Barriers to Innovation for University of Guelph Undergraduate Students Returning to a Family Farm after Graduation

By:

Chris Danderfer

A Major Research Paper
Presented in partial
Fulfillment of the requirements
for the degree of
Master of Science
in
Capacity Development and Extension

University of Guelph

Guelph, Ontario, Canada

August, 2015

Table of Contents

1.0 Introduction

1.1 Statement of Purpose

The purpose of this research is to examine the barriers that Ontario Agricultural College (OAC) undergraduate students may face when trying to implement new ideas on their family farms during and after their programs. This issue will be considered from the viewpoint of the students and from faculty of various levels within the University of Guelph to gain a better understanding of how the University of Guelph views the role of undergraduates in agricultural innovation. Furthermore, areas for improvement, as identified by participants, will be discussed in order to create a basic framework that can be utilized for future conversations on how to improve OAC programs in order to enable undergraduate students to become a stronger source of agricultural innovation.

1.2 Introduction

The terms ‘undergraduate students’ and ‘students’ will be used interchangeably within this paper to refer to the University of Guelph student participants of the study. Within this context, OAC undergraduate students are any undergraduate students, regardless of years studied, that are enrolled in an OAC program and who intend to return to their family farm to work in some capacity after graduation. The second group of participants in this study consists of University of Guelph faculty members involved in rural affairs, innovation, and agriculture, and who are employed within the OAC, researchers working for private agricultural innovation groups, and government workers involved with agriculture and knowledge sharing. Within this paper, these participants will be referred to as ‘faculty members’ or ‘faculty’, ‘researchers’ or ‘innovation researchers’, and ‘government workers’ respectively. . Innovation in this paper views

"learning at the core of innovation processes, as any change in a social or economic organization that "Improves a certain state of affairs results in a change in the available knowledge. Moreover, it highlights a specific type of learning 'social learning' which affects shared cognitive frames and coordination in a network (Knickel, Brunori, Rand, and Proost, 2009, p. 139-40).

The University of Guelph enrolled 17,769 Canadian undergraduate students, and granted 4,885 bachelor's degrees in 2013 (CUDO, 2013, A.3 and A.6). Between 2005-06 and 2014-15 the number of full-time undergraduate students enrolled at the University of Guelph increased from 16,920 to 22,943 (COU, 2015, Table 3). By using data from the University of Guelph, OAC attendance was reported at approximately 450 students (University of Guelph, 2015, Enrollment). The University of Guelph has also experienced increased revenues and savings during the same time period. Since 1992, the total endowment of the University has increased by 677% from $35.2M to $308.9M. In 2013-14 research based activities brought in $123.2M in revenue and the University of Guelph – OMAFRA partnership brought in $64.0M, 17% and 9% of total revenue, respectively. This speaks to the University of Guelph's increasing commitment to research, innovation, and sustainability. The Ontario Agricultural College (OAC), and the Ontario Ministry of Agriculture, Food, and Rural Affairs (OMAFRA) – University of Guelph partnership are primarily responsible for carrying out the University of Guelph's progressive agenda in agriculture and related fields

The OAC describes itself as "a global leader in education, research and service in agriculture, food, environmental sciences and rural community development" (OAC, 2015, About). The OAC is composed of six academic units: the Department of Animal and Poultry Science, the Department of Food, Agricultural and Resource Economics, the Department of

Food Science, the Department of Plant Agriculture, the School of Environmental Design and Rural Development, and the School of Environmental Sciences (OAC, 2015, About). The U of G – OMAFRA partnership describes itself as providing "numerous other benefits include(ing), research breakthroughs, safer food, better disease monitoring and prevention, and new products and technology," (University of Guelph, 2015, About the Partnership). Both organizations are key organizations within the provincial, national, and international agricultural innovations and technology fields.

1.3 Problem Statement

The University of Guelph, OMAFRA, and the OAC have a focus on research and innovation. Within agriculture, the University, OMAFRA, and the OAC focus on the areas of Food, Agriculture, Environment, and Communities (OAC, 2015, About). The primary output of the three organizations is patentable research and theoretical advances in resource management (OAC, 2015, About & University of Guelph, 2015, About the partnership). Ultimately, most of the technology and practice innovation that arises from the University of Guelph, the U of G – OMAFRA partnership, and the OAC focuses on monetization, patentable creations, and economic advancement within the existing agricultural-industrial system. As the University has expanded, so have its innovative partnerships and research capabilities, leading to significant benefits to the agricultural industry and society, creating a positive feedback loop that increases local, regional, and national innovative processes (Cowan & Zinovyeva, 2013).

While the benefits of increased innovative capacity within communities and regions are obvious, the University, OAC and OMAFRA are missing opportunities to promote bottom up innovative adoption. This paper therefore intends to investigate what these barriers may be, how OAC undergraduate programs help students overcome these barriers, and in what ways

undergraduate students may be aided in gaining skills and characteristics that allow them to better overcome barriers to innovation.

1.4 Primary Research Goal

The primary goal of this research paper is to create a comprehensive description of the current level of support that OAC undergraduate students receive in overcoming barriers to innovation and contrast this with suggestions for an ideal improved level of support that could exist in the future.

1.5 Research Objectives

1. Identify and describe the barriers to innovation undergraduate students may experience when returning to their family farms.
2. Describe how OAC undergraduate programs currently support students in overcoming barriers to innovation.
3. Suggest improvements that allow undergraduate programs to better support undergraduate students in overcoming barriers to innovation on their family farms.

1.6 General Methodology

Primarily qualitative methods were used to collect data from students and faculty within the OAC. A focus group was held with seven participants, all of who were undergraduate students within the OAC. Student participants were asked three questions relating to barriers to innovation on their farms and their comfort and ability to overcome them. The responses from the focus group informed the literature review by identifying what barriers to explore in related research as well as suggesting ways in which their education aided them in overcoming barriers to innovation three interviews were then conducted, one with an OAC faculty member, one with

a member of the OAC faculty also involved with the University of Guelph-OMAFRA partnership, and one from a private agricultural organization. These interviews focused on the perception of the innovation barriers graduated students face when returning to work on farms, how the organizations they represent supported students, how an undergraduate education benefited students, and what improvements could be made to undergraduate programs to better help students overcome these barriers. The focus group and interview responses provide the basis for the analysis of the challenges students face when returning to family farms and the support they receive in association with their university education.

1.7 Organization of the Research Paper

Following the introduction, the second chapter of this paper includes a literature review discussing the challenges facing primary producers and family farms within a rapidly evolving industry and the need for sustainability. This section will discuss the connection between sustainability and innovation, and the common sources of innovation within agriculture. Lastly, undergraduate students returning to family farms will be discussed in terms of their role within the agricultural sustainability and innovation landscape.

Chapter three focuses on the rationale for the focus of the study, the methodology used in conducting the primary research for this paper, data collection tool designs, data collection, analysis, and coding techniques, and the limitations and benefits of the selected data collection strategy.

The fourth chapter of this paper presents the findings of the study and discusses them. This chapter is separated into three major areas: the first involves a brief description of the innovation communication landscape in agriculture and a discussion of undergraduates roles

within, the second focuses on perceived barriers to innovation for undergraduate students returning to family farms, and the third involves the role that an undergraduate education and academic institutions play in reducing or overcoming these barriers. The barriers are categorized based on economic, social, and environmental causes, while the discussion of undergraduate education's role in mitigating barriers focuses on the utility of Skill Building, Life Experience, and Relationship Building benefits.

Chapter five discusses the conclusions of the author and relays six suggestions for improving programs in the OAC and the wider university to better equip students to deal with barriers to innovation.

2.0 Literature Review

2.1 The Need for Innovation in Agriculture: A Road to Sustainability

Agricultural innovation is the process of imagining, creating, and dispersing new ideas, techniques, products, and technologies, within the agricultural industry. The barriers to innovation discussed within this paper are therefore defined as obstacles that prevent OAC graduates' uptake of new innovations on their family farms. There are significant social, economic, and environmental issues that necessitate the adoption of innovations on family farms.

While, as of 2013, only 1.7% of Canadian GDP is created by primary producers, when secondary producers are also considered, this number rises to 8.0%, with over 2.1 million people relying on primary and secondary agricultural production for employment (Agriculture and Agri-food Canada, 2013). These numbers suggest that a significant portion of the existing Canadian workforce participates within the agricultural sector to some degree. Between 1991 and 2006 the number of farms in Canada has been reduced from 280,043 to 229,373, while the average

number of acres per farm has increased from 598 to 728 (Statistics Canada, 2007). In 2013, there were 205,730 farms in Canada, down 10% from 2006 (Agriculture and Agri-food Canada, 2013). In Ontario, the number of individual farms dropped from 68,633 in 1991 to 57,211 in 2006 (Statistics Canada, 2007). The reduction in the number of farms in Canada is a result of a number of issues: Aging owners, a lack of interest in farming from younger generations, rising land and asset prices, stagnant commodity prices, and the reduction of land quality.

Figure 2.1: Distribution and Average Age of Farm Operators in Canada

Canada	1991	1996	2001	2006	1991	1996	2001	2006
Age of farm operators	number of operators				percentage distribution			
Under 35 years	77,910	61,055	39,915	29,920	19.9	15.8	11.5	9.1
35 to 54 years	187,585	200,170	185,570	164,160	48	51.9	53.6	50.2
55 years and over	125,380	124,380	120,705	132,975	32.1	32.3	34.9	40.7
Total	390,875	385,605	346,190	327,055	100	100	100	100
Average age	47.5	48.4	49.9	52	...	...	...	...

(Stats Canada, 2007)

Figure 2.2: Distribution and Average Age of Farm Operators in Ontario

Ontario	1991	1996	2001	2006	1991	1996	2001	2006
Age of farm operators	**number of operators**				**percentage distribution**			
Under 35 years	18,440	13,835	8,975	7,070	18.3	14.3	10.6	8.6
35 to 54 years	48,005	48,995	44,150	40,280	47.6	50.5	51.9	48.9
55 years and over	34,470	34,105	31,885	35,065	34.2	35.2	37.5	42.5
Total	100,915	96,935	85,010	82,415	100	100	100	100
Average age	48.3	49.4	50.7	52.6	...	...	...	...

(Stats Canada, 2007)

The average age of farm owners in 2006 in Canada was 52 (Table 2.1) and in Ontario 52.6 (Table 2.2) (Stats Canada, 2007). Less than ten percent of farm operators in Canada and Ontario are under the age of 35, while over forty percent are over the age of 55 (Stats Canada, 2007). The average age of farmers continues to rise due to a general disinterest in the lifestyle, but it is hard to determine what this actually means. It makes more sense to therefore discuss specific trends or externalities that may influence interest in farming for younger generations.

One such trend is the near-constant rise in land prices occurring across Canada. Urban development pressure and rising cash crop prices have led to significant increases in land values in North America (Weber and Key, 2014, p. 1334). According to Farm Credit Canada (FCC), average Canadian land prices have risen by at least 14.3% and as much as 22.1% each year since 2011 (FCC, 2015, p. 3). In Ontario, land prices rose by at least 12.4% and as much as 30.1%

over the same time period (FCC, 2015, p. 8). In an attempt to maximize economies of scale, producers are competing for any available land in order to grow their farms and income in the long term, since "generally, crop yields and income are increasing with farm size and farm intensity," (Reidsma, Ewert, & Lansink, 2009, p. 421). Net farm values have continued to increase year-upon-year as asset values have risen while interest rates have remained low (Agriculture and Agri-food Canada, 2013). Lower borrowing costs benefit older, wealthier farmers who, having a longer lending history and a larger pool of collateral, are able to negotiate larger loans at better terms than younger, less established farmers (Weber and Key, 2014, p. 1334). This contributes to a cycle where available land is often absorbed into larger farms rather than made available to new or younger producers.

Reidsma, Ewert, and Lansink (2009) further suggest that after climate and land type differences, "input intensity, economic size and the land use type are important factors influencing spatial variability in crop yields and income" (p. 421). Greater access to cash allows older farmers to afford greater input intensity and put a larger amount of land into production. Additionally, greater access to financing allows farmers to better implement expensive new seed strains and crop types that have improved returns. Farmers face further difficulties, as "a higher Canada-U.S. exchange rate and rising input costs [has] led to competitive challenges for the sector," which must be addressed by "increasing investments and innovation" (Agriculture and Agri-food Canada, 2013, Section 5).

High asset prices, escalating land values, the need for large economies of scale, and a higher US-Canada exchange rate means that young farmers, defined as being between 18 and 39 years old, account for only 7.5% of primary producers in Canada (Agriculture and Agri-food Canada, 2013). Young producers generally report higher income, both on- and off-farm

(Agriculture and Agri-food Canada, 2013). Daberkow and McBride (2003) associate increased age with reduced adoption of innovation, and also suggest that younger producers tend to be more educated in general (p. 163). Along with income, agricultural innovation researchers tend to focus on education levels and age as key factors in agricultural innovation uptake.

Although younger producers tend to make more from their on-farm activity, most farmers, regardless of age, rely on off-farm income to supplement their on-farm income (Jette-Nantel, Freshwater, Beaulieu, & Katchova, 2011, Statistics Canada, 2009). In Canada, between 2002 and 2006 "the share of total income originating from off-farm sources for operators of unincorporated farms (with gross farm revenue of $10,000 and greater) grew from 55% to 62%" (Statistics Canada, 2009, p. 4). Part of the growth in off-farm revenue can be attributed to increasing income volatility over the past decade. Total net farm income within Canada was $3,587,870,000 in 1981, reaching a minimum of $261,381,000 in 2008, peaking at $8,038,218,000 in 2011, and registering at $7,122,677,000 in 2012 (Statistics Canada, 2014). This volatility resulted in a range in total net income for farms in Canada of $7,776,837,000 between 2008 and 2012 (Statistics Canada, 2014).

Within Ontario a similar pattern emerges. In 1981, net farm income in the province was $688,879,000, reaching a minimum in 2007 of -$142,662,000 and peaking at $1,471,647,000 in 2012 (Statistics Canada, 2014). This represents a growth of 114% in net farm income between 1981 and 2012. Recently though, significant volatility has been present. Between 2007 and 2012 net farm income in Ontario increased from -$142,662,000 to $1,471,647,000, a change of $1,614,309,000 or 110% in terms of 2012 net income levels for Ontario (Statistics Canada, 2014). While farm net income has increased since 1981, significant volatility has been

experienced in Canada and Ontario in the last decade, with reported numbers varying by hundreds of percent over that time.

