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# University of Guelph/OMAFRA

Impact Study

December 14, 2007

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# 1.0 Executive Summary

## 1.1 OMAFRA/University of Guelph Agreement

Predating 1996, the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) and the University of Guelph (UG) have shared a unique relationship and common interests, involving the development of research and academia in agricultural sciences at the University, and thus the development of strong talent, innovation, and agricultural industries in the City of Guelph and throughout Ontario.

In 1996 OMAFRA and UG formalized this relationship, in the form of a dedicated funding agreement whereby OMAFRA would provide UG annual funding (approximately \$54 million base funding in 1997/1998) to support:

- Research and development (R&D) programs;
- Delivery of agricultural diploma and assorted continuing education programs through 3 regional agricultural colleges;
- Veterinary Clinical Education Programs through the Ontario Veterinary College (OVC); and
- Delivery of both routine and advanced laboratory services.

This collaboration has heavily contributed to the University's development into a globally recognized agri-food centre of excellence, while effectively supporting the vibrant, globally competitive, multi-billion dollar agri-food industry of Ontario.

## 1.2 The Study and Methodology

The University of Guelph ("University") engaged Deloitte and Touche LLP ("Deloitte") to quantify the economic impact of this agreement, as well as examine key qualitative impacts resulting from the agreement that are considered extremely difficult to quantify.

Our methodology included:

- A traditional economic impact analysis of direct, indirect, and associated operational expenditures resulting from the support provided through the OMAFRA/University of Guelph dedicated funding agreement;
- Approximately 30 interviews with high profile stakeholders in the agri-food industry in Ontario to gather feedback on the past performance of the agreement;
- Six case studies examining specific, significant activities and wide-ranging contributions that have occurred under this funding relationship consisting of:
  - OMEGA-3 Enriched Eggs;
  - Agricultural Diploma, Continuing Education, and the Veterinary Clinical Education Programs;
  - Ridgetown Campus and Soybeans;
  - The Environmental Farm Plan and Best Management Practices;
  - Zoonotic Diseases; and
  - Agricultural Research and Innovation.

## 1.3 Economic and Cluster Impacts

Traditionally economic impact analysis for research based activities has been difficult to assess, and as a result there have been a wide range of results. For the purposes of this study we developed a conservative model to assess the direct and indirect economic impacts of the expenditures. Based on our economic impact analysis for a given year of the 10-year agreement term, it was concluded that funding of \$54.8 million in 2006/2007 OMAFRA funding has had a substantial economic impact to the provincial economy, with impacts of \$118.9 million from direct and indirect expenditures and \$102.6 million from associated expenditures funded through the agreement. Based on the case study examples presented in this report and current economic research in the area, we further estimated that an additional amount exceeding \$900 million is attributed in spin-off impacts, which brings the total provincial economic impacts of the agreement to over \$1 billion for a one-year period. The

quantum of the additional spin-off activities is supported by our review of both current economic research in the area and specific case study examples that were reviewed in this report. Viewing the spin-off impact from both a specific example basis and from economic impact model basis provides greater credibility to the estimates generated. A summary of the impacts are outlined below:

<b>Total Economic Impacts (\$ millions)</b>		
	<b>Total Expenses</b>	<b>Economic Impacts</b>
Direct and Indirect Expenses	\$89.4	\$118.9
Associated Spending	\$78.8	\$102.6
Spin-off Impacts		\$929.4
<b>Total</b>	<b>\$168.2</b>	<b>\$1,150.9</b>

Due to its strength and capacities in veterinary and agricultural sciences, the University of Guelph is also a core component of the existing Guelph agri-food cluster. This cluster is made up of approximately 60 ag-tech bio companies and 24 research facilities, contributing to approximately 6,000 jobs in Guelph and making up almost 10% of the local workforce. It is also a significant instrument in attracting external investments, as this dynamic agri-food cluster has attracted an estimated \$330 million since 2002.

A traditional economic impact analysis cannot factor in all of the benefits that this agreement provides to the province. Canada has seen first hand the negative impacts from both an economic and public health viewpoint of zoonotic diseases such as SARS, Avian Flu or BSE (“Mad Cow disease”). Significant efforts are exerted under the OMAFRA/UG agreement for researching and monitoring these and other threats. The impact related to the avoidance or prevention of a significant outbreak cannot be effectively quantified for a traditional economic impact analysis and as such is not part the benefits outlined above. However the prevention of zoonotic disease does have significant economic benefits and readers of this report should be cognizant of this.

#### **1.4 Qualitative Highlights**

Collectively, OMAFRA’s contributions to UG’s multi-faceted research, education, and laboratory services has translated into significant benefits affecting industry development, employment, health and public welfare, and environmental sustainability. It would not be practical to highlight all of the significant accomplishments that have been fostered by this agreement, as such we have chosen to provide the reader with six case studies which will provide a deeper view into a few key impacts that this agreement has made:

##### **Product Innovation and Commercialization**

The University of Guelph and OMAFRA’s direct investment in OMEGA-3 research from 1980-1995 is estimated at approximately \$1.8M, leading to the large-scale commercialization of the OMEGA-3 enriched egg and producing significant returns on a global scale; this research has since been extensively cited, awarded, and heavily involved in the knowledge transfer process.

##### **Developing a Talented Labour Pool**

Through the extensive educational programming supported by OMAFRA and offered at UG and through its affiliated and regional campuses, UG is supplying a talented labour pool with applicable skill sets to the evolving agricultural sector in Ontario, and advancing the skills and training of those currently employed within the industry. Education programs supported by OMFRA include Associate Diploma, Certificate, Apprenticeship, Business Development, and the Doctor of Veterinary Medicine (DVM) programs, as well as graduate student research training, thus providing the Ontario agri-food sector and rural communities diverse expertise in Environmental Management, Food Science, Horticulture, Landscaping, Equine Science, and Veterinary Medicine, just to name a few.

##### **Industry Development, Innovation and Protection**

Critical research at UG funded under the agreement has led significantly to the development of numerous examples of innovation leading to public welfare protection and agri-food industry development.

Some such notable examples include:

- Advancing the soybean industry and an estimated \$650 million soybean market in Ontario through the development of functional soybean varieties, responding to emerging threat of soybean rust from the United States, and managing previous threats of soybean aphids and soybean cyst nematode;
- The research, surveillance, and testing of zoonotic diseases, a major health threat transferred from animals to humans, potentially resulting in detrimental public health and economic impacts; and
- Substantial developments in all of the OMAFRA supported research areas, including genetic testing and improvements in crop development and farm animal breeding; development in bio-products including biogas, bioactive paper and the use of bio-composites materials; and advancing a variety of healthier food processes and products.

### **Environmental Issues**

The collaboration of faculty, research and education in subject areas concerning agricultural production and environmental management has created a strong wealth of knowledge, which has built the Environmental Farm Plan program and Best Management Practices. These programs serve as successful, self-directed training for conducting farming operations in an environmentally sustainable manner. Thus far these programs have successfully engaged approximately half of the Ontario farming community who are proactively working towards conserving natural resources and playing an important role in preventing environmental damage and crises.

### **1.5 Summary**

The remainder of this report outlines in detail our study approach and our findings. The report, through its various approaches will demonstrate that the OMAFRA/UG agreement has contributed significantly to the province economically, environmentally and on the human capital front.

## 2.0 The Study

### 2.1 Purpose

In 1996 the Ontario Ministry of Agriculture, Food, and Rural Affairs (OMAFRA) and the University of Guelph entered into a formal dedicated funding agreement, whereby OMAFRA provided the University funding for research and development, delivery of agricultural diplomas through regional agricultural campus', support for the Veterinary Clinical Education Program (VCEP) through the Ontario Veterinary College, and the delivery of both routine and advanced laboratory services.

The University of Guelph ("University") engaged Deloitte and Touche LLP ("Deloitte") to quantify the impact of the dedicated funding agreement between OMAFRA and the University over the past 10 years. Thus, the purpose of this study is to document the impact of the funding agreement between the University of Guelph and OMAFRA.

It should be noted that though there has been a long standing relationship between the University and OMAFRA, this study focused on the formal ten year funding relationship that was entered into in 1997.

### 2.2 Our Approach

In order to document the impact that this agreement has made, we undertook a number of different methods to highlight this impact:

1. We have performed a traditional economic impact analysis of the expenditures that were funded by the agreement and the associated impacts of those expenditures. Our approach and methodology for the economic impact of the funding is outlined in Section 4 of this study.
2. We have provided six case studies which provide snap shots into a few of the very important activities that have occurred under this funding relationship. These case studies address several of the key issues and challenges that the agri-food industry is facing.
3. We conducted interviews with almost 30 high profile stakeholders in the agri-food industry in Ontario, in order to solicit their opinion on the past performance of the agreement.

### 2.3 Impact

We have attempted to illustrate the impact that the funding relationship between OMAFRA and the University has had in Ontario. Our approach to documenting the impact that has been made is to identify how some of the significant work that is funded has provided a meaningful impact to a "typical taxpayer" or "person on the street".

In order to accomplish this we have chosen to explore the impact of this agreement on a number of levels. We have compiled the "economic impact" of the funding that was provided by OMAFRA. This will enable one to determine how the funding agreement has contributed to the economy of the province. In addition, we have in two select instances outlined the economic impact of two industries whose development is significantly tied to the activities funded by the agreement. These examples enable one to assess how the funding agreement has contributed to new industries, however the industry impacts of the agreement certainly go well beyond these two instances. We have also looked briefly at the economic impact of the economic cluster that has evolved around the University of Guelph.

The impact of this agreement cannot be quantified solely in pure economic terms. Many activities that are funded by this agreement have significant non-economic value or are difficult to assess with accuracy. We have also chosen case studies to highlight how some of the activities of the University have impacted the lives of those in Ontario in a non-economic way, such as environmental, health, or public policy.

## 3.0 Background

### 3.1 Present Situation: Province of Ontario and OMAFRA

The strength and future potential of the agri-food industry in Ontario cannot be understated. Ontario alone has over half of the "Class 1" (highest quality) agricultural land in Canada and even more Class 2 and Class 3 land, both of which are considered very suitable for agriculture. There are over 56,000 farms in Ontario with total cash receipts of more than \$8.3 billion, accounting for almost one-quarter of all farm revenue in Canada.<sup>1</sup> The food processing industry is the second largest manufacturing industry in Ontario, behind transportation.<sup>2</sup> This is why, through OMAFRA, the Government of Ontario has focused on facilitating the continued development of the agri-food industry in Ontario. This focus supports and fosters growth in the critical areas of innovation, education, and research initiatives; investment; environmental sustainability; food safety; international trade; and enhanced marketing.

The Government of Canada has noted that significant lags in income in Canada relative to the United States are due to a lack of productivity, and innovation in particular<sup>3</sup>. Also recognizing this, the Ontario government is very keen on supporting agricultural innovation in the province, in order to drive Ontario to continuously compete in the global economy. This is a critical yet expanding area of focus with only some relatively new provincially directed programs currently underway. For instance, the Premier's Award for Agri-Food Innovation Excellence honours exceptional individuals who have strengthened the industry through innovation. The five-year, \$2.5 million award was announced as part of the 2006 provincial budget. Recent award winners are products and innovations in emerging industries that include natural biogas and fuel producers, local low-cost organic farm products, and an agri-tourism farm facility. The Ontario BioAuto Council and the Ontario Ethanol Growth Fund are examples of additional recent provincial initiatives aimed at exploring innovations in agriculture. The Premier's Research Chair in Biomaterials and Transportation encourages the innovation of new cost-effective bio-based consumer products and technology, supporting interdisciplinary research in chemical and structural engineering, agricultural chemistry, plant biology, and traditional and molecular plant breeding. U of G was recently awarded the \$3-million Premier's Research Chair as part of the Ontario Research Chairs program.

Pertaining to educational growth, specialized programming utilizing community and local resources, and new rural and agricultural cooperative education courses are being advocated by the provincial government. Recent areas of provincial investments in agriculture include rural infrastructure and economic development as well as farm income stabilization and support programs. Ontario is also looking to enhance the marketing of local agricultural food products, adding to the growth potential of the agri-food industry. For example, during the summer of 2007, the Ontario government is introducing a new \$12.5 million 'Buy Ontario' marketing strategy aimed at increasing consumer demand for local foods across the province. This strategy is aimed to increase support for local farmers, the rural economy, and the environment.

### 3.2 Emerging Trends in the Global Agri-Food Industry

Recent trends in agriculture include advancing towards a more internationalized agri-food industry, biotechnology developments, environmentally conscious practices, and a focus on safe and healthier food products and delivery. Although these trends suggest a new and growing marketplace through innovation, they are also interconnected factors that can heavily influence one another. For example, in order to successfully trade agricultural products internationally, food safety and environmental regulations become essential to conducting business, thus influencing the scope of agriculture and its potential. Innovating and adapting to a changing marketplace are fundamental to the competitiveness of the industry and essential priorities for the government of Ontario, OMAFRA, and the University of Guelph.

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<sup>1</sup> <http://www.gov.on.ca/ont/portal/!ut/p/.cmd/cs/.ce/>

<sup>2</sup> "Workforce Ahead Summary – A labour Study of the Food Processing Industry", Alliance of Ontario Food Processors, 2005

<sup>3</sup> "Canada's Innovation Strategy". [Government of Canada](#).

### 3.3 University of Guelph

The University Of Guelph was formally incorporated in 1964, however its history dates back to 1874 when the Ontario School of Agriculture was established on a farm provided by the Ontario government. In 1880, it became the Ontario Agricultural College (OAC). From 1888 until 1964, the OAC operated as an extension of the University of Toronto, until being established as the University of Guelph on the basis of founding colleges in 1964.

Today, the University of Guelph is highly significant to the support and growth of the agri-food industry in Ontario and Canada. It is a renowned Canadian university, with over 17,500 students, and has a reputation for being research intensive, collaborative, and dedicated to internationalism.

The University has consistently received significant recognition identifying it as a powerful institution in the field of agricultural sciences. It is one of the most research intensive universities in Canada, and, in a recent *Science Watch* worldwide study, was ranked 7<sup>th</sup> for its impact on agricultural sciences over the past decade. It was the only Canadian university to be among the top 25 institutions ranked for agricultural research for the period 1996 to 2006. Agricultural research papers published by University researchers were cited over 8,000 times between 1996 and 2006 and when measured according to impact or citations per paper, Guelph was placed 12th among universities worldwide. For four consecutive years, the University of Guelph has been ranked among the top comprehensive research universities in Canada in a report by Research Infosource Inc. (published in the *National Post*), and was also recognized as the top medium-sized university in the country for both education and student services by the University Report Card online survey, which appears in *The Globe and Mail*.

UG was recently ranked 7<sup>th</sup> globally for impact and cited 8,000 times ranking it 12<sup>th</sup> in the world for citation.

Its Ontario Agricultural College (OAC) is considered a global leader in the disciplines of environment, agriculture, food, and rural communities. Recently the OAC has introduced major new programs in growing areas such as organic agriculture, greenhouse technology, and plant biomaterials applied to transport industries. The Ontario Veterinary College (OVC) has made significant contributions to animal health and welfare, public health in the areas of food safety and the control of zoonotic diseases. Collaborative efforts funded by the provincial government and the agri-food industry towards various agricultural research initiatives at the University have resulted in numerous success stories in the field of agricultural science. Through this growth in research and academia, the University of Guelph continues to be instrumental to agricultural innovation and is thus shaping agricultural industry trends and supporting provincial agricultural growth objectives.

The Ontario Veterinary College (OVC) is the oldest veterinary college in Canada and the United States, educating veterinarians since 1862, and officially becoming a part of the University of Guelph in 1964. The OVC seeks to advance veterinary and comparative medicine through undergraduate, graduate, and continuing education learning, as well as extensive research and services. Its mandate includes pursuing “new approaches and technologies in order to understand mechanisms of animal, human, and environmental health and disease, and to solve important problems confronting Ontario, Canada and the world”. College graduates are often sought after to work in areas such as clinical practice, food safety, public health, and ecosystem health across the globe.

### 3.4 OMAFRA / University of Guelph Special Relationship

OMAFRA and the University of Guelph have shared interests related to the health, advancement, and sustainable development of agri-food in Ontario and supporting the international competitiveness of the Ontario agri-food industry. Since the University's inception in 1964, the Ministry and University have had a unique agreement, whereby OMAF (changed to OMAFRA in 1994 with the addition of Rural Affairs) provided transfer payments that allowed the University to offer diploma programs in agriculture and related disciplines, and to manage extensive research programs in support of Ontario's agriculture, food, and related industries.

Previous to 1996, OMAFRA also directly and independently managed and operated infrastructure and programs at separate colleges of agricultural technology, the Province's Agriculture and Food Laboratory Services Centres, the Horticultural Research Institute of Ontario, and other veterinary laboratories.

In the years leading up to 1996, it became apparent that expanding educational and research opportunities, and the addition of laboratory services, was in the best interest of the University. As



such, and given: i) the progression of the longstanding relationship between the University and the Ministry, ii) unified interests, iii) mutual commitment to continued collaboration and integration, iv) OMAFRA's interest in divesting day-to-day management of these laboratory and educational institutions, and v) the belief that a consolidation / restructuring would better serve the interests of the people of Ontario, OMAFRA agreed to transfer (with continued support) and the University agreed to assume responsibility for agri-food laboratory services in the Province, as well as the operational management of each of these laboratory, research and educational institutions.

In 1996, OMAFRA and the University entered into a 10-yr dedicated funding arrangement. The University assumed the operations of the aforementioned institutions, and accepted a mandate to leverage them and progress towards creating industry advancements and developing new cost sharing opportunities. OMAFRA agreed to provide annual financial support (an average of \$51.5M has been provided over the past 9 years). The special relationship between OMAFRA and the University remains unique in the Canadian university system, if not throughout North America. The agreement has since been extended through 2008, and a new planning process is currently underway with respect to the implementation of a long term renewal of the agreement.

### 3.5 OMAFRA/University of Guelph Agreement

The expanded comprehensive Agreement formed in 1996 specifies government funding for:

- Research and development (R&D);
- Delivery of agricultural diplomas through 3 regional agricultural campus';
- Support for Veterinary Clinical Education through the Ontario Veterinary College (OVC); and
- Delivery of both routine and advanced laboratory services.

By focusing on these areas collectively, OMAFRA is demonstrating commitment towards its primary objective to foster a prosperous, nationally and internationally competitive, agri-food industry in Ontario. The agreement facilitates the positioning of Ontario as a leader and desirable supplier of commodities, ingredients, food and bio-products on a global scale.

The University of Guelph and OMAFRA Agreement also specifically supports programs and operations at a number of provincially owned facilities. These include three regional agricultural campuses of the University of Guelph at Alfred, Kemptville, and Ridgeway, offering college-level agricultural diploma and research programs, both covering the spectrum of livestock, horticultural, and field crop disciplines. Collectively with the University of Guelph main campus, approximately 3,000 students have graduated from the Associate Diploma programs over the past 10 years. There are also fourteen research stations located throughout the province, three of these being major stations located near Guelph at Arkell, Elora and Ponsonby, as well as a major laboratory testing facility in Guelph. Jointly these stations consist of a vast array of specialization units such as Beef, Swine, Equine, Poultry, Dairy, Sheep, Aquaculture, Horticulture, Agronomy, Crop Production, and Pest Management. These campuses and research facilities are crucial to the agricultural science research process as well as training development.

Funding categories contained within the Agreement incorporate research infrastructure, research and education salaries, and the training and development of highly qualified staff members. OMAFRA funding has represented between 16% and 25% of total University revenues over the last ten year period. The Agreement's 2007/2008 Preliminary Budget states that in the fiscal year 2005/2006 approximately \$77.2 million of University revenues were provided by this Agreement, a significant portion of which funded 95 faculty and 464 staff members based at various locations throughout Ontario. In this budget document, total 2006/2007 OMAFRA Agreement revenues were forecasted to be approximately \$82.7 million, with \$54.8 million in funding from OMAFRA (the 'transfer' payment under the Agreement), \$1.8 million in diploma tuition revenues and \$26.1 million in revenues earned from operations of programs and facilities under the Agreement.

Agreement funds are approved jointly by the University and OMAFRA and administered by University/college departments in relation to specific program allocations, and are reported separately within the University's operating budget.

Any remaining funds or deficits in a fiscal year are contained within the Agreement and are fully carried forward into the next fiscal year. Upon review and confirmation, the OMAFRA budget is presented annually to the University's Board of Governors.

In April 2006 the ownership of all previously provincially owned assets associated with the OMAFRA Agreement, i.e., the 3 regional campuses and 14 research stations were transferred from the Ministry of Public Infrastructure and Renewal to the Agricultural Research Institute of Ontario (ARIO), which included an agreement that the university would assume responsibility for operation and maintenance of these lands and buildings. Major capital project costs are funded through separate ARIO funds and a joint OMAFRA, ARIO and University planning process.

### 3.6 Guelph Agri-Food Centre of Excellence

The OMAFRA / University of Guelph agreement has had a clear and positive impact evidenced in the clustering and growth of numerous agri-food organizations, agri-food research and technology resources around the university and its 30-acre Research Park, identifying it as a recognizable agri-food centre of excellence. This dynamic and valuable clustering effect has created linkages among businesses and industry associations that connect a province-wide land-based agricultural and food sector to the University.

The Guelph area is well-known for its strengths in areas as diverse as agri-food and veterinary medicine, human nutrition and family development, environmental studies and engineering, rural development, and planning. Approximately 6,000 people are now employed in the agri-food sector in the Guelph region, at organizations such as OMAFRA, regional offices of Agriculture and Agri-Food Canada, the Canadian Food Inspection Agency, the Guelph Partnership for Innovation, Public Health Agency of Canada, Guelph Food Technology Centre, Mars Landing, Ontario Agrifood Technologies, industry associations, input suppliers and many agri-food research and development organizations. The cluster enables significant cooperation among private and public sector interests, suppliers, and competitors, on business processes, purchases, investments, strategies and technical research.

Numerous specific research achievements can be attributed to the agreement supported by the agri-food cluster development in the Guelph region. University of Guelph technology and research has, for example, led to:

- The recent development of a DHA milk product. DHA is an omega-3 fatty acid that can now be found in certain commercial milk products. Omega-3 and lutein eggs were also developed at the University of Guelph. Omega-3 fatty acids are a family of polyunsaturated fatty acids that have been linked to potential health benefits in various research studies.
- The first Canadian-bred soybean cultivar was also developed in Guelph, and soy is now found in over 300 products. The Guelph region continues to be a leader in soy research, including ongoing studies examining the expansion of soybean health properties and the development of soybean crops that will grow well during shorter seasons.
- Indoor air biofiltration is an OMAFRA funded project at the University that also has potentially great benefits in terms of improved air quality, health protection, and reduced energy consumption.

Looking forward, the University of Guelph, the City of Guelph and the private sector are jointly sponsoring a project called the Guelph Technology Commercialization Centre (GTCC) – a new state-of-the-art biotech facility dedicated to start-up companies. This development, along with the relatively recent emergence of other BioEnterprise-sponsored organizations in the Guelph region (for example, Rothsay BioDiesel, Evolution BioFuels, and Ontario BioAuto Council) represents additional signs of exciting things to come.

The emergence of a number of organizations in the Guelph region includes Rothsay, BioDiesel, Evolution BioFuels, Dynamotive Energy Systems and Ontario BioAuto Council and highlights exciting things to come.

## 4.0 Economic Impacts

### 4.1 Background

#### OMAFRA/University of Guelph Agreement Background

Over the last 10 years annual funding provided by OMAFRA has remained relatively stable, ranging between \$49.7 million and \$54.8 million per year. In terms of funding allocations, approximately half of this funding goes towards Research programs, followed by Education, Laboratory Services, and VCEP.

The following chart outlines the amounts and allocations of OMAFRA funds (in millions) transferred for the fiscal years running from May 1 to April 30 for the years 1998 until 2007, totalling \$463.8 million. For the 2006/2007 year, total funds transferred were an additional \$54.8 million.

OMAFRA agreement funding* (\$million)	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Guelph-area Research **	29.1	30.3	27.0	27.8	26.8	28.6	28.4	25.0	26.2	25.6
OAC Diploma	0.7	0.7	0.4	0.1						
Alfred Regional Campus ***	2.3	2.3	2.4	2.0	2.0	2.2	2.2	2.3	2.7	2.1
Kemptville Regional Campus ***	4.0	4.1	4.1	4.0	4.0	3.3	3.5	3.7	4.2	5.7
Ridgetown Regional Campus ***	4.2	4.1	3.9	4.0	4.0	4.0	3.7	3.9	4.0	5.6
Veterinary Clinical Education Program	4.7	4.7	4.7	4.7	4.7	4.6	4.7	4.8	4.8	4.7
Laboratory Services	9.0	8.7	8.2	10.1	9.0	8.2	7.9	10.0	8.1	11.1
Total:	54.0	54.8	50.7	52.7	50.5	50.9	50.4	49.7	50.0	54.8
Total OMAFRA Funding										518.6

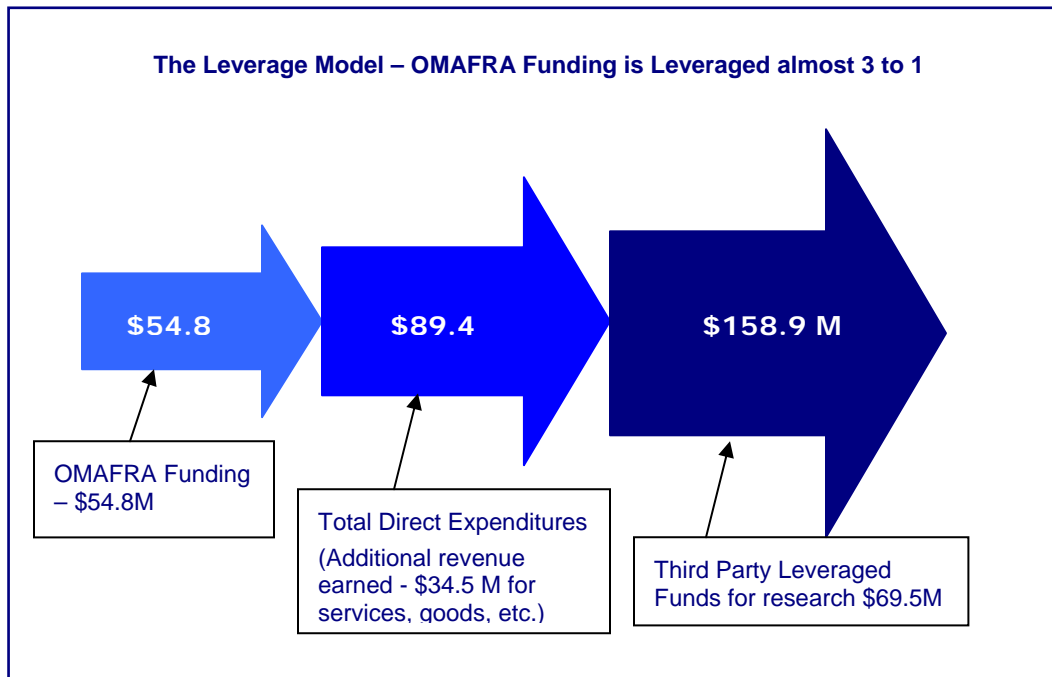
\*The University of Guelph fiscal year ends April 30, whereas the OMAFRA fiscal year ends March 31. Data reported is actual program expenditures and therefore includes variances from budgeted amounts due to year-to-year carry-forward surpluses or deficits, and/or capital program differentials. The capital program is funding separate from and in addition to the OMAFRA Agreement, but is administered and reported on in conjunction with the Agreement programs.

\*\*Guelph-area Research includes Arkell, Elora, Ponsonby, Woodstock and Guelph (Turfgrass) research stations, the former HRIO locations (Vineland, Simcoe, Bradford) and all Guelph campus research activities.

\*\*\*These amounts include both Research and Education program costs.

