Farm Level Policy — Agricultural Policy Research Network

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Farm Level Policy Annual Report and Final Report
(April 2007 to March 2008)

Overview 2007-08

The key accomplishments for the network during the 2007-08 fiscal year were:

- Fund 11 new research projects at eight different universities.
- Complete the CJAE special issue on "Crisis in Agriculture and Resource Sectors: Analysis of Policy Responses"
- Publish eight policy briefs on-line.
- Organize a session at the 2007 CAES meetings on the Agricultural Policy Framework

The network end date was extended to March 31, 2008 from December 31, 2007. In addition, the network was granted an additional extension for 2008-09.

Research 2007-08

Funding for 11 new research projects was approved. The projects were at the Universities of Victoria, Lethbridge, Alberta, Saskatchewan, Manitoba, Guelph, McGill and NSAC. Included in the new round of research were eight new principle researchers who had not been funded by the network previously. The focus of the approved research was on policy relevant research. Descriptions of new projects can be found on the website, http://www.farmlevel.re.ualberta.ca/, starting with project 516.

The new research included cow-calf international competitiveness, transfer efficiency of government payments, designing livestock revenue insurance, evaluating prairie grain handling system and impact of government programs on land values. Summary abstracts for many of the projects were compiled for the APRN workshop in January 2009. An electronic version of this document is included with the package. Additional information summarized from the annual project reports are below.

Education and networking

The network continues to emphasize the training of graduate students. NSAC graduated one of their first M.Sc. students and this student was funded in part by the network.

Bryce Stewart, University of Alberta was awarded the best M.Sc. thesis award by the Western Agricultural Economics Association and he was the co-winner of the Canadian Agricultural Economics Society M.Sc. thesis award.

The networked organized a CAES principle paper session on “The Farm Level Framework for APF II: The Next Generation” for the Portland academic meetings July 29 to August 1.The speakers were:

- -Sparling, David. “Reflections on the APF - Objectives, context and results”. University of Guelph and Executive Director, Institute of Agri-Food Policy Innovation.
- -Jeffrey, Scott R. & James Unterschultz. "Business Risk Management in the Next Generation APF: A CAIS Study". University of Alberta
- -Weersink, Alfons. “An evaluation of environmental policies in the current and upcoming Agricultural Policy Framework.” University of Guelph.
- -Discussant: Dave Culver. Chief, Farm Data Analysis. Agriculture and Agrifood Canada.

The University of Victoria management team member, Kees van Kooten, assisted in organizing a global conference on 'Agricultural Policy Changes: Canada, EU and the World Trade Organisation' from 13-15 September 2007 in Victoria. The network provided $5,000 in financial support for the workshop.

The CJAE special issue on “Crises in Agricultural and Resource Sectors Workshop: Analysis of Policy Responses” was published in December 2007. This special issue was from the 2006 workshop jointly sponsored by the networks and the CAES. The network leader was one of the special editors.

Eight network policy briefs arising from network related research were published and these are on the website at http://www.farmlevel.re.ualberta.ca/Publications/PolicyBriefs/.

Management Team and Leader Activities

The management team reviewed research proposals and approved 11 new research projects.

Three members of the network made presentations at the APRN network workshop in January in Ottawa. Presentations were by Dr. S. Jeffrey (U of A.) on CAIS, Dr. R. Schoney (U of S.) on prairie wheat farm competitiveness and Dr. S. Clark (NSAC) on P.E.I. land use rotation policy in potato production.

Network leader, Dr. Unterschultz presented made two presentations to AAFC on best management practice and/or farm support issues on March 18 2007.

Finances

Financial report for 2007-08 is submitted separately to AAFC documenting the use of funds received from AAFC. The budget of $285,000 for 2007-08 was spent on research and running the network. During the first three plus years of the original network agreement, the network spent over $749,000 over the life of the original network agreement. The original agreement was for a maximum of $750,000.

As part of the original network agreement, the University of Alberta (VP Research, ALES faculty and Rural Economy) returned part of the overhead deducted from the AAFC grant to a separate U of A. research account. These funds could be used fund research and other network activities. These funds were expended in 2007-08 to support work on drafting policy briefs and to fund four additional research projects at other Universities. The four FLP sub-grants funded by the overhead account are:

FLP-517 An Econometric Model of Multivariate Stochastic Production Functions for Manitoba Crop Agriculture. Barry Coyle, University of Manitoba

FLP-522 Effects of Agricultural Policies Upon Farmland Prices. Jared Carlberg, University of Manitoba

FLP-523 Supplying Ecological Good and Services from the Agricultural Landscape through Auction Mechanisms. Paul Thomassin, McGill University

FLP-534 Policy Impacts on Organic and Locally-Oriented Food Production in British Columbia. G.C. van Kooten, University of Victoria

The combined funds sent to these four projects above totaled $55,851. As mentioned these funds are over and above the original contribution from AAFC.

Additional funds were expended over the three years on graduate students and a part time research assistant for the FLP using the funds provided by the U of A

Planned Activities 2008-09

-Fund five to seven new short term research projects to be completed by March 31, 2009.

-Receive and post research reports and policy briefs from research.

-Support CAES Ottawa workshop in October 2008.

-Organize network workshop to coincide with CAES workshop on October 23 and present Farm network research.

Overview of FLP from 2005 to 2008

Objectives of Network: The FLP, funded by AAFC, undertakes farm level relevant research on international competitiveness, sustainable production, risk management, regional integrations and social integration. The FLP funds academics at Canadian institutions and high priority is placed on graduate student training. The FLP promotes networking among academics and government on farm level policy issues. The total budget over the life of the FLP is $750,000 and nearly all of this budget was expended.

Background: The FLP contract was finalized in March 2005 and the first call for research proposals occurred in spring of 2005. The end date on the first FLP contract was December 31, 2007 but this end date was extended to March 31, 2008.

January 2005 – March 2008

Since January 2005, the Farm Level Policy (FLP) Network has held 2 workshops, a mini symposium and organized principle paper session. Presentations from the following activities are posted on the FLP website (http://www.farmlevel.re.ualberta.ca/Meetings/). A workshop was held in Edmonton, Alberta from January 31 – February 2, 2005 to develop farm level research issues. The workshop brought together university researchers from across Canada and internationally to look at farm level issues and brainstorm on FLP objectives. AAFC representatives, graduate students, AAFRD representatives and others attended the workshop. There was a blend of formal presentations by local, national and international speakers as well as two breakout sessions. The breakout sessions were used to generate ideas and discussion on the future direction of the network. The breakout sessions identified a huge number of potential research questions: farm income, land use, farm level environmental issues and rural development were key issues raised.

The FLP teamed up with the Canadian Agricultural Economics Society (CAES) and the Canadian Agricultural Trade Policy Research Network (CATPRN) to co-host the "Crises in Agricultural and Resource Sectors Workshop: Analysis of Policy Responses" from October 15-17, 2006. 18 papers on various policy issues were presented from authors across Canada, the United States and Europe. A number of these papers have been published in the December 2007 special issue of the Canadian Journal of Agricultural Economics (CJAE). A post workshop session had graduate students and researchers update the FLP Network members on their research progress.

Throughout the 2006/2007 fiscal year, members of the FLP management team also participated in the Agriculture Policy Research Network and the Farm Income Measures workshops. On June 19, 2007, the FLP Network, Alberta Agricultural Economics Association and Department of Rural Economy sponsored a mini symposium on bio-energy policy in North America with presentations from Dr. Janaki R. R. Alavalapati (University of Florida) and Dr. Doug Young (Washington State University).

During the joint AAEA-CAES-WAEA annual meeting held in Portland, Oregon from July 29 – August 2, 2007, the FLP sponsored a principle paper session titled "The Farm Level Framework for APFII: The Next Generation". The session involved three presentations plus a discussant presentation.

There were two rounds of open research calls to Canadian Universities. In total, twenty-one different research projects have been funded. These projects have been spread across eight different Canadian universities, involved over thirteen graduate students and seventeen different lead researchers. Two of the graduate students have completed Ph.D. programs. Two of the M.Sc. graduate students supported by FLP have earned honorable mention (2005) or been awarded outstanding M.Sc. thesis (2006) by the Canadian Agricultural Economics. A list of the projects in included in the email attachment summary document for the January 2008 APRN workshop.

FLP Research Results 2005-07

This research output applies to long-run issues such as productivity, land use in the rural-urban fringe, environment regulations across regions, farm structural change and risk management. Brief summaries of research outcomes are below.