In some cases, producers have created Alternative Marketing Arrangements (AMAs) to reduce risk within volatile commodity markets (Hu, 2015, 2900). These AMAs allow farmers to hedge against risk, and increase profit as inputs rise, in order to maintain profitability. Despite efforts to hedge risks, Jette-Nantel et al. (2011) found that the variability of gross farm revenue positively affected "the likelihood of off-farm work and the level of off-farm employment income," and "farm size was inversely related to the level of off-farm employment income," (p. 1). Jette-Nantel et al. also suggest that for a "majority of farm families and operators in OECD countries, off-farm or non-farm occupations have become a significant source of income and a major determinant of their well-being," (Jette-Nantel, Freshwater, Beaulieu, Katchova, 2011, 1).

Income volatility and the need to hedge risk results not only in the need for farmers to look for off-farm work, but also in a significant amount of government support. Agriculture and Agri-food Canada estimates "agricultural support spending at 14% of gross farm income in 2011, compared to 8% for the United States" (Agriculture and Agri-food Canada, 2013). Canadian producers receive a much larger share of their income from the Canadian government than their counterparts in the United States.

2.1 Focuses of Innovation Research in Agriculture

The issues pertaining to income, government support, market volatility, declining farm numbers, increasing land values, and aging demographics, have made innovation a predominant focus within agricultural research. Government, university, and industry researchers have played a significant role in attempts to modernize agricultural practices and introduce economically viable products and technologies. Political researchers have also shown interest in the field from

the perspective of policy analysis. Environmental researchers inhabit a central role in the field, evaluating practices and technologies focused on reducing ecological damage caused by modern farming practices.

Government support for agriculture in Canada was reported as $7.5 billion in 2011-2012, representing 26.7% of agricultural GDP (Agriculture and Agri-food Canada, 2013). Agriculture and Agri-food Canada (2013) provides further data reporting "2011-2013 program payments account for 36% of government agricultural support, while funding for research and development accounted for 30%," with the actual expenditure on research in 2011-12 being $561 million (p. 30). The Canadian government spends almost the same amount of money on research and innovation as it does on direct producer support. Historically, the primary forces determining the development and adoption of agricultural innovation have been seen as "the economic and social signals received from the marketplace, government policy, and technology" (McRae, Smith & Gregorich, 2000, p. 5). This point of view represents a free-market or capitalist mentality, based on the idea of a straightforward process of demand, development, and supply of innovation.

The supply and demand theory has proven to not fully explain the progress, or lack of progress, experienced in agricultural innovation (Perkmann & Walsh, 2007). Slowly, over the last decade and a half, government research has shifted towards working with farmers to observe connections between policy, economics, agriculture, and the environment in an attempt to try to better understand the multidimensional properties of agricultural innovation and adoption (McRae et al., 2000). According to Berger (2001), governments have "attempted to develop a new … approach for the prediction of diffusion processes, natural resource use changes and policy responses" (p. 247). Despite a movement towards a partnership model with producers to

determine needs within the agricultural system, certain authors have suggested that a "sustainable form of agriculture is now more urgently needed. The policy challenge in agriculture — to ensure optimal and sustainable social, economic, and environmental benefits — has become more pressing and complex than ever" (McRae, Smith & Gregorich, 2000, p. 5).

In addition to problems developing sustainable alternatives to modern agriculture, many researchers have found that the classic market based supply-demand approach to agricultural innovation creation and transfer has failed to adequately raise awareness amongst producers, suggesting that "operator education and computer literacy, full-time farming, and farm size positively affected the probability of … awareness while the effect of age was negative (Daberkow & McBride, 2003, p. 163). Younger farmers tend to be better educated, as discussed previously. Since only 7.5% of farmers are under 39 years of age, the fact that awareness of innovative practices is significantly lower among older, computer illiterate, and less education farmers does not bode well for the classic approach to innovation adoption. Further, 60% of farmers rely on off-farm work to support themselves, preventing them from farming full-time and, according to Daberkow and McBride (2003), significantly reducing their awareness of new innovations. Moving forward it is clear that more research is needed on the social aspects of innovation adoption to determine how awareness and financial ability influence innovation adoption. The idea that producers will take a purely rational perspective has passed, necessitating a greater focus on the individual characteristics that cause producers to make the choices they do.

Compared to innovation in a Canadian context, agricultural innovation in developing countries focuses on universities, and is largely driven by a need for "productive and profitable agriculture and related services," which are critical to "the successful attainment of the Millennium Development Goals (MDGs) of halving poverty and hunger by 2015" (Rosegrant et

al., 2006, p. 3). Many governments in developing nations exhibit a lack of capacity when it comes to supporting impoverished farmers, meaning:

> *Unfortunately for many developing countries agricultural growth is low and that has exacerbated poverty in those regions. Sustained agricultural growth depends on availability of appropriate technologies and their adoption for innovations in agriculture. This need has become more acute with increasing demand for food due to growth in population, increasing per capita income coupled with high rate of urbanization, biofuel production, and emerging issues like climate change. With its high calibre human resources, equipment and other resources, the universities are well placed through their research programs to create the knowledge and technologies required for agricultural growth to occur (Asenso-Okyere & von Braun, 2009, p. 1).*

Ultimately, adherence to the belief that increased agricultural production within developing nations is the key to reducing and eliminating poverty suggests that universities must take a leading role in creating and sharing knowledge that can be used to innovate within agriculture (Asenso-Okyere & von Braun, 2009). As knowledge spreads, increased production should result, much like what happened in Canada, where one farm went from being able to feed 6 other people to being able to support 60 others in a few decades (McRae et al., 2000). Research on agricultural innovation in developing nations regularly refers to the need for a governmental focus on "knowledge and science for innovation in agriculture," and a "contribution from the universities in generating this knowledge and making it available for utilization" (Asenso-Okyere & von Braun, 2009, p. 3). Agricultural innovation policies and research in developing countries prioritizes the mobilization and transfer of skills and knowledge to the rural areas and producers that can implement them.

Figure 2.4: Change in oilseeds planted per year, 1991-2006

Crop (Acres)	1991	1996	2001	2006	% Change, 1991 - 2006
Wheat	34,997,892	30,688,674	26,836,192	24,266,011	-31%
Oats	3,047,074	5,052,683	4,670,615	5,099,298	+67%
Barley	11,180,156	12,951,236	11,606,068	9,118,090	-18%
Total	49,225,122	48,692,593	43,112,875	38,483,399	-22%

(Statistics Canada, 2007)

Figure 2.4: Change in oilseeds planted per year, 1991-2006

Crop (Acres)	1991	1996	2001	2006	% Change, 1991 - 2006
Canola	7,762,385	8,726,366	9,347,765	12,423,579	+60%
Soybeans	1,478,812	2,166,870	2,675,033	2,970,449	+101%
Total	9,241,197	10,893,236	12,022,798	15,394,028	+67%

(Statistics Canada, 2007)

From an environmental perspective, agricultural innovation research focuses on the implementation of practices that improve ecological health and reduce environmental damage caused by modern farming practices, as a path towards sustainability. As Alonge and Martin (1995) state, "during the last decade, there has been a paradigmatic shift occurring within the agricultural community – a shift from mere emphasis on higher productivity to include a concern for sustainability" (p. 34). The new alternatives sought by ecologically minded researchers are required to be "economically profitable and environmentally sound agricultural production systems …, ranging from alternative, low-input, biodynamic, to organic farming" (Alonge & Martin, 1995, p. 34). Consumers seem to support a shift in focus from modern industrial

agriculture towards sustainable practices. A growing number of people have begun to call for an increase in availability of organic foods, foods produced in an environmentally conscious manner, and foods that fulfill cultural needs, although these demands are only being met slowly (Agriculture and Agri-food Canada, 2013).

While sustainability may be a focus for public and academic research, financial incentives have encouraged farmers and corporations to focus on cash crops that return a higher margin. Between 1991 and 2006, the amount of land seeded to wheat, oats, and barley in Canada has declined by 22%, from 49,225,122 to 38,483,399 acres (Statistics Canada, 2007). Over the same time period, combined canola and soybean acreage has gone from 9,241,197 acres planted per year to 15,394,028, representing an increase of 67% (Statistics Canada, 2007). The streamlined crop-production systems developed by companies such as Monsanto and Bayer to accompany soybean and canola production have greatly increased the use of synthetic fertilizer and pesticide use (McRae, Smith, & Gregorich, 2000; Statistics Canada, 2007). Alonge and Martin claim that the high level of production resulting from modern agricultural practices is "achieved at the cost of massive damage to the natural environment and troublesome social disruptions," which leads to "the consequent displacement of family farmers; over-capitalization and huge farm debts; massive environmental degradation from non-point contamination of surface and groundwater with agricultural chemicals; and, the rapid depletion of non-renewable natural resources" (Alonge & Martin, 1995, p. 34).

Many farmers still perform carbon intensive practices such as tilling crop residue back into the soil. In Canada, over 20 million acres of farmland are tilled to re-introduce crop residue, representing 28% of agricultural land prepared for seeding (Statistics Canada, 2007). A much higher percentage of Ontario producers still rely on ecologically damaging tillage, with

2,929,031 acres subjected to tillage re-incorporating nearly all crop residues back into the soil, which represents 43.9% of agriculturally active land in Ontario (Statistics Canada, 2007). The amount of land managed with zero- or no-till practices is 33,811,822 acres across Canada, and 2,083,361 acres in Ontario, representing 46.4% and 31.2% of land prepared for seeding, respectively (Statistics Canada, 2007).

Research done on the long-term benefits of a paradigm shift towards sustainable farming methods proposes that "costs would be significantly lower since farmers would have directly saved on inputs and received premium organic prices for most of their goods sold, thereby reducing government costs related to supporting farm finances" (McRae, Martin, Juhasz, & Langer, 2009, p. 120). With growth in retail sales estimated by industry at 15–25% (per year), "organic food represents the only significant growth sector in Canada's food system" and, with evidence of significant environmental and economic benefits, "organic sector development should be a priority for governments" (McRae, Martin, Juhasz, & Langer, 2009, p. 121). Despite the potential for positive results from the introduction of paradigm shifting innovations:

> *Is it instructive to note that many of the respondents still expressed neutral or negative perceptions about some of the selected practices. The study also showed farmers' perceptions of the research and educational efforts should be directed towards making sustainable agriculture as profitable and compatible as possible in order to facilitate farmers' transition from conventional to sustainable practices. (Alonge & Martin, 1995, p. 34).*

To better facilitate a constructive and holistic innovation process, needs assessment and analysis are required on a constant basis in order to convey new innovations most efficiently to those who can best utilize them (Alonge & Martin, 1995). The evolving process of holistic economic, environmental, and social innovation in agriculture requires regular scrutiny in order to ensure adaptability and long-term sustainability.

2.3 Universities and Innovation Uptake

The few agricultural innovation researchers that focus both on knowledge transfer and acquisition and the role of universities primarily focus outside of Canada and North America. These researchers provide interesting, but general/non-specific, conclusions. Asenso-Okyere and von Braun (2009) suggest that universities increase their focus on experiential learning in order to produce high quality graduates who would be able to solve the myriad of problems facing the food and agriculture system (p. 1). Iqbal et al. believe that "'trust' from social capital theory along with subjective norms and attitude from theory of reasoned action were … factors influencing the knowledge sharing intentions" in educational settings (p. 11051).

Researchers that do work in North America are involved mostly in describing how the increasingly de-centralized Canadian university innovation system is formed through partnerships with industry and government organizations and cooperatives in recognition that the:

> *Knowledge economy has changed the theme of innovation management. Knowledge sharing not only reduces the cost of the production or service, but also contributes to the success of the organization because knowledge sharing helps in avoiding the mistakes and develops the ability to innovate [and encourage]positive influence on the innovative capabilities of the university. (Iqbal et al., 2011, p. 11051)*

Mansfield and Lee (1996) further this idea by positing that "the interface between industry and the universities is of key importance in the promotion of technological change," since there is "intense interest in the characteristics of universities that have contributed most importantly to industrial innovation in various fields" (p. 1051).

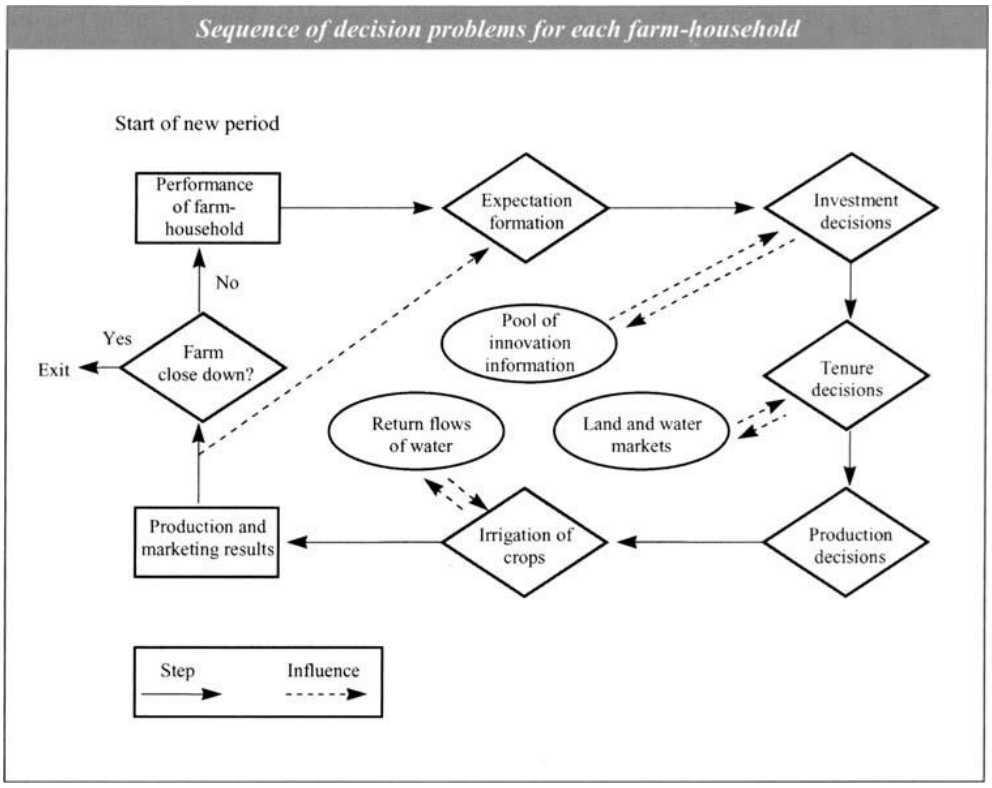
More recent research involving the Canadian university innovation system calls the university-industry-government interactions a 'Triple Helix,' where "increased importance of knowledge and the role of the university in incubation of technology-based firms has given it a

more prominent place in the institutional firmament" (Etzkowitz, 2003, 294). The 'Triple Helix' is created out of "characteristics of collaborative relationships between universities and industry, and develops a research agenda informed by an 'open innovation' perspective" (Perkmann & Walsh, 2007, p. 259). Over the past two decades, many large Canadian universities have evolved into what might be considered 'entrepreneurial universities' that not only generate knowledge, but put those results to use to further develop knowledge, but also to gain financial benefit (Etzkowitz, 2003, 294). Within the system that Etzkowitz (2003) describes, the "government acts as a public entrepreneur and venture capitalist in addition to its traditional regulatory role in setting the rules of the game. Moving beyond product development, innovation then becomes an endogenous process…, encouraging hybridization among the institutional spheres" (p. 328). Perkmann and Walsh (2007) put forward their opinion that "the role of practices such as collaborative research, university–industry research centres, contract research and academic consulting…are widely practised" (p. 259).

