialization)

**Location:** University of Saskatchewan

**Project Leader:** Murray Fulton

**Graduate Student:** Xiao Zhihua

Xiao is examining the decision by producer organizations to invest in agricultural R&D. Existing empirical evidence suggests that producer groups are under investing in agricultural R&D as evidenced by the high rates of return that have been estimated for the activities they have undertaken. These calculations, however, rest on a number of key assumptions, including that farmers are able to capture all the benefits from R&D and that they conceptual the investment decision in the way assumed by the underlying theoretical model. The purpose of this thesis is to re-evaluate the decisions made by producer groups and to see if this re-evaluation alters the conclusion that producer groups have underinvested.

Producer groups are collective organizations. There are a number of explanations as to why collective organizations might have trouble raising capital, explanations that carry over to the case of R&D funding. These explanations include the horizon problem and the portfolio problem (Olson 1971, Jensen and Meckling 1979, Cook 1995, Vitaliano 1983). The horizon problem (Jensen and Meckling 1979, Cook 1995, Vitaliano 1983) occurs when the farmer's time horizon of staying in the group is shorter than the expected payback time of the R&D investment. As a consequence of this shorter time horizon, the anticipated returns to R&D – which is inherently has a long time horizon – will be less than would be expected were the longer time horizon to be used. The portfolio problem (Jensen and Meckling 1979, Cook 1995, Vitaliano 1983) emerges when farmers are forced to contribute to group interests that constrains their diversification across assets. R&D check-offs and the subsequent investment in R&D can be seen as part of a farmer's investment portfolio. If they are risk averse, farmers may wish to spread their investments away from R&D and towards other assets, thereby reducing their willingness to invest in R&D. As a result they will pressure group decision makers to reduce R&D investment.

The first major objective of this paper is to recalculate the internal rate of return (IRR) of R&D at the producer group level by incorporating the horizon problem, risk aversion and the portfolio problem into the rate of return analysis. The incorporation of the horizon problem involves an explicit consideration of the land tenure arrangements at work in agriculture, since these land tenure arrangements affect the degree to which the benefits of agricultural R&D are shared between tenants and land owners, and hence on the incentives that these different groups have to invest in agricultural R&D.

The second major objective is to consider the way in which farmers view the decision to invest in agricultural R&D and the risk that flows there from. More specifically, the thesis will look at how prospect theory and the theory of mental accounts might affect the agricultural R&D decisions made by farmers. Although this part of the thesis is not yet developed, thought is being given to undertaking economic experiments to estimate the degree to which farmers frame the agricultural R&D problem.

2.2.13: Time Inconsistent Commercialization Competitions

**Research Area:** (2) Functional Food and Food Processing Development  
(3) Bio-energy/Bio-product Development  
(C) Industry Coordination and Commercialization;

**Lead Investigator:** Jim Vercaemmen, University of British Columbia

**Supported Student:** Anna Zubchenko (currently completing her second semester of the M.Sc. in Agricultural Economics program at UBC)

**Research Period:** April 1, 2010 to March 31, 2011

**Other Sources of Support:** Funding will be requested from the BC Innovation Council. If successful, the amount requested from CAIRN will be reduced to achieve \$18,000 total funding.

**Issue:** Commercialization of technologies by entrepreneurs is an important source of innovation and growth. A lack of financing (typically venture capital), which is required to move early stage innovations into the product development and commercialization stages, often dooms socially valuable innovations to permanent failure. This failure is especially problematic for society if the potential spillovers from the project and/or the environmental externalities addressed by the project are large.

In an attempt to address pre-commercialization market failure, public agencies often provide entrepreneurs with financial assistance. Because of limited resources and information asymmetries, it is common for governments to use commercialization competitions and to require matching contributions by the entrepreneurs who are awarded a commercialization award. For example, the British Columbia Innovation Council (BCIC) recently awarded prizes ranging from \$150,000 to \$250,000 to four entrepreneurs who were competing in the 2009 Competition of Agricultural Technologies (CAT) competition. Receipt of these awards are contingent on matching contributions by the winning entrepreneurs.

Public agencies, which host commercialization competitions, may have dual objectives. From an ex ante perspective the agency would like to induce each entrepreneur to devote an efficient amount of resources to his/her project, accounting for resource costs and the expected social benefits associated with successful commercialization of the innovation. From an ex post perspective, the commercialization award should maximize the expected social value aggregated across all projects, which may entail maximizing the number of socially valuable projects which are successfully commercialized.

**Research Objectives:** The purpose of this research is to demonstrate that the ex ante and ex post objectives of a public agency may be in conflict when setting the ex ante parameters of a commercialization award competition and subsequently choosing which entrepreneur will receive the award. Specifically, the award criteria, which are publicly announced when the commercialization competition is launched, may be different than the ex post award allocation criteria, which is retained as private information by the agency. In other words, agency decision-making in the commercialization competition may be time inconsistent. Informal discussions about time inconsistent award policy by those involved in the BCIC CAT competition was the prime motivator for this paper.

Kydland and Prescott (1977) clearly articulated the consequences of time inconsistent outcomes. They assert that such outcomes are the result of discretionary policy, which they define as “the selection of that decision which is best given the current situation and a correct evaluation of the end-of-period position”. They conclude that time inconsistency, which often results when policy is discretionary policy, always results in suboptimal social welfare. The concept of time inconsistency has most frequently been applied to monetary and fiscal policy (Klein, 2009) and international trade policy (Lapan, 1988).

**Model:** A pair of entrepreneurs each has a project with positive expected social value. Neither entrepreneur can privately commercialize his/her project because the high cost of project

development and the risk of failure deters outside investors. In the spirit of Laffont and Tirole (2003), a public agency would like to induce each entrepreneur to devote an efficient level of resources toward project development and would eventually like one or both of the entrepreneur's projects to be commercialized. Due to a limited budget the agency announces a commercialization competition.

At stage 0, when launching the competition, the agency announces that it will pay an award of size  $Z$  to the entrepreneur who achieves a project with the high social value, provided that the project is commercially viable after the award is paid. If the award is sufficiently large then at stage 1 each entrepreneur will agree to participate in the competition and will allocate private capital toward project development. The optimal allocation of capital by one entrepreneur depends on the allocation of the other entrepreneur, and thus the solution will constitute a Nash equilibrium. In fact, the structure of the game is similar to that of patent race between two oligopolists (e.g., Delbono and C. Denicolo, 1993).

In stage 3 of the game the level of capital allocated by a particular entrepreneur is combined with a random shock variable to determine both the level of private capital, which is available for project development, and the post commercialization social value of the project. The random shock reflects financing and market uncertainty which entrepreneurs face, even when comparatively high levels of private resources have been devoted to the project.

In stage 4 the agency awards the commercialization prize. If the random outcomes are such that neither entrepreneur has a project that can be successfully commercialized after the award is paid, then the award is not paid. If both entrepreneurs require the award to commercialize then the entrepreneur holding the project with the highest social value earns the award, and the outcome is ex post time consistent. The problem arises if the random outcomes are such that one entrepreneur has generated sufficient external capital to finance the project without the award and the other entrepreneur is in a position to commercialize only if the award is received. According to the ex ante criteria, the first entrepreneur should be allocated the award. However, in this particular situation the agency can raise social welfare by allocating the award to the second entrepreneur because this will result in both projects rather than just one project being commercialized. In stage 0 the pair of entrepreneurs will recognize that the award competition is time inconsistent and so will allocate a lower level of private capital toward their project and possibly choose to not participate in the competition. The agency will be required to raise the award amount to compensate for the time inconsistency, and this raises the overall cost of delivering the program.

