GROWING INNOVATION: AGRICULTURAL INNOVATION POLICY IN PERSPECTIVE

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Paper presented at the

Innovation Systems Research Network
Fourth Annual Meeting
held at the Hotel Loews Le Concorde
Quebec City, Quebec, May 9-10, 2002.

FIRST DRAFT: Please contact the author before quoting from this paper.

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Using the results from interviews with innovators in agriculture, this paper argues that government policies internationally and in Canada have the effect of favouring some innovations over others. In the context of Canadian agriculture, funding and intellectual property (IP) policies and laws give preference to the creation of applied research innovations. As one public innovator explained, "Matching money with industry money means funding goes to things that industry is interested in." The focus on applied innovation is compounded by IP legislation. As one innovator observed, "IP ownership may inhibit innovation. Given some companies' control over core technologies you can't move without them, [this] restricts [one's] ability to function." Another concern about funding and IP, and the consequent focus on biotechnology, is that other areas of agriculture are being neglected. The organic agriculture industry is a case in point. Despite rapid growth of this sector internationally and within Canada – on average 20% per annum (Shaffer 2002) – the amount of research dollars it attracts is being marginalized within Canada. In order to provide an academic setting for these issues, we will turn our attention to an analysis of some theoretical paradigms related to innovation and scale. Later in the paper some research results from interviews with agri-biotechnology and organic agricultural innovators are summarized. This will lead us to policy recommendations for agriculture. We will also discuss some implications for innovation theory. But first, we will explore definitions of innovation, with particular attention to innovation in the Canadian context.

Innovation is defined by Niosi *et al.* (2000: 4) as, "technical novelty—new or improved products or processes…" and by Lundvall (1993: 278) as, "the creation of qualitatively different, new things and new knowledge". Innovation is seen as the force of 'creative destruction' that Schumpeter perceived as driving economies (Anderson and Gallini 1998, Bradford 2000). The Conference Board of Canada in its 2nd Annual Innovation Report (2000) underscored the importance of innovation for the Canadian economy, "Innovation is one of the main contributors to long-term economic growth." Within the context of this global knowledge-based economy, Canada is improving its innovative capacity. Porter *et al*. in the World Economic Forum report (2002) using the Current Competitiveness Index, rank Canada's present innovative capacity as eleventh with respect to 75 other countries. However, looking out over the next five years with the Growth Competitive Index, Canada is forecasted to move into third place after Finland and the United States. This indicates that we are becoming more innovative as a country. These projections, however, are not guaranteed. So, the question is, what can Canada do to be more innovative?

In an effort to try to shed some light on this question, this paper will focus on the research and development end of the process, where the creation of new techniques and technologies occur. We know that while the products of innovation are made manifest at a local or even individual scale, the process of innovation is affected by influences from many scales (David and Foray 2001). As it is the process that forms and creates a direction for innovation (Pavitt 2000), it would be helpful to determine what these influences are by studying multiple scales at the same time.

In order to decipher the consequences of these influences, this paper focuses on governmental policy and the impact it has on innovators in agri-biotechnology and organic agriculture. Governmental influences are examined from local, regional, national, and international perspectives. These policies are found to influence innovation capacity through funding directions, access to IP and, basic research.

Prior to presenting the empirical research, an overview of relevant themes in the literature will be presented as they relate to: arguments for using influences from multiple scales to study innovation; knowledge flows; and intellectual property issues, especially as they relate to the need for more basic research.

Scale as an organizing principle in economic geography

Since the late-1980's there has been an on-going debate about the relative effect of influences from scales that span the global to the individual and their impact on the creation of innovation. The learning region approach represents one viewpoint in this discussion of innovation. This perspective characterizes economic activity as being flexibly specialized with the emphasis on strong ties between institutions at the regional scale (Piore and Sabel 1984). This vision is said to be especially relevant for knowledge-based industries as interaction and the exchange of information is key to innovation and learning (Amin and Wilkinson 1999). As well, in a learning economy networks are viewed as the conduits for the exchange of information between institutions and the development of innovation (Storper 1997). Adopting the assumptions of the regional learning approach, the importance of local firms is seen as being tied to the increased globalization of the markets, reflecting a heightened need for integration at the regional scale (Todtling 1994). This is perceived to create the need for a more regional focus for economic activity, with local institutions acting as the primary force in innovation and knowledge exchange. However, some scholars question the validity of the learning region approach, suggesting there are factors deriving from other scales that are equally, if not more relevant in developing a total understanding of economic activity (e.g. Florida and Kenney 1990, Staber 1996, Harrison 1997, Markusen 1999, Lovering 1999).