After reviewing research on the subject, clear gaps in research into the adoption of agricultural on family farms have been identified. In 2001 Berger concluded, "after several decades of government regulations, most agricultural and development economists now share the conviction that decentralisation, innovation and market solutions," will overcome slow growth in the agricultural sector (p. 245). Based on the information provided in the paper thus far, it seems clear that, despite an increased reliance on market solutions and decentralization in Canada, producers are still relying on oil seed production over food crops, facing increasing land prices, and often forced to supplement their income with off-farm activities. Market forces are not enough to distribute income in a way that allows small farmers to stay in agriculture without finding other income sources. The Canadian government has reduced extension services, and

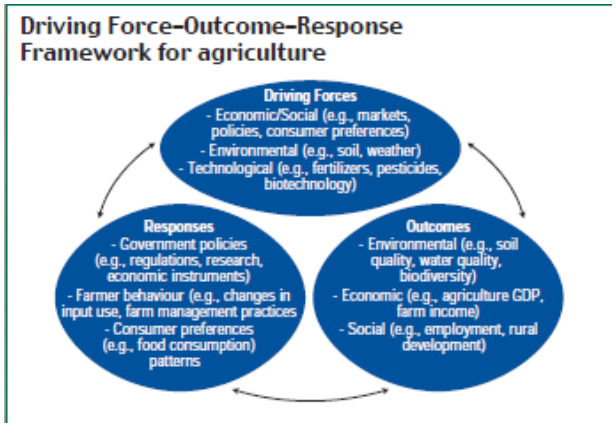
gotten rid of many market controls like the Canadian Wheat board. Despite these moves, farmers have experienced little change, and potentially some reduction, in their ability to make a living in agriculture (Alonge & Martin, 1995, p. 40).

Figure 2.5: Sequence of decision problems for each farm household



(Berger, 2001, p. 245)

Figure 2.6: Driving force-outcome-response framework for agriculture



(McRae, Smith & Gregorich, 2000, p. 2)

In many cases, producers appear stuck at the information gathering stage, unable to successfully overcome their risk adverse nature to reap potential benefits in order to reject or accept innovation. Research focusing not only on farmers needs for "adequate agronomic and economic information about the practices," but also about the barriers that exist on farms beyond simple economic issues is missing (Alonge & Martin, 1995, p. 40). As seen in Figures 2.5 and 2.6, innovation and technology are considered factors within the success of a farm organization, but their relationship to other factors is ill defined. It is understood that innovation benefits organizations and producers through the introduction of new ideas, most often reducing costs or increasing revenues, or reducing ecological harm and improving long-term production through sustainable practices. What is not as well understood is how innovation is accepted. If all new technologies that improved financial outcomes were accepted, an increase in the number of farmers exhibiting zero-till tenancies and an increase in the incidence of organic farming would be expected, but this has not been seen to the level predicted. It is also not well understood why

increased education, especially to a university level, does not impact innovation adoption on family farms to a greater degree. In Hoffman's words:

> *A puzzle remains why schooling does not have broader direct impacts in agriculture. Furthermore, as we proxy education or general intellectual achievement by schooling in our empirical research, this has led to biased interpretations of impacts when general intellectual achievement of school graduates changes over time and perhaps in nonlinear ways. (Hoffman, 2001, p. 333)*

At this point, "there are few if any universal variables that regularly explain the adoption of conservation agriculture across past analyses," and so further research should focus at the micro level, with individuals, small groups, and communities rather than trying to identify trends at a macro level (Knowler & Bradshaw, 2007, p. 25). Knowing this, the utility of identifying the barriers to innovation experienced by undergraduates returning to family farms and the role of university programs in aiding them to overcome these barriers becomes clearer. The research conducted in this study strives to explain why education does not currently have the effect expected on innovation adoption, and provide some suggestions as to how this might be changed.

3.0 Design and Methodology

Chapter three describes the methodology and conceptual framework that informed the data collection process, analysis of the data, and the benefits and limits of this process.

3.1 Methodology

The rationale behind this research is to uncover the barriers to innovation that undergraduate students experience when returning to family farms and consider how the University of Guelph currently supports graduates in overcoming them. This study will also provide information on potential changes to the undergraduate experience that may better enable students to overcome barriers to innovation, as suggested by faculty members and agricultural

innovation researchers. The exploratory and descriptive nature of this study is useful in attempting to understand and describe the barriers to innovation undergraduate students experience when returning to their family farms and attempting to implement new techniques, technologies, and products. Furthermore, the description and analysis provided by this study will be useful in guiding further research related to undergraduate-university relationships in the OAC, and the reasoning behind the adoption or rejection of innovation on family farms. Descriptive research relies on techniques that quantify and specify the experiences and characteristics of individuals and groups that share a specific social grouping (Palys & Atchison, 2008,). Exploratory research requires interaction with individuals and groups within their social context to better understand the phenomena or events they experience in order to develop more specific research questions and clarify issues to analyze in future research (Palys & Atchison, 2008, p. 39).

The methods used to collect data from undergraduate students, faculty members, and innovation researchers in this study were primarily qualitative, but some quantitative aspects are included within the structure of the study. A focus group was held with undergraduate students who were in OAC programs and intended to return to their family farms after they graduated. The focus of the group data collection was to determine the type and intensity of barriers to innovation that they had experienced already, or perceived as being likely to occur in the immediate future. From this focus group, and based on the research objective, questions for key informant interviews were drafted for the faculty and researcher interviews. A semi-structured interview format was adopted to allow flexibility in the barriers to innovation discussed, based on the person interviewed, and to allow the interview to flow towards topics of importance. The purpose of the interviews was to further examine how those within the educational and

agricultural innovation fields understand undergraduates as vectors of innovation, and how non-students perceive the barriers these students face. Faculty members and agricultural innovation researchers are ultimately those who can effect changes to educational programs, encouraging the building of skills that are necessary to overcome the barriers student innovators face on family farms.

3.2 Research Participants

This study was initiated to answer questions about barriers to innovation experienced by students returning to family farms after a former student contacted the researcher's advisor. Following the researcher's first meeting with the student to discuss the topic of the research focus; nine more students were asked to participate in the study through their connection to the original student. All participants were members of OAC undergraduate programs who intended to return to their family farms when they graduated. Many also had part-time jobs: working on-farm during the school year, working at the school in an agricultural setting, and/or working on their family farm during the summer. These students were chosen using a purposive sampling technique, where "people and locations are intentionally sought because they meet some criterion for inclusion in the study" (Palys & Atchison, 2008, p. 124). In total, seven students chose to participate in the study, forming the undergraduate portion of the participant group, referred to as the focus group in this paper. Focus group participants were recruited in a face-to-face manner where the nature of the research was explained and questions regarding the research process were answered by the researcher.

Interview participants were also chosen through purposive sampling (Palys & Atchison, 2008). Potential participants were chosen from three separate categories: Private research, government, and academic. Private research candidates were sought from private organizations

involved with agricultural innovation, government candidates were recruited based on their involvement with OMAFRA and its innovation initiatives, and academic candidates were considered among those involved in teaching within the University of Guelph and/or the OAC. These candidates were contacted via email with a standardized script outlining the research methodology and naming the primary researchers, while a longer four-page letter of information was attached to the email in an effort to address possible questions regarding participation.

A list of potential participants was selected based on their involvement with agricultural innovation and reputation within the field. Online databases, personal experience, and suggestions from the author's research advisors were all utilized as sources for identifying potential participants. After names were collected, the candidates' professional backgrounds were analyzed, and they were either chosen for contact or taken off the list. Those removed from the list were removed after further research into their work and published research made it clear they were not involved in innovation in a way that would be useful to examine in this study. A total of 12 people (5 from academic backgrounds, 4 from private research backgrounds, and 3 from government backgrounds) made the list as potential participants; 8 were selected for contact and 5 were interviewed. Two of these five interviews were deemed unusable, as the participants were considered to have given feedback that indicated they did not fully understand the nature of the research, or were not involved with innovation in a way that was useful for analysis based on the goals and objectives of this paper. The three interviews analyzed in this paper include one from an academic participant, one from a participant involved in government and academic organizations, and one from a member of a private agricultural innovation group.

(See Appendix 6.1 through 6.3 for an example of the consent forms, email scripts, and letter of information used.)

3.3 Focus Group Discussion

A focus group was a simple way to collect a large amount of data, from a large amount of people, on the barriers to innovation perceived or experienced by undergraduates and their opinion on how their degrees would help them overcome these barriers when they returned to their families' farms. The focus group was held on March 11th, 2015 with seven participants, from the ten who had initially been contacted in-person as described above. Focus groups are often used to collect group opinions on pertinent topics within a short time period (Palys &Atchison, 2008, p. 159). The focus group was determined to have provided a significant and valuable amount of data. Students were present from four of the six divisions of the OAC, including: the Department of Animal and Poultry Science, the Department of Food, Agricultural, and Resource Economics, the Department of Food Science, and the Department of Plant Agriculture.

The focus group was conducted by the graduate student researcher, and author of this paper, with the aid of another graduate student who had received training in Facilitation and Conflict Management through graduate courses. Both graduate students were supervised by the principal investigator. All participants signed a consent form or verbally acknowledged consent at the initiation of the focus group, provided their first names, and identified their academic programs and year of study. The focus group was held in the Landscape Architecture building at the University of Guelph. Participants were asked three separate questions. After a question was asked, participants were given 2 to 3 minutes to write their thoughts down on paper provided to them. They were then allowed to discuss their responses as a group before allowing them to be

written down on a flip chart located at the front of the room. The graduate student investigator led the discussion, while the graduate student assistant recorded answers on the flip chart. Each participant was allowed an opportunity to voice their answer to each question, and answers were verbally verified by the student investigator. Some answers were amalgamated because of similarity, based on the discretion of the participants. Participants were then given five sticky dots with which to vote for the answer(s) they felt most important to each question. There was no limit to how participants were able to use their quantity of dots. They were allowed to put all five dots on one answer, put them on five different answers, or refrain from using any. After they had voted, the number of dots on each answer was recorded and the group moved on to the next question. For the last question students were only given one dot, since they were asked to rate their comfort. They were asked to place the dot in one of five sections on a scale from not comfortable at all to very comfortable to identify their personal comfort level with overcoming barriers on their family farm.

Participants were asked to set aside an hour of their time to complete all three questions of the focus group. The first question asked participants to name barriers to innovation either present or perceived as being present for undergraduates returning to family farms. The second question asked participants to identify ways in which their undergraduate experience might help them overcome these barriers, and the third question asked them how comfortable they were overcoming these barriers (See Appendix 6.4 for Focus Group Questions). At the end of the focus group, each participant was asked to write down any other thoughts or concerns they had and submit them to the researchers if they felt comfortable doing so. Participants were asked to remove their name from their papers to maintain anonymity. The anonymous collection of

additional data ensured the accurate recording of ideas and allowed participants to voice any other thoughts they were embarrassed about bringing forward in front of the group.

3.4 Semi-Structured Key-Informant Interviews

The key-informant interviews employed a semi-structured format, with open-ended questioning methods. This self-directed method was chosen in order to collect in-depth responses in participants' own words (Palys & Atchison, 2008, p. 170-171). Interviews were chosen for the non-student participants involved with the study for three reasons: First, opinions on barriers to innovation, solutions to barriers, and evaluations of the current undergraduate programs of the OAC and their ability to support students in overcoming barriers was likely to vary across respondents. Second, to accommodate the professionals' schedules, given their limited time to perform activities not directly related to work and the difficulty that would have been involved in coordinating a focus group. Lastly, because of the exploratory and descriptive nature of the study, gathering a deeper, more personal view of the subject was deemed more important than gathering broader but less informed data.

Eight potential interviewees were contacted, and five agreed to interviews. Two of these interviews were not useable for this study. The two excluded interviews failed to fully address many of the topics related to the purpose of this study. In one case, the interviewee indicated a misunderstanding of the goals of the study and felt unable to provide useful or pertinent information. The five interviews were conducted between July 4th, 2015 and August 15th, 2015. One interview was done over the phone, and four were done at the offices of the participants. Interviews lasted from 20 to 50 minutes. The three interviews used in this study were between 35 and 50 minutes long. The 2 unused interviews were destroyed, in electronic and audio forms. All five interviewees provided consent. The four in person interviewees provided written consent in

the form of a signed letter of consent. The phone interviewee gave verbal consent, which was noted on a consent form by the interviewer.