**Applicability of the Research for CAIRN:** Commercialization of innovation is an important area of CAIRN research, but it has not received much attention in prior CAIRN projects. Although the proposed research is purely theoretical, it raises an interesting question about the time inconsistent nature of policies and procedure, which are used by agencies that explicitly or implicitly manage awards competition. For example, in academia professors routinely compete in grant competitions and in tenure and promotion competitions. In both cases, time inconsistency means that outcomes, which maximize social value, are typically not achievable. In the future if public agencies increasingly rely on competitions to induce innovation, it is important that they consider the consequences of time inconsistency and attempt to minimize its impact by using a rules-based approach to decision making rather than a discretionary approach.

**Timelines and Progress to date:** Thesis is in progress. Theory section and background chapters have been written. Application for ethics board approval is currently underway. Targeted completion date of the thesis is December 31, 2011.

The first six month of 2010 was used to build a two-firm game theory model of a CAT competition. In the first stage a public agency announces the competition in order to induce a pair of firms to invest in R&D. In the second stage of the Nash game the pair of firms simultaneously choose innovation effort to maximize their profits. The equilibrium effort levels of firm are combined with a pair of random shock variables at the third stage of the game in order to determine the social value of each participating project and the level of financial support that is required for successful commercialization. In the fourth stage the public agency awards the prize in a way that maximizes commercialization value. The analysis demonstrates the existence of time consistent and how time inconsistency reduces the incentive for the firms to invest in their innovations.

In second half of 2010 was used to design a set of experiments, which are currently at the ethics approval stage. The goal of the experiments is to reveal the potential for a time inconsistent outcome in a simulated commercialization competition.

Structure of the experiment:

1. Data generation. Using Excel the data are randomly generated for 10 projects on three factors: i) pure market value of the project, ii) amount of private contribution by entrepreneur, iii) amount of financial support needed to commercialize the project;
2. Laboratory experiment to test for time inconsistency. Eighty participants will be presented with the data generated in the first stage. They are asked to rank the projects in order to maximize the commercialization value of the submitted projects subject to limited funds. The data obtained at this stage will be used to run regression analysis and then test the time inconsistency hypothesis.
3. Focus group experiment to shed additional light on time inconsistency. Four groups of four participants will review the first stage data. Each group will be asked to discuss and rank the projects utilizing the same decision criteria as that discussed in point (2). The focus group discussion will be evaluated in order to obtain information about the reasoning for their decision. The information obtained at this stage will serve as an illustration of actual motives and criteria behind the winner selection process.

## ***2.2 CAIRN Commissioned Papers Initiated in 2010/11***

In 2010/11 CAIRN funded a number of commissioned papers and policy briefs.

*2.2.1: An Estimation of the Impact of Education Levels on Innovation Rates and Firm Success in Food Processing. Derek Brewin and Alessandro Alasia, Statistics Canada.*

**Funding sources:** CAIRN, Statistics Canada and University of Manitoba

**Objective or Abstract:** To help researchers study innovation in food processing, Agriculture and Agri-Food Canada and Statistics Canada have conducted an Innovation in the Food Processing Industry Survey. Stabler and Olfert (2002) argued that food processing had a unique role in rural areas in Canada because of potential links between needed inputs and the rural landscape.

A survey of western food processors was also conducted by the University of Saskatchewan and used in MacDonald (2006), Brewin and Omidvar (2008) and Brewin et al (2009). This survey lacked the scope and success (there were only 44 responses regarding the education variables) of the Statistics Canada survey but it did find some interesting results. Within this sample, education variables were found to be significant drivers of product innovation and innovation rates were affected by in-house investments and location. The results of the Innovation in the Food Processing Industry Survey confirm the importance of innovation. Product innovations led to higher margins most (64%) of the time and process innovations reduced costs or increased productivity (Statistics Canada).

The importance of education and human capital has been a significant focus in Statistics Canada. As recently as January of 2010, Statistics Canada published Beckstead et al who suggested that human capital explains a great deal of the income differences in urban and rural regions and that rural under investment in human capital has been a factor in poorer rural income growth. Alasia (2005) also linked human capital to innovation rates and poor rural incomes. The innovation survey and food processing has also been the subject of numerous reports at Statistics Canada.

The objective of this study is to confirm previous findings using the more comprehensive Innovation in the Food Processing Industry Survey. The only way to look at education levels for these companies is to tie the Innovation survey to regional education through regional education levels of workers in the food-processing sector of the same region as the firms in the innovation survey.

**Timelines and Progress to date:** Data has just recently been shared with Alasia and Brewin. They expected to draft present a draft report by June of 2011 to be presented at the CAES. Other deliverables include a presentation at Statistics Canada and the publication of the research results in the form of a Statistics Canada working paper and journal article.

*2.2.2 “Assessing the Effects of International Trade on Private R&D Expenditures in the Food Processing Sector”- Pascal L. Ghazalian*

[http://www.ag-innovation.usask.ca/cairn\\_briefs/publications.html](http://www.ag-innovation.usask.ca/cairn_briefs/publications.html)

**Objective or Abstract:** This study empirically investigates the effects of imports and exports on private R&D expenditures in the food-processing sector. An analytical framework discussing the various effects of international trade on R&D activities is presented. This is followed by an empirical analysis that uses a dynamic empirical specification for current R&D expenditures and for a cumulative measure of R&D stock. The empirical investigation is applied to a panel dataset covering OECD countries over the period 1987-2006. The empirical results show that increases in import intensity levels induce reductions in private R&D expenditures whereas increases in export intensity levels promote larger private R&D expenditures. These outcomes imply that the R&D-enhancing effects of exports are countered by the R&D-reducing effects of imports.

**Timelines and Progress to date:** Project Completed and posted on CAIRN Website

2.2.3: Measuring Agricultural Productivity Growth and Efficiency in Canada-Stavroula Malla, Alexander B. Darku, and Kien C. Tran

**Students Involved:** Mitchel Robert Laffin [B.A.] & Anirban Kar [M.S]

**Objective or Abstract:** Agricultural productivity is important with respect to economic efficiency, living standards, international competitiveness, and economic sustainability. The importance of agricultural productivity for policy development and implementation requires careful analyses of its determinants and dynamics. However, there are mixed and sometimes competing results or evidences regarding agricultural productivity growth in the world, with predominant results that agricultural productivity growth has slowed, especially in the world's richest countries. As global population is expected to grow significantly in the next few decades, agricultural productivity is even more important with respect to food inflation, food security, and the overall cost of living to a significant portion of the Canadian population. It is therefore imperative to improve productivity growth in agriculture through innovation to ensure that supply of food and raw materials will keep pace with demand in order to avoid increase in prices.

The goal of this study is to examine the nature of agricultural productivity growth in Canada. Specifically, the study quantitatively estimates the magnitude of agricultural productivity and efficiency in Canada. Our approach is based on a stochastic production frontier framework which allows for direct decomposition of total factor productivity growth (TFP) into output growth, input growth (scale effects), change in return to research over time, technical change and change in technical inefficiency. The approach also allows to capture the heterogeneity among farmers and to differentiate it from productive inefficiency. The results of this study are compared and contrasted to existing estimates of other OECD countries; and make policy recommendations that could increase the Canadian productivity growth and economic efficiency.