#### Leveraging Funding

Though OMAFRA provided \$54.8 million in base funding, the University of Guelph was able to attract almost two dollars for each dollar provided by OMAFRA. This leverage is accomplished in two fashions. First the base funding is leveraged through revenues generated directly through program and operation delivery. Examples of such revenues include tuition, residence fees and meal plans; sale of milk, eggs, crops and other products from the research stations; and sale of diagnostic and testing services by the 'agri-food' and 'animal health' laboratories. In 2006 this accounted for \$34.5 million. As such the programs supported by the agreement had a budget of approximately \$89.4 million (this amount reflects total program expenditures and does not include recoveries and transfers). Secondly the funding is leveraged via the attraction of other third party private or public funding. The research projects and other activities that the agreement supports attracted an estimated additional \$69.5 million (in 2006 the actual was \$69.85 million) in leveraged public and private funding. The diagram below visually demonstrates how the \$54.8 million almost triples and grows to \$158.9M.



## 4.2 Economic Impacts

### Types of Economic Impact

The purpose of this economic impact analysis is to quantify the impact to the provincial economy as a result of the operations of the programs and activities funded by the OMAFRA/University of Guelph agreement. Measuring the direct expenditures does not adequately reflect the economic impact of University activities in the community. Expenditures on goods and services have a “ripple effect”, as the expenditures circulate in the community. For example the purchase of a supply or service by the University from a company creates a ripple effect as the vendor of that supply or service will incur expenditures to fulfill the purchase. This ripple effect is known as the “multiplier effect”.

Generally, economic impact can be summarized in four areas:

- **Direct economic impacts:** refers to total expenditures on goods and services, including wages and benefits, for the operations of a facility, service, or program.
- **Indirect economic impacts:** refers to the purchase of goods and services to produce the goods and services directly purchased for the operations of the facility or service. It measures the various interactions with other businesses which supply the necessary materials and services, which lead to indirect demand for goods and services from other industries.
- **Induced economic impacts:** refers to the impact of personal expenditures by people who have been paid wages and salaries for the operations of the facility, service or program and for the production of indirect goods and services.
- **Associated / inferred economic impacts:** refers to the spin-off impacts generated by the operations of the facility, service or program. For example, the spending associated with the agri-food cluster spawned by the OMAFRA / University of Guelph program would be considered an associated impact.

### Purpose, Methodology and Considerations

In completing this study, Deloitte utilized an econometric input-output model. This model incorporates appropriate input-output multipliers from Statistics Canada’s Industry Accounts Division, which measure the amount of exogenous industry output shock per dollar of expenditure. We measure the economic impact based upon the operational spending of the University, the faculty and staff, students and visitors to the regional campuses, resulting from the support provided through the OMAFRA/University of Guelph dedicated funding agreement. Specifically, the areas of funding under examination are: Research, Diploma and Continuing Education, VCEP, Lab Services, and Minor Capital.

These funded areas for which we will consider both direct and indirect economic impacts encompass the operation of the following activities:

- **Research:** Diverse array of research programs, including programs conducted at the main campus, Alfred, Kemptville, Ridgetown regional campuses, as well as fourteen research stations located province-wide;
- **Diploma Education:** Associate Diploma and Continuing Education programs offered through the Ontario Agricultural College (OAC) at the Alfred, Kemptville, Ridgetown, and main campuses;
- **Veterinary Clinical Education Program (VCEP):** The Ontario Veterinary College (OVC) Clinical Education Program (CEP), the D.V.Sc. Program, and the Externship Program at the College;
- **Laboratory Services:** Delivery of an array of routine and developing laboratory services;
- **Minor Capital:** Addresses critical facility deficiencies pertaining to animal care, health and safety, code compliance, as well as crucial equipment purchases for the various campuses and research stations;

### **Base Year**

For the purpose of this report we have calculated the economic impact for the 2007 year. Though there were some fluctuations in the funding levels, the fluctuations were not material. The average level of funding for the time period was \$51.9 million, and as such the 2007 data is less than 6% higher than the average. The 2007 year was chosen as it is the most current, it is representative of prior years, and had the highest amount of available data.

University of Guelph Operating Expense Statements for 2006/2007 and OMAFRA/University of Guelph Agreement Annual Reports were utilized in obtaining expenditure details. At the time of this study, the Agreement's Annual Report was unavailable for the 2006/2007 year; therefore data from the 2005/2006 year was utilized where required. In addition, a number of assumptions have been made in order to assess and evaluate various potential impacts that shall subsequently be discussed further.

### **Expense Analysis**

Our approach to the economic impact is to determine the actual expenditures incurred by the University to operate the programs outlined previously, and apply the economic impact multiples on those expenditures. As noted previously the total expenditures for these programs exceed the amounts transferred by OMAFRA.

### **Items Not Explored**

This study is primarily focused on spending impacts and does not review all of the potential economic impacts associated with research collaborations, incubators and business start-ups that could have occurred at the University, or the economic benefits derived from potential joint ventures or partnerships that could have been occurred between the University and regional campuses and their surrounding communities. We have outlined two specific "spin-off" examples for the purpose of this report. However any additional impacts that could be reasonably associated to the agreement or the cluster will be in addition to the amounts calculated.

This report does not include the associated impacts from numerous business development and conference events held at the three regional campuses. Thus, the economic impacts of the spending resulting from these conferences, through organizational costs incurred or the local spending of attendees represent further impacts in addition to the various impacts explored in the following sections.

## **4.3 Impact Analysis**

### **Direct and Indirect Economic Impact**

In our model, we have used the University's total operating expenses of \$89.4 million for the supported programs. For the purposes of this report we have categorized the expenditures as – Personnel, Travel, Operating, Capital Equipment, and Allocated Service Cost expenses.

These expenses include the following items:

- **Personnel:** salaries, wages, and benefits of faculty members, librarians, research assistants, teaching assistants, training programs, and health plans;

- **Travel:** recruitment costs, relocation costs, field trips, and other travel costs;
- **Operating:** professional services fees, leasing and rental of various equipment, maintenance of various equipment, material supplies, and utilities;
- **Capital Equipment:** books, electronic resources, farming and scientific equipment, and furniture; and
- **Allocated Service Costs:** administrative support, human resources, and maintenance staff costs.

Including the Allocated Service Costs, total expenses in 2006/2007 were approximately \$37.33 million for Research, \$20.13 million for Education, \$4.1 million for VCEP, \$24.9 million for Laboratory Services, and \$3 million for Minor Capital.

Deloitte's findings conclude that, in total, the University of Guelph Research, Education, VCEP, Lab Services, and Minor Capital expenditures associated with the OMAFRA/U of G funding agreement are estimated to have an economic impact of \$118.9 million to Ontario's economy.

Given their levels of funding and expenditure, the areas of Research, Lab Services, and Education have the greatest economic impacts at \$52 million, \$30.1 million, and \$27 million respectively. The VCEP and Minor Capital areas have economic impacts of \$5.5 million and \$4.3 million respectively.

Personnel and Operating Costs are the expense categories resulting in the largest economic impacts, at \$54.2 million and \$51.1 million, followed by Allocated Service costs, Capital Equipment, and Travel at \$9.5 million, \$2.7 million, and 1.4 million respectively.

The following chart summarizes the economic impacts of each program.

#### Direct Funding, Actual Expenditures, and Total Economic Impact

Programs/areas	Direct funding	Actual expenditures	Total impact
Research	\$31,793,000	\$37,326,000	\$52,003,658
Education(*)	\$7,175,000	\$20,127,000	\$26,970,104
Veterinary Clinical Education Program	\$4,743,000	\$4,063,000	\$5,508,672
Lab Services	\$11,105,000	\$24,911,000	\$30,114,047
Minor Capital Expenses	\$62,000	\$2,979,725	\$4,313,793
<b>Total</b>	<b>\$54,878,000</b>	<b>\$89,406,725</b>	<b>\$118,910,274</b>

\* - As noted previously, due to reporting constraints, some research costs at regional campuses are included in this amount

#### Economic Impacts by Programs and Categories

Program economic impacts	Research	Education	VCEP	Lab services	Minor capital	Total
Personnel	\$20,561,079	\$13,210,052	\$1,908,465	\$18,432,057	\$91,876	\$54,203,529
Travel	\$456,299	\$391,756	\$357,234	\$232,652	\$10,178	\$1,448,120
Operating	\$22,199,487	\$12,840,325	\$3,150,769	\$9,512,556	\$3,354,990	\$51,058,126
Capital equipment	\$159,027	\$153,296	\$0	\$1,538,689	\$856,748	\$2,707,760
Allocated service costs	\$8,627,767	\$374,675	\$92,205	\$398,092	\$0	\$9,492,739
<b>Total</b>	<b>\$52,003,658</b>	<b>\$26,970,104</b>	<b>\$5,508,672</b>	<b>\$30,114,047</b>	<b>\$4,313,793</b>	<b>\$118,910,274</b>

In summary, in 2006/2007 the OMAFRA/University of Guelph dedicated funding agreement consisted of \$54.878 million in funding, supported Research, Education, VCEP, Lab Services, and Minor Capital expenses of \$89.407 million resulting in direct and indirect economic impacts of \$118.910 million in the provincial economy.

## 4.4 Associated and Spin-off Economic Impacts

### Associated Expenditures

#### *Student Expenditures*

In terms of additional induced spending, we considered the economic impacts related to student spending incurred as a result of the funding and support provided to the Associate Diploma and Continuing Education programs.

In order to estimate the average annual student expenses for a student enrolled in the Associate Diploma or Continuing Education program, comparable expense data was utilized from University of Guelph average undergraduate student spending as well as the EKOS study "Making Ends Meet", a report on average annual student spending. Areas of expenses include books and supplies, accommodation, food, transportation, entertainment and miscellaneous items, and clothing.

According to the 2005/2006 Annual Report, there were 861 full-time students enrolled in the Associate Diploma programs, and 463 students enrolled in Continuing Education programs. Continuing Education enrolment is calculated according to the diploma equivalent enrolment, given 55,592 continuing education days in 2005/2006 and 120 student days for Associate Diploma students in a year, at 6 hours per day. When applied to the simple average of University of Guelph and the EKOS study estimated annual student expenditures, estimated spending by Associate Diploma and Continuing Education students totals approximately \$9.3 million (See table below, the estimated total student spend is equal to the estimated spending of the Diploma Program students (\$8.77M) and the Continuing Education Students (\$0.5M).

Based on our estimate of annual Diploma and Continuing Education student spending of approximately \$9.3 million, the resulting provincial economic impact is approximately \$12 million.

The significant portion of this impact comes from student spending on accommodation, food, and entertainment and miscellaneous expenditure items.

#### Student Spending Economic Impacts

Full-time Student Expenses	Estimated Average Spend per full-time student.	Total Spending by Associate Diploma Program (Full-time)	Total Spending by Continuing Education Students	Total Impact of Student Spending
Books and Supplies	\$250	\$215,250	\$115,750	\$473,009
Accommodation	\$4,426	\$3,810,646		\$3,810,646
Food	\$2,657	\$2,287,917		\$3,269,504
Transportation	\$826	\$711,246	\$382,470	\$1,720,381
Entertainment and Misc	\$1,677	\$1,443,897		\$2,327,415
Clothing	\$350	\$301,350		\$430,638
<b>Total</b>	<b>\$10,186</b>	<b>\$8,770,306</b>	<b>\$498,220</b>	<b>\$12,031,594</b>

### Associated Research Impacts

Also supplementing core funding are external leveraged funds through public and private sources attracted as a result of the OMAFRA/U of G agreement, primarily focused in research support. According to the 2005/2006 Annual Report for the agreement, additional and leveraged funding associated with the Agreement in 2005/2006 totalled \$66.9 million in research funding, including \$2.95 million in infrastructure funding for research. This funding is utilized towards similar although separate research related objectives as the OMAFRA/U of G Agreement.

For the purpose of this study we have assumed that the \$69.85 million in leveraged public and private funding was spent in a similar manner (portion of salary and overhead costs) as the other program expenditures. The total economic impact resulting from this funding is estimated at over \$90.623 million.

## Spin-off Economic Impacts

Numerous agricultural economic studies have sought to examine the return on investment and benefit-cost ratios to research in agriculture. Based on a survey of numerous agricultural economic studies identifying benefit-cost ratios of agricultural research, these returns typically range anywhere from 2.1:1 for a commodity such as sheep up to 114.6:1 for dairy<sup>4</sup>. The more common benefit-cost ratios appear to be 10:1 up to 20:1, meaning that every dollar invested in agricultural research results in a return of \$10-\$20 worth of benefits to the economy. The high rates attributed to public agricultural research occur partly due to the nature of these investments, which is characterized by an initial investment followed by several to many years of payback<sup>5</sup>.

The method and consideration behind determining these returns can typically consider the following<sup>6</sup>:

- Expenditures on agricultural research generate new knowledge, eventually leading to improvements in technology that is adopted by farmers;
- Technology adoption increases average productivity; and
- Higher productivity of agricultural resources leads to lower costs, higher production, and/or exit of some resources from the agricultural sector.

<b>Source</b>	<b>Benefit-Cost Ratios</b>
George Brinkman (2003)	2.1:1 – 114.6:1
K.K. Klein et al. (1996)	10:1 – 62.1:1
Keith O. Fuglie et al. (2007)	10 :1
<b>Deloitte's Estimate</b>	<b>10:1</b>

Taking the conservative estimate of 10:1 and applying this to investment in agricultural research by OMAFRA in 2006/2007 and associated leveraged research funds (less the economic impact of \$52 million from direct research expenditures and associated economic impact of \$90.6 million from leveraged research funds) results in estimated spin off benefits of approximately \$929.4 million. The table on the next page summarizes the estimated spin-off effects of the research expenditures.

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<sup>4</sup> George Brinkman "Strategic Policy Issues for Agricultural Research in Canada". [A Journal of the Canadian Agricultural Economics Society](#).

Keith O. Fuglie and Paul W. Heisey "Economic Returns to Public Research". [United States Department of Agriculture Economic Research Service](#).

K. K. Klein, B. Freeze, and Allan M. Walburger. "Economic Returns to Yield Increasing Research on Wheat in Western Canada".  
K. K. Klein. "Publicly Funded Research in Agriculture: Time for a Shift in Paradigm?".

<sup>5</sup> George Brinkman "Strategic Policy Issues for Agricultural Research in Canada". [A Journal of the Canadian Agricultural Economics Society](#).

<sup>6</sup> Keith O. Fuglie and Paul W. Heisey "Economic Returns to Public Research". [United States Department of Agriculture Economic Research Service](#).



## Impact summary

	\$ millions
OMAFRA research funding	31.8
Leveraged funds obtained	5.5
Third party funding obtained	69.9
Total expenditures	107.2
Multiplier	10.0
Estimated total economic impact	1,072.0
Less	
Direct and indirect impact previously calculated	142.6
Estimated economic spin-off impact of research	929.40

We have highlighted just two examples of such spin off impacts, and we have provided case studies later in this report describing these two example industries that have a high degree of linkage to the research funded by the OMAFRA and University agreement. The OMEGA-3 egg and soybean industries have been estimated at approximately \$1 billion in farm gate value and both of these industries were significant benefactors of the base research funding from OMAFRA. Though one cannot argue that the total economic impact of these industries are solely the bi-product of the funding agreement, the link and the connection back to the funding arrangement is undeniable. In addition, these are only two industries that we have highlighted, there are numerous other examples of how research funded by the Agreement has had a very significant economic impact. Though an accurate amount cannot be calculated, the total impact is very significant.

### 4.5 Summary of Economic Impacts

The economic impacts associated with the funding agreement are as follows:

#### Direct and Indirect Impacts

The agreement provides \$54.8 million worth of “base level” funding, which supports the operating expenses of the University’s Research, Education, VCEP, and Lab Services. The spending associated with this program generates an economic impact of a \$118.9 million.

#### Associated Impacts

The programs supported by the agreement leveraged the funding into an additional \$69.9 million of additional funding. This additional funding had total economic impact of \$90.6 million.

The associated economic impacts related to student spending were estimated at \$12 million.

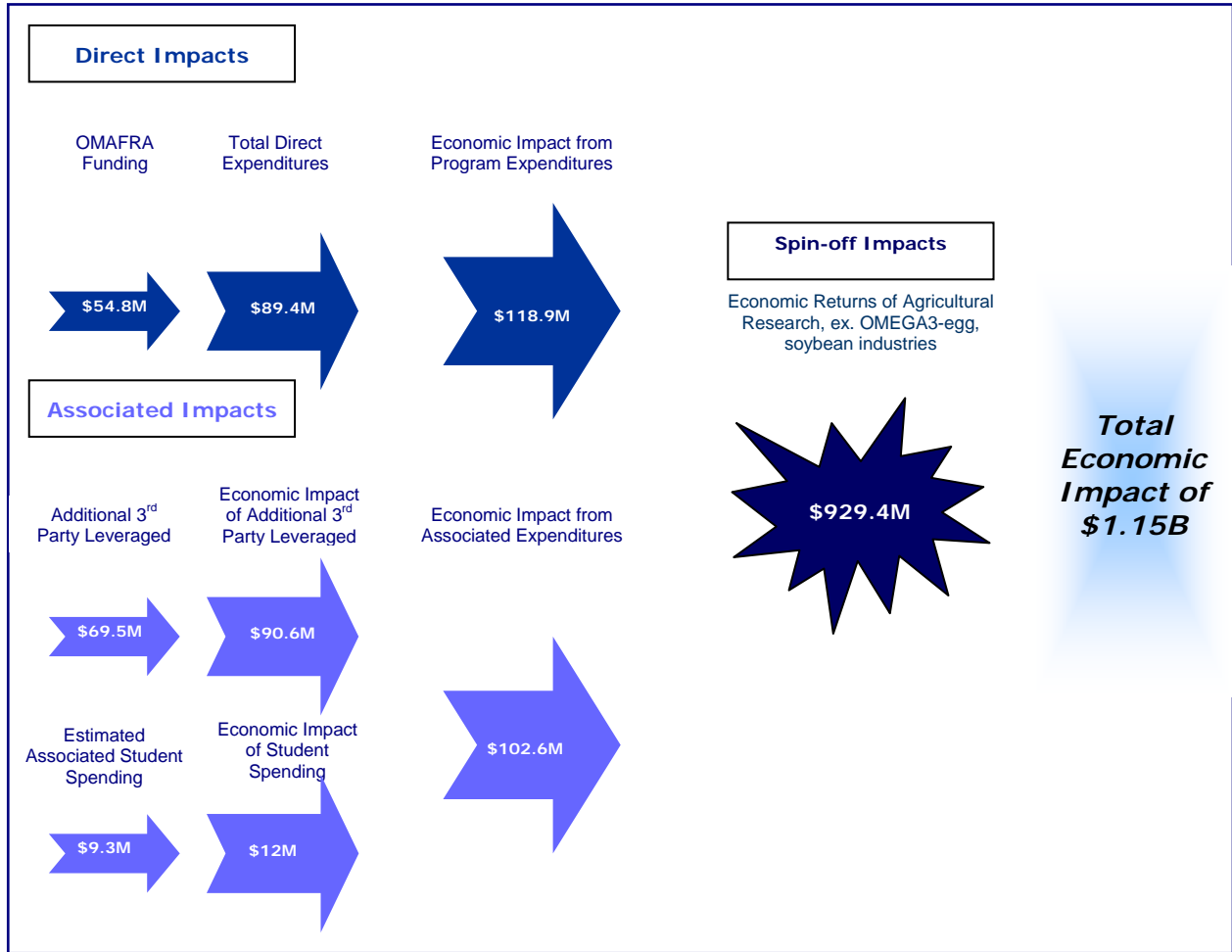
#### Spin Off Impacts

Though measuring spin off activity is inherently difficult, for the purpose of this report we have utilized the widely reported benefit-cost ratios of agricultural research to determine spin off impacts of approximately \$929.4 million annually. As examples, we have highlighted the economic impacts of two industries with significant ties back to the funding agreement. Though there are other numerous examples, these two industries have been highlighted to illustrate the potential economic impact that this funding agreement has made.

#### Total Impacts

Thus the total economic impact generated from the \$54.8 million dollars of OMAFRA funding is estimated to be \$1.15 billion. The following diagram provides an illustration of the economic impact of the agreement.

## Diagram of Annual Economic Impacts



# 5.0 Economic Cluster

## 5.1 Guelph Agri-Food Cluster Impacts

### Introduction

It is not a surprise that a 2005 issue of Canadian Business Magazine highlights Guelph as the top agricultural biotech cluster in Ontario and in the top two in Canada. The City of Guelph has long been renowned for its significance in agriculture. The University of Guelph (UG) has in large part contributed to this perception, due to the distinguished research and education offered at the University and associated Colleges. In the past decade, UG and the City of Guelph have grown beyond the perception of simply offering great research and education. The Guelph area, and particularly around UG, has developed into what has become known as an agri-food cluster.

The enhanced partnership between UG and Ontario Ministry of Agriculture and Food and Rural Affairs (OMAFRA) includes key events such as the relocation of OMAFRA employees adjacent to the University campus in the early 90's, followed by the partnership agreement reached in 1997. This in turn led the way for the University and the City of Guelph in becoming a rapidly growing centre of agri-food business, education, research and provider of laboratory services. This "cluster concept" has had and will continue to have important economic benefits for not only the Guelph area, but for the provincial economy.



## Overview of The Guelph Agri-Food Cluster

The City of Guelph is proudly home to approximately 60 ag-biotech companies, 24 research facilities within the University of Guelph, and over 6,000 jobs in the ag-biotech sector<sup>7</sup>. Guelph in total employs nearly 74,000<sup>8</sup> people. This would imply that nearly 10% of the workforce is employed in the agricultural and biotech sector. This level of employment has created a significant pool of human capital in the region. Multinational companies such as Monsanto, Syngenta, Bayer Crop Science, and Semex have set up in Guelph because of the ability to closely interact with research and the ease of

Nearly 10% of the Guelph population is employed within the ag-biotech sector, which is home to 60 ag-biotech companies and 24 research facilities.

Over \$330 million in agri-food investments has been attracted to the region since 2002.

access to human, capital, and government resources. Another significant advantage of the cluster in Guelph is the ability to attract investment. Since 2002 alone, over \$330 million in agri-food investment has been drawn to the region<sup>9</sup>. During discussions with the economic development office of the City of Guelph, they noted that the Cluster has had a significant impact on attracting investment into the community. They had stated that the cluster, with the research pillar provided by the University, and OMAFRA providing the government and

regulation pillar, had been a key contributing factor in attracting business such as Monsanto. In Appendix A we have included a listing of the key cluster participants.

The growth and development of the cluster has also spawned many significant innovations developed by researchers at UG over the past decade. These include the development of the omega-3 egg, the first diagnostic blood test for omega-3 fatty acids, an innovative wood composite building material, and many others. In recognition of the ability and opportunity for further innovation in the cluster, the Guelph Partnership for Innovation was established in 2002, whose mandate is “to coordinate information sharing among life science and agri-food companies in Guelph and area while promoting and supporting investment opportunities and business development in the region”.

The development of infrastructure in Guelph and around UG has further benefited cluster organizations. Aside from several research parks, the cluster is home to the Guelph Food Technology Centre (GFTC). GFTC is a unique feature of the cluster in Guelph as it is Canada’s only not-for-profit, non-subsidized research technical centre for the food industry. The centre assists over 500 companies and organizations, and provides training to over 3,600 people each year.

### What makes up a Cluster?

Economic clusters can be defined as “geographic concentrations of interconnected companies, specialized suppliers, service providers, and associated institutions in a particular field that are present in a nation or region”<sup>10</sup>. Economic clusters are not new, but their evolution and economic significance has been increasingly recognized over the past couple of decades. Research by Michael Porter of the Harvard-based Institute for Strategy and Competitiveness has helped to define economic clusters in the modern era and provide insight into their advantages and their important role within an economy. Clusters “represent an important forum in which new types of dialogue can and must take place among companies, government agencies, and institutions such as universities”<sup>11</sup>.

### Key Components of a Cluster

An industry based cluster may begin as a result of various factors, including access to employees with specialized skills, a university research centre, advantageous physical location, and well-developed infrastructure<sup>12</sup>. There are also many factors that come into play which may determine how successful an economic cluster is. Christian Ketels, of the Harvard Business School, notes that firms and organizations in a particular cluster share four critical characteristics<sup>13</sup>:

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<sup>7</sup> Information provided by the Guelph Economic Development Department

<sup>8</sup> FP Markets – Canadian Demographics 2006

<sup>9</sup> Information provided by the Guelph Economic Development Department

<sup>10</sup> <http://www.isc.hbs.edu/econ-clusters.htm>

<sup>11</sup> Porter, Michael E. (2000). Location, Competition, and Economic Development: Local Clusters in a Global Economy.

<sup>12</sup> <http://www.photonicsclusters.org/whatisacluster.html>

<sup>13</sup> “European Clusters”, Christian Ketels, Harvard Business School, 2004

- **Proximity:** Organizations need to be sufficiently close in space to allow any positive spill-overs and the sharing of common resources.
- **Linkages:** The activities of the organizations need to share a common goal.
- **Interactions:** There should be a certain level of interaction amongst the organizations.
- **Critical Mass:** There needs to be a sufficient number of participants present.

The Guelph Agri-Food cluster no doubt possesses these characteristics (see the **Guelph Agri-Food Cluster map on page 19**, and **Appendix A** for further details). At the heart of the cluster is the University of Guelph, well known for agricultural, veterinarian and life science programs. Within close geographic proximity to the University are several government agencies, multinational companies, research facilities, and commodity organizations. The list of companies and organizations points to the fact that the Guelph area has developed a “critical mass” of organizations in the agri-food sector. Many of these organizations interact through research and innovation, public policy, or business transactions. Close interaction and the ability to create synergies are two of the many important advantages of the Guelph agri-food cluster.

### **Cluster Advantages**

From an economic standpoint, a cluster may attract new investment, encourage local expansion, and stimulate entrepreneurship<sup>14</sup>. Clusters provide benefits to organizations within a cluster such as synergies amongst participants and knowledge sharing through close interaction, as well as overall macroeconomic advantages including new infrastructure and the attraction of investment. As highlighted above, significant investment and infrastructure development has come to Guelph as a result of the agri-food cluster. Some of the other prominent cluster advantages as well as specific examples relating to the Guelph cluster include:

*Increased productivity and efficiency* – Over 60 agricultural commodity organizations and some multinational companies locate in Guelph to facilitate technology transfer of production and best practices leading to environmental sustainability and improved profitability developed from research at the University of Guelph to farm businesses located across the province. Conversely, the location of commodity organizations in close proximity to UG allows for industry influence on research priorities to ensure maximum economic and environmental benefit to the industry.

*Innovation* – An inventor, Ian Muir, developed imitation cedar shake shingles made out of recycled plastics and agricultural biomass. Access to capital in order to do the proof of concept in Guelph was supported by the Agricultural Adaptation Council (AAC), a Guelph based industry association that funds innovation. The proof of concept led to the formation of a company called Wellington Polymer that commercialized the product in Chatham Ontario and now sell their product both domestically and internationally. Wellington Polymer is further highlighted below.

*Increased business formation and entrepreneurship* – Development of improved genetics at the University led to the creation of Semex, and recently, to commercialization of semen sexing technologies that generate exports around the world. Recently a water company started commercializing new water purification technologies that will reduce water-borne diseases from being spread in hydroponics based flower greenhouses as well as leading to extending the shelf life of cut flowers, many of which are exported from Ontario.

*Access to human and capital resources* – As noted above, the Guelph Agri-Food cluster employs over 6,000 people, including over 3,700 people at the University of Guelph. As the cluster continues to grow, so too does the amount of talented and diverse human capital within the cluster.

### **Industry Examples and Testimonials**

#### *Wellington Polymer Technology Inc.*

Wellington Polymer Technology Inc. (WPTI) has spent over six years developing “Enviroshake”, a composite-based roofing product that combines environmental responsibility and premium quality. This biofibers composite is made up of materials such as scrap flax straw, hemp, and plastics, thus utilizing materials that are not biodegradable in a functional manner and also serving as a valuable source of income for farmers.

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<sup>14</sup> <http://www.business-sa.com/Content.aspx?p=58>

Enviroshake also replicates the look of a cedar shake and is marketed in direct competition with natural cedar shakes and premium roofing products. Noted benefits of this product include increased durability, UV protection, wind, hail, mould, mildew, and insect resistance. In addition, any scrap materials generated in the manufacturing process are recycled back into the system, and the product itself is recyclable as well. This is widely recognized product, as it is GreenSpec-Listed as an environmentally preferable product and it received the Canadian Agri-Food Award of Excellence for Innovation in 2001.