The proponents of these diverse schools also generally use one scale as a focus when describing the process of innovation. This is then translated into research, the development of a theoretical paradigm or a policy that is targeted to the local, national, international or global innovation system, or compares the relationship of one scale to another.

These scholars point to influences that come from outside the local milieu such as policy, legislation, national norms, multinational corporation (MNC) organizational culture, and investor priorities. These are all said to shape the parameters in which an institution operates, thereby influencing the direction of innovation (Sayer and Walker 1992, Gertler and DiGiovanna 1997, Dicken 1998, Lawson 1999, Antonelli 1999).

Many scholars suggest, instead of studying one scale such as the regional or global economies, a look at the simultaneous operation at multiple scales is needed (Sayer and Walker 1992, Grabher 1993, Gertler 1997, Clarkson 2001, Warrian and Mulhern 2001, Cooke 2002). This paper proposes that by purposefully looking at the influences on innovation from multiple scales, it may be possible to gain an appreciation of more of the variables and how they influence the direction of innovation. Theoretically, this would give us a clearer picture as to what is really going on for researchers as they go through the creative process. From a practical perspective, it may give policy makers some additional tools for creating an even more supportive innovation milieu in Canada.

To do this, we will begin with some models of innovation in order to see how innovation is characterized. We can then explore some ideas about where these influences may interject themselves into the innovation process, and hypothesize about the results of these influences on attempts to create innovation.

Models of innovation and the flow of information

We are long past considering innovation as strictly linear, moving along a straight track from R&D to the sale of a product. We now have a variety of models that help to work out the points at which contributions are made to the innovation process, and the institution providing the input and the interconnections and flows that take place as innovation is created (Massey *et al.* 1992, Pavitt 2000, Gibbons *et al.* 2000). But, now that we have opened up the black box of the innovation process and acknowledge that an interactive model is needed to describe innovation, we still need to know where the inputs come from for generating innovation, the nature of these inputs and how they contribute to or constrain innovation. For present purposes, we are particularly interested in identifying policy influences from multiple scales, and their impact on innovation.

Questions related to influences on innovation are aimed at understanding more about the flow of knowledge and whether or not this movement is being optimized. The purpose is to identify the elements that are facilitating and impeding innovation. This understanding may then be used to further improve the innovation environment, and would help to maximize the innovation potential. One aspect that obviously affects innovation is policy formulation as that related to innovation and research. Experts who have studied the flow of information have concluded that, in some cases, policy is one factor that can stimulate or inhibit the free flow of information (Gibbons *et al*. 2000).

IP protection is among the governmental policies that can influence innovation. And there is evidence of IP policy at one scale influencing innovation capacity at other scales. For example, David (2001), in examining the digital technology industry and the related IP laws, concluded that free access to knowledge is – in a disadvantageous way – constrained through the knowledge being copyrighted based on the European Community's Database Directive. David calls this the 'tragedy of the public knowledge commons' as knowledge that is important to the public good, is now falling under the protection of IP laws. As a result, he urges countries to act in ways that would safeguard free access to the information that needs to remain in the public domain. It is suggested that without protective mechanisms, there is the risk that innovative capacity is constrained because too much knowledge is locked up through copyrights and patents. In this way, supranational policy does have the potential to restrict innovation within national and local milieus.

In a discussion of the affect of IP on cumulative research and the implications of various licensing scenarios on access to knowledge needed for innovation, Scotchmer (1991:40) concludes, "…the prospects for fine-tuning the patent system seem limited, which may be an argument for more public sponsorship of basic research." Scotchmer is referring to national IP laws that may limit access to technology, process, or knowledge that might be needed as a foundation for the creation of further innovations. Her solution: Avoid locking up critical information; and, increase the amount of public basic research so that idea generation and its fruits are more usually publicly managed and owned.