The preliminary results of the study indicate that agricultural productivity growth in Canada has slowed down and is lagging behind that of the United States, its major trading partner, as well as many OECD countries. The analysis also showed that farm level specific characteristics significantly impact on their ability to implement new technologies. This has an important implication on the measurement of farm level inefficiency. The study also examined the implications of the results for the formulation of research policy, and how alternative policies could enhance overall productivity and growth in the Canadian agriculture sector. If Canada is going to realize its economic potential in the global market place, it must create a policy environment in which the agricultural research sector remains vibrant.

**Timelines and Progress to date:** Data Collection (Country Level; Regional Level; Province/Divisional/Sub Divisional; Farm Level); Literature Review; Preliminary Results; Draft paper

2.2.4: Measurement of Agricultural Productivity Growth and Efficiency: Accounting for the Effect of Innovations -Stavroula Malla, Kien C. Tran and Alexander Darku,

**Objective or Abstract:** Agricultural productivity growth in Canada is a topic of continuing interest to policy makers and researchers who aim to improve on economic sustainability, efficiency, living standards, and international competitiveness. Recent evidence suggests that

agricultural productivity growth in Canada has significantly slowed down as well as lagging behind that of the U.S. and many OECD countries. Measuring productivity growth is imperative but a challenging task. There exist many methodologies for measuring productivity growth and efficiency, which differ by concept/type of productivity and by approach of measurement. However, each method has its own advantages and disadvantages depending on the research question at hand.

The main objective of this commissioned paper is to propose a new approach/model to estimate agricultural productivity growth and efficiency that explicitly account for R & D investments. In addition, the most common approaches that account for technical change will be discussed and compared to our proposed approach. To account for R & D investments using a simple stochastic production function, we propose to model the marginal productivity of inputs use as a function of the past R & D investments. Hence, our approach allows for the interaction between current inputs use and past R & D investments which one can think of as capturing the return to research (or innovations). Though our approach is based on a stochastic production frontier framework, it imposes minimal assumptions on the structure of the model. Thus it is quite novel, flexible, easy to implement and can be easily adapted to either aggregate data or individual farm level data with very little modification. Moreover, our proposed approach allows for direct decomposition of total factor productivity growth (TFP) into input growth (scale effects), change in return to research over time, technical change and change in technical inefficiency.

Lastly, the advantage of our proposed approach/model (based on random coefficient stochastic frontier model) is that it allows for the model to capture the heterogeneity among farmers and to differentiate it from productive inefficiency. Heterogeneity can arise for various reasons. For example, because the adoption and implementation of new technology is costly, farmers adopt new technology only with considerable lags. If cost of installation differs across farmers, there will be some variability in the type of technology used by farmers. Therefore in practice, production possibilities are expected to differ not only among farmers but over time as well.

**Timelines and Progress to date:** Literature Review: Concept/Type of Productivity and Approach of Measurement (Productivity & Efficiency); Development of the Theoretical Framework & Empirical Methodology; Draft Paper.

*2.2.5: Functional Foods and Nutraceuticals Regulations, Policies and R&D in Canada and Around the World- **Stavroula Malla***

**Funding sources:** CAIRN

**Student(s) Involved:** Eric Kofi Sogah [B.A]

**Objective or Abstract:**

The scientific evidence and awareness of the correlation between diet and health; increasingly sedentary lifestyles; aging population; and the ever increasing health care cost in Canada and other countries with publicly funded health care systems have increased the interest in healthier food products [functional foods and natural health products (FFNHP)]. The World Health Organization identifies nutrition as a significant and manageable determinant of chronic disease, stressing the need for a shift in nutrient intake towards 'healthier' foods. Recent policy responses have included measures to better inform consumers about the

nutrient content of foods to facilitate healthier eating choices. Furthermore, there are a lot of policy implications regarding the regulatory environment for approval of new FFNHP and the current labeling regulations for health claims on FFNHP.

By examining the FFNHP health claims, regulations, policies and R&D in Canada and around the World, this project will help broaden our understanding of this important sector. It will also allow us to compare and contrast different policies and regulations around the World; and finally, make public policy recommendations that could improve Canadians' well being and increase social welfare. If successful policies from other countries can be adopted, this will accelerate and foster innovation in the sector. The growing burden of health care cost remains a key policy issue in Canada. Hence, the potential effects on public health care costs of increasing the consumption of functional/healthier foods in diets is of major policy relevance.

The study consists of a broad review on the FFNHP industry with respect to consumer awareness, acceptance and willingness to pay; industry and market prospective; product development; and regulatory situations. The investment patterns of the FFNHP industry in Canada, U.S, E.U, and Japan are also assessed. Furthermore, the study examines and analyses the current FFNHP's health claims situations in Canada and several other countries (U.S, E.U, U.K, Sweden, Russia, Japan, Australia, New Zealand, Korea, China, Taiwan, Singapore, Malaysia, Hong Kong, India, Thailand, Philippines and Brazil). Differences in regulations, policies and health claims as well as challenges facing the industry are explored. Policy implications/recommendations are discussed.

**Timelines and Progress to date:** *Extensive Literature Review; Data Collection; Review of Health Claims, Nutrition Labeling, Regulations, and Policies around the World;*

Two Draft Reports:

- Assessing FFNHP Industry: A Comparative Overview and Literature Review;
- FFNHP Regulation in Canada and Around the World: Nutrition Labels and Health Claims

**2.2.6: Innovation Performance, Strategies & Capacity in Canadian Food Processing Industry-Bodo Steiner & John Cranfield**

**Funding sources:** CAIRN

**Student(s) Involved:** Robin Smart, Former M.Sc. student at the University of Guelph

**Objective or Abstract:** The project aims to provide an up-to-date analysis of innovation obstacles and governance issues in the Canadian food-processing industry. In line with the concept of 'national innovative capacity' as introduced by Furman (2002), the proposed analysis attempts to distinguish the different sources for the differences in food processors' intensity to innovate across Canada. To do so, we will focus on governance issues related to food manufacturers' innovation performance in terms of product innovations, process innovations and patent applications. The results from Furman (2002) suggest not only that public policy plays an important role in affecting a country's national innovative capacity, but also that patenting activities and institutional obstacles to innovation could be distinguished in analyses of national innovation systems. By focusing on the role of industrial organization and elements of Canada's national policy environment as it impacts the food processing sector, we hope to come closer towards a first analysis of Canada's national innovation system

as it applies to the food processing sector. From Furman (2002) we anticipate that such an analysis can provide a more nuanced view of the empirical determinants of national patenting activity in the food processing sector, compared to the "limited factors highlighted by ideas-driven growth theory" (p.930). The data to be used will come from the 2004 'Innovation in the Food Processing Industry Survey' conducted by Stats Canada, as well as the 2009 'Survey of Innovation in Food and Beverage Processing'.

**Timelines and Progress to date:** April 2010 – March 31, 2011. We came across a number of administrative obstacles that have not yet made it possible to access the database, but we are confident that these can be overcome and that subsequently the analysis can proceed smoothly.