In 1998 WPTI set up a two-year research and development pilot project in Guelph, after which it was purchased and relocated to Chatham under new ownership. Ian Muir, who originally conceived Enviroshake, notes that Guelph served as an extremely useful location because of the agricultural expertise at the University of Guelph, and having both the University and OMAFRA within such close proximity assisted in supporting WPTI's consulting requirements.

### *Dynamotive Energy Systems*

Dynamotive Energy Systems Corporation is an energy solutions provider based in Vancouver, with additional offices located in the USA, UK and Argentina. Dynamotive develops and markets biofuel technology and products based on its patented fast pyrolysis technology. This technology works to turn dry waste biomass and energy crops into bio-oil for power and heat generation, and this bio-oil can be further converted into vehicle fuels and chemicals. Dynamotive Energy Systems Corporation are emerging leaders in converting biomass residues and energy crops into fuels that are technologically viable, environmentally sound, and economically competitive to fossil fuels.

Dynamotive has received several awards including the Energy Research and Development Award from the Canadian Institute of Energy in 2002, and the Environmental Business Journal Technology Merit Award in Clean Energy in 2006, which was in recognition of demonstrating the commercial viability of using forest and agricultural waste for power generation and heating at its bio-oil plant in West Lorne.

Dynamotive's new flagship plant is being developed with MegaCity Recycling Inc., operating under the name Evolution Biofuels Inc., and is located in Guelph. Once in full operation, the plant will process 66,000 dry tonnes of biomass a year with the energy output equivalent to 130,000 barrels of oil. The site has the capacity for up to four plants, administrative and engineering offices. In addition, it can potentially house Dynamotive's technical research and development function. President Larry Herman considered Guelph to be the "Agricultural centre for the province" and chose Guelph for the plant location largely because of UG's presence.

### **Other Well-Known Clusters**

For comparative purposes, it is worth mentioning how the components and advantages of the Guelph cluster align with other well-known clusters. Similarities can be seen between these clusters and the Guelph Agri-Food cluster. Renowned universities, government supported agencies, large companies, significant human capital resources, collaboration and synergies, and a geographic proximity, are some of the consistent components making up these successful clusters.

Within Canada, one of the well-known agricultural biotech clusters is in Saskatoon. The National Research Council of Canada (NRC) spearheaded the growth of this cluster by revamping its existing research facility in Saskatoon in 1983. This enabled plant biotechnology stakeholders to use the research facility as the focal point of the cluster. The NRC helped to propel the region through sophisticated research labs and industry support to its partners. Some of the key organizations within this cluster include the NRC, Agri-Food Canada, University of Saskatchewan, Protein Oilseed Starch Corp, Dow AgroSciences Canada and Ag-West Bio Inc. The NRC partnering with these and other organizations has led to this cluster experiencing great success in the commercialization of innovative technologies. The Saskatoon ag-biotech cluster now has the following<sup>15</sup>:

- 40 Ag-biotech companies;
- 30 nutraceutical and functional food companies, which generate annual revenues of nearly \$60 million; and
- 1,100 staff in the cluster's private and public sector organizations

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<sup>15</sup> Information provided by the National Research Council of Canada

Internationally, one of the most well-known clusters is Silicon Valley. This cluster spread out from Stanford University to become the biggest high-tech cluster in the world. Beginning with the creation of the Stanford Industrial Park in the 1950's to attract high tech companies, the area now contains thousands of electronics and information technology companies, including Intel, IBM, HP, Apple, Cisco, Sun Microsystems, eBay, Google, among many others. The innovation, concentration of companies, and level of employment stemming from Silicon Valley has been truly remarkable.

There are other examples of clusters however each cluster has similar traits to that of the Guelph cluster. Namely there are significant research activities (both general research and applied), there is a significant government or policy presence, and significant industry presence. The Guelph Ag cluster has all of these elements present.

### **Summary**

With the University of Guelph at its heart, the formation of the Agri-Food cluster has been advantageous to numerous stakeholders. The cluster has the key components that have made other clusters around the world successful. Economic advantages have included a concentration of skilled labour and a vast number of agri-food organizations, attraction of investment dollars, and significant innovations. The unique partnership between UG and OMAFRA has triggered the development of this centre of excellence in agri-food.

## 6.0 Case Studies

For the purpose of this report we have chosen six cases to highlight how activities that are supported by the agreement address key issues or challenges in today's agri-food environment.

### **Product Innovation and Commercialization**

As one stakeholder that we interviewed aptly put it – “We no longer face the challenge of ensuring that we produce enough food to feed people in Canada. Today's challenge is creating foods that address new consumer demands, and in particular health demands or requirements of consumers.”

*“We no longer face the challenge of ensuring that we produce enough food to feed people in Canada. Today's challenge is creating foods that address new consumer demands, and in particular health demands or requirements of consumers.”*

Research supported by OMAFRA through the University of Guelph has led to product innovations that are meeting consumer demands. The development of the OMEGA 3 egg which is highlighted in the first case study is an example of product innovation and commercialization. In addition this case highlights how innovation can address costly health issues.

### **Developing a Talented Labour Pool**

Like all industries, developing a talented labour pool is critical to the success of the industry. The agreement supports the University of Guelph in the delivery of several key programs providing associate diploma and continuing education programs. Over the past ten years, 3,400 students have graduated from the diploma programs alone offered by the University of Guelph, with these programs directly supported by the agreement. Through OMAFRA funding the University also offers a wide range of continuing education, certificate, apprenticeship, and business development programs, enabling industry professionals to continuously build upon their skill sets. In addition, the research programs at UG are heavily a part of the educational process as these programs train numerous graduate students and post-doctoral fellows.

### **Industry Development, Innovation and Protection**

Research under the agreement has led significantly to the development of the soybean industry in Ontario. Research has seen the development of soybean varieties that can thrive in Ontario and varieties that resist disease. This has created a very significant industry in Ontario with extensive economic benefits.

In addition, the case highlights how important continuing research is to the agri-food industry. As one stakeholder we interviewed noted, “you cannot predict nature and as such you cannot predict the issues that the agricultural sector will face”. This is why providing a constant level of research capacity is critical to the agri-food industry. The soybean industry in Ontario is a prime example of an industry that has faced varying challenges that required technical solutions and an industry that is now facing the emerging threat of soybean rust from the United States. The researchers supported by the agreement are currently working on meeting this new threat, and similar previous threats such as soybean aphids and soybean cyst nematode are being worked on by these OMAFRA-supported research programs.



## **Environmental Issues**

The environment has consistently been one of the top of mind issues among Canadians. As such Canadians are beginning to view all economic practices through a new environmental prism and agriculture practices are not excluded. Farmers across Ontario are being asked to think about their land, their buildings, the products they use, and many other factors from an environmental point of view. They are reviewing how their practices affect the environment – the air, soil, wildlife and water sources around their farm. They are considering new ways of working that will decrease the risks to the provinces' precious natural resources.

The fourth case outlines how the Environmental Farm Plan program and Best Management Practices, supported through agreement funded research, have lead to cultural changes in the farming community and have increased the profile of environmental issues on the farm.

## **Public Health**

With nearly three quarters of all new diseases being from animal origins, zoonotic diseases pose a significant health and economic risk to Ontario. In Canada, we have seen first hand the effects of diseases such as "mad cow" and "SARS". The monitoring, detection, and prevention of zoonotic diseases is crucial for the benefit of public health and the economy. This case highlights how with the support of OMAFRA funding, the Animal Health Lab at UG plays a vital role in the monitoring and surveillance of such diseases. It also highlights how researchers at UG are working to prevent the occurrence and outbreak of zoonotic diseases. The integration of various disciplines such as veterinary medicine, human health, and environmental science is essential to combat the risk. The funding agreement has enabled the basis of such integration to occur at UG and has enabled UG to be at the forefront of zoonotic disease research and surveillance.

## **Innovation in Agriculture**

This case highlights the rich history of research and innovation at the University of Guelph. Innovation is a key element in improving the productivity of our economy, and this also holds true for the agri-food sector. This case outlines a few of the many innovative developments that have made the University recognized on a global basis for its research capacity and proficiency. The case highlights the programs and research stations at the University and how the University plays a key role in bringing innovation to the agricultural sector in the province.

## Case Studies

# Case #1 – OMEGA-3 Enriched Eggs

**Abstract** – With egg consumption in decline in the 1980's due to cholesterol concerns Dr. Leeson set out to re-invent the egg by reducing its cholesterol levels. Typically the path to discovery is never straight forward and this case is no different. Along the way to re-creating the egg Dr. Leeson changed the direction of his research due to a chance encounter with colleague Dr. Holub. Dr. Leeson discovered that an egg can be enriched with OMEGA 3, an essential fatty acid that is known to improve cardiovascular health. Dr. Leeson helped develop the OMEGA 3 enriched egg which was one of the first “functional foods” developed in Canada. This discovery addressed a major dietary need, and gave a boost to an industry under pressure. His research and findings have contributed significantly to the scientific base for further discovery and innovation in creating foods that address the health and lifestyle issues of today's population. The support provided to Dr. Leeson by the University of Guelph and the Government of Ontario provided Dr. Leeson the opportunity for this breakthrough.

## 1.0 Introduction

Upon completing his PhD in Poultry Nutrition at the University of Nottingham in 1974, Steve Leeson had opportunities to pursue his teaching career and research interests all over the world. His decision to accept a faculty position in Canada was nevertheless relatively easy. In his words: “nowhere else in the world was there an opportunity to leverage the resources of a major University and a supportive Government like there was at the University of Guelph” (UG).

Now thirty-three years later, and currently serving as the Chair of the Department of Animal and Poultry Science at the University, he suggests that the unique funding relationship between the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) and the UG is a main reason for his never leaving the University, and that the relationship has contributed significantly to his success in the research, development, and commercialization of OMEGA-3 enriched eggs.

In fact, Dr. Leeson suggests that the development of the OMEGA-3 enriched egg could never have happened without the combined support of the poultry industry, OMAFRA and the UG. He explains that not only is a large portion of his salary covered under the OMAFRA/UG funding agreement, but equally essential to his success has been the provision of advanced research stations, such as Arkell, which houses some 6,000 laying hens, the use of critical lab equipment, the support and availability of skilled technicians, and a host of other resources provided by the Ministry and University. Furthermore, Dr. Leeson suggests that the OMAFRA/UG funding relationship has provided him with support, guidance, and structure, whilst also providing “autonomy”, “nimbleness”, and “flexibility”. He emphasizes that without all of these things in combination, the OMEGA-3 enriched egg and the many other exciting functional foods now coming to market would most likely not have originated in Ontario.

The story of the development and commercialization of the OMEGA-3 and other enriched eggs into what is now estimated to be a \$375M<sup>16</sup> annual market in North America is an example of the success of this unique funding relationship and research environment; a perfect storm of expertise, supportive colleagues, supportive industry, a supportive University, and a supportive Provincial Government.

The story of Dr. Steve Leeson's development and the subsequent commercialization of the OMEGA-3 enriched egg is a great example of the success of the unique funding relationship between OMAFRA and the University of Guelph.

According to Dr. Leeson, the discovery simply would not have been possible without the support of all of the stakeholders including the University, the industry, and the Provincial Government.

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<sup>16</sup> Source: Canadian Egg Marketing Association (CEMA)

## 2.0 The Need to Re-invent the Egg

### **The Challenge**

- Widespread consumer focus on reducing heart disease
- Media linkage between cholesterol and heart disease had put the egg industry in a cross-fire
- An egg-producing industry in disarray:
  - 10% drop in consumption; led to a 40% drop in egg prices.

### **The Solution**

- Need to reinvent the egg industry
- Create a heart disease fighting weapon
- OMEGA-3 enrichment using natural feeds

### **The Benefit**

- Adequate OMEGA-3 consumption can potentially reduce heart disease in Canada by 50%
- Such reduction would save approximately \$9.5 billion in healthcare expenses annually

In the late 1970's and early 1980's, significant media attention was given to the increasing number of heart attacks and related heart problems being suffered across North America. Cholesterol was identified as a major contributor, and emphasis on reducing cholesterol consumption became more and more prominent in media, schools, and nutrition guides across the United States and Canada. Egg consumption declined significantly through this time period as consumers sought to avert the "bad" (saturated) fats and cholesterol then associated with egg consumption<sup>17</sup>. Due to moderately high cholesterol content in eggs and the negative perception of the effect of egg consumption on human cholesterol levels, poultry producers were particularly affected, and were forced to respond by reducing their egg prices significantly. Despite reducing prices by nearly 40%, consumption still declined, as egg marketers were able to gain little traction in the face of these highly publicized cholesterol concerns. (Reference Graph 1) The result was tremendous pressure on the entire poultry industry. According to Dr. Leeson, "it just became apparent that there was a need to reinvent the egg."

## 3.0 Enriched Egg Research

With the support of the University of Guelph and OMAFRA behind him, Dr. Leeson's initial research focused on examining cholesterol levels in eggs, and particularly ways whereby egg cholesterol levels might be reduced. For the most part he, like others at the time, made little progress. His research suggested that there was no way to materially reduce egg cholesterol, by natural means, while still providing a whole-egg product that consumers would demand (due to either increased production cost [i.e. price], taste, colour, consistency, and/or other contributing factors). He began considering other alternatives.

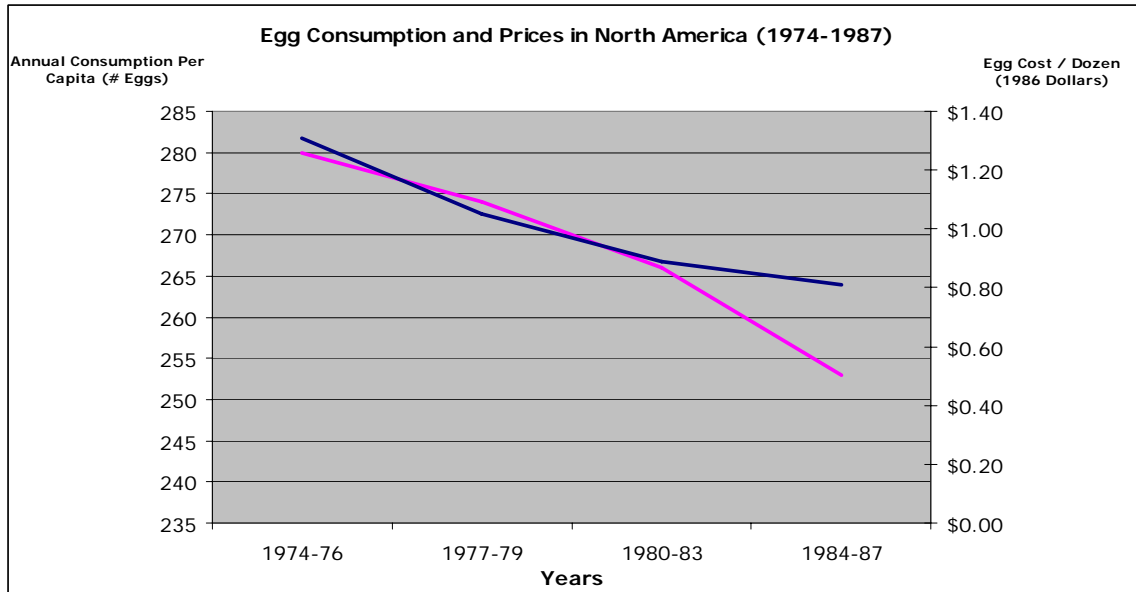
Dr. Leeson actually credits a chance encounter in a hallway with current colleague, and UG fatty-acid expert, Dr. Bruce Holub, as

critical to the initial OMEGA-3 enriched egg research breakthrough.

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<sup>17</sup> A common mis-perception still exists; many still believe that increased consumption of eggs results in increased cholesterol levels. In fact, increased egg consumption does not materially affect human cholesterol levels. Extracted from *Globe and Mail*, April 20, 1996 "...In the test of subjects fed four eggs each day, there was no significant change in blood cholesterol levels among those whose daily egg intake rose from none to four. It is believed that this reflected the fact that eating cholesterol does not cause most people to experience higher cholesterol levels."

**Graph 1. Egg Consumption / Capita and Prices US (1974-1987)**



Egg Prices declined significantly between 1974 and 1987 as consumers became increasingly concerned about heart disease, and media attention focused around the role of egg consumption in increasing risk of heart disease. Source: Statistical Abstract of the United States (corrected for inflation)

The OMEGA-3 enriched egg was developed in 1995 by Dr. Steve Leeson and his team of supportive colleagues using expertise and facilities provided by the University of Guelph and funding provided by OMAFRA.

Today, OMEGA-3 eggs account for 12% of the egg market, and represent a \$375M annual market in North America.

Dr. Holub is a nutrition expert in the department of Human Health and Nutritional Sciences at the University of Guelph and his research interests at the time related primarily to humans and the reduction of risk factors that contribute to cardiovascular disease, as well as the early correlation between increased OMEGA-3 fatty acid consumption and reduced heart problems. Being aware that North Americans were ingesting far too little OMEGA-3 fatty acids as a whole, Dr. Holub had been investigating flaxseed (known to be proportionally high in OMEGA-3 content) as a potential means whereby humans might increase their OMEGA-3 consumption.

In humans, OMEGA-3 fatty acids are classified under the category of “essential” fatty acids – essential in the sense that the human body requires them but can not produce them on its own – as such they must be acquired directly through diet. Found in fatty fish, shellfish, flax and other seeds, OMEGA-3s (the name refers to the positioning of chemical bonds on fatty-acid chains) are three polyunsaturated acids – DHA, EPA, and LNA. These “good fats” have recently been verified to support the cardiovascular, reproductive, immune, and nervous systems.<sup>18</sup>

As they relate directly to the cardiovascular system, and at the cellular level, OMEGA-3 (good fats) compete with the saturated (bad fats) for the same binding opportunities, and thus the increased presence of these good OMEGA-3 fatty acids will decrease the impact of the bad saturated fats that are already ultra-common in our current society’s food environment. Specifically, OMEGA-3’s help prevent blood platelets from clotting in arteries, reducing the chance of thrombosis. They also make cell membranes in the heart tissue more flexible, making the heart both more resistant to and resilient during arrhythmia. Lastly, OMEGA-3’s help reduce the impact of triglycerides; the presence of which increases arterial thickening, and the associated risk of heart attack.

As a direct result of this encounter with Dr. Holub, Dr. Leeson had the idea that finding a way to *enrich* eggs with these (good) OMEGA-3 fatty acids might represent a greater research opportunity than focusing on *reducing* egg cholesterol and/or (bad) saturated fats. He describes the next few years, during which time he began exploring the possibility of feeding flax seed to chickens, as a real shot-gun

*“Prior to the launch of the OMEGA-3 egg, market research suggested that less than 20 percent of people had even heard of OMEGA-3 nutrition.”*

<sup>18</sup> American Journal of Clinical Nutrition (2006;84:5-17)

approach that included “a lot of trial and a lot of error”. For instance, there was much time invested just to have flax categorized as a legitimate feed ingredient, required so that he could have permission just to begin commercially experimenting with it. After overcoming this administrative hurdle, he explored flaxseed nutrient management in chickens and was thrilled to discover that flax-fed hens did indeed produce eggs high in OMEGA-3 fatty acids (i.e. that the OMEGA-3 fatty acids could indeed be transferred from the flax seed through the chicken to the egg!)

However this was just the first hurdle, there were still significant issues to research, such as the balance between the science of enriching the egg to suitable OMEGA-3 levels (i.e. % flax in feed formula) vs. production costs (due to significantly higher feed costs associated with including flax in the feed formula.) Mortality was also an issue as chickens experienced diarrhea and other health problems if the percentage of flax seed composition became too high. Dr. Leeson was well aware of the big picture ramifications of his research – he knew that for his discovery to have real commercial meaning, he needed to ensure that the entire value chain from producer through to end consumer would need be happy with the practical outcomes.

In the process of developing the OMEGA-3 enriched egg, Dr. Leeson was able to leverage the support from OMAFRA and the University of Guelph into significant additional financial support from the private sector, including the Ontario Egg Producers Association and the Flax Council of Canada.

During this research-intensive time period, Dr. Leeson was able to leverage the support of OMAFRA and the University into additional annual financial support from organizations including the Ontario Egg Producers (approx. \$15,000 annually) and the Flax Council of Canada (\$10,000 annually). The support and involvement of industry associations and producers also contributed significantly as advances were made.<sup>19</sup>

In 1995, Dr. Leeson and his colleagues published a peer-reviewed article validating that flax-fed chickens (in the proper ratios) produced OMEGA-3 enriched eggs which looked and tasted the same as regular eggs, but which also had nutraceutical value that might help reduce the risk of human heart disease. The “designer egg” was officially born. In true win-win-win fashion, Dr. Leeson describes: “the consumer has a new source of important nutrients, the egg farmer has a new market for their products, and the hen gets to eat more wholesome, natural feeds.”

#### 4.0 Enriched Egg Commercialization

Burnbrae Farms (Lyn, Ontario) was the first to market the OMEGA-3 enriched egg.

They have played a critical role in transforming the Canadian consumer's perception of the egg from harmful commodity into a highly specialized and “heart-disease combating weapon.”

Such transformation has been nothing short of remarkable, and should be recognized as one of the great marketing success stories of recent Canadian business history.

The OMEGA-3 enriched egg was an equally big win for egg marketers, distributors, and retailers. As far as business marketing cases go, the OMEGA-3 enriched egg has been just as successful from a commercialization standpoint as it is from a research and development standpoint. Leveraging Dr. Leeson's exceptional research, they were able to transform the market's perception of the egg from an old, ultra-generic, into a highly specialized and heart-disease combating weapon.

Burnbrae Farms (based in Lyn, Ontario) was the first egg distributor to market OMEGA-3 enriched eggs in Canada. Because Dr. Leeson's research was published (i.e. available to the public), and as Burnbrae's management team had close contact with Dr. Leeson, Dr. Holub, and the University throughout the entire research process, Burnbrae was well positioned to market OMEGA-3 enriched whole eggs and related products immediately upon receiving the necessary Canadian Food Inspection Agency (CFIA) approvals.

According to Margaret Hudson, Vice President Sales & Marketing at Burnbrae Farms, the OMEGA-3 enriched egg was launched to relatively little fanfare in 1996. A press release was distributed

announcing the benefits of the enriched eggs, but relatively little media attention was received. According to Hudson, “prior to the launch of the product, market research suggested that less than 20 percent of people had even heard of OMEGA-3 nutrition. And of those, it was something like half of

<sup>19</sup> Dr. Leeson has since followed-up his OMEGA-3 research with similar studies around, for example, lutein, and has been able to leverage his OMEGA-3 research into even greater private sector support for his research in this area, an amount he estimates to have been approximately \$70,000 annually.

those people thought it was important, and half of those people would be willing to purchase the product. So at the time, we had a less than five per cent chance of actually getting someone to buy OMEGA-3 enriched eggs.” However, ten years of persistent efforts by Burnbrae and other egg marketers in communicating the benefits of this egg product have helped educate Canadians. Recent market research reports suggest that consumer awareness related to the importance of dietary OMEGA-3’s is now over 50%. In 2006, OMEGA-3 and other enriched eggs, including many off-shoot liquid egg products, represented approximately 12% of all egg sales in Canada, and 50% of Burnbrae’s total sales. Canadians are also further ahead of their counterparts south of the border in their adoption pattern, as more enriched eggs are now consumed per-capita in Canada than in the United States.

Physicians are now advising patients who are at risk of heart disease to consider daily consumption of OMEGA-3 enriched eggs.

As a result of the research and commercialization generated in Ontario, many Canadians from coast-to-coast now perceive the enriched egg as a product containing essential dietary requirements, one that has true nutraceutical value, one that physicians even actually prescribe. One key element of Burnbrae’s marketing communications strategy has been targeting physicians directly – with the message that the consumption of one enriched egg each

day will result in adequate OMEGA-3 levels – thereby reducing one’s risk of heart disease. A conversation with Dr. David Stewart, a prominent family physician based in Lethbridge, Alberta suggests that egg marketers are getting their message through. Dr. Stewart acknowledges that he regularly encourages patients who are at risk of heart disease to consider daily OMEGA-3 enriched egg consumption in order to increase their OMEGA-3 levels.

## 5.0 Further Development of the OMEGA-3 Egg – Functional Foods

Dr. Leeson published supplementary work on the development of lutein enriched eggs. Lutein, is a pigment naturally found in the petals of marigolds, and is another essential nutrient that humans are consuming less-than-adequate amounts of (.5 mg a day on average). All sources referenced in the research of this case have suggested that 6 mg per day (or 42 mg/week) of lutein can reduce macular degeneration, a disease that affects approximately 33% of people over the age of 55 worldwide.

Burnbrae Farms is also now working closely with the Canadian National Institute for the Blind (CNIB) on communicating to the public the benefits of their new OMEGA PRO enriched egg, which contains both OMEGA-3 and lutein, and which is now increasingly available in supermarkets across the country.<sup>20</sup> Ms. Hudson commented: “Our goal is to do to lutein what we did for OMEGA-3 nutrition in terms of bringing it forward to consumers and increasing their awareness, because people are suffering from age-related macular degeneration due to a lack of lutein in their diet.”

In addition to the work he has published on lutein enriched eggs, Dr. Leeson also mentions his current research around eggs enriched with “Product X” which he estimates may have \$10M-\$20M market potential in Canada, and which he believes will also have a host of related impacts on off-shoot functional food products around the globe.

Development of OMEGA-3 enriched foods has extended beyond eggs. A quick visit to the local supermarket will result in one noticing that OMEGA-enriched orange juice, milk, butter, yogurt, bread, pork, beef, and even chocolate are all available. A whole host of modern functional food research and product lines (enriched with essential nutrients beyond just OMEGA-3s) has been influenced by Dr. Leeson’s enriched-egg research. Scientists around the world are constantly examining nutrition deficiencies in their respective populations, and are exploring new ways to enrich popular food items with essential nutrients that will make people healthier worldwide. Producers, distributors, and marketers are working with the research community to help bring these products to market. Dr.

Egg Marketers are now working to leverage Dr. Leeson’s recent research around lutein enriched eggs.

Canadians’ current average consumption of lutein is below levels recommended by nutrition experts. Proper consumption levels can help reduce macular degeneration, which affects 1/3 of all people over the age of 55.

*“Our goal is to do to lutein what we did for OMEGA-3 nutrition in terms of bringing it forward to consumers and increasing their awareness, because people are suffering from age-related macular degeneration due to a lack of lutein in their diet.”*

<sup>20</sup> This is again based on recent research published by Dr. Leeson in 2003, where he determined optimal feed ratios for chickens in order to produce eggs enriched with both OMEGA-3 and lutein

Leeson is excited to have played a role in this functional food trend, and he looks forward to further contributing towards it. He states: "If we can put the nutrients people need in the food they eat, we'll have a healthier population." This ironically is similar to what Hippocrates ("The Father of Medicine") said over two thousand years ago – "Let food be thy medicine".

## 6.0 Economic and Other Impacts

According to Health Canada, heart disease is the number one killer in Canada, and also is the most costly disease in Canada, putting the greatest overall annual burden on our National Health Care system. "Diet's rich in saturated fat" are ranked number two on the list of factors contributing most greatly to heart disease. According to the University of Ottawa Heart Institute (UOHI), over 1/3 of all deaths in Canada can be attributed to heart disease or related ailments. UOHI's website<sup>21</sup> also indicates that when considering direct and indirect costs, heart disease costs the Canadian economy approximately \$18.5 Billion annually.

According to the Food and Nutrition Board, Institute of Medicine (National Academy of Sciences, USA) the average adult male currently consumes 78mg of all OMEGA 3's daily. Tests<sup>22</sup> have shown that increasing intake of EPA and DHA<sup>23</sup> to 183 milligrams a day can reduce one's chances of contracting cardiovascular disease by 50 per cent. According to Burnbrae Farm's website, each one of their Nature Egg OMEGA PRO eggs contains 125mg of EPA and 125mg of DHA, and a total of 400mg of all OMEGA-3s. Though egg marketers do not explicitly communicate this directly with consumers, one might extrapolate that consumption of 1.5 of these OMEGA PRO eggs per day can reduce one's chances of cardiovascular disease by 50%.