The suggestion that basic research can be used to protect the interests of the 'commons' is note-worthy. This is especially important given that several researchers have found evidence that basic knowledge is necessary to stimulate and sustain an innovative economy (Laursen and Salter 2002). In studying the pharmaceutical industry, Toole (2000) found that by increasing the dollars invested in basic research by 1%, there was a 2% - 2.4% jump in the number of commercial products. Scott *et al.* (2002) review the substantial literature that relates to the importance of basic knowledge. In a survey of 10 studies conducted from 1958 to 2000, they found that the estimated increased rate of return from basic agricultural research ranged from 20% to 67%. As well as the direct monetary return, there are also intangible, indirect benefits that accrue from publicly-funded basic research, including the compounding effects of: new information, trained graduates, enhanced connections within the scientific community, improved ability to resolve problems, better methods and research tools, spin-off firms and additional collective insights. In these cases we have evidence that regional, national or supra-national decisions about research priorities influence the innovation potential at the local scale.

This literature review raises some interesting questions for the creation of the best possible innovation environment. For example, the extent of basic research, and the impact of IP are two policy issues that deserve a closer look. For the purposes of this paper, we will focus on three questions. First, are there influences from government policies created at multiple scales, and, if so, what are they? This second question concerns whether or not these influences have effects. This question asks: is there an impact of policies from different scales on the kind of research that is being undertaken? The final question relates to the impact of one particular policy area. This question asks: how do IP laws and policies from multiple scales affect innovative capacity?

What follows is an attempt to shed some light on these questions from the perspective of both agri-biotechnology and organic agricultural innovators. The case of agri-biotechnology innovators is presented since it is one area targeted through Canadian national innovation policy. The organic sector is used to illustrate the case of an alternative, yet marginalized industry that is nevertheless growing. Both of these agricultural sectors will be considered from multiple scales and points of view.

Agricultural innovation in southwestern Ontario: The research

In order to answer some questions about innovation in agriculture, open-ended interviews were conducted with 60 agricultural innovators working in southwestern Ontario, Canada. The people interviewed create product, institutional, technology and/ or process innovations. Of these, 30 researchers are involved in developing innovations related to agri-biotechnology research; the other 30 are engaged in organic agriculture[1] with the exception of four public researchers who are involved in non-biotech approaches (these 30 are all going to be considered as organic). For a further breakdown of the people interviewed refer to Table 1.

	Organic innovators			Biotechnology innovators		
	Farmers	Suppliers, distributors	Public institutions, NGOs	University	Government	Private industry
Number of innovators	11	10	9	10	10	10

Table 1 – Number of agricultural innovators interviewed by sector and institution affiliation

THE FINDINGS AND DISCUSSION

In the following sections funding, organizational, agricultural and intellectual property influences are considered as they impact innovation. The results from the interviews mentioned above are reported for both organic and agri-biotechnology innovators. It needs to be noted at this point that considering innovation from multiple perspectives (agri-biotechnology and organic, and within these groups, public and private) and multiple scales (local, regional, national and global) is not a neat process. Sometimes, there is not even consensus in the results reported within a group. In reading the next sections, it would be useful to bear this in mind. To the extent possible, these often conflicting points of view will be pulled together in the concluding section of the paper. We will begin with a review of results that relate to funding issues.

Research funding

This section of the paper presents the research results that relate the most directly to funding issues for agri-biotechnology and organic innovators. First is a discussion of the funding issues that were common to both types of innovators. This focuses primarily on the requirements that are specified by both provincial and national governments and the resulting strong ties to applied research. Following this is a presentation of funding requirements as they relate specifically to each sector.

<u>Shared funding issues</u>

The bulk of funding for public agricultural research comes from two sources: federal and provincial. Federal funding is available from Agriculture and Agri-Food Canada (AAFC) and the

[1] Three of these innovators work in the public sector to develop non-biotech innovations that might be used by the organic sector. For reporting purposes, these innovators are included in the discussion of the organic innovators.

National Science and Engineering Council (NSERC), with the bulk of the funding provided by AAFC. In 2001, AAFC funded $295.2 million in total expenditures for science in agricultural research (Sauriol 2002). Provincially, research dollars are allocated by the Ontario Ministry of Agriculture and Rural Affairs (OMAFRA). The researchers that received funding from these sources are grateful for the support they are given. They emphasized that this money helps to ensure that research continues in universities and in public research facilities. However, there were suggestions for improving the funding approaches for provincial and federal governments.

Both OMAFRA and AAFC tie research dollars to matching dollars from non-governmental sources. The rationale for this type of funding requirement is twofold. The first goal is to increase the overall dollars available for research. The second aim is to fund research that has real potential to be applied by connecting public researchers with private industry (AAFC 2002). There are benefits and drawbacks that have been created by these federal and provincial governments funding stipulations. From the positive viewpoint, two researchers indicated that being tied to the private sector helps to get their innovations to market faster. The link with industry facilitates the commercialization and marketing of products.