A list of ten questions was developed by the research team based on the research objectives and influenced by focus group responses (See Appendix 6.5 for interview questions). Each participant was asked the same ten questions, and up to five additional follow up questions were asked based on the nature of the participant and their responses. In addition to these questions, participants were asked whether they identified their role in the agricultural innovation industry as private, government, or academic. Of the three used interviews, one identified as academic, one as private, and one as both government and academic. These categories were used as a way to compare interview responses. These interviews were recorded on an audio recorder and then transcribed into an electronic document.

3.5 Data Analysis

The data collected from the focus group was coded into emergent categories. Each individual response to the focus group was considered in light of other responses and placed with similar responses, leading to the development of individual coded groupings. These groups were then compared based on the number of responses in each group, and the number of votes each response received during the focus group.

The interview responses were coded line by line into categories by highlighting significant text and assigning it to a category based on its content. These categories were then considered for similarity and separated into major thematic categories. Common themes were identified, described, and analysed. Due to the exploratory and descriptive nature of the study, small number of participants in the study, and lack of substantial quantitative data collection, coding was done by hand and further analysis using SPSS was thought unnecessary. Data

collection and analysis was performed with descriptive intentions. The point of the interviews was to allow participants to identify what topics they believed were most important regarding the organizations transition in management and work environment. I therefore chose not to develop *a priori* codes, and instead followed an emergent coding process. To do this I adhered closely to a coding process largely inspired by Burnard's *A Method of Analysing Interview Transcripts in Qualitative Research* (1991). Interviews were transcribed verbatim and analyzed to identify emergent ideas. These ideas were then assigned as nodes within the coding framework. The second stage of the coding process involved thematic coding based on the research goals of this study, capacity development themes, and previous agricultural innovation research. I was not confident in my NVivo abilities so I used a cut-and-paste method to code the interviews.

3.6 Data Collection Methods: Merits and Limitations

3.6.1 Merits

Focus groups allow participants to give responses in a free and personal manner and also allow the researcher to consider individual responses in light of other's answers. When combined with the sticker-voting method described previously, focus groups effectively allow the group to weigh the responses provided. Participants in the focus group determine which issues are important to them, allowing researchers to better understand the group and the context within which it exists (Palys & Atchison, 2008). Responses within the focus group are analyzed and validated by the group being studied, removing the need for the researcher to be the only source determining the value of responses. Focus groups offer participants a forum to voice their opinions and feelings directly to the researcher, while potentially having the support of likeminded individuals to validate them (Palys & Atchison, 2008).

Personal interviews allow participants to convey private, embarrassing, or unpopular opinions with researchers in a way that is not possible in group or anonymous settings. Interviews also allow researchers to ask follow up questions and clarify responses to ensure more accurate information is received, preventing misinterpretation of responses. A face to face setting enables researchers to put participants at ease through changes to their voice and body language, potentially increasing the depth and detail of responses. The privacy of personal interviews generally allows participants to convey private information in a more accurate and useful manner without fear of exposure, especially compared to focus groups or group interviews (Palys & Atchison, 2008).

3.6.2 Limitations

The public nature of focus groups can in some cases intimidate participants, making them unwilling to share opinions they wish to remain private or that they feel may conflict with those of the group. Therefore, information may not accurately reflect how participants feel about the subject the researcher is collecting data on (Palys & Atchison, 2008). To prevent misrepresentation of data as much as possible, participants were asked to write down responses they were uncomfortable sharing on a sheet of paper, without their name, to give the researcher at the end of the focus group. This allowed participants an outlet to express opinions to researchers while maintaining their privacy. At the beginning of the focus group participants were asked to sign consent forms, or verbally assign consent, prior to information collection. It was also conveyed to participants the importance of keeping all responses generated by the focus group private.

One limitation to personal interviewing occurs when responses are ambiguous, which can lead to misinterpretation of information by researchers. Additional questions were asked only in cases where the research was unsure of a response, in order to reduce ambiguity and clarify responses by collecting further information. The body language, tone, and manner in which questions are asked to participants can also influence or bias the information provided by participants (Palys & Atchison, 2008). To avoid different researchers achieving different responses because they ask questions differently or use different body language, the same researcher performed all interviews, and asked the same set of questions to each participant.

A general limitation to this study is the lack of generalizability and conclusiveness. There were not enough participants to allow for the significance and confidence of collected data to be established. It was difficult to establish cohesion between interviews with such a small participant group. Furthermore, participants were not randomly, but purposively, selected for the study. Lastly, this study lacked a means of triangulating data, meaning that the views of the participants cannot be portrayed as representative of the population from which they were selected. The collection of quantitative data is one way that triangulation could have been possible.

4.0 Research Findings

4.1 Introduction and Overview of Findings

Chapter four describes the major findings of the study in regards to barriers to innovation facing undergraduate students returning to family farms after graduation. Data was collected from seven undergraduate students from four different departments in the Ontario Agricultural College (OAC) through a focus group in March 2015. Further data was collected through personal interviews from participants involved in some way with agricultural innovation, either

as a promoter of innovation or as a trainer of future innovators. There were five interview participants, but only three interviews were deemed useful for this study, one with a participant from a private innovation organisation, one who identified both as an academic and a government supporter of innovation, and one participant who identified only as an academic supporter of undergraduate innovators. These interviews were held between July 5th, 2015, and August 19th, 2015. Key issues identified from the focus group and interviews were combined with the research goals and objectives to create the research findings discussed below.

4.2 Current Innovation Models

Although this study focused primarily on barriers to innovation for undergraduates and how their university education may help them overcome these barriers, it seemed important to also gather information on forms of innovation communication and the current role of undergraduates within innovation communication. The reasoning behind this is that undergraduate students returning to family farms will become the next generation of farmers. Their choices and actions will determine the course modern farming will take in the near future and so integrating them into agricultural innovation structures could speed the uptake of innovative processes and technologies. Since younger and more educated farmers tend to be more environmentally conscious, serious benefits could arise from better including young farmers as stakeholders in agricultural innovation (Knickel et al., 2009)(Mouysset et al., 2013).

Researchers also suggest that a movement from linear agricultural innovation models to systemic models is important for agriculture moving forward (Knickel et al., 2009). Consider the linear model created by Berger (2001) to describe a farmer's decision making model (p. 249). A number of factors such as prices, wages, water availability, and location are input, considered against factors such as soil quality and land use, and farm decisions are output as land us

patterns, income, and innovation diffusion curves (Figures 4.1 and 4.2). All this does is tell us how the process works. It is not very particular, and ultimately is not a strong indicator of what will happen in real-life settings, only what should happen. Berger's model is heavily influenced by economic models and has the same failure as they do: it fails to understand humans as complex beings with an incalculable number of connections influencing their behaviour.

Figure 4.1

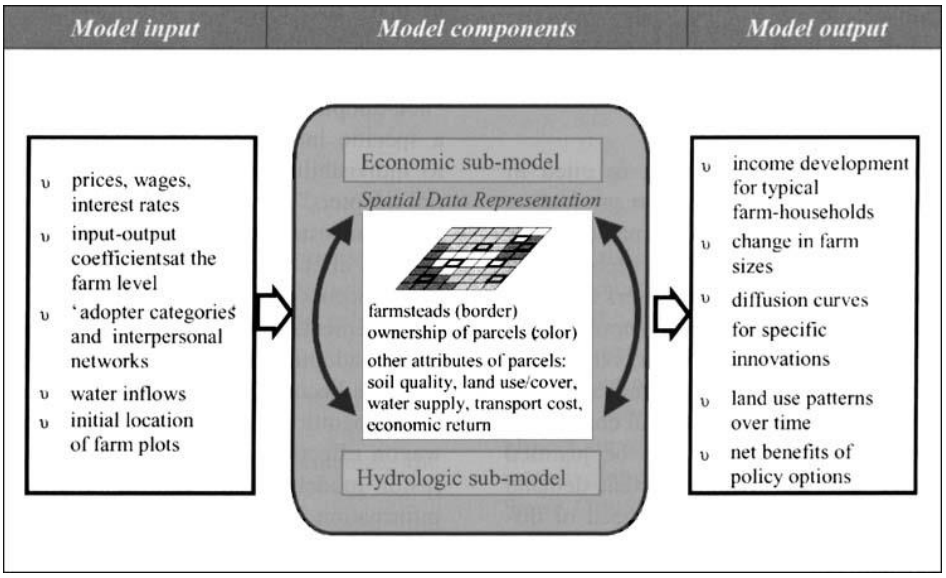
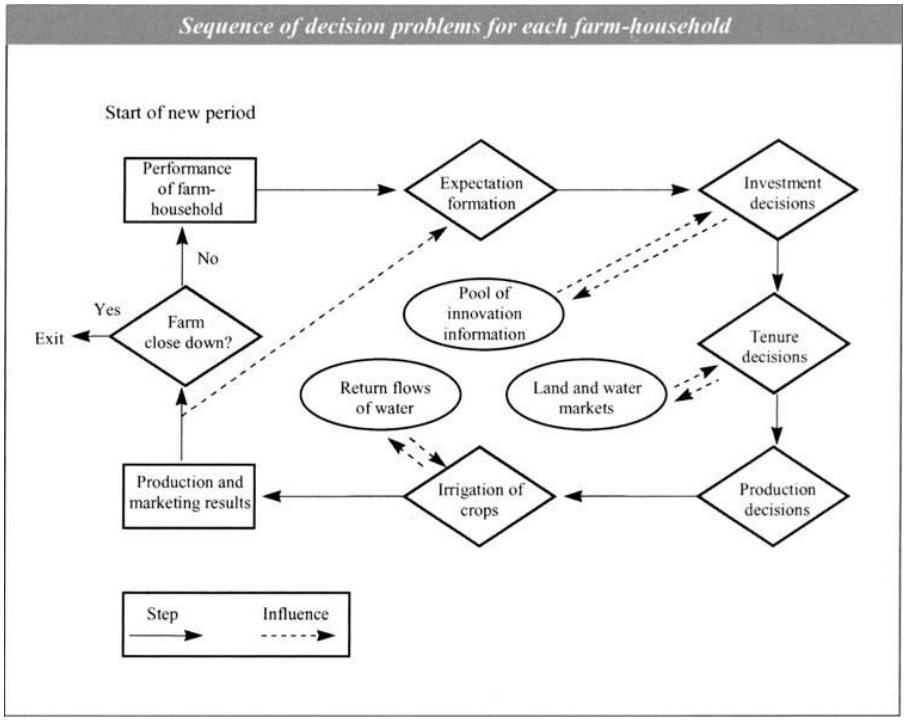


Figure 4.2

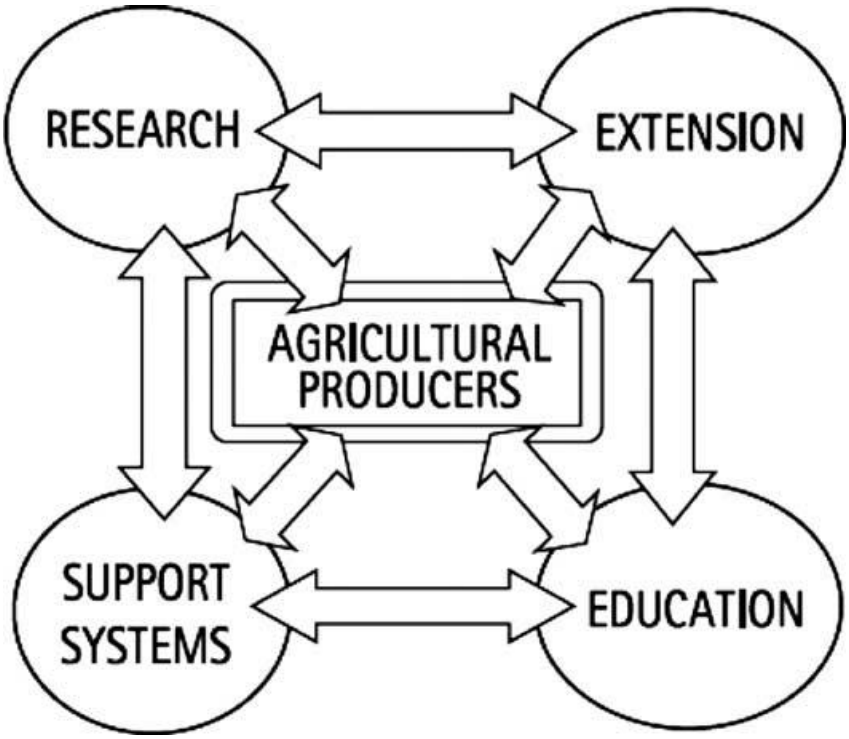


Consider also Rivera's model below (2005). It is quite simple, with four components outside of agricultural producers sharing knowledge with each other and producers. It correctly maps the major organizations trading information within the agricultural sector, at least historically (Research, Extension, Education, and Support Systems). But it still treats knowledge and innovation transfer as a commodity that is created, transferred, and utilize. Knickel et al. suggests that, "In a simplistic way, the functioning of innovation can be seen as the result of a linear process from conception to adoption," but that moving forward,

"In the new hybrid networks view, innovation occurs when the network of production changes its way of doing things, so that innovation is mainly related to the resulting pattern of interaction between people, tools and natural resources. This approach gives us a key to understanding the evolutionary trajectories taken by innovation in different temporal, geographical and sectoral contexts." (2009, p. 139-40).

Thus it is important to understand who receives innovation knowledge, who implements it, and how they are receiving information in order to try and direct our efforts in a collaborative direction, working in a contextual fashion.

Figure 4.3



(Rivera, 2005)

4.3 Forms of Innovation Communication and the Role of Undergraduates

Figure 4.4

	Electronic	Physical
Individual	-Smartphone Apps -Open Access Journals	-Print Publications -Liaison Programs -Extension Services
Group	-Social Media -Websites -Webinars -Listserv -Email	-Town Hall Meetings -Interactive Presentations
Indirect	-Partnerships with Media and Outreach Programs -Advising Government Policy -Retail Marketing	

The figure above depicts a list of strategies that private organizations, government groups, universities, and farmer organizations use to convey knowledge and innovation information to producers. Strategies are organized into five groups: Electronic-Individual, Physical-Individual, Electronic-Group, Physical-Group, and Indirect. Electronic and Physical refer to the medium of information transfer, while Individual and Group refer to the target of each strategy. Indirect refers to strategies that are targeted at both individuals and groups, electronic and physical. Indirect strategies may utilize any of the strategies from the other four areas of the figure.