Agricultural Productivity in Western Canada: Agricultural productivity has been growing over the past sixty years. However, productivity growth in the crops sector has slowed down in the past ten years and the growth has been slower that the increase in the "cost-price squeeze". A key positive link with the productivity growth is R&D.

Competitiveness: A 2005 international competitiveness study on wheat and canola indicates that farmers in Saskatchewan were among the most competitive in wheat production and were of average competitiveness in canola production.

Environment and Pollution Havens: There is evidence that intensive livestock operations will move to regions with relatively lower environmental standards. However these operations are less likely to move within a region to areas with lower environmental standards. Agglomeration economies (i.e. local infrastructure and services) are important to the location of intensive livestock operations.

Structural Change: A long run model of farm structural change reported that direct government support programs slow the rate of structural change in Western Canada but do not change the direction of structural change from small farms to larger farms. Some capitalization of government programs into land values occurred.

Land Use: The greenbelt legislation in Ontario protecting farmland from urban development has thus far had a mixed impact on farm land values. Exploration continues on the reasons for the mixed results on land values. Similar research by network researchers in B.C. on land values in a GIS framework is being used by the provincial government to evaluate land use policy.

Additional results may be found on the network website and future results will be posted as these are provided by researchers.

Research Progress Reports by Project 2007-08

FLP – 500: Crop rotations, soil degradation and land use policy in PEI
Researchers: J. Stephen Clark, Emmanuel Yiridoe, Gordon Brewster, Nova Scotia Agricultural College

One graduate student completed their program. Developing report and policy brief from research.

FLP – 501: Mitigating and compensating agricultural land-use externalities in British Columbia
Researchers: G.C. van Kooten, University of Victoria

Highlights of Results

1) Urban influences play a significant role in the determination of respective farmland prices, which are not justified alone by potential agricultural rental rates. However, farmland protection through the ALR does make land more affordable for farmers.
2) Negative externalities associated with proximity to non-agricultural land decrease farmland value by up to 31%, and farmers pay a premium for land that is less fragmented and further within the ALR zone.
3) When compared with other farmers, hobby farmers pay a premium for land inside the ALR, but not for land outside the ALR. This is likely because residential value and potential for development are more significant factors than the type of farm outside the ALR.
4) The lack of an open-space premium for residential properties near ALR land may indicate a lack of confidence in the ability of the ALR zoning to prevent further development of the agricultural land.

Agricultural production at the urban-rural fringe in Canada faces challenges from competing development interests and urban spillovers that contribute to problems such as farmland fragmentation and discontinuity of farm services. In this research, we explored the impacts of different spatial and farm characteristic factors on farmland values near the city of Victoria, British Columbia, with the expectation that results would be comparable in other regions.

The models developed show that farmers pay less for land within the Agricultural Land Reserve (ALR), but they pay a premium for land that is less fragmented and is located further from the edges of protected tracts of agricultural land. However, residential demand seems to be greater than farm demand, as evidenced by the high market value for smaller properties, and the significant gap between rental rates and reasonable rates of

return for investment in land. While farmland protection in the form of the ALR is a positive factor, further action may be needed in order to sustain long-term productive agriculture in these zones.

The results also accentuate the importance of "edge-planning", as the values of both farmland and residential properties are decreased by negative spillovers from one land-use type to the other. Municipal planning should focus on attempts to build better neighbour relations and reduce the negative impacts of farms on urban residents and vice versa.

This research project has contributed to the education and training of one undergraduate student, two PhD students, and one research associate. The researchers have gained significant proficiency in GIS and statistical techniques and thus increased potential for further contributions to research in this area. Work on this project has composed the majority of the forthcoming PhD dissertations by Tracy Stobbe (Economics, University of Victoria) and Geerte Cotteleer (Wageningen University).

13 to 15 September 2007. International Conference on Agricultural Policy Changes: Canada, EU and the WTO, held in Victoria, BC,. This conference brought together researchers from Europe, Canada and the United States to discuss a variety of issues around topics such as environmental impacts of agricultural policy, the European CAP, agricultural issues in a global economy and food safety. Papers from the conference are to be published in special issues of *J of European Integration* and the *Can J of Agric Economics* (forthcoming December 2008).

FLP – 502: Typical cash crop farms – Saskatchewan (IFCN)
Researchers: R.A. Schoney, University of Saskatchewan; Richard Wharton, Saskatchewan Agriculture and Food

Wheat is a major agricultural commodity produced in Canada and the EU. Germany and Canada are among the global top ten wheat producers. Though both countries produce nearly the same products and thus compete in the same world markets, wheat farms in both countries feature diverse production systems with different cost and revenue structures.

Four efficient case farms are delineated by producer groups, two in the Canadian prairies and two located in northern Germany. Costs and returns for 2006 are calculated at the farm gate. In terms of surface area, the two Canadian farms are much larger with acreages varying from 1,862 to 4,047 hectares while the German farms vary from 300 to 1,300 hectares. German farms are more profitable than Canadian prairie farms primarily because of the CAP payments. Removing CAP payments results in roughly comparable profits per tonne within a size group.

In terms of costs per tonne, direct expendable costs are very similar between the two countries; intra-country differences between the farm sizes and locations are greater in

many cases than inter-country differences. Next, transshipment costs are calculated to a common destination of North Africa. Not unsurprisingly, Canadian prairie farms are not cost competitive with their German counterparts at North Africa due to higher transportation costs; thus, they must compete with higher quality wheat or wheat that commands a premium such as durum in these markets.

Costs are divided into three groups: insensitive, moderately sensitive and very sensitive to energy prices and exchange rates. In the case of energy prices, Canadian prairie farms are somewhat more vulnerable than northern German due to higher Canadian transshipment costs. Again because of higher international transshipment costs, Canadian costs, CIF, North Africa are more sensitive than German costs. However, because commodity prices are also affected, this increased sensitivity can be regarded as an offset or natural hedge and thus desirable.

There is a detailed report of results, consisting of 67 pages. A summary report is posted to the farm level website. Note that four new Canadian prairie farms were surveyed in 2007: two in Saskatchewan and two in Alberta. Cost comparisons are important to policy makers and students in that it helps them better understand their domestic industries and its competitive world environment. It can also give better understanding of current energy issues.

FLP – 503: Development of agent-based models of farm and rural structural change
Researchers: R.A. Schoney, James Nolan, Scott Bell, University of Saskatchewan

Farmland Auctions (Adam Arsenault)
An important component of our modeling is farmland auctions. This thesis focuses on incorporating agent heterogeneity, feedback, strategic bidding and learning into an ABM farmland auction model and assessing the impact of various auction types on farmland pricing efficiency and surplus farmland price generation.

The Freeman ABM (2005) is modified to accept four auction types:

- The English auction,
- The First-Price-Sealed-Bid (FPSB),
- The Second-Price-Sealed-Bid (SPSB or Vickrey) and the
- The Third-Price-Sealed-Bid (TPSB).

This research demonstrates that, in the absence of exogenous shocks, all auctions appear to be relatively robust, ultimately resulting in the same farmland market characteristics at simulation's end. The fact that all auctions produced a similar market suggests that even when bidding behavior is suboptimal in a theoretic sense, properly designed auctions can still elicit the correct bidder response and nudge an industry in the correct direction.

Agricultural Structure (Peter Stolniuk)
The primary purposes of the Stolniuk thesis are to 1) project the agricultural structure for Saskatchewan CAR 7B thirty years into the future and 2) investigate the impact of

alternative price scenarios on its farm structure. We are interested in the following farm structure characteristics:

- farm numbers,
- farm size and distribution of size,
- production characteristics,
- demographic characteristics,
- land tenure and
- individual and aggregate farm financial health.

1. Under historical prices and yields, farm numbers are projected to continue to erode at a rate of 2.5-3.5% per year primarily through the diminished number of small farms. Note that this is somewhat higher than historical rates as the willingness of many small farms to subsidize farm operations with off farm employment (i.e. hobby farms) is not considered.

2. Increased farm efficiency gains through size and machinery technology generally result in higher farmland prices and leases as farmers compete with each other in farmland markets.

3. The relative competiveness of grain to livestock is affected by relative price ratios. Marginal farmland is transitional to grain or livestock use; its ultimate land use is very sensitive to relative price ratios. Hence, programs such as biofuel subsidization programs which disturb historical price ratios can affect transitional land use.

This research establishes the foundation for evaluating a number of public policies including those which alter price relationships.

FLP – 504: Effects of urbanization on Canadian agriculture
Researchers: Alfons Weersink, University of Guelph

Research complete.