## **2.3 CAIRN Policy Briefs 2010/11**

### **January 2010 - Prescott and Vercammen**

The Effect of Green Energy Policies on Innovation

### **March 2010 - Ghazalian**

Innovation and Export Performance of the Food Processing Sector: Opportunities and Limitations

### **March 2010 - Ghazalian**

Going Multinational: Exploring the Interactions Between Innovation and FDI in the Food Processing Sector

### **March 2010 - Vercammen**

Regulation and Innovation for Agri-Food and Renewable Energy

### **March 2010 - Sparling, Laughland and Schaufele**

Policy, Industry Strategy and Healthy Food Innovation

### **May 2010 - Shakeri and Gray**

Has Canada Caught Dutch Disease?

### **December 2010 - Darku and Malla**

Agricultural Productivity Growth in Canada: Concepts and Evidences

### **April 2011 - Gray and Bolek**

Some International Successes in Funding Crop Research for Implementation in Canada

### **April 2011 – Lenhardt and Vercammen**

Extension of Honey Bee Pest and Disease Innovations to Canadian Beekeepers

## ***2.4 Conferences and Workshops***

### ***ERCA-CAES Policy conference and meeting –Ottawa-January 2011***

The CAIRN network hosted a very successful “Future of Food and Farms in Canada” conference and work shop. The Conference was very well attended by industry, government and academics. There were approximately 350 registrants, which greatly exceeded our expectations. While it has not been finalized, there was virtual consensus to do something very similar next year in terms of timing, location, venue and general program structure. The presentations from the conference are posted on the CAES and CAIRN website.

<http://www.ag-innovation.usask.ca/2011policyconference.html>

### **3.0 MEMBER INNOVATION RELATED RESEARCH ACTIVITIES AND PUBLICATIONS AND PRESENTATIONS (Partial Listing)**

The CAIRN is a large policy network made up of 33 members. The CAIRN activities outlined in Section 2, which have some component of CAIRN funding, only represent a small fraction of member activities related to innovation research and policy development. As a network, CAIRN can foster greater knowledge sharing and coordination among members, and importantly can enhance communication with the public and private sector that can utilize the knowledge and expertise of the members.

The sheer volume of work undertaken by Network members creates a significant challenge for communication both for the members, who already have very many reporting requirements, and for the CAIRN resources required to assemble a reasonably current inventory and to disseminate the information.

This section has compiled a partial listing of member activities, publications and presentations, and future research plans that some members have chosen to share.

For the coming year a part time employee will be engaged to more systematically collect information on member activities, research results and plans. Recognizing the time costs of the members, mechanisms such as web-based searches for publications, member cv updates, short interviews will be used to collect the information. The information will be disseminated on the website, in a list serve and quarterly newsletter.

*Derek Brewin*

#### ***Innovation Related Projects:***

*A Review of Plant Breeding Incentives in the UK (as part of WGRF study with Richard Gray).*

#### ***Objective or Abstract:***

Plant breeding requires the manipulation of genetic material, through crossing, mutation or genetic engineering to improve on elite varieties by changing the traits effecting yields, or disease resistance. Historically genetic improvement came from crossing among the populations available to ancient farmers. Plants that survived a devastating disease, or provided better yields and ripened at the same time were saved – selected – and often inbred, which lowered total diversity in the population used by humans. These selected varieties took on value. They provided more food, better resistance to disease, and utility to growers.

Eventually the process of plant breeding became more complex until huge investments were being made in the storage of genetic material, microbiology research, testing and multiplying seed. The realities of self-pollinating seed make the benefits of this investment difficult to capture from growers through seed sales. Underinvestment in agricultural research is becoming a global problem and plant breeding is particularly difficult to manage (Alston et al, 2009). This project will explore the current and historical research systems for cereal breeding in several countries. Public sector research, regulations and institutions that offer returns to private researchers are explored, especially as they relate to the growers access to quality cereal seeds.

***Innovation Related Presentations:***

Brewin, D.G. (2010). A review of farm level responses to phosphorus regulations in Manitoba, Canada. 120<sup>th</sup> Seminar of European Association of Agricultural Economists on External Costs of Farming activities. Chania, Greece. September 1-3, 2010.

Brewin, D.G. (2011). Options for Filling the Research Funding Gap: The Importance of Pulse Levy Dollars. Annual Meeting of the Manitoba Pulse Growers. Winnipeg, Manitoba. February 9, 2011.

***Innovation Research Plans for the coming year:***

I have been given approval for: *Firm R&D Investment in Plant breeding with and Without Farmer-saved Seed Levies and Complementarities Between Seed Products and the Breeding Process*. This research will include a discussion of the current and historical research systems for plant breeding in other countries, and the tactics taken to overcome the market failure caused by farmer saved seed and lag times in basic research. Public sector research, regulations and institutions that offer returns to private researchers will be explored, especially as they relate to the growers access to quality cereal seeds. The paper will then attempt to develop a theory of breeding firms with or without public sector competition, base level research and levies on farmer saved seed.

The theoretical basis for a complementary relationship between innovation in the product and process dimensions has been espoused by other researchers (Athey and Schmutzler, 1995; Mantovani, 2006) with some empirical support (Brewin et al, 2009). In plant breeding some processes like the genetic engineering of herbicide tolerance have been found to support product innovations (like hybrids developed using the herbicide tolerance of one crop as a way to select the parents in a cross).

A theoretical model of plant breeding was already developed by Galushko, 2008. This research will look at current international systems that adjust the returns to research like farmer saved seed and end user levies and incorporate them into that model. We will also attempt to explore the ramifications of increased complementarity between seed production systems and the attributes of the seeds to see if this changes optimal investment levels

Ryan Cardwell

***Innovation Related Publications:***

Ghazalian, P.L. and Ryan Cardwell. 2010. "Multilateral Trade Liberalization and FDI: An Analytical Framework for the Implications for Trading Blocs." Proceedings from CAES Annual Research Workshop. Printed in *Journal of International Law and Trade Policy* 11(1): 192-212.

Cardwell, Ryan and P.L. Ghazalian. 2011. "[The Effects of the TRIPS Agreement on International Protection of Intellectual Property Rights](#)." *International Trade Journal* 25(4), forthcoming.

***Innovation Research Plans for the coming year:***

How has dependency on trade with developed countries affected protection of IPRs in developing countries?

John Cranfield

***Innovation Related Project 1:***

*Critical success factors to capturing value from emerging markets for health enhancing foods from Ontario's agri-food sector*

*Objective or Abstract:*

The overall goal of this project is to identify critical success factors which enhance the ability of firms in Ontario to create and capture value from emerging markets for health enhancing food products, namely functional foods, nutraceuticals and natural health products. The specific research objectives are:

1. Identify firm perceptions of these critical success factors, and how such perceptions vary across product sectors and firms/entrepreneurs.
2. Assess the impacts of the identified critical success factors on the ability of firms to create and capture value and how such impacts vary across product sectors and firms/entrepreneurs.
3. Identify the range of strategies/management practices that firms use to create and capture value.
4. Evaluate the effectiveness of the identified strategies/management practices in terms of enhancing the ability of firms to create and capture value in the emerging market for health enhancing foods.
5. Provide guidance to public and private sector stakeholders regarding the best management practices and strategies firms could employ to promote value creation and capture in these emerging markets.