The most common strategies used are Electronic-Group strategies. They allow people wishing to pass on information to do so easily, quickly, and to a large group of people. Some of the interview participants were partially interested in the use of social media. All three had

integrated it into their websites, and one participant said that despite initially discounting tools like Twitter,

> *"In the last year I really learned to use effectively Twitter to highlight certain things which you can do in a short phraseology, and I've had very positive response to some of the postings on things and I know were it not for the tool I never would've got that information out and read by those particular groups within that population so that's convinced me now that, "Okay, two years ago I discounted that as basically a fluffy technology, nowadays I'm using it, but I'm using it in concert with 10 other communication tools for outreach."*

Along with email and websites, these three electronic-group strategies were utilized the most. In many cases they were supplemented by other strategies, primarily print publications, such as magazines, leaflets, or short articles, and open-access journals online. The utility of print journals may seem outdated, but participants pointed to the high average age of their target audience in general, but also the diverse groups of people they were trying to reach as an important factor in their use of printed material. Open-access journals are a newer development that reduces the cost of printing and distributing material while allowing a large audience to access important research documents first hand.

Although there is a significant range of accessible innovation transfer tools, there still a number of difficulties involved in transferring knowledge and innovation in agriculture:

1. Cost
    a. Maintaining a broad spectrum of information transportation channels can be quite expensive. Agriculture involves a number of different farm-types, different ages, cultures, geographic circumstances, and other demographics. Many of these demographic require different mediums in order to best transfer information. As one participant relayed, *"many of them, are still using more standard tools and approaches because these things are quite expensive to actually be able to maintain and put in place, even something simple like building an interactive and*

up-to-date website is a very expensive task if you've got volumes of information to go in."

2. Small Number of Comprehensive Organizations
    a. Because of the costs associated with maintaining a broad suite of innovation transfer channels, there are only a few larger public and private organizations that are able to reach all major demographics of producers. This forces smaller organizations to rely on larger groups to relay the information they wish to pass on, which may cause them to alter the information based on demands from larger groups, or may restrict the volume of information that can be transferred.
3. Highly Variable
    a. Some sectors of the agricultural industry are organized better, are funded better, or are prioritized by private and public groups. The better funded and organized sectors receive more and better information in a timelier manner, on average. Variation in the quality, timeliness and volume information can make it hard to evaluate information across different sectors.
4. Difficulty in Evaluating Information
    a. Organizations that focus on innovation transfer often lack the funds and time needed to fully evaluate their methods and alternative methods in addition to their normal tasks. An interview participant said *"…you really don't know whether they work any better than another tool, because it's its scientific study all on its own to take tool A, tool B, put it out there and then try to measure the effectiveness of the communication transfer and then the effectiveness of the*

knowledge uptake by a stakeholder and then the effectiveness of the knowledge transfer to whatever they are doing in their company."

5. Difficulty of Demographics
    a. With the large variety in the characteristics wanting to access information it is hard to know what method will best reach them. Trial and error may be required in order to find the best strategy to reach target demographics. During data collection, a participant stated *"... looking at the effectiveness of a Twitter feed with 90-year-old that's having a hard time smart phone and then knowing that an 18-year-old, or a 15-year-old student working on the farm in high school probably has a smart phone but they're not reading a four page fact-sheet."* To be successful in the long-term, a diverse group of methods are needed to maximize the penetration of information.
6. Retiring Dated Methods
    a. The cost of evaluating the impact of certain knowledge diffusion strategies makes it prohibitive. There is also a tendency to assume that classic methods will continue to work in the future. This is true in many cases, but as the world moves increasingly on line and older producers continue to retire, classic diffusion strategies are becoming less and less effective, and "…At a certain point if... The easy approach might be to have it in paper, but that may not be the most efficient way of doing it. So at some point you may have to discontinue one mode of that in order to move people along."

Throughout the interview sections regarding strategies for innovation transfer, none of the three participants identified undergraduates as a common strategy. Undergraduates were

viewed as receivers of information, and as actors and decision makers on farm, but not as vessels for transferring or carrying information despite their role as future owners of farms in Ontario and Canada. Graduate students are seen as the primary innovators and knowledge generators at the university level. When asked about undergraduate specifically as methods of innovation and knowledge transfer, interview participants provided a number of benefits that they saw in working with undergraduate populations. A figure summarizing the benefits of the population is provided below.

Figure 4.4

Beneficial Characteristics of Undergraduates in Innovative Transfer	
An Investment for the Future:	Two interview participants believed that "there is recognition within the (University of Guelph/OMAFRA Partnership) that we need to do more for undergraduate students because they are the next graduate students. All graduate students are undergraduates at some point in time."
A Large Pool of Potential:	A faculty member interviewed recognized that "is the fact that on this campus we have 22,000 undergraduate students, and only 2000 graduate students, so you've got 10 times as many, so if we're going to talk about an information portal, why not target the ones where you've got 10 times as many mouths who are talking to somebody else."
Energy and Intensity:	Undergraduate students are usually happy to learn and, for good or bad, buy strongly into ideas they are exposed to during their university experience, especially during their first few years. One interviewee recalled his university days, remarking "When I was an undergraduate student I was an absolutely relentless mouthpiece back to my parents and my family about what was going on at university and what we were doing." Undergraduates are willing to pass information to anyone willing to listen. They can leverage their relationships to further spread knowledge and

	innovation.
Personal Involvement in Ag:	One participant in the interviews made a point about the personal relationships many OAC undergraduates have with farm owners and operators, remarking, "… every one of our undergraduates that comes from an Ag background; a lot of them go home and work on the farm in the summer or engage in some form of agri-food activity in the summer time. So why wouldn't you be using them to feed back the latest and greatest, right?"
Ambassadors for the School:	Not only are graduates of OAC programs able to transfer information on innovation and implement innovation on their own, they are able to encourage others to attend OAC programs and increase the number of people possessing critical thinking skills and the other benefits of undergraduate programs discussed further on in this paper.
Involvement with Ag Leaders:	Many members of Ontario agriculture organizations such as the Federation of Agriculture or similar groups are university graduates. These groups have contact with many producers on a regular basis and if they have significant numbers of university graduates on staff they are able to leverage their skills and knowledge to cover a larger group of people. Therefore the skills and knowledge imparted on them during university can pay back multiple times.

4.4 Barriers to Innovation

There were seven focus group participants. For the first two questions, each participant was given five votes and was allowed to place their votes on any of the issues identified, and in any number (i.e.: they could place all five on one issue, or all five on separate issues, or anywhere in between). 35 votes were cast on each of the first two questions (7 participants x 5

votes = 35 total votes). Charts were then created to visualize the number of issues identified, the number of votes each received, and the percentage of votes each issue received.

For the first question, what do you see as barriers to innovation for students returning to the farm, twelve issues were identified. These twelve issues were then sorted into three different categories: Economic, social, and environmental barriers. Economic barriers consist of barriers that are primarily created by monetary or capital issues or deficiencies. Social barriers are created as the result of relationships between two or more people. Environmental barriers are barriers created by factors external to the farm itself, but which directly impact the farm and the people involved with it. Environmental factors are generally not able to be controlled by farm owners and workers. A list of the twelve potential barriers generated by question one follows below (Table 4.1, Table 4.2)

Figure 4.5

Question 1: What do you see as barriers to innovation for students returning to the farm?	Votes
Financial Issues	9
Openness to Technology	7
Unwillingness to Change	6
Risk Aversion	5
Entrenched Power Hierarchy	3
Credibility	2
Not Enough Labour	2
Not Enough Time	1
Uneven Power Balance	0
Ability to Expand	0
Generation Gaps	0
Trust	0
Total	35

Figure 4.6

Economic Barriers as Perceived By Students		
Type of Barrier	**Votes (n=35)**	**% of Total Votes**
Economic		
Financial Issues	9	25.71%
Risk Aversion	5	14.29%
Total	14	40.00%
Social		
Openness to Technology	7	20.00%
Unwillingness to Change	6	17.14%
Entrenched Power Hierarchy	3	8.57%
Credibility	2	5.71%
Generation Gaps	0	0.00%
Trust	0	0.00%
Uneven Balance of Power	0	0.00%
Total	18	51.43%
Environmental		
Not Enough Labour	2	5.71%
Lack of Time	1	2.86%
Ability to Expand	0	0.00%
Total	3	8.57%
Total	35	100.00%

As discussed by the focus group participants, financial issues refer to a lack of working capital, or an inability to acquire working capital that could be used to obtain technologies or products that could benefit the farm financially, or even environmentally. In this case, although a producer may wish to adopt a new cropping system, and is sure it would increase net farm income, they may not have the money to buy new equipment or new inputs to implement the system. Additionally, a farmer may be theoretically willing to implement changes on-farm that reduce ecological impacts of farm practices, there may be a negative direct financial return in doing so, either because the changes are expensive to implement and there is not a suitable financial return for doing so, or because implementing these changes causes productivity to decrease. Financial issues were identified as the most prominent issue reducing innovative practices by students returning to farm. This falls in line with classic linear models, which focused on the technical and economic issues as primary causes for the adoption or non-adoption of innovation (Knickel, Brunori, Rand, and Proost, 2009, p. 131) (Rivera, Qamar, and Mwandemere, 2005)?

The second economic barrier identified by focus group participants is Risk Aversion. Risk Aversion in this case is unwillingness to pursue potential beneficial futures based on uncertainty and incomplete information during the present. Risk aversion exists in degrees and represents a farmer's willingness to make a decision based on the uncertainty of potential benefits and costs of that decision in the future. Risk aversion ranked fourth among twelve barriers identified by student participants with 5 votes. Risk aversion is another common topic for research in agriculture, especially as it pertains to adoption of environmental practices. Mouysset, Doyen, and Jiguet (2013) suggest that risk aversion is most often dealt with through incentives and payments from public bodies (p. 96).

Information gathered from the focus group and interviews suggests that there may be a place for mentorship, critical thinking skills, and extension programs in dealing with risk aversion. Part of risk aversion is indeed related to economic uncertainty, but part of it is related to incomplete or uncertain information. Contact with experts through mentorship programs and extension services allow farmers to gather more information from reliable sources, partially eliminating guesswork and uncertainty. Furthermore, a stronger focus on critical thinking and evaluation within undergrad programs could allow them to make stronger decisions when faced with a decision that requires knowledge their degree has not provided them with. Education and critical thinking skills are often correlated to innovation adoption (Knight, Weir, & Woldehanna, 2003). Perhaps a focus on economic incentive balanced with expert advice, and a skill set allowing more deliberate decisions would reduce risk aversion barriers that undergraduates face.

Although economic issues are often thought of as primary factors influencing innovation adoption on farm, the undergraduates present in the focus group identified only two economic barriers. While the two barriers identified, Financial Issues and Risk Aversion, ranked 1st and 4th with 9 and 5 votes respectively, Economic barriers received only 40% of the votes in the focus groups, while Social Barriers received 45.71% of the votes, containing the 2nd and 3rd most popular answers.

The first Social barrier identified is Technological Comfort. Receiving seven votes, Technological Comfort ranked 2nd among barriers to innovation identified during the focus group with 7 votes. Student participants described Technological Comfort as the openness, or lack thereof, of their parents and coworkers on their farm. Low technological comfort would lead to a farm owner, or a manger, deciding not to take advantage of a beneficial innovation because it would require learning new processes. This most often happens when new technology is

introduced, rather than when old technology is updated. New technologies require new skills to be developed rather than older skills improved upon. In some cases the skillset needed to use new technologies may be completely foreign to a producer and that might encourage them to continue using current systems. A good example of this is using smartphones and computers to look up product information, contact information, record seeding and harvest information, or to track costs and incomes.

Although many farmers have taken to doing one or all of these things, many of them are younger farmers. Older producers still tend to rely on non-electronic means to find and track the same information. Often they will call a third party for information they need, or they may contact a third party just to have the third party pass them on to someone who can help them. This process takes time and can be complicated. If s student returns to farm and has learned about a new technology through classes, or through work experience while at school, they may not be able to use it because their parent may not be willing to learn the new skills needed, or because they do not trust technology. Students come from a highly technology reliant system at the university where they use laptops and smartphones, all kinds of software, and are taught to be open to new ideas. When they return to farm it may be difficult to adapt to their new environment, and they may exist at the opposite end of the technological comfort spectrum from their parents or farm workers.

Unwillingness to Change was the 3rd most important barrier identified by the focus group, with 6 votes. While related to Technological Comfort, Unwillingness to change is less about avoiding new technology and more about maintaining the status quo. Unwillingness to change may in some cases be related to Risk Aversion, but is most often related to the difficulties of changing systems and ways of doing things. This can be disruptive in the short term as

employees may have to learn new roles, daily routines for the producer are altered, and extra attention is needed in order to implement new systems. Participants suggested that Unwillingness to Change was a result of the current system being easier to maintain because of familiarity and experience, while the new system would require producers to start over. "Unwillingness to change" values comfort over long-term benefit.

Entrenched Power Hierarchy gathered 3 votes from focus group participants. This barrier describes the difficulties students may have implementing innovative ideas when a strong decision making hierarchy is in place. The people holding decision making positions in the farm hierarchy may not be open to innovation, or they may just be unwilling to give up power to another person. Anyone wishing to introduce new ideas in a situation like this would have to deal with the difficulties of innovating and reducing, removing, or restructuring the existing hierarchy in order to implement new ideas. After spending four years or more away at school, farm hierarchies may develop to exclude students. While they are away their spot in the hierarchy may disappear or their influence may wane. Trying to integrate into or change this power hierarchy can prove difficult, especially for a young student freshly graduated.

Credibility received two votes when identified as a barrier to innovation for undergraduate students. Credibility relies significantly on trust, which was a barrier that was identified but received more votes. Personal experience and knowledge are the key factors influencing factors of credibility. Students can be considered to be knowledgeable when they graduate, but they often lack significant experience and experiential knowledge. This leads to a lack of credibility perceived by others. Students lack a record of successful decision making on the farm and so their decisions or ideas are seen as questionable.