FLP – 505: Determinants of on-farm investments in environmental protection
Researchers: Emmanuel K. Yiridoe, J. Stephen Clark, Nova Scotia Agricultural College; Mike Trant, Statistics Canada

Among the Double-Hurdle model specifications tested, the inverse hyperbolic sine (IHS) heteroscedastic DH model best fit the data for investments in (i) manure storage (i.e., manure storage construction or major renovation), and (ii) vegetative improvements (i.e., shelterbelts, windbreaks, buffer-strips and fencing) for livestock farmers. Among crop producers, the IHS heteroscedastic DH model best fit the data for investments in (i) vegetative improvements (i.e., shelterbelts, windbreaks, buffer-strips and fencing), and (ii) chemical storage (i.e., pesticide, chemical, or fuel storage or major renovation). Nested univariate and bivariate model specifications tended to be excessively restrictive, and supports the adequacy of a more generalized or flexible model specification.

Farm environmental protection investment decisions were significantly affected by region (i.e., farm location factors) especially for livestock producers. Average property value had a positive impact on the level of investment in Manure Storage, and in Vegetative Improvements. Farmers in Quebec tended to have a higher probability to invest in the three structural BMPs than farmers in other Canadian provinces. In addition, among those farmers willing to invest in Manure Storage, for example, those located in Quebec tended to invest more.

Demographic characteristics significantly affected the structural BMP investment decisions for livestock producers. For example, age of the principal farm operator had a significant and negative impact on investments in Manure Storage.

The level of investment was also positively affected by farm income, and government support payments for environmental protection investments.

Although magnitude of the effects of the probability of investing, and unconditional level of investment were generally small, the results support the hypothesis that agri-environmental regulations in some provinces (especially Quebec) have encouraged higher adoption, and a tendency for farmers to increase investment in the three structural BMPs studied.

There were variations in investment decisions (i.e., in terms of both the decision to investment, and the amount invested) across farm types. For example, the conditional level of investment in Manure Storage by beef and poultry producers was significantly less than for hog producers. Specifically dairy farmers invested $2400 less, beef farmers spend $5700 less, and poultry farmers invested $4100 less than hog producers in Chemical Storage systems.

Investment decisions were significantly affected by government financial support for on-farm environmental stewardship. However the actual effect depended on structural BMP type. For example, a one percentage point increase in government financial support for farm environmental protection increased the probability of crop producers investing in Chemical Storage by 0.04%, and 0.3% for Vegetative Improvements.

The results from this study contribute new information and provide a basis and options for targeting (i.e., precision-conservation of) agri-environmental stewardship program support and management. Estimated cost-share elasticities for investments depended on the structural BMP type and farm type. Yet, in Canada, most farm environmental stewardship programs both at the federal and provincial levels of government generally are not targeted at particular farm types or farm environmental conditions. For a agri-environmental policy that is aimed at generating the highest improvements in farm environmental conditions per unit amount of government support payment, then non-targeted farm environmental stewardship programs are appropriate. Such non-precision conservation schemes allow farmers to make environmental protection investments consistent with individual farmer’s economic incentives. On the other hand, although such non-targeted programs can generate the highest environmental protection

expenditure per government dollar received, they may not focus on the most polluting farms or farm issues. If the most heightened environmental concerns exist on farms that currently do not (adequately) invest in such farm environmental protection structural BMPs, then non-precision conservation schemes may not achieve the desired environmental quality objectives, compared to targeted schemes.

Furthermore, a farm environmental targeting strategy that generates the highest benefits relative to the associated costs also requires not only identifying farmland uses which generate the highest environmental quality impacts, but also importance of the impacts to society.

FLP – 506: A farm simulation model of BMP adoption for improvements to off-farm water quality
Researchers: Peter Boxall, Scott Jeffrey, University of Alberta; Wanhong Yang, University of Guelph

Working on project report.

FLP – 507: Farm level pricing and risk management of canola in Western Canada
Researchers: James R. Unterschultz, Tomas Nilsson, University of Alberta; Charles Pearson, Alberta Agriculture, Food and Rural Development; Derek G. Brewin, Jared G. Carlberg, University of Manitoba.

Increasing demand for Western Canada's Canola has led to high prices. Farm price risk is related to the changes of returns in an operation; changes that are caused by unpredicted variation in input and/or output prices. Different tests have been conducted to determine the strength of the relationship between canola cash prices and canola or soybean futures prices. Strong short-run and long-run relationships are required for hedging to work as a risk management tool. Weekly regional data from 1998 until 2007 (469 observations), that comes from the WCE and other source are used in time series Vector Regression models to test for Unit Roots and Co-integration; measures of price relationships. . Preliminary results show a close relationship between Canola cash price and Canola future prices and a relationship between Soybean cash prices and Soybean future prices. The results also indicate a co-integration between these commodities; U.S. Soybean prices tend to lead Canola prices. Estimation results indicated that futures prices lead cash prices. This is important for hedging.

FLP – 509: The effect of land-use restrictions on agricultural and residential land values Researchers: Brady James Deaton Jr., University of Guelph

The empirical results suggest that Ontario's Greenbelt influenced farmland property values.

1. The Ontario Greenbelt did affect farmland property values
2. The greenbelt/zoning effect on property values varied depending on the farms proximity to the GTA.

3. For farms in close proximity to the GTA, the Greenbelt reduced farmland property values.

A great deal of agricultural production occurs in near urban areas where the majority of Canadians live. Subsequently, farmland figures as a prominent input into issues concerning land use and growth control. One method by which governments control the land use is through zoning. In these situations, a variety of constituents (farmers, government officials, rural and urban residents, etc.) consider the costs and benefits of zoning. Our analysis provides empirical information on the effects of zoning on property values and thereby, illuminates both the general effects of zoning and the distribution of those effects across rural and urban residents. One Ph.D. student was completed.

FLP – 515: Understanding rates of farm-based agri-business start-up, failure and growth in rural Canada
Researchers: Spencer Henson, University of Guelph

No report. An abstract is available in the January 2008 APRN workshop document.

FLP – 516: An economic analysis of cattle farms in Southern Alberta
Researchers: Danny LeRoy, Kurt Klein, University of Lethbridge

Information related to production costs on cow-calf and feedlot enterprises in Southern Alberta were collected, organized, synthesized and tabulated. Using an analytical framework developed by Agri-Benchmark (formerly the International Farm Comparison Network, headquartered in Braunschweig, Germany) this data are used in an ongoing related research endeavor the objective of which is to compare costs of production across several countries. For the purpose of this project, however, the data from Alberta are analyzed with reference to a base year to identify, delineate and quantify the changing nature of production costs.
1. Costs of production data were collected across selected cow-calf and feedlot enterprises in Southern Alberta using primary and secondary sources. (completed)

2. The collected data were formatted, tabulated and included in the analytical framework developed by Agri-Benchmark. (completed) This will permit a comparison and contrast with competing enterprises located elsewhere. (in progress and the focus of another study)
3. The collected data are being analyzed with reference to a base year to identify, delineate and quantify the changing nature of production costs. (in progress)

The preliminary analysis reveals that changing input and output prices are affecting the profitability of livestock enterprises in Alberta. The standardized criteria highlight how changing economic circumstances affect comparative advantage.

FLP – 517: An econometric model of multivariate stochastic production functions for Manitoba crop agriculture

Researchers: Barry Coyle, University of Manitoba

Based on multivariate GARCH literature, a method of estimating multivariate stochastic technology models under constant correlations of yields is proposed. This substantially simplifies earlier models of multivariate stochastic technologies under constant correlations. Of more general interest, two models of input impacts on yield correlations are developed. The first approach provides a general specification of impacts without imposing positive definiteness (pd) of the yield covariance matrix. This approach can be estimated as an extension of feasible generalized least squares. The second approach provides a more restrictive specification that attempts to impose pd on the yield covariance matrix. This model seems easier to estimate than standard multivariate GARCH models of nonconstant conditional correlations that address pd.
These various models of multivariate stochastic technologies are applied to a recent large farm level panel data set for Manitoba crop agriculture. This data set includes crop specific quantities of four fertilizers (nitrogen, phosphorous, potassium and sulfur), and we focus on the six major crops (wheat, barley, canola, oats, flax, rye).

Econometric results suggest that all approaches to estimation of multivariate technology models proposed here are tractable. This is important given the novelty of the approaches and the large size of the farm level panel data set.

Results.