Results from in-depth interviews with managers/entrepreneurs from various functional food or natural health product producing firms/organizations in Ontario highlight the importance of five different issues related to critical success or barriers to success. These issues are regulation, skills, capital, industry infrastructure and internal resources.

Regulation was usually the first issue that interviewees highlighted and was typically viewed as a barrier. Specifically, constraints to innovation due to regulation that were raised during the interviews included:

- 1) The time it takes for products to obtain regulatory approved
- 2) Uncertainty with respect to regulatory requirements
- 3) Inability of regulations to keep pace with the rate of innovation
- 4) Lack of regulatory compliance monitoring leading to competitive imbalance and consumer confusion

There were a number of issues highlighted with respect to business skills for firms related to food for health. These issues include:

- 1) Many firms suffer from a skills gaps in relation to innovation
- 2) Uncertainty with respect to where and how to access the required skills
- 3) A significant skills gaps was identified with respect to marketing

While every interviewee highlighted that capital can be a constraint, it was often not the “top of mind issue”. Nonetheless, while capital is available, the process by which firms can access capital can often be slow, there is a lack of understanding of types of programs that are available and a perception that the level of government support is decreasing as competition increases.

With respect to industry infrastructure, there was a general feeling that firms tended to cluster – often around universities. This makes it easier to find complementary skills and develop the types of partnerships that can be critical to successful innovation. While it is always difficult to identify the right partners, having areas of focus on specific industries helps. Critical mass is also important relative to some of the supporting industries. This can relate not just to companies that can run or help with clinical trials but also to banks having the knowledge and capacity to deal with the specifics of the food for health industries.

Lastly, it was noted that the lack of internal resources can be limiting for small firms, but sometimes also for larger companies.

***Innovation Related Project 2:***

*Identifying successful business models, strategies and policies for promoting the Canadian bioeconomy*

**Funding sources:** Ontario Ministry of Agriculture, Food and Rural Affairs

**Timelines and Progress to date:** Ends March 31 2012

*Objective or Abstract:*

The objective of the study is to increase understanding of how Ontario’s bioeconomy is evolving, the forces shaping the industry, the opportunities for the future and the policies that support or inhibit the development of bioeconomy firms.

The proposed research includes two complementary strategies to achieve the objective:

1. Case studies examining firm level changes, challenges and strategies in Ontario’s bioproducts firms, with a focus on biochemical and biomaterial value chains.

The first component of the research will involve research case studies of Ontario bioeconomy firms using semi-structured interviews with senior level managers. This approach allows researchers to develop a deeper understanding of the factors affecting companies in the biochemical/biomaterial value chain, the perceptions of managers and their strategies for their companies around topics including partnering, innovation, challenges and opportunities. This project will be completed in the first year.

2. An econometric analysis of the Statistics Canada Bioproduct Development Survey 2009.

This analysis will examine industry-wide trends and differences between provinces, subsectors and input types using the survey data that will be released in late 2010. A comparison with earlier data will be completed using the 2003 and 2006 surveys.

This project will help inform policy makers about bioeconomy trends and policies that are affecting the industry positively or negatively. It will inform industry leaders about the kinds of strategies that have been effective in developing the industry and in supporting innovation. It will also improve awareness about the roles and opportunities for Ontario farmers and agri-businesses to develop and capture the value from the shift to a new bioeconomy.

Secondary research and the literature review highlight the focus of policy and regulation on biofuels and bioenergy, but not necessarily on other bioeconomy sectors. This lack of policy and regulation that targets bio-based chemical and materials has led to a market-driven shift toward biorefinery-based chemical alternatives. This research is unique in its focused efforts on biorefinery-based chemicals and their role in the larger provincial bioeconomy.

Some preliminary observations and findings that will guide our analysis and final discussion:

- Bio-based products are experiencing rapid growth which is expected to continue very strongly over the coming years. This fundamental global trend has triggered a vast interest in bio-based products (including chemicals and materials) and placed them high on the strategic agenda of most players in a variety of value chains.
- In the chemicals industry, biorefinery-based chemicals stand to confer advantages to players who can find drop-in molecules for existing value chains, rather than developing *de novo* value chains around new molecules.
- Nonetheless, new molecules create new foundations for value chains but merge with latter stage infrastructure, players and products, some of which are well established.
- Motivations to enter the value chain differ across firms:
  - *Bio-focused firms* enter to build a new bio-based idea into a successful business;
  - *Chemical firms* are driven by finding replacement to oil because of cost, assurance of supply and environmental impact;
  - *Chemical consumers/end product assemblers* are responding to customer/consumer demand for sustainable products.

#### ***Innovation Related Presentations:***

John Cranfield. “Productivity and research along the value chain: Friend or foe to the producer?” Policy Education Program, OMAFRA, Guelph ON, 2 February 2011.

*Pascal Ghazalian*

#### ***Innovation Related Publications:***

Ghazalian, Pascal L. 2011. “Assessing the Effects of International Trade on Private R&D Expenditures in the Food Processing Sector”. Canadian Agricultural Innovation and Regulation Network (CAIRN) Commissioned Paper. Saskatoon, SK, Canada.

#### ***Innovation Research Plans for the coming year:***

“Endogenous IPRs and Exports of Primary Agricultural Commodities (e.g., canola, soybean): Effects and Causation in the Presence of International Spillovers, Freedom to Operate, and International IPR Agreements” (with S. Malla).

Richard Gray

***Innovation Related Projects:***

In addition to the CAIRN funded projects, I was on a one-year sabbatical leave that commenced July 1, 2010. As such I undertook a number of related projects with a common goal of understanding crop research innovation systems in the OECD countries and how they could be implemented in Canada. The projects have specific objectives and deliverables that will enhance the understanding of how various innovation systems function, what incentives they create, how well they perform, and how desirable features could be applied in Canada. The funding for the projects came from several sources including, University of Saskatchewan (for my sabbatical) leave, the Western Grains Research Foundation, AAFC, my host institutions, which provided office resources, and the various institutions that supported my collaborators.

The research into innovation systems in the EU focused on agricultural research funding and commercialization systems in France, the UK and in Sweden. Derek Brewin on sabbatical leave visiting the University of Reading, examined the evolution and privatization of the UK research system. A visit to the University of Uppsala in Sweden, with the assistance of Giannis Karagiannis and Yves Surrey revealed a system where both public and private research investment in applied production related agricultural research has declined dramatically. My research into the French crop innovation system revealed a very large public research sector undergoing significant transformation and rationalization. The French end point royalty system for wheat is negotiated, uniformly applied across all varieties, and has low transactions costs. LimaGrain, a cooperative owned by 600 French farmers plays the dominant role in wheat breeding in France and has become a very large multinational seed industry enterprise.

The research into the Australian Agricultural research system began during the first four months of 2011 in collaboration with Julian Alston and Katarzyna Bolek (Ph.D. student). An in-depth literature review in combination with interviews of over a dozen senior officials, has given us a detailed perspective of many aspects of the innovation system. Bolek’s dissertation will examine the evolving wheat commercialization system and the dynamics of end point royalties. The goal of the project is to assess the Australian agricultural system with the aim of understanding how the best features can be repeated in Canada, the US and elsewhere. To date the project has produced a draft research report (Some International Successes in Funding Crop Research and the Pathways for Implementation in Canada) and a policy brief.