The last three social barriers identified are Power Differential, Generation Gaps, and Trust. None of these three barriers received any votes despite being identified by the group as potential barriers. Interestingly, the interview participants identified gender gaps as being a likely barrier to innovation. Power differentials in relation to parent-child persona relationships were also identified as barriers by interview participants.

The social barriers to innovation identified in the focus group garnered 18 total votes which amounts to 51.43% of total votes. Social barriers to innovation were voted the most important by the focus group participants. It is interesting that many studies focus on adoption of innovation from the perspective of financial motivation and in some cases education but ignore social barriers that could prevent adoption even when it makes financial sense.

The last grouping of barriers to innovation is Environmental Barriers. These are not ecological barriers, but barriers that exist external to the students and their family farm. Environmental barriers are set by factors outside of a farm operator's control, and would need a concerted effort on a higher level to overcome. Environmental barriers were the least concerning barriers according to the focus group. There were only three barriers identified in this category and they received only three votes, which is 8.57% of the total votes cast.

The most prominent environmental barrier identified is 'Not Enough Labour'. This category reflects both the lack of labour currently available on farm and shortages of qualified labour available to be hired. Farms usually operate with as few employees as possible to cut down on costs. Some provinces even have laws exempting farm and agricultural labour from the same laws that govern most other industries, allowing workers to work more hours without time off. If a new project is planned, or a new venture is started, there may not be enough labour on hand to fully carry out these plans. If that is the case, they may be reduced, or even cancelled. If

the farm does wish to ahead with new projects, it may prove difficult to find qualified labour in significant numbers, or who possess the needed skills, or at the right price. These factors of skill, price, and number are out of the control of the individual farm. They are determined by the interaction of all members of the labour market. The cost for labour will rise in areas with low unemployment, or areas with established and profitable industries. In many cases younger people leave rural areas to pursue higher paying jobs in other areas. A lack of suitable labour can sink a project even when it will provide substantial benefits.

'Lack of Time' is the second environmental barrier identified and it received one vote. Lack of time is similar to the barrier mentioned above regarding a lack of suitable labour. Many farms rely on few workers working long hours, especially during planting and harvest. With so much of their time occupied by current farm activities, many farmers find it difficult to start new projects. New projects and implementing innovations would be difficult for a recent graduate. The farm would likely benefit the students extra labour being devoted to current tasks, and new projects would require a diversion of attention that may not be doable.

The last environmental barrier identified is 'Ability to Expand'. This barrier could be better termed as non-financial barriers to expansion. Farmers that border growing metropolitan areas may not be able to expand as these areas claim and rezone land away from agriculture. In other areas, the presence of a few large farmers may mean that land is not often on the market. 'Ability to Expand' exists regardless of a farms financial ability. Although 'Ability to Expand was suggested as a barrier, it received no votes.

Of all the barriers suggested by focus group participants and then voted on, 'Financial Issues', 'Openness to Technology', 'Unwillingness to Change', and 'Risk Aversion' were the four most important to participants, in that order. Of the twelve barriers and 35 votes, these four

barriers gathered 77% of the votes cast. ‘Financial Issues’ and ‘Risk Aversion’ have been previously covered quite extensively in agriculture and innovation research, especially in regards to ecological and environmental harm-reduction strategies. (Mouysset et al., 2013)(Knight et al., 2003). ‘Openness to Technology’ and ‘Unwillingness to Change’ have not been as extensively researched in agricultural settings and often is tied to education and age, while the specific social factors of age and education that affect technological adoption have been describe as too difficult to examine effectively (Berger, 2001). Even studies on risk aversion in agriculture reach conflicting conclusions. In some cases risk aversion prevents diversification, and in others encourages it (Hellerstein, Higgins, & Horowitz, 2013, p. 807).

Interview participants were also asked to identify barriers to innovation that they thought could apply to undergraduate students returning to family farms. The purpose of this was to gauge the understanding of agricultural innovators and educators had of the issues students identified. The reasoning is that large or obvious disagreements between the views of the two parties could cause undergraduates to be less supported than they should as innovators in a field desperately needing them. The barriers identified by interview participants are listed and discussed below.

Figure 4.7

Barriers to Innovation for Undergraduates Returning to Farm*
Economic
Risk Aversion
Social
Communication Skills
Generational Gaps
Experience
Differences in Value Sets
Power Relations
Reputational Credibility
Variability
Goals
Needs
Experience
Age
Family Relationships
Environmental
Inconclusive Science
Understanding of Farm Context

*As identified by interview participants

The first and only economic barrier identified by interview participants was 'Risk Aversion'. All three interviewees mentioned risk adversity or aversion as being important barriers to farms adopting innovation, whether in reference to students returning to farm or within the farming industry. One interview participant suggested that, *"…there are always financial issues and limitations in terms of what you might be able to do, and there's the reality of making a living, which is to say that, for somebody that might be struggling, they won't be as apt to try new tillage practices as somebody who is doing ok."* For those farms and operators having difficulty maintaining cash flows or undergoing a stressful periods in the life of their organization, adopting new practices may be the last thing on their mind. People often have trouble looking forward to find an innovative or novel solution to their problems and instead try to return to a period in time during the past where their organization was successful. Despite the fact that their current position is in many ways a reflection of what their organization was in the past, and therefore that their organization was not sustainable over the long term, many people tend to look backwards on past states in a romanticized manner. Innovations are then considered risky when compared to known states in the past, preventing adoption of new techniques and ideas at the expected, or optimal, rate. Another participant stated: *"It's a…a different thing with a farm. You can't fail; you can't just start a new farm, right? So it's a pretty big deal to farmers, the benefit has to be obvious. They like to stay where they feel safe, and spending money isn't always an option."* This quote relates to the personal nature of farming. A factory worker or a retail worker can apply to other jobs, but they lack a personal connection or vested interest in these jobs. Many producers identify as a producer within their social and personal lives. Because they have so much invested in farming, they can be very risk-averse financially. Innovation rates therefore are far below the optimal rates that mathematical or cost-benefit models would suggest.

The first social barrier described by interview participants is ‘Communication Skills’. This barrier is further divided into two sub categories, generational gaps in communication style, and experience in communication. The foremost component of generational gaps in communication style was identified by a participant as *“…it’s also an important thing that receiver of information nowadays also has an expectation to have a level of excellence in communication.”* This touches on two important points. One, students, and younger people in general, may not develop their communication skills as well now as in the past. Communication receivers are expected to have an ability to understand and interpret a speaker much more often nowadays than in the past. This may cause some students returning to farm to have difficulty conveying information. The older generation of farmers, of which 92.5% are over the age of 39 as of 2006, may not actively engage in communication, placing the burden of explanation on the speaker (Statistics Canada, 2006). Two separate expectations emerge for the communication process, often leading to inefficient conveyance of knowledge, information, and ideas. In this scenario, even with new ideas with high returns on investment, a student may have difficulty relaying the necessary information to decision makers, preventing implementation of innovation.

The second issue within communication barriers is experience. Although students returning to farm may have a wealth of theoretical knowledge, and some experiential knowledge from working in agricultural settings over summers or during internships or research placements, many of the farmers, farm owners, and operators have years of experience communicating ideas and interacting with a variety of people. Students likely don’t have that experience and are mostly used to communicating in highly similar peer groups, and often about topics on which they agree. Explained by a participant there is, *“…no question communication is something that’s a developed and seasoned skill that you get with time. It’s unusual, for example, to see a*

dynamic and organized and compelling speaker who's 19. They do exist, but I'm saying it's not that common, whereas that individual is usually between maybe 25 and 55." The difficulty with this aspect of the communication barrier is the need for time. Some communication skills can be worked on, and universities may put a greater emphasis on teaching communication and facilitation skills, improvement is largely a factor of practice over time. This experience also teaches important contextual awareness. A separate participant said, *"…ok if I'm talking to a government bureaucrat, if I'm talking to a farmer, I'm talking to a 15-year-old about something, I'm talking to my mom, who is 91, who wants to understand the benefits of omega-3 fatty acids, but doesn't know about long-chain saturated fats, this and that. You have to change the vocabulary but each one is a viable communication goal to try and achieve."* Without previous interactions with members of these social or demographic groups, it is difficult for a speaker to modify their word choice and manner of speaking to most efficiently deliver ideas. Within a farm setting it will take time for a student who has recently begun working full time to meet and understand the decision makers in such a way that they can communicate with them in a highly successful manner.

Differences in Value Sets were also identified by two of the three interview participants as being significant barriers to innovation. An explanation of this barrier comes from a participant: *"…there's no question that the younger generation now that are undergraduates have very different set of social work and ethical values then perhaps their parents' generation. They view work life balance differently, they view the importance of everything from say relationships to holidays to compensation to job rewards and everything differently."* The participant then went on to describe how differences in goals, beliefs, and values affect the choice to adopt certain practices and techniques. If a student returns to their families' farm with a

new understanding and valuation of ecological sustainability, but the farm operator is primarily focused on income and personal benefit, it would be difficult to find a middle ground that is acceptable to both. With two conflicting paradigms there are certain arguments that make sense in one but not in the other, and so the disagreement is not simply over uncertainty of the value of an innovation but over whether any importance or relevance can be attributed to an argument at all.

The power relations barrier is fairly simple. Defined by one interviewee, *"…a power based differential in a family where the mother or father they're the boss and they're doing it their way because they've always done it that way and they're not going to let a twenty year old tell them something, especially if it's their own kid, maybe."* This barrier involves focusing on stereotypes and the source of information rather than the quality of the information being transmitted. The choice to adopt or reject proposals or suggestions relies on personal opinions or views towards the person bringing the idea forward. These opinions may be accurate, but the reliance on a generalized idea of the person and their identification with certain social groups can lead decision makers to reject an idea or improvement even if it has significant value. People in positions of power often try to maintain power and allowing others to make decisions or suggest policy and goals can reduce their power. Operators will also try to protect their position and their farm from innovations they perceive as dangerous. In many ways the power relations barrier is related to judgement based on character rather than merit.

Reputational Credibility was another barrier brought up by all participants. This barrier is primarily caused by a lack of previous history of good decisions and a lack of experience. Like communication experience, this is something that has to be built up over time with a record of making beneficial choices and building an image as a credible broker of knowledge and

information. Specifically in reference to students, there's is a belief that if you are, *"an undergraduate in that age group and I mean I guess you have to have issues around reputational credibility," Well, I mean you're only twenty years old, what do you know about this," right?"* Furthermore, while a student may have a lot of knowledge pertaining to their major in university, and a degree of theoretical knowledge, outside of their schooling, *"…that same twenty year old in another environment doesn't yet have credibility because they don't have reputational street credibility for what they're talking about."* Rightly or wrongly, students returning to their farms might be viewed as lacking credibility. Their suggestions could be ignored until they have made an impression sufficient to establish their credibility.

The variability within undergraduates can also be seen as a barrier to their ability to implement innovations. This barrier is interesting in that it involves a service issue that leads to less than efficient skill transfer, contributing to the presence of other barriers down the road. Information gathered from the interviews stated that, *"…undergraduates themselves are a demographic who is highly varied, right, from very young to a little older, very immature to very mature, seasoned in terms of broad based knowledge, to being new and novice at it."* This variability makes it difficult to design programs or establish skill based initiatives that effectively serve all different types of undergrads. With so much variation it is difficult to teach general skills without sacrificing effectiveness in order to simplify the process. Determining when to introduce skills into the curriculum is also difficult. One academic participant described this variability by saying, *"Undergraduates are anything from fresh out of high school, one minute later they're an undergraduate, to senior undergraduates with very capable skills in a number of different areas."* A number of questions arose in the interview over when to implement experiential work and broad communication and critical thinking based strategies. Ultimately,

the variability of undergraduate students and the differences in their goals and programs makes it difficult to create programs that suit all of their needs while being easy to administrate. Although inefficient transfer of skills to undergraduates is not necessarily a barrier to implementing innovation, it certainly exacerbates other barriers.

Age was also mentioned by all three interview participants as a barrier to innovation. Although it could be combined with other barriers and has an effect on things such as credibility, the fact that all three interviewees specifically pointed it out merited its inclusion as a separate category. Two factors that were implicated in the age barrier are thought processes and a tendency towards emotive responses. One participant suggested that although, *"…I don't say this with any disrespect but it's an age related thing, is that obviously early stage undergraduates have a less mature thinking approach than senior undergraduates."* Undergraduates are described as having a tendency to not fully weight pros and cons, or not understanding the full context a problem occurs within. Additionally, common beliefs on undergraduates from faculty indicate *"…that they have a lot more emotive responses and reactions to things that are not necessarily based on a thoughtful and analytical and balanced and an objective taking of all of the facts and then having an opinion based on that."*. Although universities are seen as a source of developed critical thinking skills, these skills will continue to develop throughout a person's life. After graduation it may take time for critical thinking skills to be integrated into real world situations. Collecting experience within agriculture will help mediate age related issues.

The last social barrier to innovation identified by interview participants is Family Relationships. The main support for this barrier comes from *"…the baggage that a family brings, that a relationship brings."* There are special relationships that exist between parents and children, and there are good and bad aspects to these relationships. They are often supportive and

encouraging, but they also contain decades of baggage by the time a student graduates. The memory of past interactions has a strong influence on the course of future interactions. Difficulties seeing children as adults or as partners or peers within the farming context can also prevent a useful implementation of innovations. It is a hard to define relationship that varies across family units, but, *"…sometimes somebody else's dad or mom can day something that you'll accept, but not if it came from your own parents. No question about that."* Dealing with the family relationships barrier is difficult and can cause a lot of damage outside of the farming roles of parents and children.

The last two barriers brought up during interviews are considered environmental barriers. They are Inconclusive Science and Understanding of Farm Context. Inconclusive Science means that one report or study might claim large benefits and another might claim the opposite. Determining which is right may be difficult, and as a student in a situation where science is inconclusive, it may be difficult to make a case for implementation. Participants acknowledged that, "*Science can still be confounding on a lot of things, you might have a certain way of doing things and yet you might look to the information and research and you get two different opinions on it. You still have to make an informed judgement call, so there can be complexities."* With evidence on both sides, a decision often comes down to experience or power dynamics, making it difficult for a student to implement change in a confounding environment.