-The hypothesis of constant correlations of yields is rejected, i.e. yield correlations depend on input levels. This suggests that it is important to model impacts of inputs on yield correlations as well as on yield variances.
-Estimated elasticities of correlations can be substantial. For example in the general model of correlations for wheat and barley yields, elasticities with respect to the major fertilizer (nitrogen) range from +26% to +65% .

-Results also indicate the importance of specifying second order flexible functional forms for yield variance equations as well as for expected yield.

The primary impact of this research is on methodology for estimation of input impacts on farm level yield risk. More specifically this is the first research on input impacts on the multivariate aspects of yield risk, i.e. on yield correlations. Since farm decisions such as diversification of crop portfolios depend fundamentally on yield covariances as well as variances, this is an important extension of literature on stochastic production functions. Such research should ultimately influence farm decision making and policy models. AAFC has a strong ongoing interest in simulating impacts of programs such as CAIS and Production Insurance

FLP – 519: An evaluation of moral hazard risks in Government of Canada farm business risk management safety net programs
Researchers: Scott Jeffrey, University of Alberta

Thus far the project has reviewed the literature on the topic area. A model for a representative farm has been developed for Southern Alberta. This model will be used to evaluate the moral hazard questions.

FLP – 520: Designing revenue insurance for the cow-calf industry in Western Canada
Researchers: Tomas Nilsson, University of Alberta

Introduced in 2003, the Canadian Agricultural Income Stabilization (CAIS) program was designed to mitigate the downside risks of the agricultural sector. It provides producers with two benefits. First, it increases an enterprise's expected income. Second, it reduces the variance of the income distribution. The combination of higher expected income and lower distributional variance improves the expected utility of farmers. Yet, CAIS is a voluntary program and it is not costless. Enrollment in the program requires the payment of a fee, which, in the absence of risk, reduces expected income. Consequently, reductions in income variability may be off-set by the cost of the program. A producer must consider both the potential benefits and the costs of her participation decision. Further, recent experience has demonstrated that output prices are susceptible to sudden, "catastrophic" declines, which are independent of "ordinary" price movements. The potential for negative, catastrophic shocks exacerbate the unpredictability of farm incomes. Albertan cow-calf producers are vulnerable to these unexpected livestock price movements.

This research provides insights into four areas. First, it provides insight into the long-term CAIS program participation decision for a risk-neutral and a risk-averse Albertan cow-calf enterprise. Next, if participation is assumed, outcomes under several Elected Protection Levels are assessed. These provide some guidance for coverage level decisions. The benefits (costs) under varied protection, risk-aversion and discounting levels are calculated. Third, catastrophic price risk is introduced. The change in producer welfare from two scenarios (with and without the prospect of large, negative price declines) is computed – i.e., the welfare loss (gain) from the introduction of (potential) catastrophic shocks is determined. Finally, some initial simulations of producers' willingness to pay for supplementary catastrophic risk revenue insurance are presented. A simulation capital budgeting model is built. For simplicity, only price risk is considered. Two scenarios are examined: with and without the potential for catastrophic risk. The representative Albertan producer is assumed to have constant relative risk averse (CRRA) preferences. Four methods are used to evaluate this paper's objectives: a) stochastic dominance, b) the coefficient of variation for producer income, c) certainty equivalence welfare analysis and d) willingness to pay calculations.

The results demonstrate that there is a substantial welfare gain to producers' decision to participate in the CAIS program. Further, the gains are increasing as the Elected Protection Level increases. The greatest gain in producer welfare occurs when the enterprise opts for full CAIS protection. Even with the CAIS program, some cow-calf operations may be willing to pay for supplementary insurance to guard against large

negative shocks. Events like the BSE crisis can be severely detrimental to Albertan livestock producers. As a consequence, some producers may want greater risk protection than that provided by the CAIS program. The results indicate that there may be noticeable producer welfare gains from the purchase of catastrophic revenue insurance. Further research would be required to determine whether this class of insurance contracts would even be of interest to cow-calf producers

FLP – 521: Beef industry competitive benchmarking study: Measuring the efficiency and productivity of Ontario and Alberta cow-calf operations
Researchers: Getu Hailu, Maury Bredahl, University of Guelph; Scott Jeffrey, University of Alberta

The research indicates that the average technical, allocative and economic inefficiencies are 17%, 22% and 33% respectively. There are significant departures by Alberta cow-calf producers from the most production efficiency beef farms. Contributions to the inefficiency were identified in the study. Improvements in production efficiency at the cow-calf level would lead to improvements all through the beef chain.

FLP – 522: Effects of agricultural policies upon farmland prices
Researchers: Jared G. Carlberg, University of Manitoba

Three principle findings of the research include:

- Decisions made by policymakers can have profound impacts upon farm wealth by changing the value of agricultural land, the biggest asset on the farm balance sheet
- Policies that affect farm income can dramatically alter the value of agricultural land via the income capitalization principle. A policy that increases costs for farmers (or decreases revenues) will impact land values
- Policies that alter the ways in which agricultural land can be/is used can affect the value of the land. There can be unintended consequences for farmland values of policies not directly aimed at farmers owning/renting that land.

With increasing prices for many (non-livestock) agricultural commodities, the financial farm landscape is changing at a faster pace than perhaps ever before. Because farmland is the largest pool of farmer wealth, policies that affect the value of that asset have the potentially to dramatically alter not only the value of the asset itself, but also the ability of younger/newer producers to expand their operations.

This project is significant to Canadian agriculture insofar as it identifies the impacts of agricultural policies. The decisions made by governments are not without implications for owners of farmland that extend beyond their short-term impacts on farm income.

FLP – 523: Supplying ecological good and services from the agricultural landscape through auction mechanisms
Researchers: Paul Thomassin, McGill University

No report

FLP – 524: Measuring farm income and the contributions of federal agri-food programs to farm income stability in Canada
Researchers: Rakhal Sarker, University of Guelph

No annual report. Abstract submitted to policy network in January 2008 is presented here.

Abstract
Aggregate farm income is widely viewed as an important indicator of the wellbeing of farmers and the viability of farm businesses in Canada. Consequently, media interests in the forecasting of aggregate farm income by the AAFC during last few years have been very high (Short, 2007). Declining farm incomes across all revenue classes during last five years have also ignited emotional debates and occasional farm protests across the country. Despite these debates and farm protests, however, little has changed in the way farm incomes are measured in Canada. While we appreciate the fact that Canada is a small exporter on the world market and is a price taker, in the era of growing globalization little attention has been focused in these debates on the reasonability of the prices determined for grains, oilseeds and red meats on the world market. Despite significant changes in production conditions, structural attributes and market orientation of farming in this country over last 50 years, farm incomes are still measured following an approach which is more than 50 years old (Statistics Canada, 2007).

A number of recent studies on farm income and farm business risk management under the Agricultural Policy Framework (APF) suggest that (i) farm income and farm family income both have been variable across all sizes in Canada (Negelschmitz, 2007a,b), and (ii) the Canadian Agricultural Income Stabilization (CAIS) program has been effective in addressing farm business risks in Canada (Jeffrey and Unterschultz, 2007). A study on Canadian farm incomes by Mussell et al. (2005) suggest that there is a significant diversity in farm incomes across regions, farm types and farm sizes and that farm income situation has been worsening across all sizes and regions despite various support programs in Canada.

A preliminary analysis of last five years data obtained from CANSIM suggest that falling market revenues and rising operating expenses are responsible for recent decline in aggregate farm income in Canada. Various support programs have not been adequate to compensate the declining farm income at the aggregate level across regions in Canada. However, when farms are classified into five different operating income classes, the results suggest that farm support programs have been successful in fully compensating the losses in farm incomes for farmers generating total net operating income worth $250,000 or more. Despite their best effort, support programs have not been successful in

addressing declining farm income issues adequately for farmers with less that $250,000 in net operating income. While the results are preliminary, they do highlight two important policy dilemmas: (i) Shall we focus on maintaining a "magic number of total farms" in Canadian agriculture and design policies to ensure sustainability of these farms? Or, (ii) shall we focus on the most profitable farms and design policies to enhance their competitive positions in an increasingly global market for agro-food commodities? Since the challenges faced by these farms are different, the designs of these policies have to be different to achieve the intended outcomes.

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Nagelschmitz, K. (2007b). Is Low Income Persistent among Canadian Farm Families? A Longitudinal Profile, 1983 to 2004. Agriculture and Agri-Food Canada, Sir John Carling Building, Room 651, 930 Carling Avenue, Ottawa, Ontario.
Short, C. (2007). Farm Income Measurement Issues: A Policy Perspective. Agriculture and Agri-Food Canada / Statistics Canada Joint Farm Income Workshop, Ottawa, Ontario, March 5-6, 2007.