However, many people in the organic sector along with several agri-biotechnology public researchers expressed concern about the matching funding requirement and the direction this is taking publicly funded research. While acknowledging the importance of applied research, there is also a need for research that stands alone without private sponsorship. The most frequently mentioned deterrent pointed out during interviews is that only researchers with goals that have applied benefits can get funding through these matching programs. A public researcher expressed the concern that having business driving research may be bad for science. This means that private interests largely determines research directions. An organic grower observed:

> The multi-national/ big business model of agriculture is favored through government policies in marketing and research and the allocation of money. The percentage of money allocated to organic agriculture is very small even though the market is growing and it gives a high return to the farmer, the government does not try to grow the industry. Not even the 2% that would represent the percent of Ontario organic farmers is provided.[2]

In addition to this issue, some biotechnology university researchers expressed the concern that too much money is allocated to applied research. As this links government research to private industry priorities, there is unease that the matching funding policy may stifle innovation as a

[2] These percentages are consistent with AAFC numbers. In fact the AAFC, according to one government official, $2.8 million dollars were given to the organic industry in 2001 to be used over a one to five year period. This represents 0.95% of total AAFC research budget for 2001 of $295.2 million.

broader vision is constrained. One key informant pointed out that without the broader view that comes with doing basic research, the reputation and publication options for researchers in the public domain suffers. As industry matching is required for many grants, it is difficult to do the basic research that is needed to publish in respected journals. A result may be that our scientist's international reputations and connections that are so crucial to creating innovation may be suffering.

Another implication of this method of funding is that there is only minimal basic research taking place in agriculture. Public researchers in biotechnology and innovators in the organic sector expressed the need for more fundamental research. One researcher explained, "Most funding is for applied research, while most innovations require basic research." The implication here is that although we may be making incremental contributions, our contribution through the development of breakthrough innovations is less likely. Another researcher observed, "Applied research is well funded. Basic, non-medical research is not well funded. The only money for basic research is from NSERC. These are very small amounts. (Public researchers) cannot compete internationally with this kind of funding." One innovator pointed out that NSERC divides small pie into so many small pieces that they are useless. It was suggested that fewer proposals should get money so the grants per project could be larger. This would enable more significant research to take place.

<u>Organic issues</u>

The problem with the need for matching funding as specified by AAFC and OMAFRA is highlighted in the case of the organic industry as it does not have a substantial corporate base. As a result, both basic and applied research that could be beneficial to the organic industry is effectively excluded from competing for government funding as there are no private resources that can match government dollars. One innovator explained that organic farming, "operates from a different paradigm, (it) emphasizes management techniques and how to connect with and work the local farm ecosystem". In order for publicly funded organic research to be possible the matching condition would need to be removed as a criterion. One supplier commented that, "there is a need for generic research that isn't linked to chemicals and GMOs (genetically modified organisms)." As a result of this, and other government initiatives, government policy is seen by organic farmers, suppliers and distributors as being strongly biased in favor of agri-biotechnology and chemical technologies.

Practically, this translates into few information or human resource supports for organic producers from the provincial ministry or the federal department of agriculture. One farmer explained the experience of approaching a government agency for support when he started up as an organic farmer a few years ago, "when I wanted to begin farming organically, I was told that it could not be done…(The government person) did not try to help or connect me with someone who could help." However, as this farmer continues, "this lack of information from the government may help organic farmers to be more innovative". The feeling of many innovators is that in order to be innovative, you have to be challenged and need to be pushed. A lack of information and resources can be a source for this challenge. Overall, the sentiments of many in the organic community were expressed when one of the suppliers explained:

> We need a government that understands agriculture, that (sic) knows the importance of a healthy agricultural system and the spin-off benefits to the economy. The government doesn't realize what is has here.

Despite the perceived lack of support, research is taking place on organic farms at the local level. Every innovator interviewed was conducting some kind of formal or informal experimentation to improve processes, equipment or infrastructure. Disappointingly for innovators in organics, the interest in these Canadian organic innovations is not coming from Canadian universities, governments and growers but from institutions and individuals outside of Canada. Several organic innovators interviewed indicated that the creative environment, level of support and the acceptance of their innovations is greater outside of Ontario and Canada in places in the U.S., Asia and the EU. There is better acceptance and support at the international scale for these innovators.