Understanding farm context highlights the need to collect and understand accurate information from sources outside a farm, but also the importance of being able to collect accurate information about factors on the farm. It is hard to determine the worth of a new practice or new technology if there is no accurate information on soil types, nutrient levels, crop yields, and other important farming factors. This barrier occurs when farmers and students returning to farm do

not know enough about their own farm to make an informed decision, or else are unable to contextualise information given to the properly. To overcome barriers related to misunderstandings of farm context, students must be aware that, *"…circumstances on one farm are always going to be different than circumstances on another farm. It's not only the quality of the information coming at you but the quality of your own information so that you can use that information in a good way, we have to be able to filter through that information and complexity of it to be able to apply it."*

After comparing the barriers identified by students and the barriers identified by educators, researchers, and innovators within agriculture, there appears to be very little overlap. There were five barriers identified by both groups, but of those five, interview participants identified three that received no votes during the focus group (Generation Gaps, Uneven Balance of Power, and Trust), while the other two identified received only seven of the thirty five votes (Risk Aversion and Credibility). The figure below summarizes this data.

Figure 4.8

Overlapping Barriers	
Students (# votes)	**Non-Students**
Risk Aversion (5)	Risk Aversion
Generation Gaps (0)	Differences in Value Sets
Uneven Balance of Power (0)	Power Relations
Credibility (2)	Reputational Credibility
Trust (0)	Family Relationships

4.5 Undergraduate Degrees and the Reduction of Barriers to Innovation

Focus group participants provided eight suggestions on how their degree will help them overcome any barriers they may face: Exposure to New Experiences, Networking, Credibility, Transferable Skills, Scientific Method Knowledge, Experiential Knowledge, Learning to be a Better Manager, and Access to Expert Knowledge. The ways a degree can help overcome barriers to innovation, the number of votes they received from the focus group is summarized below. A figure is also included that sorts the benefits of a degree into three categories: Skill Building, Life Experience, and Relationship Building. The number of votes each benefit received and the percentage of overall votes received are also included.

Figure 4.9

Question 2: How has your university experience aided you in understanding and overcoming barriers to innovation on your farm?	Votes
Exposure to New Experiences	9
Networking	8
Credibility	6
Transferable Skills	5
Scientific Method Knowledge	3
Experiential Knowledge	2
Learning to be a Better Manager	2
Access to Expert Knowledge	0
Total	35

Figure 4.10

Benefit of Degree in Overcoming Barriers to Innovation		
Type Of Benefit	Votes (n=35)	% of Total Votes
Skill Building		
Transferable Skills	5	14.29%
Knowledge of Scientific Method	3	8.57%
Better Management Skills	2	5.71%
Total	10	28.57%
Life Experience		
Exposure to New Experiences	9	25.71%
Credibility	6	17.14%
Experiential Knowledge	2	5.71%
Total	17	48.57%
Relationship Building		
Networking	8	22.86%
Access to Expert Knowledge	0	0.00%
Total	8	22.86%
Total	35	100.00%

The first category benefits were sorted into is Skill Building. This category is focused on benefits that come from skills explicitly taught by the school with the intention that they be useful in the future. The three benefits places in this category are Transferable Skills, Knowledge

of the Scientific Method, and Better Management Skills. These benefits received 5, 3, and 2 votes respectively, for a total of 10 votes and 28.57% of total votes.

Transferable Skills are skills specifically taught through courses at the University of Guelph. These skills include things like reading, writing, and research aptitudes as well as more program specific skills on animal care, environmental management, or farming techniques. Transferable skills are skills that are intentionally included in the University of Guelph curriculum in order to benefit graduates when they leave the school. In other words they are the point of a university education. They are what employers look for, and what a student should expect to learn while at school.

Knowledge of the Scientific Method is a term used by focus group participants to describe the critical thinking skills developed by students at university. Student participants believed that the their university education provided them with a comprehensive and balanced skill set for recognizing problems, searching for and evaluating information, and implementing solutions. This benefit was also recognized by interview participants as a development of critical thinking skills. Interviewees suggested that, *"…it's all about this broader level of awareness in a competitive world. You know, filter through the issues that are going on and what that education has done is helped him make those informed decisions, giving him the confidence to make the call."* Whether known as knowledge of the scientific method or as critical thinking skills, these two benefits of a university education are directly linked to overcoming the two environmental barriers identified by interview participants: Inconclusive Science and Understanding Farm Context. Critical thinking skills help students evaluate conflicting theories or ideas. Students would have a lot of practice in doing this once they graduate, as many higher level undergraduate courses require evaluation, presentation, and defense of material students have collected. The

scientific method would help students collect and analyse data on far to look for important relationships and co-occurrences, which then helps them make informed decisions. One study participant believed that *"…you've read those ten books and gained some information out of that, and I think that's important, but perhaps even more important is the thought process you go through, even if it's the rational scientific method."*

The last Skill Building benefit identified by students is developing better management skills. By working on group projects, studying, taking courses, and dealing with the administrative structure of the university students have developed the ability to prioritize work, manage their time, assign work, work independently, ad deal with people in an effective manner. In a farm setting there a student will have to deal face-to-face with employees and family members on a daily basis. They will also have to make business and work decisions that require an ability to make the best decision for the farm as a whole. Effective management skills make operating a farm and implementing new ideas much easier.

A second category was developed by coding focused group responses: Life Experience. This category included three ways in which an undergraduate education benefits students: Exposure to new experiences, credibility, and experiential knowledge. These benefits brought in 9, 6, and 2 votes respectively, for a total of 17 votes, or 48.57% of the total. These three skills all revolve around gaining experience in a setting similar to what they may face in the real world, but mediated by the university. The University can provide a number of opportunities working at the school, doing research, working in Guelph, providing internships and work placements, and interacting with students and faculty. Students can encounter a large number of new situations and experiences while at school, but are allowed the time to integrate these situations and develop skills for dealing with them. By being involved in a number of these opportunities

students can gain significant experience before they even leave school. Together, experience with new situations and experiential learning can develop the credibility and reputation of students before they graduate, making the transition to farm life easier. Developing experiential knowledge and being exposed to new experiences and ideas was clearly the most important benefit in overcoming barriers to innovation that focus group participants believe they received from their university education.

The last category of benefits developed from the focus group is relationship building. The two benefits in this category are Networking and Access to Expert Knowledge. Networking received eight votes. Networking was described as coming into contact with people who have different skill sets and experiences that could aid students in dealing with problems they encounter in the real world. Going through four years of school, students have met industry representatives, faculty, and other students that are willing to share knowledge and lend expertise eve after graduation. Networking allows individuals to build a large web of relationships that provide support during times of need. Access to expert knowledge is similar to Networking, but focuses more on knowing faculty members at the University of Guelph that are experts in certain fields and may be willing to share their opinion on the solution to problems that may arise on farm. This benefit received zero votes.

The key-informant interviews provided two additional benefits. The first was developing critical thinking skills, which was also identified by focus group participants and was therefore discussed above. The other is building communication skills. Since interviewees identified communication related issues as a barrier to innovation, it makes sense that they would see undergraduate programs as building communication skills to overcome these. An academic interviewee relayed a focus on communication based skill development stating that:

"…one of the key deliverables is a team assignment that requires a public presentation and defence of the thing to give them skills in both media communications, public speaking, defending ideas, communicating back and forth with a bunch of mock stakeholder groups that range from the smart ones to the dumb ones…we nowadays are incorporating those kinds of approaches because they know you need to be able to communicate, to be able to defend an idea, to be able to debate, okay, to be able to honestly evaluate honestly pros and cons of a particular idea or something to be able to have a meaningful dialogue."

The point of exercises such as this are not only to encourage students to identify problems, collect information and resolve issues, but to have them actively practice conveying knowledge and information to others in an effective and efficient manner. It can take time for people, especially younger, newly graduated students to become comfortable communicating ideas and integrating feedback. Exercises in school that require debating and defending ideas are great experience for real worse situations. The benefit of practicing at university is the feedback and support university faculty can provide.

5.0 Conclusion and Suggestions

5.1 Conclusion

Student participants identified a number of barriers, but also identified a number of ways that their degree programs aided them in overcoming these barriers. Focus group students also reported high levels of confidence in overcoming barriers to innovation. It would be interesting to follow up with these students in the six months after they return to work on their farms to see how confidence levels change and to see if more barriers arise. Working on a farm over the summer may not prepare students fully for their experience returning to the farm and they may underestimate barriers to innovation. The three interview participants suggested much different barriers that would be present for students. This may come from greater experience in the field, or it may even be part of the generation gap both groups mentioned. Further, many of the barriers that were important to the interviewees were mentioned by the focus group but received no, or

few, votes. Maybe the weight students give to each issue will change as they gather more experience on farm or as they age.

Based on the results of the focus group and interviews some basic suggestions have been made:

1. **Integrating communication as a program requirement.**

Communication is important as a skill to transfer information learned in school and through experiences. Therefore, it should receive attention in its own right rather than as a secondary skill taught expressly as a means to an end. Communications are useful in all aspects of life and the best way to convince employees, operators, and peers of the need to implement new ideas and technology is to frame it with a convincing argument. If we want graduating students to act as innovators in agriculture, they need to possess the skills to effectively transfer information and knowledge. One way to do this is to require courses that specifically work on presentation, negotiation, and communication skills rather than expecting students to learn them as secondary skills through other courses. The most important barriers identified by students were social barriers, or barriers constructed through the interaction of people. The predominant benefits of a degree were also socially oriented. It makes sense that a focus on social skills and communication would have some positive impact on student's ability to overcome barriers to innovation.

2. **Improve finding.**

This is an easy suggestion to make, but one that is hard to implement. Many issues could be dealt with through additional funding in many different subjects. The additional funding in this case would be used to provide more opportunities for students to learn in non-traditional manners, improve student to faculty ratios, encourage class excursions, and more generally target

knowledge translation in undergraduate populations throughout the OAC. With more students participating in new learning strategies they will be more experienced and able to deal with barriers on graduation.

3. **Utilize mentorship programs.**

Older producers, researchers, academics, and government workers have years of experience in agriculture and have a great deal to provide to young farmers and innovators. Young farmers and innovators possess new viewpoints, knowledge, and techniques that older producers and agricultural innovators may not be aware of. Both parties have something to learn from the other and could benefit at the very least from a new perspective on the difficulties they face. A mentorship program allows these two groups to interact in an informal manner with the goal of exchanging knowledge and ideas that can lead to a healthier agricultural system. By building relationships, mentorship programs can increase resilience and allow producers to support in other in overcoming barriers.

4. **Accountable and active faculty.**

Faculty could aid students by focusing on academic service beyond just teaching their classes. Interview participants stressed that although the OAC possesses high-quality staff, in some cases faculty members could be more engaged with their students, and make their research more accessible. In order to stress a communication and service-learning component to OAC programs, faculty have to be properly engaged and be interested in participating in changing the current undergraduate paradigm. Making more faculty research available of the University of Guelph, OAC and departmental websites could encourage the diffusion of material beyond its normal audience. By engaging students and actively spreading information, students are better equipped to deal with barriers they encounter.

5. **Increase access to experiential opportunities.**

Participants in the interviews and the focus group believed that although the University of Guelph is devoted to experiential learning, perhaps even more so that other schools, there is an opportunity to expand the idea to other departments and programs. Some programs, like Landscape Architecture, do a great job of engaging with their community and stakeholders through work placements, internships, and cooperative projects. Other programs, like Plant Science, were suggested as areas where a stronger community presence could have significant benefits. Experiential learning helps students become comfortable with their industry, but it also allows them to spread knowledge to a number of organizations that may not actively be engaged by OAC programs otherwise. With stronger skills and more experience upon graduation, barriers to innovation will be more manageable.

6. **Reach out to students and producers.**

This suggestion is in some ways a step back in history. Although Canada has vastly reduced its outreach and extension networks, personal contact and guidance still seems like an effective way to manage some knowledge transfer. Contact from faculty and researchers within the OAC through email, events, and conferences could be a good way to form a network of likeminded farmers wishing to share information and ideas. The support that develops can help them overcome barriers they may be facing when implementing innovation.

6.0 Appendices

6.1 Email Script

Hi _____,

My name is Chris Danderfer and I am an MSc candidate in Capacity Development and Extension at the University of Guelph. I am currently conducting research on the "Barriers to Innovation for Undergraduate Students Returning to a Family Farm after Graduation." I am looking to recruit participants for an hour long interview about how they and their organization perceive undergraduate students and their role in agricultural innovation, as well as what barriers to innovation they identify. I have identified you as someone who is significantly involved in agricultural innovation in Guelph and Ontario at a strategic and impactful level as a part of your organization. If you would be interested in participating in this research, or have any questions or concerns, please feel free to contact me through email at cdanderf@uoguelph.ca, or by phone at 306-658-3443. I have attached a letter of information for you to read that will give you more information on the research being done.

With regards,

Chris Danderfer
MSc Candidate, Capacity Development and Extension
University of Guelph, SEDRD
Guelph, Ontario

6.2 Letter of Information

CONSENT TO PARTICIPATE IN RESEARCH

Barriers to Innovation for University of Guelph Undergraduate Students Returning to a Family Farm after Graduation

You are asked to participate in a research study conducted by Jim Mahone (Principal Investigator) and Chris Danderfer (Student Investigator), from the School of Environmental Design and Rural Development at the University of Guelph. The results of this study will contribute to the thesis of Chris Danderfer.

If you have any questions or concerns about the research, please feel free to contact Jim Mahone by phone at 519-767-1686, or through email at jmahone@uoguelph.ca.

Purpose of the Study

The purpose of this study is to identify and describe factors that prevent new ideas, technologies, processes, and techniques from being adopted by family farms in rural Ontario. These factors will be looked at from the perspective of third and fourth year students in the Bachelor of Science (Agriculture) program at the University of Guelph. This study will also look at how a university education may help students overcome the potential barriers to innovation on their own farms.