FLP – 526: The evolution of the Canadian prairie grain handling system
Researchers: James Nolan, University of Saskatchewan

An agent based model evaluating grain handling structure in W. Canada is being developed. Key results are:

1. The number of grain elevators in the network is highly dependent on farm to elevator transportation costs, but less so on the amount handled.
2. Under our model assumptions, elevator numbers do not move smoothly through time, but instead can collapse very quickly.
3. As a methodology, agent-based modeling can be used to give particular insight into the industrial structure of a spatial and dynamically competitive industry.

The grain handling system in Canada has seen enormous changes over the past 20 years, none any more visible than the consolidation of the vast prairie elevator network. For example, from 1999 to 2007, the number of elevators on the Prairies declined by about a factor of three. While many drivers for this change have been identified, we feel that

building an agent-based model of farming and elevation from the "ground up" will help better understand the drivers of industrial change in this dynamic network based industry.

There is some research suggesting that industrial change under certain circumstances may be catastrophic rather than gradual (Aschauer, 1998). The interaction between industrial policy and industrial evolution in network industries is not well understood. The suggested research helps build an understanding of the consequences, both foreseen and unforeseen, of agricultural policy on the larger grain elevator network.

FLP – 529: The transfer efficiency of government support programs
Researchers: J. Stephen Clark, Nova Scotia Agricultural College

This study estimates the transfer efficiency of government payments on Canadian agriculture. Two measures of efficiency are used: 1) The effectiveness with which government payments stabilize income and 2) The amount by which government payments are capitalized into land values. The data used are provincial in nature and so panel econometric techniques are applied to the development of estimates. With regard to the capitalization formula, we find that the capitalization of government into land values is homogeneous across Provincial land capitalization equations. Estimates of the rate of capitalization range from approximately $8.50 increase in land value per acre for every $1.00 increase in government support to a $10.00 increase in land value per acre for every $1.00 increase in government support. The income stability equations exhibited a substantial amount of heterogeneity. Four homogeneous regions were found for Canada: 1) Atlantic Canada; 2) Central Canada; 3) the Prairies; and 4) British Columbia. Among these heterogeneous regions, substantial differences in the stabilization coefficient estimates were found. These ranged from a low of only a 10% offset in income decline through increased government payments for every $1.00 decline in income for Atlantic Canada to a high of 30% offset in income decline through increased government payments for every $1.00 decline in income change for the Prairies. We conclude there are significant differences within Canadian regions in the effectiveness of stabilization programs within Canada, although the overall effect of government payments on the wealth position of agricultural producers are the same.

A draft working paper has been developed.

FLP – 534: Policy impacts on organic and locally-oriented food production in British Columbia
Researchers: Alison Eagle, G.C. van Kooten, University of Victoria

All agricultural producers in the study population market products locally, with a proportion of them certified organic (all of the organic producers in the region market locally).

The main market outlets were farm stands and farmers' markets. In general, these farmers believed that local demand for their products was increasing. Customer demand had the most significant impact on employment of good stewardship practices.

Of the three levels of government, it seemed that provincial policy was the most pertinent to economic success for these farmers. Farmers felt that the farm tax assessment and reduced property taxes for agriculture contributed significantly to their continued success in agriculture

Highlights of Results

1) The response rate for our survey of Vancouver Island farmers who market products locally was 74%, with participants eager to talk about the future of local farming.
2) Most respondents were vegetable producers, with the main market outlets being farm stands and farmers' markets.
3) About half of the total acreage was farmed with either organic or IPM methods. There was more organic production in the small to medium farm-sized categories and more IPM production on larger farms.
4) Farmers with more experience tended to have larger farms, higher farm income, more employees, and less farm debt.

Some experts believe that local marketing is one of the only means with which Canadian agriculture will continue to compete in the global marketplace. This survey of farmers on Vancouver Island helps us understand how they can survive and thrive in the urban-rural fringe.

Farm Level Policy Package Available at the APRN January 2008 Workshop

Appendix

FARM LEVEL POLICY

AGRICULTURAL POLICY RESEARCH NETWORK

INFORMATION PACKAGE

Farm Level Policy Network Information Package
Table of Contents

Farm Level Policy Network Key Activities
January 2005 – January 2008

Since January 2005, the Farm Level Policy (FLP) Network has held 2 workshops, a mini symposium and organized principle paper session. Presentations from the following activities are posted on the FLP website (http://www.farmlevel.re.ualberta.ca/Meetings/).

A workshop was held in Edmonton, Alberta from January 31 – February 2, 2005 to develop farm level research issues. The workshop brought together university researchers from across Canada and internationally to look at farm level issues and brainstorm on FLP objectives. AAFC representatives, graduate students, AAFRD representatives and others attended the workshop. There was a blend of formal presentations by local, national and international speakers as well as two breakout sessions. The breakout sessions were used to generate ideas and discussion on the future direction of the network. The breakout sessions identified a huge number of potential research questions: farm income, land use, farm level environmental issues and rural development were key issues raised.

The FLP teamed up with the Canadian Agricultural Economics Society (CAES) and the Canadian Agricultural Trade Policy Research Network (CATPRN) to co-host the "Crises in Agricultural and Resource Sectors Workshop: Analysis of Policy Responses" from October 15-17, 2006. 18 papers on various policy issues were presented from authors across Canada, the United States and Europe. A number of these papers have been published in the December 2007 special issue of the Canadian Journal of Agricultural Economics (CJAE) , edited by Dr. James Unterschultz (FLP), Dr. Kathy Baylis (CATPRN) and Dr. Wiktor Adamowicz (CAES). The peer reviewed papers can be accessed at the Blackwell CJAE website. A post workshop session had graduate students and researchers update the FLP Network members on their research progress.

Throughout the 2006/2007 fiscal year, members of the FLP management team also participated in the Agriculture Policy Research Network and the Farm Income Measures workshops.

On June 19, 2007, the FLP Network, Alberta Agricultural Economics Association and Department of Rural Economy sponsored a mini symposium on bio-energy policy in North America with presentations from Dr. Janaki R. R. Alavalapati (University of Florida) and Dr. Doug Young (Washington State University).

During the joint AAEA-CAES-WAEA annual meeting held in Portland, Oregon from July 29 – August 2, 2007, the FLP sponsored a principle paper session titled "The Farm Level Framework for APFII: The Next Generation". The session involved three presentations plus a discussant presentation. Policy briefs are under development from those presentations.

There have been two rounds of open research calls to Canadian Universities. In total, twenty-one different research projects have been funded. These projects have been spread across eight different Canadian universities, involved over ten graduate students and seventeen different lead researchers.

Farm Level Policy Network Projects and Researchers

FLP – 500: Crop rotations, soil degradation and land use policy in PEI
Researchers: J. Stephen Clark, Emmanuel Yiridoe, Gordon Brewster, Nova Scotia Agricultural College; Alan Walberger, University of Lethbridge

FLP – 501: Mitigating and compensating agricultural land-use externalities in British Columbia
Researchers: G.C. van Kooten, University of Victoria

FLP – 502: Typical cash crop farms – Saskatchewan (IFCN)
Researchers: R.A. Schoney, University of Saskatchewan; Richard Wharton, Saskatchewan Agriculture and Food

FLP – 503: Development of agent-based models of farm and rural structural change
Researchers: R.A. Schoney, James Nolan, Scott Bell, University of Saskatchewan

FLP – 504: Effects of urbanization on Canadian agriculture
Researchers: Alfons Weersink, University of Guelph

FLP – 505: Determinants of on-farm investments in environmental protection
Researchers: Emmanuel K. Yiridoe, J. Stephen Clark, Nova Scotia Agricultural College; Mike Trant, Statistics Canada

FLP – 506: A farm simulation model of BMP adoption for improvements to off-farm water quality
Researchers: Peter Boxall, Scott Jeffrey, University of Alberta; Wanhong Yang, University of Guelph

FLP – 507: Farm level pricing and risk management of canola in Western Canada
Researchers: James R. Unterschultz, Tomas Nilsson, University of Alberta; Charles Pearson, Alberta Agriculture, Food and Rural Development; Derek G. Brewin, Jared G. Carlberg, University of Manitoba

FLP – 509: The effect of land-use restrictions on agricultural and residential land values
Researchers: Brady James Deaton Jr., University of Guelph