The current costs of Macular Degeneration to the Canadian Economy are not readily available, but according to the Age Related Macular Degeneration (AMD) website<sup>24</sup> and in agreement with the worldwide figures, 1/3 of all Canadians over the age of 55 develop AMD. In Germany, according to [www.medicalnewstoday.com](http://www.medicalnewstoday.com) it is estimated that macular degeneration costs the German health system 12,455 euros (\$17,963 CAN) per patient. According to the Canadian National Institute for the Blind (CNIB), there are 2.1 million Canadians affected by AMD. As such, the total present value cost of AMD to the Canadian Health care system can be estimated to be a \$37 billion problem going forward.

OMEGA-3 enriched eggs currently represent a \$75M dollar annual market in Canada, and a \$300M market in the United States. The OMEGA-3 enriched egg was one of the early products to appear along an exponential growth curve trending towards the development of a vast array of "functional" foods – edible products that can help prevent disease or provide specific health benefits. The egg-specific ripple effects are evident, but are just the beginning. Eggs have indeed been re-invented many times over since the launch of the OMEGA-3 egg in 1996. Retail shelves now feature an assortment of nine different shelled egg options from Burnbrae Farms alone, and three different types of unshelled (liquid) eggs marketed in cartons. Prepared eggs (i.e. hardboiled, pre-scrambled, etc.) are also readily available.

According to Ms. Hudson, the market for functional food products (including enriched eggs) is growing at approximately 8% annually in Canada. The San Diego-based *Nutrition Business Journal* supports this growth rate, and indicates that global sales of functional foods are now a \$66-billion (US) industry, including \$2-billion in Canada. As the market for all foods worldwide is growing at only 1.5% annually, this trend is clearly a reflection of the aging population, their awareness of the importance of nutrition, and an increasing trend towards eating foods that they believe can help them feel younger and stay healthier. As this trend continues, the type of research performed by individuals like Dr. Leeson will become increasingly important to the consumer and the entire agricultural industry.

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<sup>21</sup> [www.ottawaheart.ca](http://www.ottawaheart.ca)

<sup>22</sup> "Here Comes the latest word in Eggs", *Globe & Mail*, Saturday April 20, 1996

<sup>23</sup> EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid) are types of OMEGA-3 fatty acids

<sup>24</sup> [www.amdcanada.com](http://www.amdcanada.com)



## 7.0 Benefits to OMAFRA and the University of Guelph

Since Dr. Leeson's research around OMEGA-3 eggs was published, the University of Guelph and OMAFRA did not directly receive any royalties from his OMEGA-3 enriched egg research and subsequent commercialization. However Dr. Leeson's contribution to enriched eggs has been recognized around the world and leveraged in hundreds of related studies.

Dr. Leeson is thrilled about the success Burnbrae Farms and other egg marketers around the world have had in marketing enriched eggs. Still, he mentions that the University has become a little more "business savvy" over the years and has since become more careful in protecting new intellectual property. As new functional food discoveries are made, OMAFRA, the University, and the Faculty themselves will be better positioned going forward to benefit more directly from their research and development efforts.

When asked to assess how much of her company's designer egg marketing success, as well as the new generation of OMEGA-enriched and other new functional foods can be attributed to Dr.

Leeson and the University of Guelph, Ms. Hudson reacts immediately. Her eyes get wider, she leans forward, and states emphatically: "Important. *Really, really, important.*" In her opinion, Dr. Leeson and the University of Guelph deserve significant credit not just for the success Burnbrae Farms has had marketing enriched eggs, but for the worldwide movement towards functional foods. For some time, Burnbrae Farms showed their appreciation for the work done by the University of Guelph by formally displaying the UG logo on the packaging of all OMEGA-3 egg cartons distributed across the country. At the very least, this inclusion resulted in the University of Guelph name entering many homes in the country (it is estimated that 90% of Canadian homes consume eggs, and Burnbrae has a majority market share nationally), building increased awareness for the tremendous work done by the University.

Dr. Leeson passes considerable credit along to his friends and colleagues at OMAFRA. In all of his publications, periodicals, presentations, etc. he ensures that he recognizes OMAFRA for their support and contribution. As he is interviewed, he extends his arms, looks around his office, and suggests that OMAFRA funding is responsible for all of it. His language and manner conveys his perception that to him, the University and the Ministry are inseparably connected, and that it is just the way it should be.

A whole host of modern functional food research and product lines has been influenced by Dr. Leeson's enriched-egg research.

When asked to assess how much of her company's success, as well as the worldwide movement towards functional foods can be attributed to Dr. Leeson and the University of Guelph, Ms. Hudson's eyes get wider, she leans forward, and states emphatically: "**Important. Really, really, important.**"

## 8.0 Summary

Dr. Leeson passes considerable credit along to his friends and colleagues at OMAFRA.

As he is interviewed, he extends his arms, looks around his office, and suggests that OMAFRA funding is responsible for all of it.

To him, the University and the Ministry are inseparably connected, and that it is just the way it should be.

The University of Guelph and OMAFRA's direct investment in Dr. Leeson and his OMEGA-3 research between 1980 and 1995 is estimated to have been approximately \$1.8M. The returns to the University, the Provincial government, and the agri-food industry have been significant on a global scale. Over the course of his career, Dr. Leeson has made outstanding contributions to Animal Science, poultry nutrition and agricultural management. He has authored or co-authored 12 books or chapters in books, 320 articles in refereed journals, 69 articles in trade journals, and has made over 500 presentations. He has been advisor to 25 graduate students, who have in turn helped the poultry industry make improvements all around the world, and has also played a major role in teaching animal nutrition and animal science courses to thousands of undergraduate students. He has been a recipient of at least four major awards – Outstanding Research (Ontario Agricultural College), Service in Extension and Public Service (Canadian Society of Animal Science), Poultry Nutrition (American Feed Manufacturers Association), the Canadian Society of Animal

Science Fellowship, and most recently in 2007, the Crampton Award for Nutritional Sciences. He attributes much of his success directly or indirectly to the funding and supportive environment he received from the University of Guelph and OMAFRA.

When asked to summarize the relationship between OMAFRA and the UG, Dr. Leeson describes the relationship between OMAFRA and UG as a "perfect marriage", and as "the best system in the world, with nothing else in the world quite like it."

Humbly and graciously, his manner suggests that he is truly proud to have spent his career at the University of Guelph, and proud of his numerous accomplishments, and especially his egg-related research.

# Case Study # 2 – Agricultural Diploma, Continuing Education, and the Veterinary Clinical Education Programs

**Abstract** – *The Ontario agricultural industry is the most diversified in Canada, and continuously progressing and evolving to encompass growth in new innovation and efficiencies, including topics in food safety, environmental sustainability, managing climate change, renewable energy, organic agriculture, greenhouse technology, plant biomaterials and rural development. The ability of educational programs to address such contemporary issues and train students for future employment and leadership in growing fields as they expand will be critical to the growth and future success of these programs, as well as the industry. In turn, as the Ontario agricultural industry is competing in a global economy, development and investment in skills and training are critical components to these educational programs and thus to the success of the province as it strives for international status. The University of Guelph with the support of OMAFRA provides the industry with the ability to attract, develop and retain talent. In 2007, the University was operating the only veterinary college in Ontario, and over the ten year agreement term had produced a total of over 3,400 graduates in the OMAFRA supported agricultural associate diploma programs. In addition, the University provides thousands of continuing education instructional days each year to those in the industry, in order for them to maintain and improve their skill sets.*

## 1.0 Introduction

The three primary educational components included under the University of Guelph (UG) / OMAFRA agreement are the Associate Diploma Program, the Continuing Education Program and the Veterinary Clinical Education Program.

**The Associate Diploma Program** – There are seven different Associate Diploma programs offered through the Ontario Agricultural College (OAC) at the Alfred, Kemptville, Ridgetown, and main campuses. These programs include Agriculture, Agriculture-Equine, Environmental Management, Food, Nutrition and Risk Management, Horticulture, Turfgrass Management and Veterinary Technology.

**The Continuing Education Program** – There are four main Continuing Education Programs offered through the OAC, in the areas of Agricultural Communications, Equine Science, Food Science, and Horticulture. There are an additional four different options available within the Horticulture program, in the sub-disciplines of Horticulture, Creating Landscapes, Sustaining Landscapes, Golf Course Maintenance, and Growing Plants for Profit.

**The Veterinary Clinical Education Program (VCEP)** – The VCEP provides annual base funding to the Ontario Veterinary College (OVC) to meet the continuing needs for veterinary graduates who have a high level of appropriate clinical experience in veterinary medicine to service Ontario animal owners and an animal referral hospital to service Ontario's veterinary practitioners and animal owners. The program provides accreditation requirements for the Canadian and American Veterinary Medical Associations as well as the College of Veterinarians of Ontario and provides the clinical education component for veterinary students in the Doctor of Veterinary Medicine undergraduate program.

In addition, each of the 3 regional campuses offer a vast collection of certificate, apprenticeship, and business development programs. These programs are diverse in response to local and regional market requirements, encompassing such new topics as Health Care Food Service and Meat Food Safety.

Collectively, these diploma and continuing education programs are diverse in format and subject matter, while individually each are very specialized in particular fields, and most of these topic areas have been subject to much industry growth and significance in recent periods. Equine, horticulture, environmental management, and food and nutrition are only some of these areas which support sizeable industries in Ontario, with collective revenues of multibillions.

## Education Component Funding

In 2005/2006, OMAFRA funding totalled \$4.2 million for the Diploma programs and \$1.7 million for the Continuing Education and Business Development Training programs. Together, this funding of \$5.9

million represented 11.7% of OMAFRA funding for 2005/2006. Allocated according to Regional Campuses, Campus d'Alfred received \$2.6 million, Kemptville Campus received \$2.0 million, and Ridgetown Campus received \$1.3 million.

## 2.0 Ontario Agricultural College (OAC)

The Ontario Agricultural College (OAC) is a broad educational network that includes the four campuses of the University of Guelph (main campus), Alfred, Kemptville, and Ridgetown encompassing various diploma programs. Currently more than 3,000 students are enrolled at the OAC, with approximately 25% enrolled in the associate diploma programs (offered primarily at the Regional Campuses and the turf diploma program at the Guelph campus) and the remaining 75% enrolled in undergraduate and graduate programs (primarily at the main campus).

Collectively, OAC departments and units provide research, education and outreach programs in the primary focus areas of food, agriculture, environment along with national and international rural communities. The current OAC budget is an estimated \$90 million per year, including \$1 million going to OAC scholarships and bursaries for exemplary students.

The College's education programs aim to prepare potential industry and policy leaders through a multi-disciplinary approach and experiential learning method. Recent developments in the College include significant new programs in organic agriculture, greenhouse technology, as well as plant biomaterials for the transportation industries. The newly added Bachelor of Bio-Resource Management (BBRM) program is a degree-based program offered jointly by the regional and Guelph campuses, training students in the rapidly growing area of renewable resources. In future years, the OAC is looking to improve the educational experience that it offers students through international opportunities and collaborations with institutional partnerships in Canada and throughout the world.

## 3.0 Alfred, Ridgetown, and Kemptville Campuses

### Ridgetown campus

Ridgetown Campus is located in the Municipality of Chatham-Kent in Southwestern Ontario, and offers degree programs, diploma programs, certificate programs, professional development, and continuing education. Diploma programs are offered in Agriculture, Environmental Management, Horticulture, and Veterinary Technology in both Conventional and Alternative streams. The Conventional stream is taught in the standard two-year format and the Alternative stream is a modified, three-year version involving distance education components.

### Campus d'Alfred

Campus d'Alfred is a French-language campus located in the town of Alfred, near Ottawa, offering diploma and certificate programs, with instruction in French. Diploma programs are offered in Agricultural Technology, Environmental Management and Food, Nutrition and Risk Management. The campus also provides a Veterinary Technology program, in partnership with Collège Boréal, based at the New Liskeard (now Temiskaming Shores) campus.

### Kemptville campus

Established in 1917, Kemptville Campus is one of Ontario's oldest agricultural education institutions, situated in Eastern Ontario, approximately 20 minutes south of Ottawa. Diploma programs are offered in Agriculture, Agriculture with Equine Option, Food, Nutrition and Risk Management, and Horticulture.

### OAC Campus Associate Diploma Summary

OAC Campus	Agriculture	Agriculture with Equine option	Environmental management	Food, nutrition, and risk management	Horticulture	Turfgrass management	Veterinary technology
Ridgetown	X		X		X		X
Alfred	X		X	X			
Kemptville	X	X		X	X		
Guelph						X	

## 4.0 OAC Associate Diploma Programs

The OAC offers two-year diploma programs, specifically funded through the OMAFRA/University of Guelph agreement. These diplomas contain theoretical and practical learning methods directed towards preparing students for continuing on to work within the agriculture and food industries. Areas of study include Agriculture, Agriculture with an Equine Option, Environmental Management, Food,

Nutrition and Risk Management, Horticulture, Turfgrass Management and Veterinary Technology. All of these programs cover a wide range of course topics, including in the supplementary areas of applied science, business management, computer applications, production and marketing.

A standard core curriculum is maintained in order to ensure continuity throughout the different campuses offering the same diplomas. Core courses are supplemented with electives in regional specializations, and new course development is reviewed regularly. Students also have the option of spending up to two semesters at an alternate campus in order to take special electives or degree courses at the University of Guelph.

In total there have been over 3,400 graduates in the associate diploma programs between the periods of May 1, 1997 and April 30, 2006, ranging from approximately 340-440 graduates per year. These figures fluctuate throughout the overall period. The bulk of graduates have been in the Agriculture program, with over half of total student graduates in this program. The remaining students then fall primarily into either Horticulture or Veterinary Technology, followed by Equine and Food, Nutrition and Risk Management. Enrolment for the 2007/2008 academic year is also expected to increase.

Associate Diploma Graduates	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
Agriculture	225	242	221	204	267	204	271	177	175	1986
Horticulture	41	100	80	95	73	67	71	53	49	629
Environmental Management								24	25	49
Food	26	23	26	8	20	10	21	28	33	195
Equine	18	13	24	28	25	26	22	0	0	156
Veterinary Technology	34	39	36	34	55	35	56	58	56	403
<b>Total</b>	<b>344</b>	<b>417</b>	<b>387</b>	<b>369</b>	<b>440</b>	<b>342</b>	<b>441</b>	<b>340</b>	<b>338</b>	<b>3418</b>

### Agriculture

Ontario has a highly diversified agricultural sector, and is considered to be the largest in Canada, employing over 96,000 in 2006, and experiencing continuous growth into 2007. Agriculture Canada estimated Ontario farm sales at approximately \$8 billion in 2005. Agriculture is much more than farming involving highly sophisticated and technical supply and value-added chains. When these chains are linked together the multiplying effect results in net value to the Ontario economy in excess of \$15billion<sup>25</sup>.

As the largest of the OAC Diploma programs, the Agriculture Diploma program supplies substantial graduates and potential employees to this industry; almost 2,000 students graduated from this program between 1998 and 2006.

Students of this program examine food production enterprise operations utilizing business management, computer, and problem-solving skills as well as agricultural production, technical and scientific information. Courses offered through the program include Livestock Systems, Marketing and Policy, Organic Plant Production, Field Crop Equipment, Crop Management and Welding.

Graduates may continue on to return to farming, working for a farm supplier, pest control product sales or focusing on animal health, environmental or farm safety issues in their fields of work.

Potential career paths include:

- Commodity markets;
- Crop input/feed sales;
- Farm supply management;
- GPS/precision farming;
- Livestock farm management;
- Pest management / product sales;
- Production management;
- Seed marketing; and
- Soil and crop consulting.

<sup>25</sup> Based on OMAFRA GDP information for selected industries

## **Agriculture with Equine Option**

In 2005 the Ministry of Agriculture, Food and Rural Affairs published the “Economic Impact of the Ontario Horse Industry”, summarizing extensive survey work of the horse industry, whereby large increases in the horse population and horse facilities in Ontario are identified between 1991 and 2001. As of 2001, there was approximately a 9% increase in the horse population from 1996 and there was an estimated 53,485 horse facilities in the province. Also within this report, the economic impact of the Ontario horse industry was estimated at over \$579 million in 2001.

Providing over 150 graduates in this field over the last nine years, the OAC Agriculture-Equine Diploma uniquely combines the fundamentals of the Agriculture program with the opportunity to specialize in the equine field. Courses offered include Stable Management, Soil Principles, Complementary Therapies, Machinery Maintenance, Equine Conditioning, and Livestock Evaluation. The Equine Option program is unique to the Kemptville Campus, and students enrolled in this program can also combine their studies with Certificates in Riding or Coaching and Horsemanship.

Potential career paths include:

- Riding instruction;
- Stable/barn management;
- Events co-ordination;
- Maintenance;
- Professional grooming;
- Training or assistant training;
- Horse transportation; and
- Buyer/seller/consigner.

## **Environmental Management**

According to Statistics Canada, Ontario’s Environmental industry is made up of technologies and services in waste, water, air, research and development, renewable energy, and engineering is collectively a rapidly growing industry with total revenues of \$6.9 billion and a 44% share of the Canadian industry in 2002.

The recently developed Environmental Management Diploma program has produced approximately 50 graduates from 2005-2006. This program addresses industry growth by training students interested in exploring and evaluating environmental issues and solutions through building their understanding of the management and protection of environmental resources. The program encompasses two further streams, in the municipal/industrial and the rural/agricultural areas. Courses include Soil Principles, Environment Monitoring, Ecology, Nutrient Management, and Industrial Waste Management.

The Environmental Management program was initiated during the water contamination crisis in Walkerton, as a need for addressing and understanding this crisis and the development of potential solutions. It is also designed to address the critical shortage of qualified sewage and water plant operators, and to train and certify staff that can support regional growers through the effective communication of new and significant nutrient management regulations affecting Ontario farms.

Potential career areas include:

- Environmental farm plan consultation;
- ISO 14000 development;
- Waste water / sewage treatment assistance;
- Nutrient management;
- Municipal environmental planning; and
- Environmental and research technology.

## **Food, Nutrition, and Risk Management**

The areas of food, nutrition, and risk management are considered to be areas of growing importance as concerns of food safety and processing, and advanced health and nutrition intensify for consumers. According to Agriculture and Agri-Food Canada, the Canadian food processing industry alone has an estimated value of over \$75 billion and 1 in every 5 jobs in Ontario is in a food / food-related industry.

The Food, Nutrition and Risk Management Diploma program has supplied this major industry with almost 200 graduates over the last nine years, providing students with a foundation in food and nutrition, food processing, and food safety that can be utilized in various food industry and healthcare sectors. The program includes courses covering Safe Food Handling, Food Preparation and Theory,

Cultural Food Practices, Nutrition in Health and Disease, and Food Hazard Analysis, as well as a field placement term.

It also enables students to obtain certain industry accreditations and certifications including the Canadian Restaurant and Food Service Association (CRFA) Certification in the National Sanitation Training Program, Workplace Hazardous Material Information System (WHMIS) training, Hazard Analysis Critical Control Point (HACCP) training, Smart Serve (responsible alcohol beverage service), and opportunities for student membership in the Canadian Society of Nutrition Management (CSNM) and the Canadian Association of Foodservice Professionals (CAFP).

Potential career areas include:

- Food service management;
- Long term care;
- Food and equipment sales;
- Nutrition education/nutrition counselling;
- Food quality assurance;
- Product development;
- Food inspection; and
- Food production.

### **Horticulture**

Gardening is considered a major leisure and business activity in North America, with business activity including design, building, and maintaining of gardens and properties throughout Ontario. Ornamental and plant sales rose 24% in Ontario between 1996 and 1998, from \$377 million to \$467 million, and Landscape Ontario estimates that gardening activities have doubled between 1991 and 2001 becoming a \$4.3 billion industry in Canada.

Horticultural tourism is also a recognized sector with significant potential, where travel is influenced by gardens/gardening activities such as botanical gardens and horticultural events. The 2000 Travel Activity and Motivation Survey conducted by the Ministry of Tourism found that approximately 25% of Canadian and American travelers seek out garden attractions and 30% seek out botanical gardens.

Supporting this thriving industry, approximately 630 students have graduated from the Horticulture Diploma program over the last nine years. This program is designed to advance the technical, scientific, business and managerial skills of students in order to support the operations of growing modern horticultural enterprises. The program offers various courses including Applied Plant Science, Soil Principles, Landscape Design, Mushroom Production, Greenhouse Management, Nursery Management, Ornamental Plant Protection, and Floral Design and Retailing. Instruction in ornamental horticulture can be transferred to various greenhouse, nursery, and landscaping operations.

Potential career areas include:

- Equipment operations;
- Horticultural technology;
- Garden equipment supply;
- Nursery management;
- Landscaping contracting;
- Lawn care / greenhouse management; and
- Garden centre management.

### **Turfgrass Management**

The Turfgrass Management Diploma program trains students to be employed in the turfgrass management sector, which is rapidly growing worldwide. The program is only offered at the main campus and combines Guelph Turfgrass Institute resources, including its workshop and laboratory facilities, together with University faculty and staff.

Specific courses offered in the program include topics in Plant Biology Turf Equipment, Turf Soil Principles, Turf Irrigation and Drainage, Arboriculture, Turf Environmental Management, and Golf Course Design and Construction.

The program prepares students for career opportunities in such areas as golf course management, lawn care, sports field management, parks management, and sod production.

## **Veterinary Technology**

The Veterinary Technology Conventional and Alternative Diploma programs have trained over 400 graduates with the technical knowledge required for veterinary technicians who can work with and support practicing veterinarians. The Alternative program is a three-year program where distance education modules are completed during the fall and winter months, and students complete hands-on laboratory requirements from May until August.

A comprehensive range of courses and training comprises of the care of large, small, laboratory, companion and sports animals, while completing a four-week externship during the final semester. Diploma courses include Livestock Production Management, Microbiology, Anatomy and Physiology, Dentistry, Animal Nursing, and Hospital Management.

This program is also fully accredited by the Canadian and American Veterinary Medical Associations (CVMA/AVMA), the Canadian Council of Animal Care (CCAC), the Ontario Association of Veterinary Technicians (OAVT), and the facilities are accredited by the College of Veterinarians of Ontario (CVO).

## **Graduate and Student Perspectives**

Student satisfaction remains very high and students of various associate diploma programs found the following positive experiences and contributions towards their careers:

- Diverse, interesting offering of useful courses;
- Extensive amount of learning;
- Knowledgeable, high-calibre instructors;
- Hands-on learning opportunities;
- Practical course application useful towards career building and experience;
- Comfortable environment, facilitating the education process;
- Enjoyable experience including the friends and connections formed; and
- Distance component of the programs such as the Veterinary Technology program provides much flexibility, and is an 'out of the box' concept.

## **Employment Opportunities**

As of May 2006 job placement was very high for graduates of the Associate Diploma programs, with placement rates ranging between 86%-100% across the four campuses and various programs. For the year 2005/2006, the 338 diploma graduates had a 93% employment rate shortly after graduation. Employment rates for 1998 ranged between 50%-100%, thus there has been significant growth in job opportunities resulting from these programs over the last several years.

When questioned on the value of hiring graduates from the OAC Diploma programs, senior industry leaders noted that these programs start by attracting high quality individuals and then further develop these individuals, many of whom will be future industry leaders. Specifically, many of these graduates have the combination of earlier hands-on training on family farms and related establishments, and together with the subsequent more formalized education of the diploma programs, this creates a very strong and talented labour pool upon graduation. Thus these leaders have hired graduates and will continue to hire graduates from these programs.

There are also expectations that these graduates will continue to be a valuable and necessary source to the industry labour pool, while innovative training in growing areas such as renewable energy and biomaterials will be especially critical. New students attaining specialized knowledge and skills in these areas will effectively shape the future of the agricultural sector in Ontario, in a manner which the existing and aging industry labour pool will not be able to do.

## **5.0 OAC Continuing Education Programs**

The OAC Continuing Education (CEP) programs are generally part-time studies intended towards professional development or personal interest, and to expand knowledge and build upon existing skills, while integrating with other day to day routines and commitments.



The three regional campuses at Alfred, Kemptville and Ridgetown offer a variety of industry-related CEP's through OAC, in the areas of Agricultural Communications, Equine Science, Food Science, and Horticulture. Many of these program and course offerings build upon the content taught with the core components of the Associate Diploma programs. These programs are designed to cater to distance and open learners, and many of these programs are designed in an internet format, allowing students a great deal of flexibility in their schedules.

In addition, the OMAFRA/UG provides for an extensive range of additional specialized certificate, functional apprenticeship and business development programs. In 2005/2006 the total training in these areas totalled 10,000 student days or and equivalent of 90 diploma students.

Between the periods of May 1, 1997 and April 30, 2006 the number of student days (6 hours per day, with 120 student days in one year) in these programs increased from approximately 40,500 to over 55,500 student days per year in total, an increase of over 37%. The Continuing Education programs continue to grow, with their revenues exceeding \$5.3 million in 2005/2006.

### **Agricultural Communications**

In the Diploma in Agricultural Communications program students are trained to communicate issues pertaining to agriculture, agri-food, the environment and life sciences within industry organizations, government, non-governmental organizations, and special interest groups. It is intended to target such roles as agricultural managers, communication and public relations officers, journalists and freelance professionals.

The program was initiated by an industry leader, as a means to fill the need of specialized agricultural communications individuals in the region. It was considered the first of its kind in Canada, but an area with much growth potential, as there were 20-30 such programs in the United States at the time the certificate program was being developed.

The Diploma of Agricultural Communications is based around five distance studies courses including topics in Agricultural Communication Theory in Action, Ethics in Leadership, as well as an internship component. Instructors within this program come from various parts of North America, many of which are considered pioneers and leaders in agricultural communication.

### **Equine Science**

The Equine Science Certificate was created through a partnership between the Equine Research Centre (ERC), the University of Guelph, and CanAdapt. CanAdapt is a program delivered by the Agriculture and Agri-food Canada which funds innovative projects supporting the long term growth, self-reliance, employment and competitiveness of Ontario's agri-food industry and rural communities.

The Equine Science Certificate consists of six distance education courses, and is designed to provide students the knowledge and understanding to better care for horses, and directly improve horse health and performance. Courses in the Equine Science include Management of the Equine Environment, Equine Exercise Physiology, Equine Health and Disease Prevention, Equine Functional Anatomy, Equine Nutrition, and Growth and Development.

The Equine Science Certificate is tailored to students looking to build on their understanding of horses, grow their knowledge in specific areas, or advance their careers. This is a multi-award winning program with approximately 900 students enrolled worldwide.

### **Food Science**

This Food Science Certificate is intended to supply an extensive understanding of food science subjects for individuals with little or no formal education in food science, individuals wishing to upgrade their knowledge, or for those looking to change careers into the food science industry.

The Food Science Certificate is composed of five degree-credit courses, including Principles of Food Science, Introduction to Food Chemistry, Introduction to Food Processing, Introduction to Food Microbiology and Introduction to Food Analysis.

The Certificate is considered to be well suited for advancing the knowledge of those interested in or employed as production supervisors, technicians, technical sales and marketing personnel, dieticians and nutritionists, and food and public health inspectors.

## **Horticulture**

OAC offers four Continuing Education Programs in Horticulture which include the Horticulturist Certificate, Creating Landscapes Certificate, Sustaining Landscapes Certificate, Maintaining Golf Courses Certificate, and the Growing Plants for Profit Certificate.

### **6.0 Ontario Veterinary College (OVC)**

The Ontario Veterinary College (OVC) is the oldest veterinary college in Canada and the United States, and the only such college in Ontario. The OVC seeks to advance veterinary and comparative medicine through teaching, research and services. College alumni work in areas such as clinical practice, food safety, public health, and ecosystem health throughout the world.

The graduate DVSc program is widely recognized for its unique blend of clinical and research training. Students engage in advanced research and clinical training in order to meet the need for biomedical and veterinary scientists and clinical specialists, as well support the requirements of faculty initiatives in national and international collaborative research. Graduates are often sought after for research, teaching, clinical and other professional positions.

Due to rapidly changing information and technology in the Veterinary profession, many veterinarians tend to be lifelong learners, and students of continuing education. The College supports these efforts through information resources, information technology, facilities, faculty and staff, and collaborations with groups such as LifeLearn Inc., a private company focused on the production and marketing of veterinary continuing education and reference programs in interactive multimedia format. Also, Equine Guelph provides continuing education to employees of the equine industry, including the Equine Certificate program.