***Innovation Related Publications:***

Galushko, V., R. Gray and S. J. Smyth. 2010. Resolving FTO Barriers in GM Canola. *AgBioForum* 13: 4: 360-369.

Gray, R. S. and S. Malla. (Forthcoming). “Managing Public IP with Downstream Inter-firm Research Spillovers.” *Canadian Journal of Agricultural Economics*.

Gray, R.S. 2010. It All Makes Cents: the Economics of Conservation Tillage Landscapes *Transformed: The History of Conservation Tillage and Direct Seeding* /Wayne Lindwall and Bernie Sonntag, editors. ISBN 978-0-9812843-1-6

Mohammad Khaledi, Simon Weseen, Erin Sawyer, Shon Ferguson and R.S. Gray, 2010. Factors Influencing Partial and Complete Adoption of Organic Farming, *Canadian Journal of Agricultural Economics*. 58 (1) pp.37-56.

Smyth, S. J. and R. Gray. (In Press) Intellectual Property Sharing Agreements in Gene Technology: Implications for Research and commercialization. *International Journal of Intellectual Property Management*

Veeman, Terrence S. and Richard Gray 2010. “Agricultural Production and Productivity in Canada” *Choices*.

Veeman, Terrence S. and Richard Gray. 2010. “The Shifting Patterns of Agricultural Production and Productivity in Canada” Chapter 6 of J.M. Alston, B. Babcock, and P.G. Pardey (eds.) *Shifting Patterns of Agricultural Production and Productivity Worldwide*. CARD-MATRIC Electronic Book. Ames, IA: Center for Agricultural and Rural Development, May 2010.

Gray, Richard S., Katarzyna Bolek, and Julian Alston. 2011. Some International Successes in Funding Crop Research and the Pathways for Implementation in Canada, A report prepared for AAFC, March.

Shakeri M. and R.S. Gray The Effect of Exchange Rates on Agriculture Products CAIRN Working Paper - May 2010

Shakeri. M. and R.S. Gray *Has Canada Caught Dutch Disease?* CAIRN Policy Brief No. 20 - May 2010

Gray R.S. and K. Bolek *Some International Successes in Funding Crop Research for Implementation in Canada* CAIRN Policy Brief Number 22 - April 2011

***Innovation Related Presentations:***

R.S. Gray. “Knowledge as a Toll Good: The Implications for Agricultural Science Policy” A presentation to the Department of Primary Industries, Melbourne, Feb16, 2011.

R.S. Gray. “Issues and Options for Crop Research Funding in a Market Economy” A presentation to the School of Agricultural and Resource Economics UWA March 25, 2011.

R.S. Gray. “Developments in Canada’s Grain Innovation System” Presentation to Department of Primary Industries Victoria

R.S. Gray “Does King Wheat Have a Future? If so where are we headed?” Presented at the 17<sup>th</sup> annual Farming For Profit Conference, Moose Jaw, June 24, 2010

R.S. Gray. "Discussion: The Economics of Food, Health Nutrition", AARES Pre-Conference Workshop Melbourne, Victoria, February 8<sup>th</sup>, 2011

Samira Bakhshi and Richard S. Gray "Is There Supply Distortion in Decoupled Payments? Evidence from the Canadian Prairies" AAEA-CAES-WAEA Joint Annual Meeting, Denver, July 26, 2010.

R.S. Gray "The Future of Crop Research in Canada: Options and Consequences" The Future of Food and Farms in Canada The First Annual Agricultural Policy Conference, January 13-14, 2011, Ottawa, Ontario.

***Innovation Research Plans for the coming year:***

A good deal of the coming year will be devoted to supervising the student research outlined above, writing reports and journal articles, and communicating the results of research undertaken during this past year. If this policy research is going to have impact on policy making in Canada, industry players need to be sharing ideas about alternatives.

Jill Hobbs

***Innovation Related Publications:***

Isaac, G.E. and J.E. Hobbs. 2009. GM Food Regulations: Canadian Debates. In A. Greenbaum, R. Pushchak and A. Wellington (eds.), *Canadian Issues in Environmental Law and Policy*. Concord, Ontario: Captus Press. 198-206. (Reprinted by permission from ISUMA-Canadian Journal of Policy Research, 2002 3(2): 105-113.)

Hobbs, J.E., B.G. Innes and A.D. Uzea. 2010. Food Quality Verification: Who Do Consumers Trust? *Proceedings of the 1<sup>st</sup> Joint EAAE-AAEA Seminar on The Economics of Food, Food Choice and Health*, Technische Universität München, Freising-Weihenstephan, Germany, 15pp

Zou, N.N. and J.E. Hobbs. 2010. The Role of Labelling in Consumers' Functional Food Choices. *Proceedings of the 1<sup>st</sup> Joint EAAE-AAEA Seminar on The Economics of Food, Food Choice and Health*, Technische Universität München, Freising-Weihenstephan, Germany, 27pp

Hobbs, J.E. S. Malla and T. Cybruk. 2010. Functional Food Innovation and Health Care Cost Savings: The Case of CLA-Enriched Milk. ATINER 5<sup>th</sup> Annual International Symposium on Economic Theory, Policy and Applications, Athens, Conference proceedings paper.

***Innovation Related Presentations:***

Lassoued, R. and J.E. Hobbs. 2011. *Co-Regulation: Exploring the Interface Between Regulation and Private Standards*. Poster paper presented at the Future of Farms and Food in Canada: the 1<sup>st</sup> Annual Canadian Agricultural Policy Conference, Ottawa, January 2011. (Won 2<sup>nd</sup> prize in conference poster competition)

Hobbs, J.E. 2011. *Recovering Consumer Confidence After a Food Crisis*. Invited presentation and participation in panel discussion in session ‘Marketing to the Future Consumer’, Banff Pork Seminar, January 19 and 20.

Hobbs, J.E. 2010. *Food Safety and Quality Verification: Governance and Consumer Issues*. Invited presentation at the workshop ‘Sustainable Behaviours in Food Chains: Organizational, Marketing and Environmental Aspects’, Università degli Studi di Perugia, Italy. September 20.

***Innovation Research Plans for the coming year:***

Continuation and expansion of the traceability technologies project.  
Completion of a project funded by the Advanced Food and Materials Research Network (AFMNET) on consumer attitudes toward traceability technologies. A consumer survey has been completed and data analysis is underway. Although funded separately through AFMNET, this project complements the current CAIRN funded project on the role of traceability technologies in food supply chains. The insights from the AFMNET consumer project should help inform the modeling in the CAIRN funded project.

Stavroula Malla

***Innovation Related Publications:***

R. Gray and S. Malla. (Forthcoming). “Managing Public IP with Downstream Inter-firm Research Spillovers.” *Canadian Journal of Agricultural Economics*.

A. Darku and S. Malla, 2010. “Agricultural Productivity Growth in Canada: Concepts and Evidences” *Canadian Agricultural Innovation Research Network (CAIRN) Policy Briefs*, Saskatoon, SK. 2010: 21.

***Innovation Related Presentations:***

S. Malla, J. Hobbs, and E. K. Sogah. 2011 “Functional Foods and Natural Health Products Regulations, Policies and R&D in Canada and Around the World.” Research Poster from the Canadian Agricultural Innovation and Regulation Network (CAIRN). *Canadian Agricultural Economics Society (CAES): The Future of Farms and Food in Canada*, Ottawa, ON, Canada, January 13-14, 2011,

J. E. Hobbs, S. Malla, and T. Cybruk. 2010. “Functional Food Innovation and Health Care Cost Savings: The Case of CLA-Enhanced Milk.” *5<sup>th</sup> Annual International Symposium on Economic Theory, Policy and Applications* Athens, Greece, July 26-29, 2010.