It should be noted that the level of support has changed somewhat over the course of this research project. It is now possible to access information about organic agriculture on the AAFC and OMAFRA web sites. There are links to association web sites such as the Canadian Organic Growers (COG) and the International Federation of Organic Agriculture Movements (IFOAM). OMAFRA has also turned their part-time organic specialist into a full-time position within the last twelve months. AAFC also continues to offer export development support to organic farmers. In 2001 there was a total of $2.8 million that was made available for various projects that range from 1 to 5 years. The money was allocated to help develop web-based courses in organic agriculture through the Nova Scotia Agricultural College, assist with certification and also provided sponsorship for an international conference to be held in Canada in 2002. Although a good start, this represents at most 0.008% of the over $333 million AAFC invested in agricultural research.

<u>Funding and Agri-biotechnology issues</u>

In interviewing agri-biotechnology university innovators who do have access to provincial and federal funding, some barriers were identified. One of these is that federal and provincial funding is not long-term. In the case of OMAFRA, money is allocated on a yearly basis. This means that long-term research cannot be reliably planned for. Several innovators interviewed indicated that there is a need for more stable, long-term money from both levels of government. Similar concerns were expressed by innovators working for the federal government. One researcher explained, "we (government researchers) need strong, uninterrupted funding for progress in long-term research. The constant worry about money is stressful."

A further critique by a university key informant was that money is awarded by region. It was suggested that instead of awarding grants as a form of regional development, they should be awarded based on merit alone. It was suggested that centers could be established where, based on critical mass, certain types of science could thrive. The bottom line for this innovator is that Canada doesn't have enough innovation money to squander on regional development.

From an organizational perspective, innovators working in the federal government are also constrained by the policies set by AAFC. They must work within areas established as priorities by politicians who are influenced by farmers, producer groups and the public. It is necessary to, "fit into the research streams". In the words of one researcher, "There is always a conflict between good science and the need to address industry issues". Many at AAFC indicated that there is an on-going compromise between the research area in which they want to innovate and what they end up doing. As one innovator explained, there is a "need to fit ideas onto the list (of acceptable projects)".

To overcome some of these issues, several public key informants proposed that there is a need for collaborative, multi-disciplinary research. A few people interviewed suggested the need for a national initiative to establish broad based and broadly supported research directions to better utilize limited research dollars. Three innovators suggested that to help resolve some of the funding problems within the public sector and to connect researchers together more effectively, it could be useful to bring together public researchers to develop start-to-finish projects. It was suggested that this would result in more connected and targeted research projects that would bring various local strengths together in a research network.

We have considered the interaction of funding with issues related to applied and basic research, the influence on the organic sector and agri-biotechnology as it determines available resources. We have examined issues that relate to the national and provincial scales, and seen how they influence the innovative capacity of researchers. It is now time to turn to intellectual property issues at different scales and determine how this affects innovation.

Intellectual property

There are entirely different interpretations of the impacts of IP expressed depending on whether one talks to an innovator in agri-biotechnology, or an innovator in the organic sector. For this reason, the two positions will be reported separately.

Intellectual property and agri-biotechnology innovators

IP laws at the international scale are viewed from two different perspectives. Primarily, those in the private agri-biotechnology industry are in favour of strong IP laws. They express a need to protect their substantial investments in biotechnology. On the other side of the coin are the public researchers who find that they are unable to afford to develop certain innovations due to licensing fees, royalties or simply blocked access to innovations.

Some individuals in the public, and most in the private domain explain that intellectual property protection is imperative for the continuation of capital-intensive research and development within the international biotechnology industry. The cost of R&D is so high that it tends to depress profits. As a result, there have been many corporate consolidations over the last five years (ETC Group 2002). This merger and acquisition activity reduces – presumably -- R&D unit costs and pools important IP assets. The argument is that if the results of the research cannot be protected then the research will cease. MNCs, since they are private for profit companies, indicate the need for a return on research and development investments. This is a concern as well for innovators in the public domain as more projects are encouraged to adopt business models and engage in technology transfer.

These innovators largely advocate for international accords that support strong IP protection. A main venue for accomplishing these goals are the World Trade Organization (WTO) Agreement on Trade-Related Aspects of Intellectual Property (TRIPS) accord that deals with harmonizing intellectual property internationally (WTO 2000). The aims of TRIPS, "include the reduction of distortions and impediments to international trade, promotion of effective and adequate protection of intellectual property rights… (WTO 2000)." As well, plant Breeder Rights (PBR) standards are used in Canada for protecting plant and animal related innovations through the Union pour la protection des organismes vegetale (UPOV) as it is not possible to patent plant or animal innovations in Canada. UPOV is overseen by the Director-General of the UN World Intellectual Property Organization (WIPO). Effectively, intellectual property laws are now established through international accords. The move internationally is to bring all IP and PBR policies in line with one another. As a result, there is relatively little control that derives from the Canadian national scale once we are signatories to these agreements.