### **7.0 Veterinary Clinical Education Program (VCEP)**

The Veterinary Clinical Education Program (VCEP) Agreement funded by the agreement between OMAFRA and the University of Guelph provides annual base funding to the Ontario Veterinary College (OVC). This funded program is especially critical as it supports the only such veterinary college in Ontario, in terms of building accredited and advanced clinical expertise as well as applied experience that is in high demand worldwide.

The VCEP specifically supports the Clinical Education Program (CEP), the D.V.Sc. Program, and the Externship Program at the College, as well as the continuing needs of veterinary graduates with clinical experience in veterinary medicine and an animal referral hospital servicing Ontario's veterinary practitioners, and both of which service Ontario animal owners. The total VCEP funding in 2005/2006 was \$4.67 million split between the Clinical Education Program (CEP), the D.V.Sc. Program, and the Externship Program.

#### **The Clinical Education Program (CEP)**

Supporting veterinary clinical training and practice, the Clinical Education Program (CEP) is the largest portion of the VCEP. Under the VCEP, the CEP received funding for 12.4 faculty full-time equivalent's in the Department of Clinical Studies and Population Medicine, 2.76 professional staff members, 21 other staff members, 6 internship students, and 2 staff veterinarians in the Veterinary Teaching Hospital (VTH) in 2006/2007. Through the CEP, students of the Doctor of Veterinary Medicine (DVM) program receive clinical experience in the VTH by working with client cases seen by the large, small and field service clinics. With the support of the VCEP, in 2005/2006 the VTH handled a total of 15,574 admissions and cases, a significant number of which were emergency cases. The Hospital offers its emergency and referral services to practitioners and the public, 24 hours a day and 365 days a year.

#### **The Doctor of Veterinary Science (D.V.Sc.) Degree Program**

The OVC Clinical Studies has three graduate programs, including the intensive D.V.Sc. program, which includes taking graduate courses, conducting a major research project, and working within applied clinical practice. Applicants must be eligible to be licensed by the College of Veterinarians of Ontario. In 2005/2006 the VCEP provided funding for 29 of the 50 D.V.Sc. students.

#### **The Externship Program**

The Externship portion is an 8-week, applied, experiential learning course for DVM students. The Externship must be conducted at approved private primary-care veterinary practices, and during these terms students learn to apply the knowledge learned in courses, work within professional medical teams, and develop pertinent problem-solving skills. They are further evaluated on the performance of their diagnostic skills, delivery of veterinary care, and technical skills. VCEP funds support student

relocation allowances, organizational staff support, operating expenses, and insurance for course delivery.

### **Employer and Student Evaluations**

The programs supported under the VCEP and OMAFRA/UG agreement are well recognized by employers, the veterinarian industry, as well positively rated by the students themselves. Upon program completion, graduates of the D.V.Sc. program were placed in various professional roles including:

- Faculty members;
- Research associates;
- Clinical Veterinary Specialists; and
- Post-doctoral fellows.

As of June 2005 10 of the 16 interns of the VTH one-year graduate internship programs were successful in obtaining residencies, 2 interns obtained fellowships, 1 intern obtained a Ph.D. position, and 1 intern obtained a post-graduate research position.

The veterinary profession and graduates from the OVC tend to experience very high employment rates. In August 2004, employers of graduates from the College were requested by the OVC to evaluate these graduates in their performance and competence on the job. Of the 64% response rate received, 94% of employers responded that they were satisfied and found these employees to be superior, very good, or good in the quality of their performance.

In 2006 the OVC requested 2005 graduates to evaluate their own performance and competence, given their knowledge and previous training. Of the 75% response rate received, 95% of these graduates were satisfied, rating themselves as superior, very good, or good in the quality of their performance.

### **Accreditations and Contributions in Agriculture**

The OVC was granted full accreditation after the Canadian and American Veterinary Medical Association (CVMA/AVMA) Council on Education site visit in February 2002 for a period not to exceed seven years. This accreditation process was originally developed by the CVMA/AVMA in order to ensure quality professional veterinary education, and these measures are now recognized on a global scale. Thus, the OVC maintains an international reputation of teaching, research, and service, while recruiting qualified candidates, and serving the veterinary requirements of Ontario. The College of Veterinarians of Ontario (CVO) administers the Ontario Veterinarians Act, and within this Act a requirement for obtaining a practicing licence in Ontario is graduation from an AVMA/CVMA accredited college. In addition, in order for a facility to provide veterinary services, it must be CVO accredited. The VTH was inspected and approved by the CVO in 2002, with its next visit to be conducted in 2009.

The VCEP is also a substantial support to UG's strength in agricultural sciences, as it supports the health and welfare of all animals (in addition to domestic animals) on a high level, thus effectively working alongside the faculty, researchers, and industry members who's efforts are invested in maintaining Ontario's excellence in the agri-food industry. This intensive focus on animal healthcare within farming operations is an important application to ensure the health and safety of numerous production processes and food products that will eventually reach consumers. The caseload of the VTH involves a great deal of incoming larger farm animals, and field service visits to farms in order to evaluate and treat farm animals. Between 2004 and 2006 the VTH made over 3,200 such visits.

## **8.0 Agriculture, Education and Industry**

### **Employment and Salary Statistics**

The Council of Ontario Universities recently published highlights from their 2004 survey of Ontario University Graduates with some results noted below for Veterinary Medicine, Food Science and Nutrition, and Agricultural and Biological Sciences. Employment rates are consistently high for graduates in these areas ranging from 91-100% for both 6 months and 2 years after graduation. Average salaries range from \$31,437 to \$55,000 six months after graduation, significantly increasing to a range of \$40,692 to \$65,938 two years after graduation.

Industry Salaries by Program Area	Six months after 2004 graduation	Two years after 2004 graduation
Veterinary medicine	\$55,000	\$65,938
Food science and nutrition	\$34,444	\$42,736
Agricultural and biological sciences	\$31,437	\$40,692

\*Employment rates are from six months after graduation

Employment Rates by Program Area	2000 employment rates	2001 employment rates	2002 employment rates	2003 employment rates	2004 employment rates
Veterinary medicine	100	100	100	100	100
Food science and nutrition	97	99	98	97	96
Agricultural and biological sciences	96	95	94	91	97

\* Employment rates are from two years after graduation

### OMAFRA/University of Guelph Agreement and Program Contributions

The education component of the UG / OMAFRA contract is valued at over \$135 million between 1998 and 2006 and has facilitated the development of agri-food industries in Ontario through training. Supporting seven different Associate Diploma programs and four different Continuing Education Programs offered at the OAC, and the VCEP at the OVC, through this agreement has come theoretical and practical training in numerous specific areas. These areas include Agriculture, Equine, Food Science, Environmental Management, Horticulture, and Veterinary Technology and Medicine, supporting sizeable industries in Ontario, and many with a recent track record of substantial growth.

Collectively, these programs support the employment potential of graduates and related research initiatives. When questioned on the perceptions of these various programs in the industry, hiring managers conveyed views of these graduates as strong and capable employees, and the high employment rates of these graduates also validate these perceptions. Some hiring managers and senior industry representatives also feel that the work and importance of various agriculture research initiatives is well supported by these programs, and that the linkages between education and research in these fields in terms of student knowledge, faculty work, and developing subject matter will always be critical to industry development.

Professional accreditations and industry recognition are also notable components of these programs as the Food, Nutrition, and Risk Management program and the VCEP have a great deal of industry and global recognition through such designations as the CRFA Certification in the National Sanitation Training Program and CVMA/AVMA accreditations.

### 9.0 Summary

Thus, these diverse UG training and development programs and their crucial funding and support result in various notable positive impacts. These impacts include the depth and breadth of course topics and student satisfaction, as well as the provided support for extensive research initiatives, preparation and training leading to diverse and rewarding employment opportunities, professional accreditations, and industry recognition. In addition, an even greater impact of these programs is the vital support provided to numerous major agricultural sectors in Ontario through the development and training of a new labour pool and future industry leaders. All of these programs have gained recognition from both industry leaders and participants, evident in high rates of post graduation employment and continued growth in the programs delivered.

# Case #3 - Ridgetown Campus and Soybeans

**Abstract** – Over the past two and a half decades the soybean industry in Ontario has experienced tremendous growth in becoming the provinces largest cash crop with a farm gate value of over \$650 million. Soybeans have grown from limited variety and use, to a crop that now has hundreds of varieties and several innovative food and non-food applications. This case highlights the soybean industry growth and the vital role played by researchers at the Ridgetown and Guelph campuses of the University of Guelph, as well as at other locations and institutions, i.e. Kemptville campus, Agriculture and Agri-Food Canada, etc. Development of disease resistant cultivars has enabled Ontario farmers to maintain higher yields and produce soybeans in Ontario's variable climate. The University of Guelph developed OAC Bayfield for example, a high yielding, disease resistant, and adaptable variety which alone has generated over \$750 million for the Ontario economy. Funding and support of the Government of Ontario has made the research and success of soybeans possible.

## 1.0 Introduction

Ridgetown Campus is not only a satellite campus to the University of Guelph (UG); it is a place where significant research takes place and educational contributions are made to the agri-food sector. Located in Ridgetown, Ontario, the campus is at the heart of the agricultural community in Southwestern Ontario and offers education programs in agriculture, horticulture, environmental management, and veterinary technology.

The research conducted at Ridgetown is very much applied research, and crosses all areas of farm production, including development and management of wheat cultivars, livestock production, soil and water management, agronomy, pest management, plant breeding, soil stewardship, farm policy and economics, and livestock nutrition. For further background on the growth of Ridgetown Campus see **Appendix B**.

Ridgetown College and the Soybean industry in Ontario is a story of incredible growth.

At the foundation of this growth in the last decade, has been the funding agreement between OMAFRA and the University of Guelph.

Through the unique funding agreement between the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) and UG, Ridgetown Campus directly receives approximately \$3.0 million annually to support faculty and research programs, some of which is directed towards soybean research. The positive impact of this funding to the soybean industry has been extensive over the past 10 years. The funding directed towards Ridgetown Campus by OMAFRA has not only provided a base for important research, but this funding has been leveraged externally by a ratio of 3:2<sup>26</sup>. Ridgetown Campus has garnered support from over 100 research partners in private industry, Ontario boards, and associations. This in turn has enabled the Campus to expand the breadth and depth of research services.

Ontario's soybean industry has seen considerable growth in recent decades in part due to the fundamental and applied research at the Guelph, Ridgetown, and Kemptville campuses. Collaboration and complementary efforts amongst researchers in Ridgetown and Guelph have significantly contributed to the expansion of soybeans in Ontario. Work in the areas of soybean breeding and genetics, cultivar development, and disease resistance, have all contributed to the superior quality and variety that now exists in Ontario soybeans.

## 2.0 The Soybean Industry: Ontario's Growing Crop

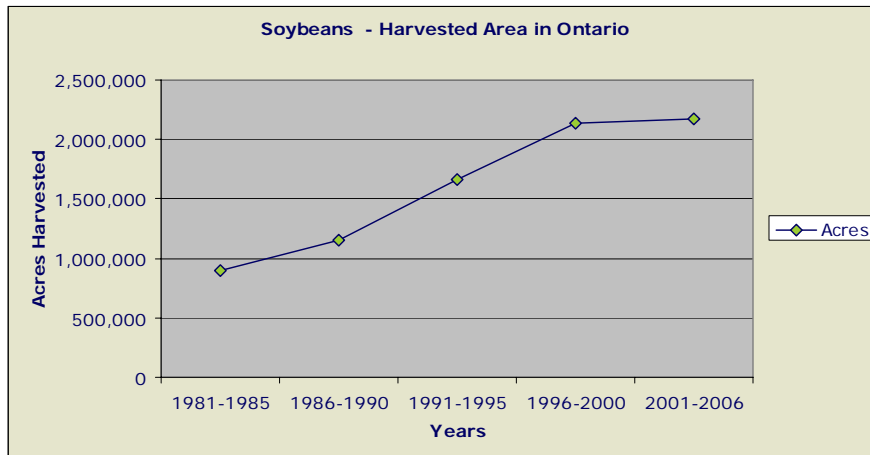
Ontario has seen a staggering growth in the production and harvest of soybeans in recent decades, where it is has grown to become the largest field crop in the province. In 1981, there were approximately 700,000 acres of soybeans harvested in Ontario, which has increased to 2,130,000 acres in 2006 (**See Exhibit 1**). That is a growth rate of 210% over the past 25 years. Average yields have also increased from approximately 32 bu/acre in 1981 to a record 46 bu/acre in 2006<sup>27</sup>. With an average price for soybeans of \$6.70/bu in 2006, this would put the market for Ontario soybeans at approximately \$656 million. Greg Hannam, a soybean seed producer, suggested that without the

<sup>26</sup> Ridgetown College: Research Highlights Brochure, pg 26.

<sup>27</sup> OMAFRA Statistics

research done by the University of Guelph, we would not have seen such growth in soybean production and yields.

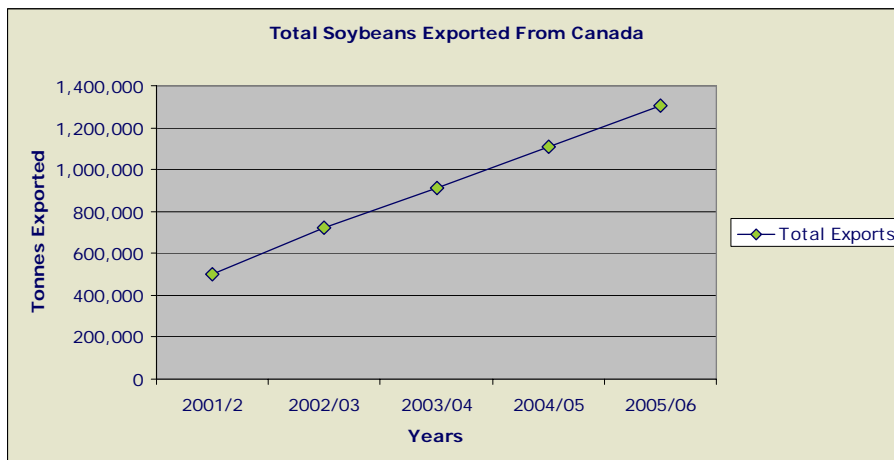
### Exhibit 1



Source: OMAFRA Statistics

Approximately 35% of Ontario soybeans are exported to other countries. The quality and variety of Ontario and Canadian soybeans has generated a large increase in soybean exports in the last decade. See Exhibit 2. Exports from Canada have increased from approximately 500,000 tonnes in 2001 to over 1,300,000 tonnes in 2006.

### Exhibit 2



Source: Statistics Canada, Ontario Soybean Growers

This has largely been driven by exports to Asian markets where exports to Japan alone have increased from 126,000 tonnes in 2001 to 323,000 tonnes in 2006.<sup>28</sup> Asia accounted for 44% of all soybean exports in 2006, and Japan alone accounted for approximately 25% of exports. Important Asian soybean food products such as soy sauce, tofu, miso, and others, demand the high quality that is known of Ontario and Canadian soybeans.

The soybean research performed at the Guelph and Ridgetown campuses has no doubt helped to provide a strong reputation for top quality Ontario and Canadian soybeans. The research has served to advance this crop to go from one of limited variety and uses to a crop with robust variety and one that now has food and industrial uses that were previously unimaginable. In **Appendix C** we have provided a list of possible uses of soy, which highlights the wide range of uses.

<sup>28</sup> Statistics Canada, Ontario Soybean Growers

### 3.0 Soybean Research Meets Industry Needs

Soybean research at Guelph and Ridgetown has been vitally important not only to the growth of the soybean industry, but in the ability to meet changing needs. UG has been instrumental in the development of short-season soybean cultivars, disease resistant cultivars, and varieties to improve human health. There are approximately 225 cultivars of soybeans commercialized in Ontario, with around 20% of these varieties occupying 80% of the soybean acreage in Ontario<sup>29</sup>. The vast selection of soybean cultivars is the result of research to provide disease resistant and value-added soybeans and to support the expansion of soybeans into newer short-season areas of the province.

The most notable variety of soybean developed by UG is OAC Bayfield. This variety has been applauded for its ability to thrive in various regions and short-seasons faced by Ontario farmers. OAC Bayfield also generates high yields and has a strong resistance to disease. "OAC Bayfield set the bar for performance and longevity..." says Martin Harry, SeCan Eastern Marketing Manager (SeCan is one of the largest marketers of seed to Canadian farmers).<sup>30</sup> In 1994 the UG soybean-breeding program (sponsored by OMAF) released the OAC Bayfield variety. Since that time, it has been the most successful soybean variety in Ontario, accounting for approximately 20% of the total acres of soybeans. OAC Bayfield has contributed more than \$750 million to Ontario's economy and brought over \$1.0 million in royalties to the University of Guelph which has been invested back into research<sup>31</sup>.

Research in the area of disease resistance has been essential to Ontario farmers. Greg Hannam mentioned that the strain resistance work of researchers out of Ridgetown and Guelph has enabled two counties in Ontario (Lambton and Chatham-Kent) to be able to grow soybeans. Due to their southern latitude and proximity to the U.S., these counties are more prone to crop diseases and insects, specifically soybean cyst nematode, soybean aphids, soybean rust, and others. Without the development of strain resistant soybean varieties, these counties might not be able to grow soybeans. Soybeans harvested in 2006 from Lambton and Chatham-Kent were approximately 233,00 and 220,000 acres respectively<sup>32</sup>, making them two of the largest soybean producers in Ontario with 21% of total acres harvested. This translates to approximately \$140 million of the Ontario farm gate market for soybeans.

Developing new strains of soybeans and disease resistance have been successful areas of research at the Guelph and Ridgetown campuses.

*"In a bad year of aphid infestation, her work might save one quarter to one third of crop revenue in the province".*

Research surrounding Soybean Aphids is another prominent example of how work out of Ridgetown Campus is directly impacting farmers. Soybean aphids are pin-head size pale yellow insects which feed by piercing the plant tissue using a tube-like mouthpart and sucking the plant sap, thereby potentially causing significant yield loss and the spreading of insect-borne plant diseases.<sup>33</sup> Greg Hannam, mentioning the important work of researchers and collaboration with OMAFRA employees based at Ridgetown, highlighted one in particular - Tracey Baute, an OMAFRA employee based at Ridgetown and a field crop entomologist (entomology is the branch of zoology that deals with the study of insects). Mr. Hannam stated that every corner of Ontario has benefited from the work of Ridgetown in this area, and that in a bad year of aphid infestation, Ms. Baute's work might save one quarter to one third of overall crop revenue in the province. Producers rely on this research to understand aphid threshold levels, so that they know what and when to spray fields. This is crucial because spraying fields is not only a significant cost to a producer, but an ineffective spraying program can expose a producer to crop loss.

Research scientists at Ridgetown Campus have also developed a strain of soybeans that is genetically resistant to soybean cyst nematode (SCN). These nematodes are microscopic, worm-like pests that damage the root system and prevent the uptake of water and nutrients.<sup>34</sup> SCN can significantly

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<sup>29</sup> Per discussion with Dr. Gary Ablett of The University of Guelph, Ridgetown Campus

<sup>30</sup> <http://www.secan.com/?sv=&category=Home&title=growth&archive=1&id=9>

<sup>31</sup> University of Guelph "Research: Focus on Soybeans", April 2004

<sup>32</sup> OMAFRA Statistics

<sup>33</sup> <http://www.omafra.gov.on.ca/english/crops/pub811/4aphid.htm>

<sup>34</sup> <http://www.omafra.gov.on.ca/english/crops/pub811/4scn.htm>

reduce crop yields, as Ontario soybean producers have experienced crop losses ranging from 5% to 100% due to SCN. Once this disease struck Ontario soybeans, screening tests were developed by the private sector to determine the economic impacts of SCN, so that farmers could decide whether or not to grow crops that are not susceptible to the nematode.

There are also emerging threats to the industry that the University is working on. Crosby Devitt, from the Ontario Soybean Growers Association, commented on the potential effects of Asian soybean rust and stated that “rust could wipe out our crop completely”. In 2001, this disease was detected in South America and in 2004, entered the southern United States. Soybean rust was first detected in Ontario in late summer 2007. The threat of significant yield loss has promoted research efforts to reduce such risk to Canadian soybean crops. Soybean rust is a fungus that attacks the foliage of soybean plants causing the leaves to drop early, which inhibits plant growth and reduces yields<sup>35</sup>. Researchers at UG are currently trying to develop rust-resistant soybeans to combat this potentially catastrophic crop disease. Researchers at Guelph and Ridgetown can also provide guidance to producers in terms of early warning, and if fields should be sprayed or what to spray with, in order to help minimize risk. If soybean rust were to wipe out only 5% of soybean crops in Ontario, this would equate to a farm gate loss to the economy of approximately \$33 million<sup>36</sup> annually. Current research to develop a resistant strain will prove to be invaluable in order to protect Ontario soybeans from the potentially devastating soybean rust.

Along with disease resistant soybean cultivars, researchers are also working to increase the health benefits of soybeans. Dr. Gary Ablett, located at the Ridgetown campus, provided an example of his involvement in research to reduce linolenic acid (“bad” fatty acids) in soybeans. This research, partially funded by OMAFRA, was published in a 2002 issue of the journal “Crop Science”. The high level of linolenic acid in commercial soybeans is considered an unstable component responsible for poor flavour and undesirable oil odour, particularly in cooking oils. The traditional process used to reduce linolenic acids, partial hydrogenation, is expensive and produces unhealthy trans fatty acids in the soybeans. Dr. Ablett and his colleagues<sup>37</sup> devised a method to decrease the linolenic acid content of soybean oil genetically, which would reduce the need for partial hydrogenation and preserve flavour stability. Soybean oil with low linolenic acid levels would therefore be beneficial to consumers because of lower trans fatty acids and stabilized flavour.<sup>38</sup> It is estimated the market for low linolenic soybean varieties in North America could grow to 12 million acres and currently there is a price premium for such soybeans of approximately \$0.40/bushel. With average yields over 40 bu/acre, this would imply enormous economic potential for low linolenic soybeans to go along with increased health benefits to consumers.

#### **4.0 Ridgetown: A Centre of Excellence for Bioproducts?**

The University has the opportunity to be a global leader of leading-edge research in biomaterials. Soy, for example, can be used to replace petroleum products in many industrial applications, see **Appendix C**. Research in biomaterials at UG will likely play a vital role in developing Ontario's bioeconomy. SOBIN (Southern Ontario Bioproducts Innovation Network), located in Chatham, Ontario, is a not-for-profit organization committed to advancing new bioproducts and finding new uses for biobased feedstock. SOBIN comments that the “timing is ideal to make Southwestern Ontario a centre for cultivating bioproducts technology and expanding the market for it. The region's high concentration in agriculture, chemical, plastic and automotive production forms a natural base for the development of new bioproducts.”<sup>39</sup>

UG and the Ridgetown Campus are well positioned to take advantage of this opportunity with an already developed strong resource base. The relationship and support of OMAFRA funding has helped develop this resource base, and further support could serve to propel a bioeconomy in Ontario.

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<sup>35</sup> <http://www.uoguelph.ca/realestate/news/2004-11-17.html>

<sup>36</sup> Using 2006 OMAFRA data: 2,130,000 acres x 46 bu/acre x \$6.70/bu x 5%.

<sup>37</sup> Valerio Primomo, Duane E. Falk, Jack W. Tanner, and Istvan Rajcan

<sup>38</sup> Journal of Crop Science (2002;42:31-36)

<sup>39</sup> <http://www.sobin.ca>



## 5.0 Summary

The relationship of Ridgetown Campus, the University, and OMAFRA, is quite evident when considering the advancement and innovations in soybeans. Researchers at the Guelph and Ridgetown campuses have played a fundamental role in the growth of Ontario's soybean industry.

The soybean breeding and cultivar development program for disease and insect resistance has truly been a success story when it comes to soybeans. The introduction of the OAC Bayfield variety and research in such areas as soybean cyst nematode, soybean aphids, soybean rust, and reducing linolenic acid in soybeans are only a few real life examples of how the research performed at UG has had profound effects. This research is helping the local farmer, but also extends far beyond that.

In the words of soybean seed farmer Greg Hannam, "to plant a seed of innovation, you have to own the farm". The research that is funded through the agreement has not only significantly led to the development of the industry in Ontario; it has contributed to expanding it and protecting it. The agreement between OMAFRA and UG has provided a base of support that spawns research, innovation, and growth. This has positively impacted researchers, producers, the agricultural community, and the economy.

# Case #4 – The Environmental Farm Plan and Best Management Practices

**Abstract** – With increasing global concerns regarding environmental sustainability and public welfare, when it comes to consumers and international export markets of agri-food products, the decision making process can significantly involve environmentally responsible production and confidence in the safety of this production process. In Ontario, the Environmental Farm Plan and Best Management Practices are notable examples where risk mitigation is being implemented at the source of agri-food production via environmental management education and behavioural change in farming operations, ensuring that both environmental and certain health standards are maintained. These programs effectively achieve far greater results in comparison to regulatory or legislative standards. In order to develop and update these programs as required, a collaborative effort takes place between the Government of Ontario, Agriculture and Agri-Food Canada, industry professionals, as well as research faculty at the University of Guelph who are greatly supported by the Ontario Ministry of Agriculture, Food, and Rural Affairs.

## 1.0 Introduction

### Purpose

The Environmental Farm Plan (EFP) is a voluntary educational and awareness program whereby farmers evaluate the environmental state of their farms and are taught best practice methodologies and risk mitigation techniques to be applied in their day to day operations. The EFP process enables farmers to identify their environmental strengths and concerns, as well as create action plans to improve on their environmental conditions.

Based on the EFP and various tools including the Best Management Practices (BMP) series, farmers assess their practices according to 23 different areas of potential concern, including key areas such as water wells, fuel storage, soil management, energy efficiency, woodlands and wildlife, and pest management.

The EFP is considered a valuable program to Ontario as it empowers the agricultural sector to take responsibility and identify its impacts on the environment, it supports effective environmental management and thus long-term sustainability for current and future generations, and it works to brand Ontario in the global market as an environmentally responsible producer of safe, high-quality food products.

At a time when there is a significantly large and growing worldwide focus on such issues as the building of long-term environmental sustainability and increasing public welfare through food safety and the mitigation of health related risks, the Environmental Farm Plan and Best Management Practices serve a vital purpose.

### Contributors and Participants

The Ontario Ministry of Agriculture, Food, and Rural Affairs (OMAFRA) and the University of Guelph are both major sources of technical expertise in the development of the EFP. Agriculture and Agri-Food Canada provides funding for the administration and cost-share. The OMAFRA and University of Guelph dedicated funding agreement has contributed to the Environmental Farm Plan primarily through the critical agricultural research programs, knowledge base, and leadership that it supports. For instance, the University, along with numerous industry professionals, assists in the development of the EFP Workbook and BMP publications, which are the principal tools utilized by farmers throughout the EFP process. These exhaustive tools enable participants to obtain some topical background education on effective environmental management, conduct risk assessments, and review and evaluate their action plans going forward. In addition, some UG professors that are, or were once supported under the OMAFRA / UG agreement have been heavily involved in the design and development of the EFP. For instance, Dr. Gord Surgeoner was instrumental in the development and scientific leadership of the EFP program, forming the public-private collaboration leading to the self-regulation focused program structure, as well providing significant contributions to program content.

The EFP is currently an internationally recognized program, and has also been adopted nation-wide. Since 1992 over 34,000 out of 56,000 farmers have voluntarily participated in the EFP program, with many voluntarily revisiting the program again at a later date to update their knowledge, plan, and

practices.

## **History and Funding**

The EFP was initiated in 1992 in seven selected Ontario counties as a pilot project, and led from within the Ontario farming community by the Ontario Farm Environmental Coalition (OFEC). The OFEC is made up of four agriculture and farming organizations (OFA, CFFO, AgCare, and OFAC), which collectively represent over 50 farm organizations across the province. The OFA contracts the delivery of the EFP to the Ontario Soil and Crop Improvement Association (OSCIA), a non-profit organization that promotes the responsible, economic management of soil, water, air and crops.

Since conception, the EFP has been funded primarily through Agriculture and Agri-Food Canada (AAFC). Up until 1997 funding was received from AAFC's Green Plan for Ontario, and since 1997 funding has been provided under the CanAdapt program, also an AAFC initiative. Since 2004, AAFC provided funding through the Agricultural Policy Framework.