Procedures

If you volunteer to participate in this study, we would ask you to do the following things:

The study involves one-on-one interviews with the student researcher. The participant will be asked to provide responses to approximately fifteen open-ended questions developed by the primary and student researchers. The interview will be semi-structured, with the interviewer having a list of specific questions but allowing the interviewee to direct the conversation to areas of interest within the context of the study. The session will be recorded. The participant can stop the session or recorder at any time. The participants responses will be transcribed, coded, and anonymized after the interview concludes. Jim Mahone (Principal Investigator) and Chris Danderfer (Student Investigator) will be the only people with access to the raw data. Any data included in the study released to the public will be treated in a fashion that prevents identification

of individuals. The time commitment for this part of the study is estimated at a maximum of one hour.

Potential Risks and Discomforts

The potential for discomfort is very low. Interviewees will only be identifiable to the interviewer. Participants can share as much or as little as they feel comfortable. Data will be recorded in a confidential manner and personal identifiers will be kept in a separate file connected to the data collected by an anonymous identifier. Participants can stop the interview at any time if they do not want to proceed, and will be reminded of this throughout the interview.

Potential Benefits to Participants/Society

Participants will be able to voice opinions in a judgement free manner. They will be able to contribute to a study that will consider their input while not identifying their individual responses.

This study will also provide more information on the difficulties that undergraduates face when returning to their family farms. The study will portray barriers to innovation from a student's perspective and give them an avenue to voice their concerns. Hopefully further research will help in dealing with these barriers.

Payments to Participants

There will be no payment to participants.

Confidentiality

The interviews will be recorded on a sound recording device. The participant can ask that the recorder be stopped at any time. The interviewer will also take notes. Recordings will be transcribed.

Every effort will be made to ensure confidentiality of any identifying information that is obtained in connection with this study. Personal data will be kept in a file separate from the data collected. This data will be held in a secure file on an encrypted device. The electronic copies (recordings, transcriptions, and notes) will be destroyed after the thesis resulting from this study is successfully defended. Hard copies of notes taken by the interviewer will be kept in a locked cabinet.

Participation and Withdrawal

You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. Participants can withdraw data after completing the interview. You may refuse to answer any questions you don't want to answer and still remain in the study. The investigator may withdraw you from this research if circumstances arise that warrant doing so.

Rights of Research Participants

You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. This study has been reviewed and received ethics clearance through the University of Guelph Research Ethics Board. If you have questions regarding your rights as a research participant, contact:

Director, Research Ethics
University of Guelph
437 University Centre
Guelph, ON N1G 2W1

Telephone: (519) 824-4120, ext. 56606
E-mail: reb@uoguelph.ca
Fax: (519) 821-5236

6.3 Consent Form

CONSENT TO PARTICIPATE IN RESEARCH

Barriers to Innovation for University of Guelph Undergraduate Students Returning to a Family Farm after Graduation

You are asked to participate in a research study conducted by Jim Mahone (Principal Investigator) and Chris Danderfer (Student Investigator), from the School of Environmental Design and Rural Development at the University of Guelph. The results of this study will contribute to the thesis of Chris Danderfer.

If you have any questions or concerns about the research, please feel free to contact Jim Mahone by phone at 519-767-1686, or through email at jmahone@uoguelph.ca.

Purpose of the Study

The purpose of this study is to identify and describe factors that prevent new ideas, technologies, processes, and techniques from being adopted by family farms in rural Ontario. These factors will be looked at from the perspective of third and fourth year students in the Bachelor of Science (Agriculture) program at the University of Guelph. This study will also look at how a university education may help students overcome the potential barriers to innovation on their own farms.

Procedures

If you volunteer to participate in this study, we would ask you to do the following things:

The study involves one-on-one interviews with the student researcher. The participant will be asked to provide responses to approximately fifteen open-ended questions developed by the primary and student researchers. The interview will be semi-structured, with the interviewer having a list of specific questions but allowing the interviewee to direct the conversation to areas of interest within the context of the study. The session will be recorded. The participant can stop the session or recorder at any time. The participants responses will be transcribed, coded, and anonymized after the interview concludes. Jim Mahone (Principal Investigator) and Chris Danderfer (Student Investigator) will be the only people with access to the raw data. Any data included in the study released to the public will be treated in a fashion that prevents identification

of individuals. The time commitment for this part of the study is estimated at a maximum of one hour.

Potential Risks and Discomforts

The potential for discomfort is very low. Interviewees will only be identifiable to the interviewer. Participants can share as much or as little as they feel comfortable. Data will be recorded in a confidential manner and personal identifiers will be kept in a separate file connected to the data collected by an anonymous identifier. Participants can stop the interview at any time if they do not want to proceed, and will be reminded of this throughout the interview.

Potential Benefits to Participants/Society

Participants will be able to voice opinions in a judgement free manner. They will be able to contribute to a study that will consider their input while not identifying their individual responses.

This study will also provide more information on the difficulties that undergraduates face when returning to their family farms. The study will portray barriers to innovation from a student's perspective and give them an avenue to voice their concerns. Hopefully further research will help in dealing with these barriers.

Payments to Participants

There will be no payment to participants.

Confidentiality

The interviews will be recorded on a sound recording device. The participant can ask that the recorder be stopped at any time. The interviewer will also take notes. Recordings will be transcribed.

Every effort will be made to ensure confidentiality of any identifying information that is obtained in connection with this study. Personal data will be kept in a file separate from the data collected. This data will be held in a secure file on an encrypted device. The electronic copies (recordings, transcriptions, and notes) will be destroyed after the thesis resulting from this study is successfully defended. Hard copies of notes taken by the interviewer will be kept in a locked cabinet. Participants will be notified of the completion and submission of the major research paper and will at this time be provided with an executive summary and/or a copy of the paper itself through email.

Participation and Withdrawal

You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. Participants can withdraw data after completing the interview. You may refuse to answer any questions you don't want to answer and

still remain in the study. The investigator may withdraw you from this research if circumstances arise that warrant doing so.

Rights of Research Participants

You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights or remedies because of your participation in this research study. This study has been reviewed and received ethics clearance through the University of Guelph Research Ethics Board. If you have questions regarding your rights as a research participant, contact:

Director, Research Ethics
University of Guelph
437 University Centre
Guelph, ON N1G 2W1

Telephone: (519) 824-4120, ext. 56606
E-mail: reb@uoguelph.ca
Fax: (519) 821-5236

Signature of Research Participant

I have read the information provided for the study "*Barriers to Innovation for University of Guelph Undergraduate Students Returning to a Family Farm after Graduation*" as described herein. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

Signature of Participant

_____
Name of Participant (please print)

_____ _____
Signature of Participant Date

Signature of Witness

_____
Name of Witness (please print)

_____ _____
Signature of Witness Date

6.4 Focus Group Questions

Question 1 – What do you see as barriers to innovation for students returning to the farm?

Question 2 – How has your university experience aided you in understanding and overcoming barriers to innovation on your farm?

Question 3 – How comfortable are you in working within your farm system to incorporate innovation on your farm?

6.5 Interview Questions

1. What do you feel are the main examples of innovation awareness in agriculture (Farm days, test plot demonstrations, newspaper, magazine)?
2. Which of these avenues ha the highest success rate in terms of innovation adoption (In general)?
3. Which avenues does your organization work with most often?
4. What role do you feel undergraduate students returning to their family farms play in the innovation process?
5. How effective are undergraduate students in aiding the innovation adoption process?
6. What barriers to implementing innovation do you perceive for these undergraduates?
7. How might the BSc (Ag) undergraduate degree help in overcoming these barriers?
8. With respect to implementation of agricultural innovation, in what ways do you believe the undergraduate experience could be improved?
9. Are there ways in which your organization supports these undergraduate students?
10. Are there any ways that agricultural organizations as a whole could better support these students?

7.0 Bibliography

Agriculture and Agri-Food Canada. (2013). An overview of the Canadian agriculture and agri-food system 2013. Departmental Publication Service. Retrieved from: http://www.agr.gc.ca/eng/about-us/publications/economic-publications/alphabetical-listing/an-overview-of-the-canadian-agriculture-and-agri-food-system-2013/?id=1331319696826#a1

Alonge, A. & Martin, R. (1995). Assessment of the adoption of sustainable agriculture practices: implications for agricultural education. *Journal of Agricultural Education, 36*(3), 34-42.

Asenso-Okyere, K. & von Braun, J. (2009). A bigger role for universities to enhance agricultural innovation and growth in developing countries. *NAF International Working Paper Series, 9*(1), 1-19.

Berger, T. (2001). Agent-based spatial models applied to agriculture: a simulation tool for technology diffusion, resource use changes and policy analysis. *Agricultural Economics, 25*, 245-260.

Common University Data Ontario. (2013). General Information. Retrieved from: http://www.uoguelph.ca/analysis_planning/cudo/general.php

Council of Ontario Universities. (2015). Fall-term headcounts by university and level, 2005-06 to 2014-15. *Ontario Ministry of Training, Colleges, and Universities*, Table 1-6.

Cowan, R. and Zinovyeva, N. (2013). University effects on regional innovation. *Research Policy,* 42: 788-800.

Daberkow, S. & McBride, W. (2003). Farm and operator characteristics affecting awareness and adoption of the precision agriculture technologies in the US. *Precision Agriculture, 4*(2), 163-177.

Danderfer, C. (2014). Barriers to innovation for undergraduates returning to family farms after graduation. *Focus Group.*

Etzkowitz, H. (2003). Innovation in innovation: the triple helix of university-industry-government relations. *Social Science Information, 42*(3), 293-337.

Farm Credit Canada. (2015). Farmland Values Report 2014. 1-12.

fourth edition, 1 – 397.

Hellerstein, D., Higgins, N., & Horowitz, J. (2013). The predictive power of risk preference measures for farming decisions. *European Review of Agricultural Economics, 40*(5), 807-833.

Hoffman, W. (2001). Chapter 7 human capital: education and agriculture. *Handbook of Agricultural Economics, 1*(A), 333-381.

Hu, W. (2015). The role of risk and risk-aversion in adoption of alternative marketing arrangements by the US farmers. *Applied Economics, 47*(27), 2899-2912.

Iqbal, J., Rasli, A., Heng, L., Ali, M., Hassan, I., & Jolaee, A. (2011). Academic staff knowledge sharing intentions and university innovation capability. *African Journal of Business Management, 5*(27), 11051-11059.

Jette-Nantel, S., Freshwater, D., Beaulieu, M., & Katchova, A. (2011). Farm income variability and off-farm diversification in Canadian agriculture. *Statistics Canada: Agriculture and Rural Working Paper Series,* 1-23.

Knickel, K., Brunori, G., Rand, S., & Proost, J. (2009). Towards a better conceptual framework for innovation processes in agriculture and rural development: from linear approaches to systemic models. *Journal of Agricultural Education and Extension, 15*(2), 131-146.

Knight, J., Weir, S., & Woldehanna, T. (2003). The role of education in facilitating risk-taking and innovation in agriculture. *The Journal of Development Studies, 39*(6), 1-22.

Knowler, D. & Bradshaw, B. (2007). Farmers' adoption of conservation agriculture: a review and synthesis of recent research. *Food Policy, 32*(1), 25-48.

Mansfield, E. & Lee, J. (1996). The modern university: contributor to industrial innovation and recipient of industrial R&D support. *Research Policy, 25*(7), 1047-1058.

McRae, R., Martin, R., Juhasz, M., & Langer, J. (2009). Ten percent organic within 15 years: Policy and program initiatives to advance organic food and farming in Ontario, Canada. *Renewable Agriculture and Food Systems,24*(2), 120-136.

McRae, T., Smith, C., & Gregorich, L. (2000). Environmental sustainability of Canadian agriculture: report of the agri-environmental indicator project. *Prairie Farm Rehabilitation Administration,* 1-25.

Mouysset, L., Doyen, L., & Jiguet, F. (2013). How does economic risk aversion affect biodiversity? *Ecological Applications, 23*(1), 96-109.

Ontario Agricultural College. (2015). About. Retrieved from: https://www.uoguelph.ca/oac/about-oac

Palys, T., & Atchison, C. (2008). Research Decisions: quantitative and qualitative perspectives,

Permann, M. & Walsh, K. (2007). University-industry relationships and open innovation: towards a research agenda. *International Journal of Management Reviews, 9*(4), 259-280.

Reidsma, P., Ewert, F., & Lansink, A. (2007). Analysis of farm performance in Europe under different climatic and management conditions to improve understanding of adaptive capacity. *Climatic Change, 84,* 403-422.

Rivera, W., Qamar, M., & Mwandemere, H. (2005). Enhancing coordination among AKIS/RD actors: and analytical and comparative review of country studies on agriculture knowledge and information systems for rural development. *Rome: FAO.*

Rosegrant, M., Ringler, C., Benson, T., Diao, X., Resnick, D., Thurlow, J.,…Orden D. (2006). Agriculture and achieving the millennium development goals. *Agriculture and Rural Development Department, Report no. 32729-GLB,* 1-48.

Statistics Canada, (2009). Statistics on income of farm operators. *Agriculture Economic Statistics, catalogue no. 21-206-X*. Ottawa, ON.

Statistics Canada. (2007). Selected historical data from the census of agriculture. *A statistical portrait of agriculture, Canada and provinces: census years 1921 to 2006 ,catalogue no. 95-632-x*. Ottawa, ON. Retrieved from: http://www.statcan.gc.ca/pub/95-632-x/95-632-x2007000-eng.htm

Statistics Canada. (2014). Net farm income. *Agriculture Economic Statistics, catalogue no. 21-010-X*. Ottawa, ON.

University of Guelph. (2015). About the partnership. *OMAFRA – U of G Partnership.* Retrieved from: http://www.uoguelph.ca/omafra_partnership/en/omafrauofgpartnership.asp

University of Guelph. (2015). Enrollment. *Facts and Figures*. Retrieved from: http://www.uoguelph.ca/info/factsfigures/enrolment/

University of Guelph. (2015). Financial. *Facts and Figures*. Retrieved from: http://www.uoguelph.ca/info/factsfigures/financial/

Weber, J. & Key, N. (2014). Do wealth gains from land appreciation cause farmers to expand acreage or buy land? *American Journal of Agricultural Economics, 96*(5), 1334-1348.