FLP – 515: Understanding rates of farm-based agri-business start-up, failure and growth in rural Canada
Researchers: Spencer Henson, University of Guelph

FLP – 516: An economic analysis of cattle farms in Southern Alberta
Researchers: Danny LeRoy, Kurt Klein, University of Lethbridge

FLP – 517: An econometric model of multivariate stochastic production functions for Manitoba crop agriculture
Researchers: Barry Coyle, University of Manitoba

FLP – 519: An evaluation of moral hazard risks in Government of Canada farm business risk management safety net programs
Researchers: Scott Jeffrey, University of Alberta

FLP – 520: Designing revenue insurance for the cow-calf industry in Western Canada
Researchers: Tomas Nilsson, University of Alberta

FLP – 521: Beef industry competitive benchmarking study: Measuring the efficiency and productivity of Ontario and Alberta cow-calf operations
Researchers: Getu Hailu, Maury Bredahl, University of Guelph; Scott Jeffrey, University of Alberta

FLP – 522: Effects of agricultural policies upon farmland prices
Researchers: Jared G. Carlberg, University of Manitoba

FLP – 523: Supplying ecological good and services from the agricultural landscape through auction mechanisms
Researchers: Paul Thomassin, McGill University

FLP – 524: Measuring farm income and the contributions of federal agri-food programs to farm income stability in Canada
Researchers: Rakhal Sarker, University of Guelph

FLP – 526: The evolution of the Canadian prairie grain handling system
Researchers: James Nolan, University of Saskatchewan

FLP – 529: The transfer efficiency of government support programs
Researchers: J. Stephen Clark, Nova Scotia Agricultural College

FLP – 534: Policy impacts on organic and locally-oriented food production in British Columbia
Researchers: Alison Eagle, G.C. van Kooten, University of Victoria

FLP 500: Crops Rotations and PEI land use policy

Petr Prochazka and J. Stephen Clark

During the last thirty years, there has been an alarming increase in pollution in PEI watercourses. This is demonstrated in Figure 1. The figure plots the average amount of nitrates in PEI streams over time. The figure shows a marked rise over time. This has led to increasing concern that the pollutants in the streams may be causing environmental damage. In particular, increased nitrate levels are causing concern over water quality and increasing number of fish kills may be causing damage to the reputation of the PEI sport fishing industry and the tourist industry in general.

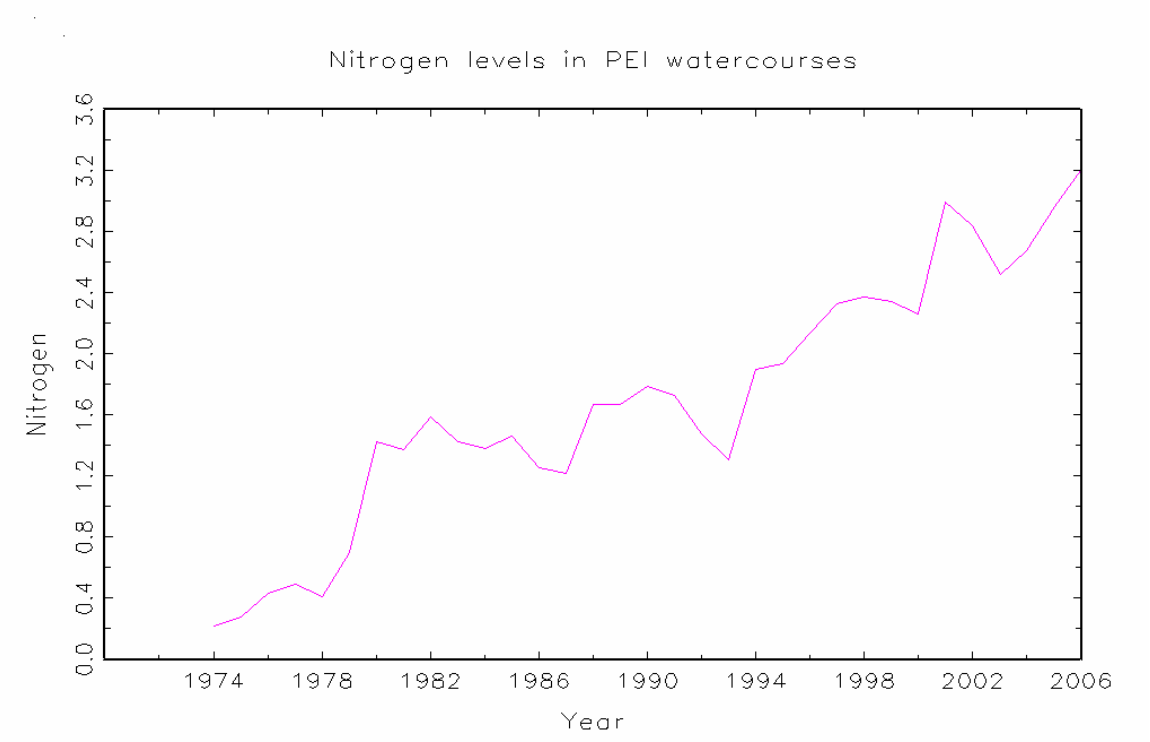

Figure 1: Average Nitrogen Levels in PEI stream watercourses

The major cause of increased nitrate levels is assumed to be the agricultural industry, especially the intensive cultivation of potatoes. The assumption that primary potato production is the cause of increased pollution on the Island is due to the fact that there has been a large expansion of the potato industry during the last two decades. This expansion has been facilitated by the expansion of processing capacity, since a new processing plant was built on PEI by McCains foods and an existing plant was expanded by Cavendish farms during the same time. This led to a large amount of land being brought into potato production, especially in Eastern PEI.

In response to the increased pollutants in PEI watercourses, the Provincial government of PEI set up a commission to study the problem and make recommendations to the Provincial government. This commission is known as the Round Table on Land Use Policy in PEI, hereafter simply called the Round Table. Several recommendations were made by the Round

Table, however, in dealing with agriculture, the two that are directly of concern to this research include:

1) The establishment of buffer zones between cultivated agriculture and watercourses. These buffer zones are intended to mitigate pollutant runoff from intensive agriculture into PEI watercourses.
2) A mandated three year crop rotation for potato producers. This rotation mandated that potatoes could only be grown one year in three, and that a forage crop would also be included in the rotation one year in three. The other year was at the discretion of the producer, but was presumed to include a grain crop (mostly wheat or barley). It was possible to have other rotations, but only if a management plan was filed with the Provincial Government.

The Round Table also recommended that potato production be restricted from slopes of severely sloped land, to avoid erosion problems that cause environmental pollutants to runoff into PEI streams.

The recommendations of the Round Table were put into law in PEI in the late 1990's. The buffer zone and rotations legislation were the first of their kind in North America, and the legislation was hailed as enlightened environmental policy. However, there are press reports that the legislation met with resistance from farm groups, who argued that the legislation, especially the crop rotation legislation, was unduly restrictive to producer choice and costly to implement. Also, the Provincial government never spent funds allocated to monitor rotations. Hence, compliance to the mandated rotations legislation is unknown. There are also some unsubstantiated reports that recalcitrant producers are knowingly noncompliant in order to be charged under the Act to test the legality of the legislation in the courts. To date, no one has been charged resulting from non-compliance.

The question that arises is why the crop rotation legislation was resisted by potato producers. To answer this question, an optimal control model of PEI potato rotations was developed. Unique to the modeling effort of potato rotations was the fact the rotations were not fixed; each year, the choice of crop is based on present and future value. The optimal control model has as its state variable nitrogen stock (that is related to soil organic matter) and as its control nitrogen fertilizer. Each year, producers are presumed to choose, based on current profit and future conservation value, the best of three crops: potatoes (high valued, high depletion crop); barley (intermediate valued intermediate depletion (conservation) crop; and ryegrass (low valued (green manure) high conservation) crop.

The results of the model can be summarized as follows:

1) Continuous potatoes (Potatoes, snow rotation). This rotation is not sustainable over the long run. The model treats nitrogen naturally occurring in the soil differently than nitrogen fertilizer. Since the only way to enhance this source of nitrogen is through the growth of grain or forage, eventually the increase in the future value of entering another crop into the rotation outweighs the current profit of growing potatoes. While continuous potatoes does not lead to a steady-state rotation, it can be sustained over the short run, particularly if natural nitrogen levels in the soil are high. This may be

true of land that has recently been brought into production, like land in the eastern part of PEI.