## **2.0 Process and Tools**

### **Environmental Farm Plan Phases and Steps**

The key phases and steps of the EFP include the following:

1. Participants attend a scheduled EFP workshop organized by an OSCIA representative in their local county or region. These workshops provide instructions and preliminary information on environmental risk assessment and action plan development.
2. As part of their Farm Review, based on the detailed rating system outlined in 23 different Worksheets within the EFP Workbook, participants complete risk assessments and produce ratings on the environmental strengths and concerns on their farms.
3. Utilizing their completed Worksheets, participants develop Action Plans to determine whether there are potential problems resulting from environmental risks on their farms, and consider appropriate methods to control these problems going forward.
4. Participants submit their Action Plans for Peer Review, a process whereby their plans are confidentially reviewed by a group of appointed local farmers for input and recommendations.
5. Once participants have their Peer Reviews completed and approved, they are eligible for the EFP cost-share program, whereby a portion of the costs (up to 90%) of implementing projects in their Action Plans is provided for by the EFP.
6. Participants begin the implementation stages in accordance with their priorities while being supported by a vast amount of resourceful information including the published series entitled "Best Management Practices" (BMP).

### **Environmental Farm Plan Workbook**

Prepared by OMAFRA, along with the contributions of UG and industry members, the EFP Workbook is the principal tool utilized throughout the EFP process. The Workbook is made up of the Farm Review and the Action Plan. The Farm Review enables farmers to view and assess their farms in detail, considering specific aspects of their farm land, buildings, and products. Through 23 different module Worksheets, each containing an average of 20 questions, the Workbook presents scenarios and raises questions for participants to self-rate their operations on how farm land, buildings, and products may affect their farm environment in terms of air, soil, water, and wildlife. These ratings are used to develop an Action Plan to identify if risks on their farms pose potential problems, and consider ways to solve and control these problems going forward. Each of the 23 Worksheets also has a corresponding Infosheet providing additional information.

The 23 Worksheet / Infosheet topics include:

- Soil and Site Evaluation;
- Water wells;
- Pesticide handling and storage;

- Fertilizer handling and storage;
- Storage of petroleum products;
- Disposal of farm wastes;
- Treatment of household waste;
- On-farm storage of livestock manure and other prescribed materials;
- Livestock yards and outdoor confinement areas (OCA's);
- Silage Storage;
- Milking Centre Washwater;
- Nuisances under the *Farming and Food Production Act, 1998*;
- Water efficiency;
- Energy efficiency;
- Soil management;
- Nutrient management in growing crops;
- Manure use and management;
- Horticultural production;
- Field crop management;
- Pest management;
- Stream, ditch, and floodplain management;
- Wetlands and wildlife ponds; and
- Woodlands and wildlife.

### **Best Management Practice (BMP) Series**

The Best Management Practices (BMP) series is a critical supplementary tool to the EFP, and also an extensive educational tool on its own. The BMP series seeks to explore workable solutions in dealing with environmental risks in farming operations, or even for residents of rural communities. BMP subject areas include Nutrients, Soil, Water, and Pest Management. According to OMAFRA, a Best Management Practice can be considered "a practical, affordable approach to conserving a farm's soil and water resources without sacrificing productivity".

This series of 16 books was published in cooperation with AAFC and the OFA. Farmers can obtain BMP copies at their regional OMAFRA offices at no cost, unless their requirements involve larger orders.

Best Management Practices series titles include:

- A First Look- Practical Solutions for Soil and Water Problems;
- Farm Forestry and Habitat Management;
- Field Crop Production;
- Fish and Wildlife Habitat Management;
- Horticultural Crops;
- Integrated Pest Management;
- Irrigation Management;
- Livestock and Poultry Waste Management;
- No-Till: Making It Work;
- Nutrient Management;
- Nutrient Management Planning;
- Pesticide Storage, Handling, and Application;
- Soil Management;
- Water Management;
- Water Wells; and
- Woodlot Management.

The contents of the BMP books are a result of various inputs and are a successful example of effective collaboration among individuals involved across the agri-food industry. Farmers, researchers, extension staff, agri-business professionals, and many faculty and researchers from the University of Guelph all work together to produce these publications.

The OMAFRA/U of G dedicated funding agreement contributes to the Best Management Practices series predominantly through the substantial support that it provides to the University's agricultural research programs in Sustainable Production Systems, Resource Management and Environment, Food, Sustainable Rural Communities, and Bioproducts. The support received by faculty members and researchers that is utilized in both agricultural and environmental management capacities enables the University to play a significant role in the content development of Best Management Practices. These University members assist in the preliminary testing, review and evaluation processes of developing

best practice options, in order to determine what practices result in the maximum environmental benefits, while being reasonable for farmers to implement.

### **3.0 Outcomes and Achievements**

#### **Awards and Recognition**

The Environmental Farm Plan has been positively received, visible not only in its strong participation rates, but also through awards, leveraged funding, and similar international programs.

The OFEC conducted a survey of farmers who participated in the EFP, finding that these farmers are generally driven by the cost-share incentive program, although approximately 70% of the participants surveyed continued their best practices after completing the program without further funding. Farmers find the program and recognition of their participation in the program a necessity in their operations in order to remain competitive in the farming community and realize certain production and environmental benefits.

The EFP is recognized by industry leaders for its application to a variety of uses, whether to alleviate pollution, preserve wild life, or positively affect ecosystem balance.

Some notable awards received by the EFP include:

- American Society of Agricultural Engineers Blue Ribbon Award, 1995;
- Ontario Ministry of the Environment Pollution Prevention Leadership Award, 1997;
- Wildlife Canada Country Canada National Stewardship Recognition Award, 2000; and
- State of the Lakes Ecosystem Conference Award, 2000.

According to OCSIA, leveraged funds resulting from the success of the EFP total approximately \$150 million since the EFP began. These funds are utilized in the cost-sharing incentives for farmers, enabling more farmers to implement greater environmental improvements to their operations.

In addition, the EFP program has set an international example, with several programs modeled after it. The OFEC notes that the EFP was originally developed from the Farm "A" Syst program at the University of Wisconsin Madison, and in turn contributed to the further development of Farm "A" Syst. Similar programs modeled after the EFP include the Land Care program used in Australia, as well as programs in Uruguay, three provinces in China, and one currently under development in Argentina. EFP Workbook samples have been sent to over 30 countries, as well as many states in the USA.

#### **Government and Stewardship**

Sustainable development encompasses comprehensive decision making that considers the economy, society, and the environment in an integrated way. The Government of Canada, through such departments as Agriculture and Agri-food Canada and Environment Canada, has taken up the mandate of promoting sustainable development through many programs, policies, and initiatives. Provincially, the Environmental Farm Plan and Best Management Practices support this national effort through an education and application process that benefits Ontario on numerous levels including rural environmental protection and food safety, resulting in consumer confidence and well-being.

Stewardship is considered critical to supporting the longevity and profitability of the agri-food industry by numerous organizations and agencies in the agricultural sector, including OMAFRA. Several senior planners and researchers in the environmental science fields find that instilling education, support, and choices in a manner like that of the EFP results in greater participation and effective action by farmers, perhaps more so than other widely enforced regulatory systems. For instance, the Clean Air and Water Acts tend to target large organizations, however there is little governance for smaller groups, and this is where a program such as the EFP can affect positive behavioural change. With an estimated 56,000 farms in Ontario, the effect of high participation in the EFP has large cumulative welfare and economic impacts for the province.

#### **Agriculture, Environment, and Economics**

The OSCIA notes that the EFP has resulted in thousands of projects and significant on-farm improvements in cropping systems, manure storage, water well management, pest management, product and waste management, and nutrient management planning. Farmers experience healthier soil and water properties, reduced pesticide usage, and preservation of nutrients, among other advancements, all of which can contribute to higher yields, lower input costs, more efficient use of available resources, and higher environmental quality. The economic implications of such farming

improvements, consequential reduced costs and risk mitigation are likely quite substantial, although difficult to quantify entirely and accurately.

Several senior researchers and faculty members at UG look to the 2000 Walkerton outbreak of E. coli contamination as a significant example of an event that was considered by some as an environmental crisis in farming. Chemical fertilizers or potentially contaminated animal waste applied to farm land can lead to harmful farm runoff into lakes slowly over time, and in this case the runoff was contaminated with E. coli, eventually resulting in the death of seven people and hundreds suffering from disease symptoms. However, much of the local farm community was largely exonerated due to having completed and implemented the EFP process, resulting in the cause being linked to poor water monitoring and management. In such instances, the precautionary measures taken by the farming community within its capacities are highly critical, especially for safeguarding against detrimental health and economic impacts. A 2001 economic impact study instigated by judicial inquiry and conducted by the Economics department at UG found an estimated total cost of \$155 million associated with the Walkerton tragedy. This included costs for the provision of safe drinking water, repairing the town water system, equipment replacements and sanitization, legal fees, lost revenues, and declines in Walkerton real estate values.

Educational programs and tools such as the Environmental Farm Plan and the Best Management Practices are critical to crisis prevention of this magnitude, but also to implementing incremental environmental improvements, resulting in a cumulatively sizeable benefit for the province when put into place by the large farming community of Ontario.

#### **4.0 Summary**

The building of consumer confidence and environmental responsibility resulting from the use of the Environmental Farm Plan and Best Management Practices in the Ontario farming community can affect the promotion of local spending for agricultural products, and can essentially enhance Ontario export markets for these products by maintaining certain environmental and health standards. These programs and tools also work to avoid potential health risks that could lead to disease, adversely affect agricultural goods and service markets and increase healthcare costs. These considerations, together with the size of the Ontario farming community, collectively suggest that there are sizeable environmental, public welfare, and economic gains resulting from such initiatives as the Environmental Farm Plan and Best Management Practices.

# Case #5 – Zoonotic Diseases

**Abstract** – Zoonotic diseases are defined as diseases that can travel between animals and humans. Zoonotic diseases have become a major concern, as 75% of all new diseases in the world in the past 10 years have originated from animals or animal products. There are numerous reasons for the increasing prevalence of these diseases, including humans increasing their global footprint, demographic changes, and economic factors. Whatever the reasons, zoonotic diseases can have devastating human health and economic impacts. Canada has seen outbreaks of zoonotic diseases such as avian influenza in poultry and cases of mad cow disease in cattle, both of which have cost hundreds of millions of dollars in economic loss.

To meet this challenge, the University of Guelph and OMAFRA funding agreement has supported activities in all aspects of this critical issue including supporting research, testing and diagnosis, monitoring and surveillance. In order to deal effectively with zoonoses, an integrated approach of disciplines including human health, veterinarian medicine and environmental science is required, and this funding agreement has provided a basis for this integrated approach.

## 1.0 Introduction

Zoonotic disease can be defined as any disease or infection that is naturally transmissible from vertebrate animals to humans<sup>40</sup>. They may be bacterial, viral, or parasitic, or may involve unconventional agents and there are currently over 200 such diseases in the world. Some of these have been around for centuries, and some are described as “emerging” diseases.

Over the past decade there have been many headline examples of these diseases in Canada, such as outbreaks of avian influenza, severe acute respiratory syndrome (SARS), E.coli, cases of bovine spongiform encephalopathy (BSE), and West Nile Virus. These outbreaks were crippling to public health systems as well as economically. These are only a few examples of zoonotic diseases which have recently become more prevalent in society in Canada and globally.

The University of Guelph (UG) has played an important role in the area of zoonotic disease, through the performance of vital research, testing and diagnosis, monitoring and surveillance. By providing essential funding, the agreement between UG and the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) has contributed to this successful research and monitoring of zoonoses carried out at UG. This research and monitoring is helping to avoid some of the potentially devastating public health and economic impacts associated with zoonotic disease.

## 2.0 Impacts of Zoonotic Disease

Zoonotic diseases present a serious public health risk to both developing and industrialized countries. According to the World Health Organization (WHO), “about 75% of the new diseases that have affected humans over the past 10 years have been caused by pathogens originating from an animal or from products of animal origin. Many of the diseases have the potential to spread through various means over long distances and to become global problems”. The global community is shrinking, as travel patterns become increasingly global in nature and as businesses now rely on global trade patterns for their industries. This shrinking world along with other issues such as human and animal demography, changes in social and cultural habits have led to the emergence or re-emergence of zoonotic diseases.

With 75% of new diseases in the world over the last 10 years being zoonotic or from animal origins, the risks to public health and the economy of Ontario are severe.

Along with the obvious public health risks, there are several important economic impacts including resource costs of disease prevention and control, lower productivity, international trade restrictions, human health costs, reduced tourism, and possible effects on the environment.

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<sup>40</sup> Definition obtained from the World Health Information (WHO).

In May 2004, WHO issued a “Report of the WHO/FAO/OIE<sup>41</sup> joint consultation on emerging zoonotic disease” to address the threat of emerging zoonotic diseases and offered several important conclusions. Among the conclusions was the fact that emerging zoonotic diseases are “increasingly recognized as a global and regional issue with potentially serious human health and economic impacts” and that current upward trends of diseases are likely to continue. The WHO Report also noted that “new mechanisms of surveillance and response are required” using new approaches, new tools, and bringing together different disciplines. Studies to “understand fully the underlying causes for disease emergence and the ecology of the agents and their hosts will assist with the effective prevention or rapid containment of future emergence events”. These conclusions allude to the importance of the research and surveillance work being done at UG in the area of zoonotic disease.

### 3.0 Animal Health Lab – Disease Surveillance & Monitoring

The Animal Health Lab (“AHL” or “Lab”) at UG plays a crucial role in the testing, monitoring and surveillance of zoonotic diseases. In partnership with OMAFRA, the Lab is part of the Ontario Animal Health Surveillance Network (OAHSN). The AHL is a full-service, fully accredited veterinary diagnostic lab and has an annual budget of approximately \$10.0 million, of which 50% is funded by OMAFRA. With a staff of 15 veterinarians and 50 technicians, the AHL handles approximately 45,000 animal cases, performs over 800,000 tests, and sends over 200 samples annually to the Canadian Food Inspection Agency (CFIA) for reportable disease testing.

The Animal Health Lab (AHL) at UG performs 800,000 tests and handles 45,000 animal cases per year.

The role of the AHL is vital in the testing, monitoring, and surveillance of zoonotic diseases.

The AHL is 50% funded by OMAFRA.

Samples are examined by the Lab to ensure that pathogens are detected quickly and contained. The Lab provides an effective early warning system and even contains post-mortem rooms where many diseases are first recognized in Ontario.

Through animal surveillance on diseases that affect Ontario livestock and poultry, the AHL is helping to provide confidence in Ontario agriculture and international trade. One of the diseases which recently had enormous economic impacts in Canada is BSE, or mad cow disease. To date, there have been 11 reported cases of BSE in Canada, the effects of which have been detrimental to the Canadian economy. In 2003, the discovery of a single case of BSE in Canadian cattle, led to the worldwide ban on all Canadian beef exports. The export market value for Canadian beef which was over \$4.0 billion in 2002, dropped to virtually zero for the three months following this ban<sup>42</sup>. The AHL’s role in monitoring this disease has therefore been very important for both economic and public health reasons. Dr. Grant Maxie, Director of the AHL at UG, commented that the lab has screened approximately 10,000 cattle over the last five years and they have not had one positive case. This type of surveillance has allowed Canada’s beef trading partners, mainly the U.S., to remain confident and provides assurance to consumers in Canadian beef products.

The AHL also monitors and provides information on disease trends, which has important implications for public health and public policy. This information enables policymakers to assess and plan for risks and determine further research needs. The AHL also provides a quarterly newsletter which disseminates knowledge and test results to veterinarians. The funding provided by OMAFRA to the AHL enables a significant amount of testing, surveillance, and early warning of zoonotic diseases. The funding also drastically reduces the cost of testing to farmers, as the AHL covers the courier fees on incoming samples. As a return on this funding, the AHL provides important detection and surveillance of zoonotic diseases. This work in turn serves to maintain public health, food safety, and international trade.

### 4.0 Researching Zoonotic Diseases

Zoonotic diseases are the focus of many important research studies at the Ontario Veterinary College (OVC) of the University of Guelph, this research is supported by funding provided to OVC through the agreement between UG and OMAFRA. Exciting and vital research is taking place at UG in areas such as avian influenza, salmonella, and antimicrobial resistance, among several others. As the examples

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<sup>41</sup> World Health Organization (WHO), Food and Agriculture Organization of the United Nations (FAO), World Organization for Animal Health (OIE).

<sup>42</sup> StatsCanada “Analysis in Brief: Mad Cow Disease and Beef Trade”, November 2003



below demonstrate, this research serves to maintain food safety and public health, reduce harmful economic impacts, and enhance public policy.

### **Avian Influenza**

One of the biggest fears across the globe in the area of zoonotic disease is currently avian influenza. This is a “contagious viral infection that can affect all species of birds but can, less commonly, infect mammals. While all bird species are thought to be susceptible to infection, domestic poultry flocks are especially vulnerable to infections that can rapidly turn into epidemics.” The subtypes of this virus known as H5 and H7 have been of particular concern, due to the highly pathogenic nature of these strains.

To demonstrate the potential economic impacts of an avian influenza outbreak, Eva Nagy, Professor of Virology at the Ontario Veterinary College at UG, described an outbreak of a highly pathogenic subtype H7N3 in British Columbia. In February 2004, this strain of the avian influenza was identified in a flock of poultry in the Fraser Valley of B.C. The disease continued to spread through poultry flocks in the region, and soon after, 2 cases were reported in humans. The CFIA ordered the depopulation of all poultry in the Fraser Valley, resulting in the death of over 17 million birds. During this time, the U.S. and other countries closed their border to B.C. and Canadian poultry and poultry products. The resulting economic impact to the B.C. poultry industry was estimated at nearly \$400 million<sup>43</sup> as well as a loss in employment.

Potentially deadly strains of avian influenza is currently one of the biggest fears in zoonotic disease worldwide.

A recent 2004 outbreak of the H7N3 strain in B.C. Poultry resulted in an economic loss of nearly \$400 million.

With such high economic costs and human health risks, research in the area of preventing avian influenza is imperative. Dr. Eva Nagy and her colleagues at UG are currently developing a vaccine that could be used to prevent the disease in chickens and other birds, and are hoping that this vaccine is available in the foreseeable future. Dr. Nagy also commented that she and other colleagues have collaborated with the Hospital for Sick Children, to develop a method to diagnose the highly pathogenic influenza A(H5) virus in humans. These research projects are partially funded by OMAFRA, and Dr. Nagy stated that this funding has been crucial to help leverage additional sources of funding. The size of the Ontario poultry industry shows the importance of research to avoid an outbreak of a disease such as

avian influenza. Ontario’s poultry and egg farms account for over \$1.0 billion in annual farm cash receipts, and Ontario is the largest poultry processing region in Canada, making up half of Canada’s entire poultry processing revenues.

### **Pork Industry**

Ongoing monitoring and testing of live Ontario farm animals by UG researchers is also helping to protect food safety and human health. Over the past six years, professor Robert Friendship of the Department of Population Medicine at UG has been monitoring 100 herds of swine across Ontario to track the prevalence of diseases linked to food-borne illnesses. Professor Friendship and his team tested for zoonotic diseases such as swine influenza, Campylobacter E. coli, and Salmonella, among others, which can contaminate meat and therefore cause illness in humans. This research, which was partially funded by OMAFRA, has been important to maintain the integrity and health of the Ontario pork industry.

### **“Super Bugs”**

Professor Cate Dewey, Chair of the Population Medicine Department at UG, stated that another area of significance being studied at the University is antimicrobial resistance. Antimicrobial resistance has become a global concern for animal and public health. It refers to bacteria that have developed to evade the effects of antibiotics, and this has important implications for zoonotic disease. Professor Scott Weese of the Clinical Studies department of the OVC at UG, has been studying Methicillin-Resistant Staphylococcus Aureus (MRSA). MRSA is a version of a common bacteria carried on the skin and in the nose that can cause skin and other infections and is resistant to many common antibiotics. Dr. Weese and colleagues have found that the disease is transmissible both ways between humans and household pets. Published in the Journal of Veterinary Microbiology, this was a significant find due to the fact that MRSA already costs Canadian hospitals an estimated \$100 million annually and

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<sup>43</sup> Inter-American Institute for Cooperation of Agriculture, “Canada’s experiences with Avian Influenza”, November 2005

causes the deaths of over 500 patients per year<sup>44</sup>. Dr. Weese has also studied the effects of bringing in companion dogs or other animals for patients in hospitals and long-term care facilities. This study found that 80% of therapy dogs carry zoonotic diseases that may pass from animals to humans and therefore these animals can in fact be a source of antimicrobial resistant and other infectious diseases in hospitals. These studies provided important policy guidelines for animal therapy programs in respect of this possibility of disease transmission between animals and humans in hospitals.

Professor Dewey also pointed out the work of Scott McEwen of the Department of Population Medicine at the OVC who has also performed important research on antimicrobial resistance. Antibiotics have long been used for disease protection and growth promotion in farm animals. The potential for there to be antimicrobial resistance in people as a result of this use in farm animals has been a focal point of study. Dr. McEwen has chaired Health Canada's Advisory Committee on Animal Uses of Antimicrobials and Impact on Resistance and Human Health, and the World Health Organization's evaluation of the termination of the use of antimicrobial growth promoters in Denmark. Professor Dewey mentioned that one of the conclusions of this WHO Report<sup>45</sup> was that there often was not a link between using antibiotics for growth promotion in farm animals and antimicrobial resistance in humans and that other countries relied on this report for antimicrobial policy. The advisory role of a UG Professor to the WHO, Health Canada, and other organizations, highlights the importance of this type of research and the impact on public policy, both provincially and globally.

## **5.0 Linking Animal and Human Health**

The University of Guelph will soon play an even greater role when it comes to the ability to collaborate and integrate research and education in animal and human health. Zoonotic diseases are increasingly becoming a public health threat in Ontario and Canada and this is driving the need for significant collaborative efforts among academic disciplines. In recognition of this fact, a new one-of-a-kind centre is based at the UG; the Centre for Public Health and Zoonoses (CPHAZ). OMAFRA and the OVC are among the partners for this Centre which is expected to generate several benefits.

This Centre will "coordinate existing and promote new collaborative research activities designed to enhance the capacity to solve problems and implement solutions in public health and to expand the pool of highly educated personnel, including a new Masters in Public Health Degree"<sup>46</sup>. It will include members from the OVC and collaborators from other campus departments and universities. The CPHAZ will also serve to increase public awareness and promote UG as a leader in the area of animal-related public health. Another important aspect of the Centre will be to contribute to implementing public policy based on scientific discoveries made by researchers. Through an increased understanding and ability to protect against zoonotic diseases that will result from this Centre, the economy of Ontario will stand to benefit.

## **6.0 Summary**

The majority of emerging diseases over the past decade are from domestic and wild animal origins, and these diseases pose a significant threat to human health and the economy. The WHO recognizes zoonotic and foodborne diseases as a major risk to public health. Canada has already seen trade restrictions resulting from zoonotic diseases in the poultry and beef industries. An outbreak of avian influenza H7N3 in BC poultry and cases of BSE in Canadian cattle resulted in devastating economic impacts to both industries.

Given the current state and heightened focus on zoonotic disease, ground-breaking research and rigorous testing and monitoring of animals has become even more important. The Animal Health Lab at UG plays an essential role in the testing and surveillance of zoonotic diseases. With state-of-the-art diagnostic capabilities and skilled scientists, the Lab is able to perform hundreds of thousands of tests to first detect diseases that have both public health and economic impacts. The Lab also monitors disease trends and disseminates knowledge to veterinarians and governmental organizations, thereby impacting public policy.

Research at UG in areas affecting animal and human health has also become increasingly important over the last ten years. Avian influenza vaccine and antimicrobial resistance research provide

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<sup>44</sup> National Post, "Superbug passed to people by pets", February 21, 2006

<sup>45</sup> "Impacts of antimicrobial growth promoter termination in Denmark - The WHO international review panel's evaluation of the termination of the use of antimicrobial growth promoters in Denmark", November 2002

<sup>46</sup> Moving Forward – OVC Integrated Plan: 2006 – 2012, January 2007

examples of how research performed at UG is contributing to the prevention and control of zoonotic disease. This type of research is protecting food safety, human health, and will hopefully help to minimize or avoid future negative economic impacts stemming from zoonotic disease. Funding provided to UG through the agreement with OMAFRA has given the Animal Health Lab the ability to provide first-rate animal testing and disease surveillance and has provided support to researchers at the Ontario Veterinary College and UG to carry out required research. These research and surveillance activities surrounding zoonotic diseases will continue to have a positive impact to the economy of Ontario, and just as importantly, the animal and human health populations.

# Case #6 – Agricultural Research and Innovation

**Abstract** – *There have been notable connections made between economic performance and innovation, and the important role of universities in innovation development. Given the size of the agriculture industry in Ontario and its involvement in food, healthcare, the environment, and the economy, agricultural innovation is critical to supporting this major industry and advancing it forward while addressing shifting global issues in agriculture. The University of Guelph, through its excellence in agricultural sciences and the OMAFRA support that it receives for its related research programs and research and laboratory facilities, is in an ideal position to drive this focus of building agricultural innovation in Ontario. Over the last decade, UG has undoubtedly excelled in agricultural research and innovation, visible in its research revenues, economic impact of OMAFRA research funds, international acclaim and recognition, completion of numerous projects, journal and book publications, attraction, development and retention of a valuable research talent pool, and most notably, its ability to explore and produce new products, processes and ideas in agricultural innovation. Some examples of such innovation include soybean, OMEGA-3, bioactive paper products, biogas and environmentally friendly fertilizer production, and transgenic pig research and development, along with various improvements in production technology, increased yields, and environmental management.*

## 1.0 Introduction

The Government of Canada has attributed lags in real income in Canada relative to the United States over the last twenty years to be significantly due to a lack of productivity in Canada, requiring substantial developments in innovation in order for the nation to realize significant economic gains and bridge this gap<sup>47</sup>.

Innovation has been defined as the “process through which economic or social value is extracted from knowledge through the creation, diffusion and transformation of ideas to produce new or significantly improved products or processes”<sup>48</sup>. Achievements in innovation are of immense importance not only to government policy makers but also to business and education leaders. Innovation plays a critical role in the current global economy with rapidly changing technologies, and knowledge becoming a significant competitive advantage across countless industries. Agriculture is not exempt from global competition; the Ontario agricultural industry must continually meet the economic challenges of a global marketplace. In addition to global competition topics surrounding safe, healthy food production, disease prevention and treatment, and developing and maintaining environmental sustainability are all of public concern worldwide, driving consumer spending decisions, export markets, and consequently industry, regional, and global competitiveness.

In Ontario, the agricultural sector is a key economic driver, visible in the 56,000 farms that the province supports, strong commodity exporting in oilseeds, pork, beef, livestock, and floriculture, along with numerous other examples. Thus, the need for exploring agricultural science and developing new concepts, products, efficiencies, and technologies becomes imperative in order to support this thriving sector.

## 2.0 Universities and Innovation

When it comes to exploring and developing innovation, universities have been identified as key contributors to research and development, and core to the process of building innovation<sup>49</sup>. Some analysts have even found the growth in productivity (and resulting income levels) in the United States in the 1990's to be a result of federal and state investment in university research in the 1980's<sup>50</sup>.

In respect to agriculture, research is considered a very important factor to enhancing the productivity and competitiveness of the Canadian agri-food sector<sup>51</sup>. In its *Science and Innovation Strategy*,

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<sup>47</sup> “Canada’s Innovation Strategy”. [Government of Canada](#).

<sup>48</sup> “Technology and Innovation”. [Conference Board of Canada](#)

<sup>49</sup> “Policy Perspectives”. [Business Council of British Columbia](#). “Canada’s Innovation Strategy”. [Government of Canada](#). [Organization for Economic Co-operation and Development](#)

<sup>50</sup> “US Industry Moderates its R&D Spending”. [Research Technology Management](#)

<sup>51</sup> George Brinkman “Strategic Policy Issues for Agricultural Research in Canada”. [A Journal of the Canadian Agricultural Economics Society](#).

Agriculture and Agri-Food Canada (AAFC) notes their priority of building critical mass through the development of partnerships among Canada's universities, government, and industrial sectors in order to enhance the return on investments in agricultural science and innovation.