R. Gray and S. Malla. 2010. “The Economics of Functional Foods.” *Canadian Agricultural Economics Society (CAES) Annual Meeting*, Denver, Colorado, July 25 – July 27, 2010.

***Innovation Research Plans for the coming year:***

“Measuring Agricultural Productivity Growth and Efficiency in OECD Countries.”

Stavroula Malla, Alexander B. Darku, and Kien C. Tran, (CAIRN)

Functional Foods and Natural Health Products Regulations, Policies and R&D in Canada and Around the World (with Hobbs and E. K. Sogah); Incentives for Functional Food Innovation: Who Pays and Who Benefits? (with R. Gray); Reducing Health Care Costs Through Innovation: The Case of Conjugated Linoleic Acid in Milk (with J. Hobbs and T. Cybruk); Innovation and Nutrition/Healthier food: Impacts on Population Health in OECD Countries in the Presence of International Regulations (with C. Viju).

Measuring Agricultural Productivity Growth and Efficiency in Canada (with A. Darku, and K. C. Tran); Equilibrium number of Firms and Research Spillovers in Spatial Markets (with R. Gray); The Rate of Returns to Canola Research in Canada (with R. Gray); Alternative Funding Systems and IPRs Management (with R. Gray); Endogenous IPRs and Exports of Primary Agricultural Commodities (e.g., canola, soybean): Effects and Causation in the Presence of International Spillovers, Freedom to Operate, and International IPR Agreements (with P. Ghazalian).

Anwar Naseem

***Innovation Related Publications:***

Naseem, Anwar, David J. Spielman, and Steven Were Omamo (2010) “Private-sector investment in R&D: a review of policy options to promote its growth in developing-country agriculture” *Agribusiness* 26(1).

Smyth, Stuart J., José B. Falck-Zepeda, Richard S. Gray, Anwar Naseem, Robert Paarlberg, Peter W.B. Phillips, Carl E. Pray, Sara Savastano, Pasquale Scandizzo, Sara Scatasta, Justus H.H. Wesseler, David Zilberman, (2010) “Policy Recommendations from the 13th ICABR Conference on the Emerging Bioeconomy: *Agribioforum* 13(2).

***Innovation Related Presentations:***

Naseem, Anwar and M Mudasser “Private Investment in Agricultural Research in Pakistan” Presented at the 14th ICABR Conference Ravello, Italy, June 16-18, 2010.

***Innovation Research Plans for the coming year:***

Submitting a proposal to IDRC to evaluate the impacts of technologies that reduce post harvest in rice processing. Supervising a student that is looking at the impact of Clearfield rice system in Brazil.

Peter Phillips

***Innovation Related Projects:***

*VALGEN* (Value Addition Through Genomics and GE<sup>3</sup>LS)

The well being of Canadians has long depended upon the agricultural industry. The VALGEN research team is investigating how Canada can benefit from applications of agricultural genomics, a new science which studies the effects of the entire set of genes making up a particular organism such as our familiar crops of wheat, flax, canola and corn. The project focuses on three crucial factors that affect how scientific discoveries make their way from laboratory to the marketplace.

See the website at: <http://www.valgen.ca/>

*Public-Private Partnerships for the Management of National, Regional and International Innovation Systems: A Network Analysis of Knowledge Translation Systems*

William P. Boland, Ph.D. Student, University of Saskatchewan  
Peter W.B. Phillips, University of Saskatchewan  
Camille D. Ryan, University of Saskatchewan

***Abstract:***

Innovation is increasingly viewed as a key determinant of economic growth. Numerous theories of innovation exist. Recent literature indicates innovation occurs at the global level. One such perspective suggests the key to economic growth is dependent on developing an institutional framework that links local non-codified knowledge with global flows of codified knowledge such as intellectual property rights and proprietary technologies. This article uses social network analysis, case study and vulnerability analysis to examine four functioning and inter-related regional and global pulse crop R&D networks. This article demonstrates that the public-private partnership is the institution framework that links local assets to global knowledge flows.

*Camille D. Ryan*

***Innovation Related Project 1:***

*Intellectual Property and FTO in Flax Breeding (with V. Galushko)*

**Funding sources:** CAIRN (in kind contributions of TUFGEN project)

**Student(s) Involved:** N/A

**Timelines and Progress to date:** Study conducted in 2010 with final report generated for CAIRN on August 30, 2010. Report has been translated into an article that is currently under review with the Canadian Journal of Plant Science

*Objective or Abstract:*

To review the global IP landscape in flax breeding and to explore the impacts of IP on FTO for flax breeding in Canada

***Innovation Related Project 2:***

*Total Utilization of Flax Genomics (TUFGEN)*

**Funding sources:** Genome Canada/GE3LS

**Student(s) Involved:** Russell Lawrence (casual)

**Timelines and Progress to date:** ongoing. Several reports have been generated on the Triffid issue, which will be translated into 1-2 articles on the topic. Other activities include the development of articles/ book chapters on PNTs, IP and FTO, which are in various stages of publication. Additionally, work is being done with SaskFlax (funded by CAAP) on the impact of the Triffid issue and zero tolerance policy on the Canadian flax industry. A report on the development of low level presence policy has been generated and is expected to be translated into an article at some point later this year.

*Objective or Abstract:*

GE3LS research on intellectual property, freedom to operate, regulatory issues around plants with novel traits and the development of low-level presence policy in Canada

***Innovation Related Project 3:***

*Public Private Partnerships in Plant Breeding: Australia and Canada*

**Funding sources:** Academy of Social Sciences Australia (ASSA)

**Student(s) Involved:** N/A

**Timelines and Progress to date:** ongoing. One on one interviews have been conducted with relevant actors in Australia. Transcripts have been generated and analysis is ongoing. Canadian 'leg' of interviews is currently underway.

*Objective or Abstract:*

Contrast and compare the organizational structures/business models that characterize both the Australian and Canadian pulse breeding industries.

***Innovation Related Publications:***

Galushko, Viktoryia and Camille D. Ryan (under review). "Intellectual Property Rights (IPRs) and Knowledge Sharing in Flax Breeding." *Canadian Journal of Plant Science*.

Bubela, Tania, Paul Schofield, Camille D. Ryan and David Einhorn. (under review). "The Mouse as a Model for Constructing a Robust Research Commons." *Public Library of Science (PLoS)*.

Ryan, Camille D. and Stuart J. Smyth. (2010). "Facilitating Innovation in Agricultural Biotechnology: An Examination of the Ag-West Biotech Governance Model, 1989-2004." *AgBioForum*. Volume 13, Number 2, Article 9. <http://www.agbioforum.org/v13n2/v13n2a09-smyth.htm>

Ryan, Camille D., B. Li and Cooper H. Langford. (Accepted). "Innovative Workers in Relation to the City: the case of a Natural Resource-based Centre (Calgary)." *City, Culture and Society*.