The importance of the international domain to patents is demonstrated by the patenting pattern of public agri-biotechnology scientists. Of the public innovators interviewed, there are thirteen public researchers in Canada who hold or have applied for patents in the last five years. As several researchers hold multiple patents, the thirteen scientists collectively hold or have patents pending on a total of 40 patents. Of all the researchers with patents, only 3 held patents exclusively in Canada, accounting for 8 of the 40 patents. The remaining 10 researchers, with a total of 23 patents, applied to the U.S. and other countries as well. Importantly a total of 10 of the 40 patents were applied for and granted exclusively outside of Canada. Since they are subject to the laws and policies that exist at these various scales local innovators feel the need to protect their innovations at multiple scales.

With this background, we can now turn to issues that are specific to different groups of innovators. We will begin this discussion with a look at issues from the agri-biotechnology perspective and then move on to the research results for the public innovators.

Private agri-biotechnology IP issues

Exploring the MNC perspective with regard to IP in more depth, we find as previously mentioned that there is generally good flow of ideas and access to IP for research and development within private companies. This information flow appears to be quite linear and contained within the boundaries of each MNC. There is a strong 'branch plant' mentality for Canadian MNC innovators. The relevance in the present context is that the internationally based head office dictates broad policy with respect to IP. This in turn constrains how Canadian private innovators create at the local level. The lack of autonomy with respect to IP creates conflicts for local innovators and raises some contradictory issues for private innovators.

In some cases, IP is seen to foster innovation. In these cases it, "gives you currency, can trade it for what you need. Today cash is probably the least interesting piece of currency you can offer when interacting with other companies". In other cases, it produces an atmosphere where people are protective of their innovations, "driving IP into dark corners as IP has value". One innovator explained, "with competitive intelligence, people play their cards a lot closer to their chest". This means that there is much less sharing of information between innovators than in pre-biotechnology days both during and after the innovation process. Even when IP is accessible and out in the open it may require, "multiple agreements to conduct research". This means that complex accords have to be hammered out before the desired innovation can begin. This can delay the innovation process as a range of departments is included in these types of negotiations. In cases where these types of negotiations take place, it is helpful for a company to have their own IP to bring to the table. As previously mentioned, IP is perceived to be more valuable than anything else in the industry.

It was noted that IP protection has made some innovations more feasible for MNCs. One innovator pointed out that there was no way prior to IP law and policy to protect large scale research developments, so there was no innovation going on. One key informant indicated that now that there is the option to protect IP and recover the investment, there is more innovation occurring. An example used was the brown-bagging of soybeans, where farmers would save seed from the previous year for planting the next. Now though, as a result of technical use agreements signed upon purchasing RoundupReady soybean seed, farmers are no longer able to save their seed and replant it the next year. This means that MNC are able to sell their seed every year giving them a more stable return on their R&D investment. This point was underlined using the example of wheat that is not yet modified through GE and has no associated patents. According to this researcher, soybeans receive the same amount of investment in research and development as wheat despite the fact that soybeans are grown on only one tenth of the acreage, and constitute a smaller volume. Accordingly, "there is increased reinvestment in R&D where protection exists".

However, it must be noted that one of the MNC surveyed does not favour the use of patents to protect its seed. This company is collaborating with public researchers to create shared innovations. This MNC supports the idea that major breakthroughs should not be locked up, but rather need to be accessible to all innovators. This is seen to facilitate innovation for the betterment of the farmer, and the consumer.

International and national IP laws and policies both stimulate and constrain innovation for private companies. Having examined IP from the private point of view, we will now turn our attention to the public agri-biotechnology innovators.