The OMAFRA / UG Agreement is a prime example of such an effort, fostering significant agricultural innovation by providing substantial support to agricultural research programs, supporting a collaboration between government, university bodies and industry in order to effectively realize a return on government investment, and resulting in benefits for the broader community and economy.

### **OMAFRA/UG Agreement Support**

In regards to agricultural innovation, the University of Guelph, and its dedicated funding agreement with OMAFRA contributes significantly to the functions of research programs, laboratory services, Ontario Agricultural College and Ontario Veterinary College educational programs, as well as various facility functions. All of these play an important role in a university's ability to engage itself in advancing its programs in innovation; however the following sections will mainly examine the more technical areas of UG's research programs and facilities. OMAFRA research programs are delivered primarily through the Ontario Agricultural College (OAC) and Ontario Veterinary College (OVC).

In regards to funding, a substantial portion of the agreement goes towards the OAC / OVC research programs. Of the approximate \$500 million transferred to the University between 1998 and 2006, approximately half, or an average of \$27.7 million per year, went towards supporting research alone, including related infrastructure and facility support.

## **3.0 UG Research Programs, Research Stations, and Lab Services**

### **Research Programs and Stations**

There are five main research programs and fourteen research stations supported under the agreement. Research is also one of the primary mandates of the regional campuses, along with delivery of the diploma and continuing education programs. The research programs delivered primarily by the OAC and OVC are quite expansive in subject coverage, including program topics in Sustainable Production Systems, Resource Management and Environment, Food, Sustainable Rural Communities, and Bioproducts.

These programs and a few select examples of program highlights and achievements within the last two years can be described as follows:

*Sustainable Production Systems (SP2)* – involves the transformation of the previous commodity-based Plant and Animal Programs to a new enlarged, integrated, multi-disciplinary, issue-based research program. Despite the transition into this new program, SP2 research in animal and plant topics has resulted in notable highlights and substantial project activity, including the examples described below.

- The Animal beef sub-program identified risk factors associated with a threatening strain of E. coli in beef animals which will facilitate the lowering of food and waterborne illnesses resulting from this pathogen, as well as mitigating negative perceptions of beef products and effects on public safety.
- The Animal aquaculture sub-program completed several studies in fish behavior and welfare assessment with the aim to improve acceptance in fish farming practices by the general public and thus also support this considerable industry in Ontario.
- The Plant program conducted research whereby saturated fats were lowered to less than 4% in UG canola breeding lines, providing healthier oil for human consumption; and research whereby strawberries could be enhanced with vitamin B<sub>2</sub> while also experiencing improved coloring.

In 2005/2006 the UG Plant research program realized numerous achievements including:

- saturated fats lowered to less than 4% in UG canola breeding lines, providing healthier oil for human consumption
- strawberries enhanced with vitamin B<sub>2</sub> while also experiencing improved coloring.

*Resource Management and Environment (RME)* – seeks to improve the planning and management of natural and economic resources while sustaining a competitive agri-food system for Ontario; some key issues of concern include efficient nutrient management, climate change mitigation and adaptation, threats to water resources, evaluating best management practices, innovation and development of market opportunities, and optimizing trade agreements.

- Improved methods of watershed modeling have been developed, which will facilitate the study of climate change scenarios, an increasingly critical concern worldwide.
- An improved price forecasting model has been developed to predict corn and soybean prices in Ontario, assisting both farming and retail operations province wide.

*Food* - undertakes research and information transfer to support Ontario food processors in the manufacturing of high quality products that are acceptable to Canadian consumers and competitive in world markets; research objectives include food quality, value-added products, and innovative technologies, processes, and systems.

- Egg supplements for preventing pathogen infection and thus preventing Salmonella colonization of chickens has lead to increasing and assuring the safety of Ontario poultry and egg products.
- A unique vegetable oil/water monoglyceride gel with cardiovascular health benefits was identified as an edible spread, with similar qualities to butter or margarine, but with lower calories and devoid of trans fatty acids.

*Sustainable Rural Communities (SRC)* – aims to contribute to the sustainability of rural Ontario by undertaking research that is effective in improving the economic, social and environmental conditions of rural communities; focuses on the objective areas of economic development, responding to change and restructuring, capacity building, and information technology.

- The SRC's Innovative Rural Communities project combined University and independent consultant funds of \$12,000 and attracted an additional \$260,000 in external funding for a 3-year period; this project has created a unique model to study and foster innovation in the rural and Northern communities of Ontario.

*Bioproducts* - facilitates the transition to a more sustainable economy by replacing petroleum-based resources with renewable plant- and animal-based resources; research is both market and sustainability-driven, exploring bioproducts such as fibre, chemicals, and co-product generation produced from agricultural-based renewable resources.

- Research in biocomposites material has lead to the building of the world's first biocomposite footbridge in the Arboretum at UG, replacing common wood fibre and petroleum-based materials with agricultural fibre; this bridge extends 10m, weighs approximately 2,800lbs, and consists of 70% polypropylene (plastic used in soft-drink bottles) and 30% wood fibre.
- The UG Bio Products steering committee is focusing funding towards developing the application of biocomposites into the auto industry, potentially replacing parts such as car seats or dashboards with agricultural, renewable materials and directing an enormous industry towards significantly improved environmentally conscious practice and production.

*Research Stations* – Underpinning the above noted programs, the OMAFRA / UG agreement supports 17 research stations throughout Ontario (14 standalone research stations and the 3 regional campuses). These stations are what makes Guelph distinctive from other life-sciences Universities, and are vital to the field experimentation and research process in areas including agroforestry, turfgrass, aquaculture, engineering, pest management, horticulture, and animal, crop, and veterinary science. **Appendix D** outlines a detailed listing of these research stations and descriptions of their operations.

### **Lab Services**

Extensively supporting all of the aforementioned Research programs at UG is the Laboratory Services (LS) Division, which provides services through four units, including Analytical Services, Regulatory Services, Research Coordination, and Animal Health Laboratories at the Guelph and Kemptville campuses. LS is a versatile analytical and diagnostic laboratory, with over 150 employees supporting UG activities and also serving a broad range of clients, including agri-food and veterinary clients within government, commercial and academic sectors for over thirty years. Lab Services is also greatly supported under the OMAFRA/UG agreement, receiving an average of approximately \$9 million annually.

The list of services offered through LS is quite expansive, including industry services such as DNA analysis, biotech and agro-chemical testing; as well as compliance, regulatory, and food safety testing dealing with commodities, pesticides, chemical residues, and allergens. These facilities and extensive

testing capabilities play a significant and collaborative role in the research and innovation activities within agricultural sciences at UG.

Many UG researchers and graduate students also receive specialized training within LS in order to support their research and field work, strengthening the relationship and collaboration between UG's Research programs and Lab Services testing units.

Recognition received by LS exhibiting high quality and standards include accreditations from the Standards Council of Canada (SCC), the Canadian Association for Environmental Analytical Laboratories (CAEAL), the American Association of Veterinary Laboratory Diagnosticians (AAVLD), as well as ISO 9001:2000 registration.

#### 4.0 Research Program Activities and Impacts in Science and Innovation

There is little doubt that UG's capacity in agricultural sciences has impacted the Ontario agricultural sector, and largely with support from OMAFRA for its research programs. UG's Research Programs have been involved in considerable activities, including totals of 1,197 completed projects, 1,054 licenses, patents, and royalty agreements, 2,836 journal publications, 951 book or chapter publications, and 4,547 conference papers among other substantial work.

Research Program Activities	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
Active Projects	332	399	347	335	327	307	319	297	278	N/A
Completed Projects	151	188	99	79	182	129	112	89	168	1,197
Licenses/Patents/Royalty Agreements	70	80	115	119	126	111	108	156	169	1,054
Peer Review Journal Publications Written		369	381	326	345	350	340	352	373	2,836
Books / Chapters Written		66	45	47	68	52	78	203	392	951
Scientific Conference Papers		521	540	454	487	449	723	562	811	4,547
Software Products		7	2	1	1	0	0	0	0	11
Media Presentations		446	323	307	190	188	304	192	179	2,129
Provincial/National Agri-food Committees		194	190	250	232	293	371	296	678	2,504

During the conducting of interviews with key stakeholders of assorted agri-food industry, academic, and government backgrounds, there was a strong widespread agreement that the support received by UG research programs was essential to the development of agricultural innovation in Ontario, given the University's prominent reputation in agricultural sciences and many key examples of work produced under the agreement.

Some key highlights commonly noted by these stakeholders include:

- Significant genetics and breeding crop improvements resulting in improvements in production technology and yields (ex. corn, soybean, and grape) and enhancements to returns on investments;
- Development of improved genetics in livestock, leading to such results as:
  - the creation of Semex, a local and recently developed company commercializing semen sexing technologies with export markets worldwide;
  - the discovery of a genetic link in cattle improving on beef tenderness and quality;
- Critical developments in innovation such as OMEGA-3, suggesting significant health benefits and resulting in sizeable growth in the OMEGA-3 milk and egg markets;
- Improvements in farming related environmental impacts such as better water retention in soil (no till) and low-impact pest management and herbicide usage;

- Valuable research work conducted in floriculture, nutraceutical tobacco plants, and natural and medicinal plants such as ginseng and Echinacea leading to substantial development and growth in the production and markets of these products; and
- Substantial content support to the award-winning, highly beneficial and successful Environmental Farm Plan, an educational environmental management program for farmers.

The following innovation profiles outline three specific examples that are significantly supported through the OMAFRA / UG agreement and identified by several stakeholders as valuable contributions in research, despite being in the earlier stages of marketability or utilization. This is mainly because they involve great work and innovation in agricultural science, resulting in significant benefits in terms of health, the environment and economics, and they are examples of effective department collaboration at UG.

### **Bioactive Paper Products**

Professor Chris Hall and fellow scientists and researchers at UG's Ontario Agriculture College, Environmental Biology department have collaborated in the development of protein enhanced paper filters that can detect and capture harmful particles, resulting in potentially great health and economic benefits through disease prevention.

Most filters are based on cellulose (a carbohydrate), and rely mostly on small pores that prevent contaminants from passing through, according to their size. The new UG filters feature special proteins that stick to cellulose. These proteins have two parts, a cellulose binding domain (CBD) to bind cellulose, and an antibody to bind pathogens and other contaminants. Thus these filters actively remove unwanted components in a variety of situations.

The challenge of these new filters is taking what binds pathogens to bind to paper as well. The protein's CBD will be borrowed from enzymes that normally bind to cellulose and degrade it, and using molecular biology tools, Chris Hall and his team create "fusion proteins" that replace the degrading component with an antibody that distinguishes harmful agents, fusing and anchoring them to the filter surface and preventing them from passing through the paper's pores.

These advanced filters have strong capabilities to protect the health and safety of Canadians, with multiple significant potential uses, including:

- Removing water contaminants;
- Purifying disease-causing antigens for medical research;
- Preventing undesirable agents from entering emergency blood supplies;
- Protecting citizens from bioterrorists; and
- Filtering the air in automobiles.

As another example, a SARS or other disease fighting antibody could be linked to paper through a CBD, and this paper could then be used to supply healthcare workers with masks to prevent them from inhaling the virus by trapping it first. Professor Hall is also investigating antibodies designed to detect species such as Escherichia coli (E. coli) and Pythium, which has damaging crop disease implications. Given the severe health and economic impacts of major disease outbreaks, such a tool and preparedness for dealing with disease prevention and treatment suggests a great healthcare advantage and potential cost savings for the province.

### **Transgenic Animals- Enviropig**

Scientists and researchers at UG and the Ontario Veterinary College are the creators behind the internationally recognized Enviropig, a phosphorus efficient, and thus "environmentally friendly", pig, developed over the last 10 years. Normally, the manure of monogastric animals such as pigs contains a higher concentration of phosphorus as indigestible (phytate) phosphorus passes through the animals' digestive tract, while other nutrients are absorbed. During manure application as fertilizer for crop growth, this leads to potential pollution of local surface and ground water through contaminated farm runoff.

The first three pigs were named "Wayne", "Jacques" and "Gordie" (rumor is after three famous hockey players). Today Guelph holds more than 100 Enviropigs, the result of 3 generations of breeding.



Enviropig has been bred, through genetic engineering, with a gene imported from a bacterium that causes these pigs to produce phytase in its salivary glands, improving its ability to digest the phosphorus contained in its food. These enzymes work in the stomach the same as the fungal phytase which is normally found in pig feed (as a supplement). Enviropig produces sufficient phytase to digest practically all of the phytate in their regular diet, not requiring feed supplements, and not resulting in the same environmental damage.

Key environmental and economic benefits from the Enviropig include:

- Up to 75% less phosphorus excretion in feces, thus manure is better suited for long-term, repetitive application to land;
- An estimated 33% less land would be required to spread manure from transgenic phytase pigs;
- Utilization of almost all the phosphorus in diet;
- No required phosphorus supplements, resulting in a savings of at least \$1.14 per pig – adding up to approximately \$6 million annually if all 5.4 million market hogs were Enviropigs; and
- Increased feed efficiency of trace minerals, proteins and starch due to comprehensive digestion.

At this point it is difficult to predict when Enviropigs will potentially be commercialized and reach customers, due to strict federal guidelines and regulations under which approval is required. The Enviropig is subject to the Canadian Environmental Protection Act (CEPA), the Health of Animals Act, and the Novel Food Regulations of the Federal Food and Drug Act. These will assure that the pork from these animals will be safe, along with the many tests already passed by scientists and researchers verifying its safety to date.

Public acceptance of genetically modified products is also an obstacle to Enviropigs introduction the market; however some UG and OVC scientists feel that perhaps it is simply a matter of time before such acceptance takes place, and the introduction of certain innovation to the public is often a timely process. Regardless, Enviropig is considered to be on the leading edge of the production of various types of genetically modified animals that can reduce the environmental footprint of animal agriculture through enhanced metabolic capabilities, and is thus considered a fine example in public research and innovation.

Some independent experts think Enviropig is a solid bet. Dr. Joann Whalen a soil expert at McGill University thinks Enviropig is even better than a non-biotech solution to the phosphorus problem that she helped develop. Whalen found that mixing limestone in with hog manure could net a 50 percent reduction in phosphorus content. But, she says, this method is expensive and impractical, as the limestone has to be trucked in to farms and requires extensive manpower to spread.

It's dealing with the problem after the fact," Whalen concedes. "[Enviropig] is definitely a much better approach -- it's more cost effective to have a pig that excretes less phosphorus."

**Source – “The Next Pig Thing”, By Leora Broydo**

Government departments and agencies supporting and collaborating in this innovative effort, include Ontario Pork, Ontario Ministry of Agriculture, Food, and Rural Affairs, Food Systems, Biotechnology Center at the University of Guelph, University of Guelph, Mars-Landing, Rural Economic Development of the Ontario Government, Advanced Food Materials Network, Natural Sciences and Engineering Research Council of Canada, and Agriculture and Agri-Food Canada.

### **Biogas/Improved Fertilizer Production**

UG Ridgetown Campus researchers are examining the potential of on-farm biodigestion units that produce methane “biogas” utilizing animal manure and other waste materials. Such an innovation suggests major enhancements in farming sustainability, environmental protection, and economic opportunities.

The main anaerobic digestion process of this research involves the production of methane to produce electricity and heat, as well as a material that is rich in nutrients and suitable for field application. This system involves transferring livestock manure into an airtight container, into which bacteria are introduced. After approximately three weeks, the anaerobic bacteria convert certain manure

compounds into methane gas and carbon dioxide. This resulting biogas is a valuable by-product which can be utilized in the production of renewable energy, as a vehicle fuel, for generating electricity, directly for cooking, heating, lighting, process heat and absorption refrigeration.

Following the anaerobic digestion process there is also a slurry mixture remaining, which can be utilized as an environmentally friendly fertilizer, as the digestion process kills harmful bacteria and removes odor from the slurry, creating a more suitable fertilizer for neighbors than untreated manure.

Ridgetown Campus researchers are also studying various mixtures of manure and other materials to examine levels of cost-effectiveness of digestion. The addition of off-farm materials that are high in carbon such as food processing wastes can dramatically increase methane yield in comparison to manure alone. Thus, separated solids from food processing operations that are typically discarded to landfill sites could be utilized in this valuable digestion process, minimizing damaging environmental impacts.

Presently there are two such digesters on Ontario farms and only a few more throughout the rest of Canada. In Germany (the largest user of this process), electricity is more expensive and these digesters and the use of off-farm material usage are encouraged via government policy resulting in 3,000 units in place on farms.

The environmental and sustainability advantages of this biogas development process are many fold, making this a very useful tool. Efficient, nutrient-rich fertilizer, sustainable energy production, and waste minimization are a few of the properties of this system that could potentially benefit the population of Ontario.

## 5.0 Additional Impacts

There are several additional impacts that add to the scientific value of work produced through the OAC research programs at UG, in terms of yielding financial benefits, supporting the University's high standing reputation, facilitating the growth of the Guelph agri-food cluster, and attracting and retaining talent.

The expansive research work through the OAC programs also results in significant revenues and economic impacts. The University of Guelph's total research income was an estimated \$126 million in 2005, and of that \$47.9 million (38%) was within the Ontario Agriculture College research units, which are supported through the OMAFRA agreement. George Brinkman notes significantly high returns on agricultural research, with approximate benefit-cost ratios of 20:1 or higher for individual commodities, and exhibiting higher returns than those for most other types of public expenditures. Within the economic impact study section of this report, it was noted that the research programs supported by OMAFRA resulted in a direct and indirect impact of over \$52 million in Ontario for 2006 alone. Additional leveraged funds in research totalled \$69.5 million, resulting in an estimated direct and indirect economic impact of \$90.6 million. Numerous industry professionals interviewed felt that without the critical OMAFRA funds serving as initial "seed money", UG's research programs would not be able to excel as they do, and thus wouldn't be able to attract this required leveraging potential.

The University of Guelph is considered one of Canada's most research intensive universities, receiving much supporting acknowledgement, recognition, and awards to this effect over the last decade. A recent *Science Watch* worldwide study ranked UG 7<sup>th</sup> for its impact on agricultural sciences over the past decade, and it was the only Canadian university to be among the top 25 institutions ranked for agricultural research between 1996 and 2006. Agricultural research papers published by University researchers were cited over 8,000 times between 1996 and 2006 and when measured according to impact, UG ranked 12th among universities worldwide. In addition, for five consecutive years UG has been ranked among the top comprehensive research universities in Canada in a report by Research Infosource Inc., published in the *National Post*. There is likely a strong cyclical effect between the OMAFRA funding and UG's outstanding reputation in agricultural research, whereby the funding supports the critical ongoing work within the research programs, advancing UG's reputation for excellence in agricultural sciences and thus substantiating both OMAFRA's and external leveraged funds as a powerful investment.

The University of Guelph was the only Canadian university to be among the top 25 institutions ranked for agricultural research between 1996 and 2006. Agricultural research papers published by University researchers were cited over 8,000 times between 1996 and 2006 and when measured according to impact, UG ranked 12th among universities worldwide.

The research capacity at UG surely contributes to the strong Guelph agricultural biotech cluster that has formed around UG, which boasts potential advantages including increased productivity and efficiency, innovation, knowledge sharing, and attraction of investment. The reputation of UG in agricultural research has potentially facilitated the attraction of several of the members in the cluster. The University is able to provide great support in terms of filling the specific research needs of the nearby government bodies, associations, and estimated 60 ag-biotech companies, many of which often contract UG for research projects or contribute to the leveraged research funds received by the University. Research at UG in collaboration with the surrounding cluster enables technology transfer of production best practices leading to environmental sustainability and improved profitability farm businesses located across the province. Known research partnerships exist between UG and Mars-Landing, Advanced Food and Materials Network, OMAFRA, and Agriculture and Agri-Food Canada, just to name a few.

Numerous stakeholders also note that UG attracts and retains a valuable talent pool of scientists and researchers, a significant number of whom are supported through the OMAFRA contract. This talent pool is often attracted to the strong and reputable institution in terms of agricultural sciences, while significantly contributing to its research and innovation capacity, and thus enabling a further building of the University's reputation as a centre of excellence and expertise base.

## **6.0 Summary**

Research is a key driver of innovation, and as such, the large and comprehensive agricultural science research programs at the University of Guelph and associated OAC and OVC translate into a significant capacity for agricultural innovation. In regards to research alone, UG has established itself as a leader in agricultural sciences, and together with OMAFRA support this has enabled UG to contribute to the agricultural sector in the form of many scientific publications, the development of a strong research talent pool and the provision of facilities and tools to support their work, and supporting research to government, industry, and commodity organizations. In addition, UG research has led to the formation of considerable examples of exceptional and advanced innovation. The University's exhaustive activities in agricultural innovation involve the addressing of critical issues and improvements in healthcare and disease prevention, food safety and nutrition, and environmental sustainability, all of which serve vital purposes to drive the Ontario agricultural sector forward, and work towards increasing and protecting public welfare.

## 7.0 Stakeholder Views

During the course of this assignment we conducted interviews with over thirty stakeholders of the OMAFRA/UG agreement. The stakeholders ranged from industry, academia and government. Though the focus of the interviews was to determine the impact that the agreement had over the past 10 years, the interviewees discussed a wide range of subjects. This section will consolidate the comments into a few general themes and will also outline some challenges or concerns that the University and the Agreement faces. Readers are cautioned that these comments are consolidated from a limited interview format, and as such further investigation would have to be undertaken prior to formulating a full opinion on some of the issues raised.

### Reflections on the Past Ten Years of the Agreement

There was consensus that over the past ten years the agreement has provided significant value to the province and to the agricultural sector. Interviewees had noted a number of areas where the benefits were derived, namely:

- The agreement has produced “great science” and a number of research “superstars”.
- The agreement has had a profound impact on developing, attracting and retaining talented individuals for the industry.
- Strengthening the competitiveness of major export products via research, innovation and training.
- Environmental improvements through better water management, improved pest management and overall environmental management.
- Crisis prevention, through research, education and monitoring of major diseases or other potential public health concerns.
- Economic benefits, including the development of a number of new products from the research generated through the agreement and increased crop yields and improved livestock productivity for farmers.

The stakeholders overwhelmingly agreed that the Agreement between OMAFRA and the University of Guelph has had tremendous benefit to the industry and the Province.

Overall, the interviewees were overwhelmingly positive on the benefits created over the past ten years of the agreement.

### Research: The Need for Capacity

A key theme that came up in many of the interviews was that the industry requires a base or “stable” of research talent. The lion’s share of the approximate \$34 million in research funding provided under the agreement supports research “capacity” or a research platform. This research capacity is effectively construed of faculty members, technicians and research stations. This funding assists in providing two key components for research - talent and infrastructure. Providing this platform allows for researchers to leverage this capacity with project specific funding. Interviewees noted that maintaining this broad based research and infrastructure capacity is critical for the province for the following factors:

(i) Agriculture is a product of Mother Nature, which is an unpredictable force. The industry is continually under different stresses - long term climatic changes, short term weather issues (such as a drought), crop and animal diseases all can impact the industry with little or no predictability. In order to respond effectively to these issues in a timely manner it is important to have the expertise and research base available to the industry, and that is what this infrastructure provides. The Agreement provides for the ability to react to unforeseen situations (drought, BSE) or to impending threats (such as in the case of Soybean Rust).

Many respondents also noted that the value that this core research capacity provides is invaluable in times of public health type crises where the timeliness and effectiveness of a response is measured in lives and millions of dollars.

(ii) There is a need to provide solutions that stakeholders feel confident in. There is a potential perception (whether correctly held or not), that solutions developed wholly by the private sector are not independent or, as some of the interviewees labeled them, “bought reports”. This perception can lead to adoption difficulties within the industry. A strong core of independent research through an academic institution provides confidence to the sector and the public.

(iii) The reality is that research breakthroughs are generally not linear in nature; they evolve in unpredictable patterns and require broad based research capabilities to augment specific research projects. In addition, the ability for a University to effectively connect and collaborate with other research projects both nationally and globally provides a visibility into other findings that can assist in both research and commercial applications.

(iv) Due to the increasing trend of convergence of different disciplines, knowledge and research (for example agricultural and public health, agriculture and fuel technology etc.) the need for a publicly accessible stable of research knowledge and capability will be increasingly required in the future to facilitate research and the resulting discoveries.

### Tomorrow’s Research Challenge

One stakeholder put it bluntly – “We have solved the problem of feeding people in Canada – the real issue is what is next”. What the stakeholder was getting at was multi-leveled, and was directly aimed at where the University should be exerting its resources in the future.

This stakeholder and many others were of the opinion that the University should expend its resources on “cutting or leading edge research”. One stakeholder highlighted the Soybean industry. The University created the OAC Bayfield soybean type – a soybean that could meet the challenges of growing in Ontario – and is widely credited with sparking the growth of this \$750 million industry in

*“We have solved the problem of feeding people in Canada – the real issue is what is next.”*

Ontario. This is the type of research that the University and OMAFRA funding should be directed to as it is an area that is under serviced by the private sector. This is in contrast to developing incremental strands of Soybeans that increase yield. Generally the private sector does not invest into very “remote” or “far off” technologies or research. However the private sector is effective in developing incremental technologies, such as improving on soybean varieties to increase yield. As such, the view point that this stakeholder as well as others held was that the research dollars should be more concentrated in cutting edge research rather than incremental research. These stakeholders reinforced their position by noting that since the majority of the research budget is dedicated to providing infrastructure, the pure research budget is limited. Due to this limited resource OMAFRA and the University should be focused on areas that are not being serviced appropriately.

Though this issue was raised, there was recognition by some stakeholders that the work undertaken by the University on its breeding program or other “incremental technologies”, are valuable from a human resource development perspective. Breeding programs for fruit, soy, corn, livestock and plants in the private sector did have value from developing students for entry into the industry, as such this aspect would have to be accommodated.

### The Guelph Cluster

Stakeholders noted that the agri-food cluster in the Guelph area and the network of the research stations and regional campuses connected to Guelph has evolved into a very well functioning cluster. This cluster has international reach and is a key feature of the agri-food industry infrastructure in the province. One stakeholder noted that the true measure of the effectiveness of a cluster is not the number of organizations in a defined area, but rather the level of connectivity between the organizations. This stakeholder and many others noted that the level of connectivity and synergies created between industry organizations, individual companies, government agencies, and specific University programs and in some cases specific researchers was very strong.

*The Guelph Cluster is effective due to the number and diversity of the organizations involved in the cluster, and more importantly, due to the level of connectivity and synergies of these organizations.*

The stakeholders noted that undoubtedly the cluster will continue to grow and develop, and that the demands of clusters will be even greater and more diverse in the future. Trends such as functional foods, industrial crops, and zoonoses will require increasingly cross-functional and multi-disciplined

talents to develop, and this cluster will need to adapt to meet them. The stakeholders had noted that the cluster is adapting and that they had confidence that with continued support the cluster will be able to meet these new challenges.

### **Concerns Raised**

Though overall there was consensus as to the effectiveness of the agreement, several stakeholders raised some concerns or challenges for the Agreement and the University.

#### *Flat Funding*

There was a general concern raised by all stakeholders as to whether the research infrastructure was being adequately maintained. Due to the fact that funding has remained relatively flat, there was concern that the capability of the infrastructure was being eroded by inflation. Stakeholders noted that not only does the research capacity become eroded, but so too does the University's ability to attract and retain talent.

In addition, stakeholders noted that the need to maintain the infrastructure and the increasing cost of the infrastructure will continue to pull more resources away from cutting edge research. Stakeholders also noted that due to the changing scope of services and increasing demands placed upon the human resources and the infrastructure supported by the Agreement that a flat funding situation was not sustainable.

#### *Adapting "what is in the box"*

Some stakeholders felt that the University could provide solutions to the industry by testing what works from available options both from North America and globally. Stakeholders noted that adapting solutions or research from other countries will reduce research and development efforts that stakeholders felt were "wasted on re-inventing the wheel". Some stakeholders were of the opinion that the University could improve in this area of "adaptive" research.

#### *Connecting Globally*

As noted previously, the University and the cluster are well positioned to network globally and this has happened in some instances. That being said, many stakeholders felt that the University needs to increase their effectiveness of networking on a global basis to jointly bring more talent, resources and solutions focusing on industry matters. Stakeholders felt that by effectively networking on a global basis there was less of a risk of duplication of efforts and that there would be greater research output in both quantity and quality.