2) Two crop, potato grain rotation. This crop rotation dominates the simulation results. It also leads to a steady state level of nitrogen and a steady state rotation. Therefore, it is sustainable. However, this rotation also leads to a significant amount of pollution from nitrate runoff. This crop rotation is likely to result in continued interference of agriculture on other industries in PEI and therefore agriculture/other industry conflicts may remain. There is evidence that this rotation is highly prevalent in PEI.

3) Three crop rotation: potato, grain forage. This is the rotation mandated by the Round Table. The results show that this crop rotation is never optimal. Much of the reason that forage never enters the rotation is due to the fact that forage is treated as a green manure. Therefore, forage enters the rotation when it is given some value other than simply its conservative effects on soil quality. When forage enters the rotation, grain leaves, implying that a three crop rotation is never optimal. The steady-state level of nitrogen is highest with a two crop, potato/forage rotation when forage is given a high enough price to make it competitive with the grain crop. The reason three crop rotations are never optimal results from the fact that the model does not consider grain/forage interactions on carbon nitrogen cycles. This is a drawback of the model. However, the fact that three crop rotations are not the dominant in PEI suggests that grain/forage interactions may not be economically important to the explanation of observed PEI crop rotations. Furthermore, the results can explain why there is resistance by producers to the mandated three crop rotation instituted by the PEI government. There is also evidence of an anecdotal nature the important aspects of grain/forage interactions not modeled can be achieved by simply adding straw to soil with spring tillage of grain. This may result in enough nitrogen/carbon interaction to ensure competitive yields without the need of loss in revenues resulting from green mature forage.

The results of the optimal control model indicate that there are important costs associated with mandated crop rotations that may explain why there is resistance by producers to this legislation in PEI. The results indicate that the choice of crop in rotation is very much an entrepreneurial decision. If this aspect of production decision making is taken out of the hands of producers through mandated crop rotations, significant losses may result. Each year, producers face a decision as to what crop to grow. At that time, decisions are made as to the tradeoff of present profit to expected future profit that results from soil conserving cropping practices. Mandated rotations take this decision out of the hands of producers, without any compensation and to their personal loss. Furthermore, mandated rotations are based on an assumption of a steady state outcome that may not be relevant to producers who have recently brought land into production. Continuous potatoes may be optimal for these producers in the short run until liquidation values of natural stocks of nitrogen are exhausted. For this reason alone, mandated rotations are likely to meet with resistance from producers.

It seems a better approach would be market based approaches: taxes or subsidies. Market based approaches influence producer behaviour and enhance the goals of environmental preservation over the long run without the potential gains resulting from short run market conditions. Therefore, flexibility is left with producers to adjust rotations as market conditions

change and can therefore result in increases in producer welfare without destroying the long-run environmental goals of society.

FLP 501: Farmland Conservation in The Netherlands and British Columbia, Canada: A Comparative Analysis Using GIS based Hedonic Pricing Models

Geerte Cotteleer, Tracy Stobbe and G. Cornelis van Kooten.

As a result of urban development, farmland in many countries is under pressure. Reasons to preserve farmland are related to cultural heritage, food safety, open space, the environment, but also as a result of slowing and restricting development. To protect farmland, countries employ different land use policies. In this paper, we examine two jurisdictions: The Netherlands and a particularly rich farming area in British Columbia, Canada. For each of these areas, we use a GIS-based hedonic pricing framework to analyze determinants of farmland values, farm survivability, and the level of speculation on farmland in the urban-rural fringe, where farmland is under urban pressure.

On the Saanich Peninsula of BC, the price of farmland within the Agricultural Land Reserve is lower than outside the ALR, indicating that zoning schemes are still at least partially credible, even though exclusions of ALR land have occurred. Further, farm parcels that are less fragmented are slightly more valuable than those that are not, and this partly offsets speculation. Yet, some agricultural activities occur outside the ALR, indicating that some farmers are able to survive without ALR zoning and amid highly fragmented landscapes, oftentimes taking advantage of agro-tourism opportunities that are in demand near the urban fringe.

Our findings also indicate that speculation or 'rurbanization' is taking place on a large scale in the Saanich Peninsula, particularly as smaller agricultural lots sell for relatively higher prices. Smaller lots are more attractive to hobby farmers and buyers of rural estates, though they are less attractive to farmers. Higher prices signify that these lots are likely bought for residential or hobby farm purposes by those craving a rural lifestyle in close proximity to a large urban area. Overall, the higher prices for small farm parcels and inexperienced buyers bode ill for sustaining viable commercial agriculture on the urban fringe.

In BC, the requirements for farm class status and lower tax rates favour farms of 1 to 4 ha and may, counter-intuitively, work against agricultural preservation as 1-4 ha parcels are clearly preferred by hobby farmers; the low threshold for achieving farm class status makes it cheaper to own a large rural estate that is not farmed efficiently or professionally. If the purpose of preferential tax treatment is to slow down development and retain open space, the policy employed by BC Assessment may be efficient. While preferential tax rates cannot halt conversion of agricultural land, they can alter the timing decisions for conversion. However, if the purpose of farm class status is to help support a viable farm economy, then preferential taxes seem to contribute to the growth of hobby farms and large rural estates by changing the relative price of land. By raising the threshold or implementing other hurdles to achieving farm class status, the government could reduce the desirability of living on large rural estates.

In The Netherlands, we find that agricultural zoning is more credible in more rural areas than urban ones, as prices in urban areas are affected by speculation to a greater degree. In urban areas, pressures to change zoning plans are much stronger and re-zoning usually favours developers. Therefore, the degree of urban development pressure determines farm

profitability and survivability as agricultural returns might then be insufficient to cover higher land costs.

In more rural areas, in contrast, nature and recreational uses of farmland compete with agricultural use. Farmland prices in rural areas are impacted by future nature zoning. The reason is that green development is often loss-generating, and prices in rural areas are still relatively low, so these are the areas where the government can still compete with other buyers of land. In urban areas, land values are too high for future zoning of nature preservation to be credible because farmers are reluctant to sell land to the government because they would earn much more selling at some future date to a developer for commercial or residential use. Furthermore, in both urban and rural areas farmers find that recreational activities, such as campsites, are becoming relatively more lucrative. As a result, more and more farmers are engaging in non-agricultural activities that compete with agriculture uses of land. Dutch farmland is consequently under development pressure in both rural and urban regions, albeit the form of development is much different in the two areas.

We can conclude that farmland in The Netherlands and in rural-urban areas near BC's fastest growing cities is under serious threat, although these threats are expressed in different ways. Urban development and nature preservation, especially in The Netherlands, compete with agriculture for land, while the types of activities constituting agriculture are shifting as well. In order to make land more competitive with urban and other uses, owners of agricultural land in both areas increasingly engage in non-agricultural, tourism-oriented activities (e.g., bed and breakfasts, camping, horse stables, u-pick berry, renting of garden plots) that enable them to earn revenues that cover land costs in addition to labour and other variable inputs. An alternative strategy involves more intensive agriculture, such as greenhouses, or a focus on speciality products, such as organic farming, intensive horticulture and grape growing. In any event, it is clear that agriculture in highly urbanized regions is changing.

FLP 501: Hobby Farms and Protection of Farmland in British Columbia

Tracy Stobbe, Geerte Cotteleer and G. Cornelis van Kooten.

Agricultural land protection near the urban-rural fringe is a goal of many jurisdictions, and none more so than British Columbia, Canada, which uses a provincial-wide zoning scheme to prevent subdivisions and non-agricultural uses of the land. A preferential tax regulation scheme for farmers is also in place, as in many jurisdictions. Small scale hobby farmers are present at the urban fringe near Victoria (the capital) both on land inside and outside of the Agricultural Land Reserve (ALR). The goal of this paper is to investigate whether the instruments used to protect farmland are economically efficient and whether or not the establishment of hobby farms is problematic in this context. We make use of a GIS (geographic information system) to construct detailed spatial variables and we employ two models to analyse our parcel-level data set: an hedonic pricing model and a limited dependent variable model.

The empirical investigations illuminate some average preferences and trends in hobby farming in B.C. The average hobby farm is a relatively small parcel of agricultural land that lies outside the ALR and often supports some livestock. Hobby farmers don't seem to mind fragmentation of agricultural land as much as regular farmers although they do seem to have a preference for being near open space as evidenced by the fact they prefer to be closer to the ALR boundary when they are outside of it and to be deeper in the ALR when they are inside it. Since the ALR provides reasonable assurance of farmland preservation, hobby farmers likely prefer situating near the ALR to guarantee their open space views are protected.