Public agri-biotechnology innovators

Intellectual property law and policy influences the innovation process for biotechnology public researchers at many scales. Locally, there are institutional IP policies that restrict the scope of collaborative research agreements. For example, AAFC has a policy for some research departments requiring that the government retain all intellectual property rights for innovations created on AAFC premises. This allows little latitude when AAFC employees are negotiating collaborative agreements with other researchers. This results in somewhat awkward negotiations when dealing with private companies or other research institutions. At the University of Guelph, the standard for dealing with plant breeding innovations is that they remain the property of the university. This has the effect in many cases of relegating the university to a role of research contractor, as the fruits of research cannot be shared. Additionally, scientists pointed out, this lack of incentive for researchers to have a stake in their innovations discourages individuals within the university from innovating. There are several innovators who called for the harmonization of IP policy across organizations to facilitate the collaboration between groups and provide individuals with incentives to create.

In contrast to this point of view, are the innovators within the public system who whole-heartedly support an IP policy for public institutions whereby the public organization retains complete control over IP. They feel strongly that as the research is funded with public dollars it should remain in the public domain.

There were concerns expressed about the degree of IP protection with respect to developments in agri-biotechnology by public innovators. As was observed, agri-biotechnology innovation tends to be a series of cumulative innovations. As a result, the patenting of core processes and platform technologies has resulted in the increased cost of developing additional innovations. This is of concern to some public researchers. Although public researchers have free access to technologies for pure research purposes, they made two points. First, just because you have access to something does not mean that you understand how to use the innovation; training or special equipment may be needed to take advantage of the technology. Second, is the question of marketing innovations that may have been developed by building on patented technologies or processes. As one innovator explained, if there are too many licensing and royalty fees to pay, innovators will not go in a particular research direction. This stops research in its tracks. Some argued though that this results in more innovation as new methods are developed that engineer around existing patents. The preponderant view though is that researchers spend a lot of time innovating around patents and that this makes innovation more costly and time consuming.

Another impediment to innovation is the inability of innovators to get access to patents as some companies refuse to license technologies for use. In some jurisdictions outside of Canada, there is no requirement to make innovations accessible. This then truly blocks innovation. One innovator explained that:

> It is not always possible to gain access to the best IP or reagents to do the job. Companies often put unreasonable restrictions on access. Public institutions and government laboratories need sufficient resources to acquire or develop enabling technologies that allow them to compete with private companies.

Patents also prevent public researchers from publishing their results in a timely manner, further slowing innovation locally and internationally. One researcher indicated that, "patent protection requires confidentiality…that impairs the free flow of ideas…Information may need to be protected for 4 or 5 years".

Having considered intellectual property from an agri-biotechnology point of view, we will now review what organic innovators shared about IP.

<u>Intellectual property and organic innovators</u>

The ownership or protection of innovation through patents internationally has raised the concern of some innovators in the organic industry. There is particular concern about access to seeds and the level of genetic diversity within different species as agriculture is narrowed to fewer and fewer crops through the concentration that goes hand-in-hand with the high cost of R&D and IP. For example, a direct result of IP laws and policies for the organic industry is the inability to access certain varieties due to proprietary issues. In some cases, growers are unable to use plant varieties as they have in the past. One supplier can no longer grow a vegetable cross as a U.S. university has patented the process of knowledge used to create this variety. This patent was granted despite this knowledge previously being in the public domain, and commonly used to produce a range of vegetables.

Another concern exists about the rationalization of the ownership and production of seeds through patents that are held in the hands of a few MNCs. One observer explained, "Patents that the "Life Sciences" companies own are too broad and apply to things that should stay in the public domain." There are now five companies that own 75% of the seed patents world-wide (ETC 2002). The organic sector sees itself as an alternative to the conventional agri-business system, and makes huge efforts to protect genetic diversity through seed saver organizations and other NGOs.

Ironically, there are benefits to IP for the organic sector. In order to make this point, we must return to the discussion of agri-biotechnology and make an important connection clear. The need for IP as a protection for biotechnology creates a link between patents and GMOs. The high cost of R&D to develop GMOs is the rationale for the IP protection, so at the end the institution that made the investment can also reap the profit. This is important as key informants attribute part of the growth in the organic industry consumer concern about GMO food – an end result of the patenting process. As one organic distributor observed:

> (The) biggest kick for organic food was the increased awareness of GMOs, the fact that industry can patent food. People lost confidence, had more questions about their food. In Europe Mad Cow disease woke people up, (the) spillover has raised questions here.

Increased public awareness and concern about food as a spin-off effect of IP and the attention received internationally, and the trickle down attention in Canada, has been a boon for the organic industry.

Having examined some IP policies and laws from local, national and international scales, we have found that there are indeed influences from each scale on the innovation process. This applies to innovators in agri-biotechnology and the organic sector alike.