## 8.0 Conclusion

The purpose of this report was to substantiate the impact that the University of Guelph and OMAFRA funding agreement has made on the Province of Ontario. In summary, this agreement has made significant contributions to the province in the following manner:

**Economically** – The agreement has an economic impact in excess of \$1.1 billion. In addition to the economic impact, the agreement has made the agri-food industry in Ontario more competitive through innovation, the development of a talented labour force as well as assisting it in dealing with the continuous and various challenges that this sector faces.

**Non-Economic Contributions** – The impact of the efforts related to the research, monitoring and other activities undertaken by the University on several public health issues cannot be accurately measured in an economic sense, however the impact on the quality of life for the population of Ontario is very significant.

**The Creation of an Economic Cluster** – The agreement and the unique relationship between OMAFRA and UG has contributed significantly to the creation of the Agri-food cluster in Guelph.

**Environmentally** – The development of the Environmental Farm Plan and Best Management Practices has assisted Ontario's farmers in addressing environmental issues. This is just one example of the environmental impacts that the Agreement has contributed to.

Overall, the impact related to this agreement is multi-faceted, far reaching and substantial to the agri-food industry and the Province of Ontario as a whole.

*Deloitte would like to thank the stakeholders that contributed to this project as well as the staff of the University of Guelph and OMAFRA for their assistance during this study.*

# Appendix A - Guelph Agri-Food Cluster Organizations

The following list details several of the companies and organizations making up the Agri-Food cluster in the Guelph area:

<b>ACC Farmers' Financial</b>	ACC offers programs for Ontario farmers and agricultural organizations across Canada. Through ACC Farmers' Financial, Ontario's farmers can access low-cost operating lines of credit for their crop inputs and advance payments on harvested crops placed for storage.
<b>AdFarm</b>	AdFarm is a full-service marketing communications agency 100% dedicated to agriculture, working only with agricultural clients to help achieve their business and marketing goals.
<b>Advanced Food &amp; Materials Network</b>	AFMNet is Canada's front line of research and development in the area of advanced foods and bio-materials – from new, lower cost antibiotics, to improved frozen food quality to faster healing wound dressings.
<b>AGCare</b>	AGCare provides science- and research-based information and policy initiatives on pesticide use, crop biotechnology developments, nutrient management and other related environmental issues surrounding field and horticultural crop production in Ontario.
<b>Agricorp</b>	Agricorp is a Crown agency of the Government of Ontario, responsible for delivering government and non-government priority products and services that assist Ontario's agri-food industry managing risks.
<b>Agriculex Inc.</b>	Agriculex builds equipment that is specifically designed for use in agricultural research.
<b>Agricultural Adaptation Council</b>	The Agricultural Adaptation Council (AAC) is a non-profit coalition of 70 Ontario agricultural, agri-food and rural organizations. The diverse membership of the AAC represents the agriculture and agri-food industry both regionally and by sector. The AAC was established by leaders from the agriculture and agri-food sector in 1995 to allocate federal government funding to support new, innovative projects to benefit the sector.
<b>Agriculture and Agri-Food Canada</b>	Agriculture and Agri-Food Canada provides information, research and technology, and policies and programs to achieve security of the food system, health of the environment and innovation for growth.
<b>Agri-Food Laboratories</b>	Agri-Food Laboratories is the largest independently owned agricultural laboratory in Ontario, providing analytical services for feed, soil and water as well as quality control testing for agricultural manufacturing of feed and fertilizer.
<b>Agri-Tours Canada</b>	AgriTours Canada provides specialized study tours and trade missions for North American and International agricultural companies and organizations.
<b>Agro-Hort Technologies</b>	Provides wholesale and post harvest care of flowers and fruits.
<b>Bayer Crop Science Canada</b>	A leading manufacturer of herbicides, insecticides, fungicides, and seed treatments, and canola seed, Bayer Crop Science Canada supplies seed and crop protection to more than 60,000 Canadians. Through research and development of new innovative crop protection weed and pest control products, the company is committed to the future of Canadian agriculture.
<b>Beef Improvement Ontario</b>	Provides data management services to enhance the competitive position of the Ontario beef industry.
<b>BioEnterprise</b>	BioEnterprise Corporation is a not-for-profit company founded in 2003 through the financial support of Agriculture and Agri-Food Canada and the Ontario Ministry of Agriculture, Food and Rural Affairs. BioEnterprise is a commercialization agent, established to help promote the creation, growth and expansion of businesses in the agri-food and agri-life sciences and bio-product industries.



<b>Canadian Animal Health Institute (CAHI)</b>	The Canadian Animal Health Institute (CAHI) is the trade association representing the developers, manufacturers and distributors of animal pharmaceuticals, biologicals, feed additives and animal pesticides in Canada. CAHI is a national association, whose members are responsible for sales of approximately 90% of the animal health product market in Canada.
<b>Canadian Dairy Network</b>	The Canadian Dairy Network mission is to provide excellence and leadership in dairy herd improvement through an efficient information infrastructure and quality genetic evaluation services ensuring Canada's continued responsiveness and competitiveness both domestically and internationally.
<b>Canadian Food Inspection Agency</b>	Food safety is the CFIA's top priority. The CFIA develops and delivers programs and services designed to protect Canadians from preventable food safety hazards and to ensure that food safety emergencies are effectively managed.
<b>Canadian Research Institute for Food Safety (CRIFS)</b>	CRIFS is dedicated to the generation of new knowledge through basic and applied research, to the training of scientists and to providing information and expertise applicable to all sectors of the food industry. CRIFS' goal is to improve safety and quality by providing sound scientific information, research and development, food safety alerts and technology.
<b>CanWest DHI</b>	CanWest DHI is a non-profit milk recording organization, providing dairy management solutions to dairy producers across Canada. The company's mission is to maximize sustainable net income of progressive dairy farms by providing management products and milk recording services to provide dairy producers with management information in order to make sound business decisions and enhance revenues or reduce expenses. Such services include basic milk recording, sales and support of herd management software, submission of Electronic Registration Applications to breed associations, herd management consulting and the continuing education in herd management topics.
<b>Controlled Environment Systems Research Facility (CESRF)</b>	The Controlled Environment Systems Research Facility and its Space and Advanced Life Support Agriculture program are an essential part of Canada's contributions to plant research and development for space and closed environment related activities. The facility provides a complete research venue suitable for measurement of plant growth, gas exchange, volatile organic compound (VOC) evolution, and nutrient remediation in a precisely controlled environment.
<b>Elanco Animal Health</b>	Elanco is a global research-based company that develops and markets products to improve the health and production of animals.
<b>Engage Agro</b>	Engage Agro is involved in the registration, sales, and marketing of specialized and niche market crop protection and pest control products in Canada.
<b>Equine Guelph</b>	Equine Guelph is the Horse Owner and Care Giver's Centre to improved health and well-being of horses through research, performance and education.
<b>Farms.com</b>	A leading provider of innovative information products and services to the global agriculture and food industry.
<b>Farm Credit Canada (FCC)</b>	FCC is Canada's largest provider of business and financial services to farms and agribusiness. FCC proudly serves Canadian agriculture as the leading provider of financing to the industry since 1959.
<b>Food System Biotechnology Centre</b>	Carries out research built on emerging knowledge of animal and plant genetics and molecular biology to strengthen Ontario's agri-food system.
<b>George Morris Centre</b>	Founded in 1990, the George Morris Centre is a Canada-wide, not-for-profit charitable organization. As an independent think-tank, the Centre provides industry decision makers with critical information and analysis on issues affecting the Canadian agri-food sector. The Centre's products and services assist public and private sector clients who are adjusting to change, and those leading the change.
<b>Guelph Food Technology Centre</b>	GFTC is Canada's only not-for-profit, non-subsidized food technology centre. GFTC provides creative, confidential technical solutions, training, consulting and auditing to the Canadian agri-food industry in the areas of R&D, product development, packaging, shelf-life, food safety, quality, and productivity improvement.

<b>Guelph Partnership for Innovation</b>	Guelph Partnership for Innovation is a regional network that acts as the gateway into the Guelph life science and agri-food cluster. GPI delivers a series of networking events, seminars and workshops directed at professional development and innovation in the agri-food and life science sectors. GPI also promotes investment opportunities and business development in the region.
<b>Institute of Agro-Food Policy Innovation (IAFPI)</b>	The Institute of Agri-Food Policy Innovation is an independent organization constituted under the University of Guelph. Its purpose is to challenge the industry and stimulate the development of agri-food and rural policies with long term benefits for the people of Ontario.
<b>Land O'Lakes Inc.</b>	Land O'Lakes Inc. is a farmer-owned cooperative, offering farmers, local cooperatives, and customers across the nation an extensive line of agricultural supplies, as well as state-of-the-art production and business services. The company a leading marketer of dairy-based products for consumers, foodservice professionals and food manufacturers.
<b>Maple Leaf Foods Agresearch</b>	A group of animal nutritionists, physiologists, chemists and veterinarians within Maple Leaf Animal Nutrition dedicated to support the development of products that promote health, productivity and meat quality. They are active in all areas of animal nutrition, including dairy, beef, swine, poultry (layer, broiler chicken and turkey), aquaculture and pet feeding.
<b>MaRS Landing</b>	MaRS Landing was created and launched in 2002 to provide a connection between agriculture and food, veterinary and rural-related discoveries with medical, scientific and health advances in Ontario. MaRS Landing facilitates business and research collaboration between stakeholders in Toronto's MaRS Discovery District, Guelph's agricultural–life sciences cluster, and Ontario's rural innovation community to create one of the continent's most comprehensive medical – agricultural research networks.
<b>Monsanto Canada</b>	Monsanto offers Canadian farmers a full line of canola, corn and soybean seed products. Monsanto uses the tools of modern biotechnology to make seeds easier to grow, which allows farmers to do more with fewer resources. The research facility in Guelph focuses on soybean seed research and breeding.
<b>Nutrasource Diagnostics Inc.</b>	Nutrasource Diagnostics Inc. (NDI) is the world leader in human nutritional diagnostic care, natural health product analysis, and clinical trial consulting for the natural health product, nutraceutical and functional food industry. NDI offers clinical validation in the areas of essential fatty acid testing, nutritional analysis testing, bioavailability, product contamination analysis and measurable health benefit.
<b>OntarBio Organic Farmers' Inc</b>	OntarBio Organic Farmers Cooperative Inc. was formed in 1989 to provide an opportunity for a small group of organic farmers in Ontario to collectively store, process and market organically grown products.
<b>Ontario Agri Business Association (OABA)</b>	The Ontario Agri Business Association (OABA) is a voluntary, non-profit organization that serves to represent the interests of country grain elevators, feed manufacturing facilities and crop input supply business, operating out of 406 business locations throughout Ontario. The Association also represents approximately 200 associated businesses that provide products and services to the crop input, grain and feed industry.
<b>Ontario Agri-Food Technologies (OAFT)</b>	Ontario Agri-Food Technologies (OAFT) is a non-profit organization comprised of members from grower associations, universities, industry and governments. The organization focuses on ensuring that Ontario producers have access to the latest technologies to compete globally and to develop new market opportunities, many of which are beyond food.
<b>Ontario BioAuto Council</b>	The Ontario BioAuto Council has a mission to position the province first in the race to meet the growing demand for affordable, sustainable bio-based products. With a \$5-million investment fund from the Government of Ontario, the council is providing support for biomaterials ventures and commercialization.
<b>Ontario Canola Growers Association</b>	Provides research, alerts, and news regarding the canola industry within the province of Ontario.
<b>Ontario Corn Producers Association</b>	The Ontario Corn Producers' Association (OCPA), founded in 1983, is a non profit association representing approximately 21,000 Ontario corn producers.
<b>Ontario Fruit &amp; Vegetable Growers Association</b>	Working in conjunction with fruit and vegetable growers around the province – and the rest of the country – the OVFGA has taken a proactive approach to ensuring that fruit and vegetable grower issues are at the forefront of the pertinent government ministries.

<b>Ontario Institute of Agrologists</b>	Ontario's Professional Agrologists (PAg) and Articling Agrologists (AAg) operate under provisions of the Act to incorporate the Ontario Institute of Professional Agrologists, 1960, statutes of Ontario.
<b>Ontario Ministry of Agriculture, Food, and Rural Affairs (OMAFRA)</b>	OMAFRA's mandate covers livestock, crops business development, land use planning, rural development, agriculture and food research, education and laboratory services and the food industry.
<b>Ontario Pork Producers Marketing Board</b>	Providing an effective and responsible regulatory marketing system that promotes a healthy, vibrant and responsive Ontario pork industry, today and tomorrow.
<b>Ontario Soil &amp; Crop Improvement Association</b>	Communicates and facilitates responsible, economic management of soil, water, air and crops.
<b>Ontario Soybean Growers</b>	Represents the interests of soybean growers in Ontario.
<b>Ontario Wheat Board</b>	The Ontario Wheat Producers' represents over 16,000 wheat producers in the province of Ontario and the most diverse region of wheat production and utilization in North America.
<b>Public Health Agency of Canada</b>	The Public Health Agency is focused on more effective efforts to prevent chronic diseases, like cancer and heart disease, prevent injuries and respond to public health emergencies and infectious disease outbreaks, the Public Health Agency of Canada works closely with provinces and territories to keep Canadians healthy and help reduce pressures on the health care system.
<b>Semex</b>	The Semex Alliance develops and markets high quality genetic technologies, products and services to benefit livestock producers around the world.
<b>SHUR-GAIN</b>	Shur-Gain owns and operates 16 mills throughout Ontario, Quebec, and Atlantic. These mills provide premixes, supplements, complete feeds and feeding programs for all major livestock and poultry species in Canada. In addition to the mills, Shur-Gain is supported by a very extensive franchise dealer network and has established retail outlets to serve both rural and urban customers.
<b>Soy 20/20 Project</b>	The Soy 20/20 Project brings government, academic and industry partners together to stimulate and seize new global bioscience opportunities for Canadian soybeans. The Project assists researchers, industry, producers and policy makers in focusing on key opportunities and working together to achieve them.
<b>Syngenta</b>	Syngenta is a world-leading agribusiness committed to sustainable agriculture through innovative research and technology. The company is a leader in crop protection, and ranks third in the high-value commercial seeds market.

# Appendix B - Case Study #3, Growth of Ridgetown Campus

## Growth of Ridgetown Campus

Ridgetown Campus was established in 1922 as a demonstration and research farm, addressing issues of agricultural production in Southwestern Ontario. Research and demonstration is the foundation of Ridgetown Campus. In these early years, experimental farmland was used for variety testing, production trials, fertility studies, and the control of insects and plant diseases. Dissemination and transfer of agricultural knowledge has continued throughout the Campus's history. In 1951, a single diploma program in Agriculture was offered, and educational programs continued to increase over the years. Up until 1997, the Campus operated within the parameters of the provincial government (OMAFRA). In 1997, Ridgetown Campus became part of UG as a result of a partnership agreement between UG and OMAFRA. This transition was a significant factor in the recent growth of the campus. Dr. Gary Ablett, currently an Associate Professor specializing in Soybean Breeding and Genetics, and former Campus Director at Ridgetown over the past 10 years, stated that "there was more freedom to develop into new areas of research" resulting from this partnership with UG.

Ken McEwan, a Ridgetown professor of Production Economics & Agribusiness, commented on the economic growth of Ridgetown Campus. Mr. McEwan echoed the comments of Dr. Gary Ablett by noting that there is now more entrepreneurship and "lots of flexibility" at the Ridgetown Campus. Mr. McEwan estimated that there is currently \$11-\$12M of economic activity occurring annually at the Campus. One of the growth areas has been in business training and conferences, generating an estimated \$2M annually, which is money that is retained to fund programs at the campus.

The amalgamation with UG enabled Ridgetown Campus to retain revenues, and further expand educational programs. Ridgetown now offers four diploma programs (Agriculture, Horticulture, Environmental Management, and Veterinary Technology) and two Certificate Programs (Landscape Management and Veterinary Medical Office Administration). Recently, the Campus has grown to offer a new four-year degree program (Bachelor of Bio-Resource Management), the first program of its kind in Canada. In this program, the first two years of study are performed at the Ridgetown Campus, and the last two at the main campus of UG. In the last 10 years at Ridgetown Campus, student enrolment has doubled from 250 to over 500 students. There are also now eight graduate students performing research at the Ridgetown campus and taking their graduate courses at the Guelph campus.

In 2006, the newly constructed Rudy H. Brown Rural Development Centre building was opened at Ridgetown Campus in order to accommodate increased enrolment. This expansion to the campus was made possible through the joint funding provided by the provincial government, the local community, and agri-food sector sponsors. Ridgetown Campus is more diverse than ever before in its course offering and student population, which has had several positive impacts on the local and agricultural communities.

One of the most significant impacts of the Ridgetown Campus has been the application of research and the accessibility of knowledge to regional producers and agri-business. Extension of vital research information is a key component of every faculty position at Ridgetown. This information is disseminated through producer meetings, field days, the South West Agriculture Conference, websites, reports and individual farm calls. Producers rely on this information to assist them in making key production decisions. The ability of individual faculty who actually conduct the research to provide their research findings directly to the end users (producers, agri-business) is a key strength of the campus and the partnership.

Each year, Ridgetown Campus, in collaboration with OMAFRA and the local Soil and Crop Improvement Associations, hosts the Southwest Diagnostic Days in July and the Southwest Agricultural Conference in January. The Diagnostic Days enable farm producers and other agribusiness people to come

Researchers at Ridgetown Campus provide over 300 extension talks annually to various producer groups and training seminars, disseminating valuable knowledge to agricultural stakeholders.

together and learn about techniques and technologies and to understand problems that may arise on the farm. The Southwest Agricultural Conference brings together academics and the agricultural community to inform attendees on current issues within the industry through lectures and workshops. These conferences attract hundreds of agricultural stakeholders, provide valuable dissemination of knowledge, and bring dollars to the local community. The research

professionals at Ridgetown Campus also provide over 300 extension talks annually to various producer groups and training seminars, as they are recognized throughout North America for their expertise. The students at Ridgetown Campus bring both an economic impact through money spent locally, and an acquisition of knowledge that will benefit the agricultural community. Tuition and lab fees from students also further support salaries of staff and enhance the quality of the educational programs at the Campus.

## Appendix C – Case Study #3, Possible Uses of Soy

### Possible Uses of Soy

The following list provides examples of food and non-food uses of soy<sup>52</sup>:

Food Uses of Soy	Non-Food Uses of Soy
Cereal	Animal feed and pet foods
Cheese	Biodiesel
Chips	Building insulation
Coffee	Candles
Creamer	Car seats
Edamame	Caulk
Energy bars	Cleaning products
Flour	Cosmetics
Grits	Crayons
Ice cream	Dishwashing liquid
Margarine	Fire logs
Meat alternatives	Furniture
Miso	Furniture polish
Pasta	Lip balm
Roasted soy nuts	Massage oil
Salad oils	Oils for machinery
Shortenings	Pond liners
Smoothies	Printing inks
Soy milk	Soaps and shampoos
Soy nut butter	Socks
Soy protein powder	Stain remover
Soy sauce	Stains
Tempeh	Wood sealer
Tofu	Yarn
Vegetable oil	
Whipped topping	
Yogurt	

<sup>52</sup> Information obtained from soynutrition.com

# Appendix D - Case Study #6, UG Research Stations

## University of Guelph Research Stations

<p><b>Campus d’Alfred – Regional Campus</b></p>	<p>The Alfred station includes a dairy facility that serves as a platform for dairy husbandry courses and provides subjects for research and demonstration projects. Research areas include organic milk production, including nutrition, animal health and economics. The Forestry and Maple Syrup unit at Alfred includes a 12 acre maple bush and maple syrup production facility, which conducts research projects involving maple bush management and syrup production. The Research &amp; Technology Transfer unit conducts environmental research and development projects on campus as well as at various private farms, residences, commercial enterprises and other research institutes.</p>
<p><b>Arkell</b></p>	<p>The Arkell Station features three research units dedicated to the study of Equine, Poultry and Swine. The Equine unit focuses on studies related to health and reproduction. The Poultry unit is equipped with a federally inspected hatchery, layer barn, broiler/brooder barn, turkey barn, special projects building and processing plant. The Swine unit is the focus of an active research environment that includes genetics, nutrition, reproduction, behaviour and housing.</p>
<p><b>Alma Aquaculture</b></p>	<p>This Alma station provides facilities for large-scale aquaculture research and quarantine of fish species new to Ontario. Researchers collaborate with members of the private sector, federal and provincial governments and other universities on commercial fish farming research in areas such as: engineering, nutrition and feed formulation, genetics and breeding, waste management, semen cryopreservation, health and animal welfare.</p>
<p><b>Elora</b></p>	<p>The 224-ha Elora Plant and Environment Research Station is located in the 2550 heat unit zone. Each year approximately 100 ha are used for research plots while the remainder are in rotation. The major crops under study include cereals (corn, wheat and barley) oilseeds (soybeans and canola), edible beans (white and coloured), and forages such as alfalfa. Main research focus areas include plant breeding and biotechnology, plant physiology and agronomy, and weed control and land management.</p> <p>The Elora Beef Research Centre (EBRC) is comprised of a cow-calf herd (housing facilities built approximately 40 years ago accommodate up to 140 cows), a new 192 head feedlot loose-housing barn built in 2004, and extensive rotational grazing pasture facilities. The feedlot barn is equipped with a new, state-of-the-art Insentec computerized feeding system which provides capability for data collection for feed intake, feed efficiency, and feeding behaviour. Research encompasses breeding and genetics, nutrition, physiology, health, welfare, management, and the environment, as well as meat quality and flavour. The research programs conducted at EBRC are closely integrated with the beef research at New Liskeard.</p> <p>The Elora Dairy Research Centre (EDRC) features a 150 cow milking herd in a tie stall housing facility with a milking parlour. Replacement heifers are housed in a free-stall barn and other facilities include maternity, calf-rearing and mature cow physiology studies wings and feed management centre. Research studies encompass genetics &amp; breeding, immunology/physiology, nutrition, animal health &amp; behaviour/welfare, economics, and environmental issues. Dairy research studies are integrated between the Elora and Ponsonby dairy research stations.</p>

<b>Guelph</b>	<p>The Guelph Turfgrass Institute &amp; Environmental Research Centre, located at the edge of the UG campus, is Canada's premier turfgrass and environmental research facility. One-third of this 60-hectare site is reserved for turfgrass and environmental research. This includes several putting greens, turf plots and demonstration areas. The centre provides professional development, consulting and information services for the turfgrass industry. Also situated on the site is the G.M. Frost Research &amp; Information Centre which houses a research laboratory, reference centre, and is home to several Ontario turfgrass industry associations. The primary focus of research involves the management of turfgrass systems.</p> <p>The Guelph Research Station is also the key site for Guelph's Agroforestry research program. Agroforestry refers to the integration of trees into farming systems, allowing for the production of trees and crops or livestock from the same piece of land in order to obtain economic, ecological, environmental, and social benefits. A tree-based intercropping research program was initiated in 1987, which features a total of approximately 10 different species of hardwoods and coniferous trees, annually intercropped with corn, soybeans, wheat, or barley.</p>
<b>Kemptville – Regional Campus</b>	<p>Kemptville, the oldest college of agricultural technology in Ontario, was established in 1916 to demonstrate and teach modern methods of agriculture. With thirty acres of manicured grounds and gardens and a campus of nearly 1000 acres, this Campus acts as an outdoor lab for landscape plants and plant identification. Research programs at Kemptville Campus focus primarily on agronomy, dairy and horticulture industries that exist in Eastern Ontario.</p>
<b>Winchester</b>	<p>The Winchester research station, operated as a sub-station of the Kemptville Regional Campus, comprises 150 acres located on North Gower clay loam, and represents approximately one million acres in the Ottawa and South Nation river valleys. Once drained, this clay loam is well suited to the annual field crops, corn, cereals and soybeans. Most of the variety trials and weed control management studies for these crops are done at this station.</p>
<b>Muck Crops</b>	<p>The Muck Crops Research Station is located in the Bradford/ Holland Marsh. This region is the largest area of organic (muck) soil developed for agriculture in the province and one of the most intensive areas of agricultural production in the country. Research at the Station focuses on the vegetable crops grown in the region, especially onions, carrots, lettuce, celery and Asian vegetables, but includes a wide variety of other vegetables. The emphasis is on discovery research in crop protection and production, to contribute to improved integrated pest management and integrated crop management of the target vegetable crops.</p>
<b>New Liskeard</b>	<p>The New Liskeard Agricultural Research Station (NLARS) operates three units in northern Ontario. The Agronomy Unit focuses on cultivar evaluation, crop nutrition and new species evaluation for adapted crop species including spring wheat, barley and oats, canola, and perennial forages such as alfalfa, clovers and grasses. The Horticultural Unit is dedicated to berry crop and vegetable cultivar evaluation, as well as virus-free plant propagation materials for potatoes and berry crops, while the Beef Unit conducts studies related to production systems, fall grazing, controlled breeding and pasture management.</p>
<b>Emo</b>	<p>The Emo Research Station, located in the Rainy River district of north western Ontario, is operated as a sub-station of the New Liskeard Agricultural Research Station. The Emo station is based on 133 acres of clay loam soil. Approximately 30 acres of the station are reserved for field crop research, primarily forages, cereal crops, and agro-forestry trials. This station is operated from the beginning of April until the end of November.</p>



<b>Ponsonby</b>	<p>The Ponsonby Dairy Centre, located approximately 8 kms south of Elora, conducts research in genetics, nutrition, physiology, health, welfare, management, and the environment. The dairy unit, a tie stall and milk pipeline setup, is also used for teaching purposes, primarily for University of Guelph laboratory sessions and veterinary students on large animal rotations.</p> <p>The General Animal Facility at Ponsonby houses a variety of production species including swine, cattle including calves, young stock, beef cow-calf and feedlot cattle and non-lactating dairy cattle, as well as sheep and goats. Its purpose is to allow researchers to bring in animals either from other research stations or from other outside sources, for temporary housing for specific research projects.</p> <p>The Sheep Research Centre at Ponsonby was built in 1988, and provides a state of the art facility for research on sheep reproduction and genetics, animal health, productivity, and some human medical research applications. The flock is unique in North America with respect to the health status of the flock, which is free from several key diseases such as Q-fever, Johne's disease, and several other diseases that are very prevalent in commercial sheep flocks.</p>
<b>Ridgetown – Regional Campus</b>	<p>Research is conducted on the main campus, which consists of 180 acres of land, and at the Huron and Cedar Springs sub-stations as well as at 50 producer sites spread across southwestern Ontario. Research projects focus on the areas of horticultural and field crop production, pest management, livestock production, business and economics.</p>
<b>Cedar Springs</b>	<p>The Cedar Springs Research Station contains 8 hectares of land and research is conducted on production and pest management in apples, peaches, grapes and strawberries.</p>
<b>Huron</b>	<p>The Huron Research Station contains 50 hectares of land and research is conducted on crop production, weed, insect and disease management on corn, soybeans, edible beans and cereal crops.</p>
<b>Simcoe</b>	<p>The Simcoe Research Station has 86.8 hectares of land on the edge of the highly productive Norfolk sand plain in the central Erie region. Its mission is to help strengthen the fruit and vegetable industries in the potentially highly productive zone along the north shore of Lake Erie. Simcoe operates research programs covering vegetables, fruits, and various alternative crops for the sandy tobacco soils of the area. The ratio of research input is about 70 % vegetables and 30 % fruit, which reflects the approximate distribution of horticultural production in the Lake Erie counties.</p>
<b>Vineland</b>	<p>The Vineland Research Station is located in the Niagara Peninsula, that portion of Ontario which is between Lake Ontario and Lake Erie. The Niagara Peninsula with its unique location, climate and soils is Canada's most important area for the production of grapes, peaches, pears, plums and cherries. The Research Station includes approximately 90 hectares of experimental tender fruit and other orchards, vineyards, rotation crop areas, ornamental plantings, greenhouses and a mushroom production unit.</p>
<b>Woodstock</b>	<p>The Woodstock Station is located on the edge of Woodstock, Ontario, comprising 170 ha with approximately 75 ha in research plots. At 2850 heat units, it is the only public research station serving a large part of cash-cropping agriculture of western Ontario. The Woodstock Station conducts similar types of experiments as Elora crops with a major emphasis on plant breeding in corn, soybeans, white beans and cereal crops, specifically for the higher heat unit zone.</p>