***Innovation Related Presentations:***

Phillips, P.W.P., W. Boland and C. D. Ryan. (2010). "Centreless Governance and the Management of Global R&D Partnerships and Plant-Genetic Resource Management." *Triple Helix VIII International Conference on University, Industry and Government Linkages*. Madrid, Spain. October 22.

Ryan, C and S. Smyth. (2010). "Exploring Social and Trade Impacts of Adventitious Presence (AP): a case study of GM Flax." *Genomics and Society: Ten Years After, Mapping the Societal Genomics Landscape*. Amsterdam. May 28.

Phillips, P.W.B. and C. Ryan (2010). "Governance of International Networks: a social network analysis of international institutions related to plant genetic resources." *Political Studies Association Conference - Sixty Years of Political Studies: Achievements and Futures*. Edinburgh, Scotland. March 29-30.

Smyth, S. and C. Ryan (2010). "Liability in the Canadian marketplace." *Flax Genomics Workshop*. Radisson, Saskatoon. February 24, 2010

***Innovation Research Plans for the coming year:***

Manuscript under development with Peter Phillips: *Innovation in Oilseeds Research* (contracted by CABI Publishing)

Stuart Smyth

***Innovation Related Project 1:***

*Transfer of University Intellectual Property*

**Funding sources:** Genome Canada

**Timelines and Progress to date:** This research is now complete and the article has been submitted to the Journal of Technology Transfer for review.

*Objective or Abstract:*

The transfer of technology plays a crucial role as an economic driver in the knowledge economy. Canada's present Science and Technology Strategy is strongly focused on knowledge transfer and one of the goals of the S&T Strategy is to facilitate this transfer. To that end, the federal government in Canada has initiated funding programs that encourage commercialization of innovative public sector research.

Many universities in North America established technology transfer offices within a decade of the Bayh-Dole Act of 1980. The vast majority of these offices were established with a 'diamonds in the sky' attitude and the thinking was that these offices would be substantial revenue stream for universities. Nothing could be farther from the truth. With the exception of a handful of universities, the revenue streams are but a mere trickle of what was hoped. Technology transfer is a diverse field and this article examines the technology transfer offices developed by Canadian universities.

***Innovation Related Project 2:***

*Barriers to Biofuels in Canada: Results of an Expert Delphi Survey*

**Funding sources:** Genome Canada

**Timelines and Progress to date:** Paper has been accepted for presentation at the 15<sup>th</sup> ICABR conference in Rome, Italy, June 26-29, 2011.

*Objective or Abstract:*

Through their diverse range of environmental, economic and policy impacts, biofuels have been constantly polarized by the mass media and academic literature. Although the body of literature that investigates macro and microeconomic effect of biofuels is rapidly growing, there is no clear depiction of the Canadian biofuel industry. Our research focuses on identification of the top five economic and regulatory barriers that presently exist in the domestic biofuel industry. A modified expert Delphi survey was used to collect qualitative information from Canadian public sector biofuel researchers and private sector industry managers. The first round of the survey included numerous open-ended questions seeking views about current challenges facing the Canadian biofuel industry, on existing government

support for first and second generation biofuels and the 'food versus fuel' ethics debate. Additional insights regarding information gaps and contrasting agendas between researchers and industry were explored as well. The second round of the survey required an ordinal ranking of the responses previously obtained allowing us to identify the top challenges for the Canadian biofuel industry.

***Innovation Related Publications:***

Smyth, S. J., A. B. Endres, T. Redick and D. Kershen. 2010. *Innovation and Liability in Biotechnology: Transnational and Comparative Perspectives*. Cheltenham, UK: Edward Elgar Publishing Ltd. x + 204pp.

Galushko, V., R. Gray and S. J. Smyth. 2010. Resolving FTO Barriers in GM Canola. *AgBioForum* 13: 4: 360-369.

Smyth, S. J., W. A. Kerr and P. W. B. Phillips. 2011. Recent Trends in the Scientific Basis of Sanitary and Phytosanitary Trade Rules and Their Potential Impact on Investment. *Journal of World Investment and Trade* 12: 1: 5-26.

Smyth, S. J., M. Gusta, K. Belcher, P. W. B. Phillips and D. Castle. (In Press) Changes in Herbicide Use Following the Adoption of HR Canola in Western Canada. *Weed Technology*

Smyth, S. J., M. Gusta, K. Belcher, P. W. B. Phillips and D. Castle. (In Press) Environmental Impacts from Herbicide Tolerant Canola Production in Western Canada. *Agricultural Systems*

Smyth, S. J. and R. Gray. (In Press) Intellectual Property Sharing Agreements in Gene Technology: Implications for Research and commercialization. *International Journal of Intellectual Property Management*

***Innovation Related Presentations:***

Grow Canada Conference. November 30-December 2, 2010. Ottawa, Canada.  
International Consortium on Agricultural Biotechnology Research (ICABR). 14<sup>th</sup>  
International Conference on Bioeconomy Governance. June 16-18, 2010. Ravello, Italy.

***Innovation Research Plans for the coming year:***

I have been asked by Edward Elgar Publishing to prepare a book manuscript for a handbook on agriculture, biotechnology and development. I have enlisted the assistance of fellow CAIRN member Peter Phillips and David Castle as co-editors on this initiative. We have developed the structure for a 400 page book and now have a signed contract with EE. The delivery of the manuscript is March 31, 2012. Enlisting the specific author of the 30-odd chapters that will need to be written and managing this process will consume much of my time.

The other activity that will be a focus for me is my activities as Co-Chair of the 5<sup>th</sup> Genetically Modified Co-existence Conference to be held in Vancouver from Oct. 26-28. The planning for this event is demanding as it will include 25 international plenary speakers, over

30 international parallel session speakers and a tour of the Port of Vancouver. Full details are available at: <http://gmcc-11.com/>

Bodo Steiner

***Innovation Related Publications:***

Steiner, B. and J. Ali (2011). Government support for the development of regional food clusters: Evidence from Alberta, Canada. *International Journal of Innovation and Regional Development*, 3(2): 186-216.

***Innovation Related Presentations:***

Zhang, J. and B. Steiner (2010). Choice behavior and preferences of Canadian consumers with Celiac disease: consumer perceptions of an IgY technology innovation, presentation at the 1st Joint EAAE/ AAEA seminar The economics of food, food choice and health, 115th EAAE seminar, September 15th to September 17th, 2010 at the Technische Universität München (TUM Business School), Freising-Weihenstephan, Germany. Anders, S., Bott, G., Umberger, W. and B. Steiner (2010). Novel Grading and Quality Standards: Insights from the Australian Meat Industry, 2010 Visions Annual Conference, Alberta Agricultural Economics Association, Red Deer, May 6, 2010.

***Innovation Research Plans for the coming year:***

Continued focus on measuring innovation activity and innovation performance in the food processing and biotechnology sector.

James Verammen

***Innovation Related Presentations:***

Verammen, J. and A. Zubchenko, "Time Inconsistent Commercialization Competitions", CAES Selected Paper, Joint AAEA/CAES/WAEA Annual Meetings, Denver, CO. July 25-27, 2010

***Innovation Research Plans for the coming year:***

- (1) Help Zubchenko complete her MSc thesis.
- (2) Continue to revise an earlier paper titled "Optimal R&D Policy with Private Learning by Grant Applicants"
- (3) Work on a project led by Murray Fulton and John Cranfield that is designed to construct a framework for evaluating innovation policy