Conclusions

It is evident from this study that innovation is influenced both positively and negatively by factors that develop at multiple scales. This is true for both biotechnology and organic innovators. If the main thrust of developing innovation policy is to stimulate creativity then, in order to develop an environment that supplies the necessary tools, one must focus from and beyond the local or even the national scale to identify all of the influences that bear on the innovation process. It is then possible to foster a policy environment within one's jurisdiction that comprehends how policy and action at other scales may be affecting one's efforts.

When considering how to fund innovation, it is important to look at all the factors that influence the potential for growth and stimulation of the economy for a sector. For agri-biotechnology, for example, it would be prudent to look at the mix of funding for applied and basic research. There may be a potential through basic research to target areas that can serve as the foundation for future innovation. While acknowledging the importance of incremental innovation as stressed in the regional systems innovation literature and elsewhere, we still need to be engaged in basic research. Basic research is the underpinning for future innovations. As one public innovator pointed out, the successful R&D policy at Stanford University is founded solidly on basic research. Perhaps ideas from the linear model that highlight the importance of the R&D end of the innovation process should be given more currency. As has been demonstrated in this paper, having too strong a link between applied research and funding undermines the development of basic research. If all we are doing is building on institutional innovations outside of Canada, we may need to ask ourselves, is this the best way to invest our limited R&D dollars? Associated with funding are issues that influence operations, including hiring policies, professional development and networking opportunities, as well as the duration and stability of funding. Additionally, problems identified at one scale provoked key informants to suggest solutions deriving from other scales. For example, the need to make innovation projects more broad based and longer in duration could be resolved by establishing working groups to determine national research objectives.

As well, there are concerns that are related specifically to IP issues. Acknowledging the need to protect R&D investment, we need to be more creative in developing IP policy. Ideally, all IP should be accessible. It should not be possible to block access to innovation through IP. Within IP legislation, a balance is needed between profitability and reasonable access to technologies and processes. Canada addresses this concern in its IP legislation, and should encourage other jurisdictions to do the same. Canada alone though faces huge obstacles in influencing MNCs and U.S. interests. We have seen recently through the soft-wood lumber dispute. It may be prudent for Canada to consider aligning itself with other trading blocs, such as the EU, to have a collective voice on these issues in the international forum.

We also need to identify factors that are outside our control. It may be prudent to ask ourselves about the contribution we can make, and the extent of the barriers. Intellectual property may well be one of these areas. We need to have a good sense where our strengths lie, and determine if we own enough of, or can lock up, the IP building blocks to dominate and excel in a specialized area. If not, perhaps we should be considering other options for agricultural research and policy.

The organic community also identified barriers to innovation. These innovators also raised questions about the need for more basic research, and the lack of infrastructure for organics. Some progress is being made in this regard. Unfortunately, the present requirement for matching funding effectively shuts the organic agricultural innovators out of the granting system. Perhaps, as the industry grows on average 20% per annum, it should be considered as an alternative for Canada's farming community by policy makers. As organic agriculture is firmly rooted in ecological farming practices, it has many environmental stewardship benefits that dovetail very well with AAFC's Agriculture and Food Policy. Perhaps, in looking at the influences on these innovations from a multi-scaled perspective, provincially and nationally we may need to consider providing more support to our fledgling organic industry. We need to recognize the innovation that is taking place and keep some innovations at home instead of letting them be used to the benefit of other countries. We should be staking out our areas of expertise in the markets that are now worth $7.8billion US and growing by an average 20% per year (Shaffer 2002). One way in which organic growers can be helped is to recognize the contribution they make as stewards through reduced taxes or some form of credit system. As well, there could be an income equalization program for conventional farmers that are transitioning to organic farming. This would stabilize farm income as they convert to the new management techniques. Centralized information, on-farm research compensation, and additional extension services would provide needed infrastructure and support. Overall, these provisions would help to grow the industry so that it can position itself within the growing domestic and international markets.

This research provides some evidence for considering multiple scales when developing innovation policy. It may challenge academics to move away from paradigms where only one scale is considered at a time. In order to provide the best chance for innovation success, we need to consider all the influences and how they interact. In order to optimize innovation, to the extent possible, it is necessary to remember that the influences that have been identified for innovation in Ontario agriculture are all necessary, but none alone sufficient, for the creation of the ideal innovation environment.

Acknowledgements

I would like to thank the Social Sciences and Humanities Research Council for providing financial support for this research. I would also like to thank Dr. Tod Rutherford for his insightful comments.

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