The negative externalities facing agriculturalists living in the urban-rural fringe do not seem to bother hobby farmers as much as regular farmers. They likely receive fewer complaints due to the less-intense cultivation or usage of their land. This indicates that hobby farming may be able to survive more easily in the urban fringe in the long run, compared to commercial farming. The fact that hobby farmers are more often than not located outside the ALR means they currently contribute to open space preservation even without the ALR zoning ordinances.

Furthermore, hobby farmers benefit from B.C.'s favourable property taxation scheme for agricultural land which sets a low threshold for obtaining tax reductions. Indeed, it is clear that hobby farmers seek parcels which place them into the category of land with the lowest threshold for qualifying for farm class status and they tend to avoid parcels smaller than 0.8 ha which would place them into the category with the most strenuous threshold. In the same vein, hobby farmers have a much lower propensity to leave their land vacant as opposed to regular farmers. All these factors point to a picture of hobby farmers as active seekers of farm class status to reduce their property tax burdens.

When surveyed, B.C. residents show strong support for agricultural land protection, but it is not clear how they would rank various values and reasons for preserving farmland against each other. Four main categories of values that agricultural land protection meets: agrarian values (which are concerned with food production and protecting the agricultural heritage and traditions of the area), environmental values (which are concerned with protecting wildlife habitat, flood protection and other environmental services), aesthetic values (which are

concerned with the preservation of open space), and anti-growth values (which see land protection as an obstacle to urban sprawl). Sometimes these values can conflict over specific land uses. For instance, agrarian values are satisfied by highly productive greenhouse agriculture, but environmental and aesthetic values are dissatisfied, whereas golf courses are desirable land uses for aesthetic values but not for agrarian or anti-growth values. It is not clear which values B.C. residents hold the most strongly with regard to the ALR, both in terms of the province as a whole and in the urban-fringe settings.

We argue that reasons to protect agriculture related to food production are not justifiable from an economic perspective. Because agricultural production is a primary output and not an externality, and government interference is only justified when there is market failure. Therefore, the argument that hobby farms should be looked at as a negative since they take land out of full-scale production and limit the expansion opportunities of regular farmers, doesn't hold. However, if aesthetic values are supreme, then hobby farming is a practice to be encouraged and the low threshold for farm class status is well-placed. That said, it is possible that the role hobby farmers play in reducing growth in an area (and thus, reducing conflicts and externalities for regular farmers) outweighs the harm they do.

It is possible that open space is valued differently by people depending on whether it is a large-scale farm or a relatively smaller hobby farm. In the future, more research will hopefully shed light on this issue and allow more definite conclusions to be drawn about whether hobby farming is serving the public interest at the urban fringe or not. A survey that compared valuations of regular farmland versus land used by hobby farmers, for instance, would be an important piece to the puzzle. Until governments know exactly what it is about agricultural land that causes the public to support its protection so quickly, they cannot design the most appropriate policy instruments to address the problem of disappearing farmland near the urban fringe.

FLP 501: Bayesian Model Averaging in the Context of Spatial Hedonic Pricing: An Application to Farmland Values

Geerte Cotteleer, Tracy Stobbe and G. Cornelis van Kooten.

In 1973, British Columbia created the Agricultural Land Reserve (ALR) to protect farmland from development. In this study, we employ GIS-based hedonic pricing models of farmland values to examine factors that affect farmland prices. We take spatial lag and error dependence into explicit account. However, the use of spatial econometric techniques in hedonic pricing models is problematic because there is uncertainty with respect to the choice of the explanatory variables and the spatial weighting matrix. Bayesian model averaging techniques in combination with Markov Chain Monte Carlo Model Composition are used to allow for both types of model uncertainty.

We were particularly interested in determining whether B.C.'s Agricultural Land Reserve was perceived to be an effective instrument for preserving farmland. We hypothesized that, if zoning is credible, farmland prices adjacent to the edges should be lower due to the reduced productivity associated with urban spillovers and externalities. Alternatively, if agricultural landowners do not believe the preservation scheme is permanent, these lands will have higher values and lower rates of investment in expectation that the land will be sold to developers in the future. We used spatial hedonic pricing models to investigate this question

We also wished to resolve the uncertainty of the choice of explanatory variables and the spatial weighting matrix in our model. Therefore, we used Markov Chain Monte Carlo Model Composition in combination with Bayesian model averaging to resolve this model uncertainty. Although basic model uncertainty could be resolved using these methods, we found they had some drawbacks as well. First, these methods are time consuming, although greater computing power partly addresses this issue. Further, these methods seem to result in lower bounds on the estimated means and t-statistics of the coefficients of interest. However, with more specific prior information this issue might also be partly resolved.

Using these techniques, we could nonetheless draw conclusions about which variables have high and low inclusion probabilities. Lot size, GDP and vacant land were very important in explaining farmland prices. Furthermore, we learned that our data are better described by a spatial error process than a spatial lag process, and that the inverse squared distance weighting matrix best describes this spatial error process.

With respect to the credibility of the ALR, we conclude that speculation is likely an important phenomenon, affecting at least part of the ALR, even though the estimated signs all support the hypothesis that the ALR is credible. For example, ALR land is sold for less than land outside the ALR, land at the ALR boundary sells for less, and farmland that is more fragmented and farther away from the heart of the ALR sells for less. However, these findings are not very robust, as none of these estimates are statistically significant and the inclusion probabilities for these variables are all very low. Therefore, we can conclude that the ALR is only partly credible, with speculation taking place at least on some parcels. This view is also supported by the fact that Saanich farmland in general is priced much, much higher than would justified by agricultural returns. Furthermore, smaller parcels are sold for higher prices

per ha than larger parcels, indicating that economies of scale in agriculture do not appear to play a role.

An alternative explanation is that the higher prices per ha signify that farmland is most likely bought for residential purposes by those craving a rural lifestyle in close proximity to a large urban area. To some extent, it is possible that the requirements for obtaining farm class status and thereby lower property taxes may, counter-intuitively, be working against agricultural preservation in BC. As smaller farmland parcels are clearly preferred by buyers, the low threshold for achieving farm tax status makes it cheaper to own a large rural estate rather than an urban residential lot. A landowner does not need to be a professional or efficient farmer, but can simply be a hobby farmer. By raising the threshold or implementing other hurdles to achieving farm status, the government could reduce the desirability of living on large rural estates, but perhaps to the detriment of serious agricultural producers.

Overall, it appears that high prices for small farm properties and inexperienced farmer-buyers bode ill for sustaining viable commercial agriculture on the urban fringe. It may also hinder preservation of open space in the longer run if such open space is being protected under the guise of preserving farmland for agricultural purposes only.

FLP 503: An Agent Based Simulation Approach to Forecast Long-Run Structural Change in the Saskatchewan Grain and Livestock Sectors

Peter Stolniuk, Advisors: Richard Schoney and James Nolan

Like many North American agricultural regions, Saskatchewan has experienced significant structural changes in the farm sector. Structural change encompasses changes in the distribution of farm sizes, land tenure and financial characteristics, as well as variations in demographic and production characteristics. These issues are often a source of discontent among farm populations because of a basic desire to maintain the status quo. Structural changes have profound and sometimes poorly understood effects on the rural economy – for example, these types of changes affect rural population levels and demand for rural infrastructure.

Traditional agricultural farm level analysis has been conducted using representative farms or groups, but this framework cannot capture the growing heterogeneity of modern farm operators or the current changes in the operating environment in agricultural regions. Agent based simulation modeling of farming and structural change captures this heterogeneity and allows ready examination of the key determinants of structural change.

For this study, a synthetic population of grain and livestock farmers was created based on survey data, layered over actual land characteristics from CAR 7B in Saskatchewan. Structural change occurs in the model endogenously as farms interact in land markets, and make decisions on land use. Farmers compete for available land in a purchase and lease market. The dynamic basis of agent based models means that individual farms in the simulation can adjust their land use over time in response to changing economic conditions or individual preferences on farm practice.

Different price and yield time paths in the simulation were developed using a bootstrap methodology on historical data. The simulation allowed structural changes in the region to emerge as a counterfactual over the duration of the data. The results indicate that many of the basic structural trends seen in the actual data remain essentially unchanged under different price and yield time paths, but the rates of change are significantly affected by differences in prices and yields. The results also indicate that shocks to grain prices will have a much greater impact on structure in this region than similar shocks to livestock prices.

FLP 505: Determinants of On-Farm Investment in Environmental Protection

Emmanuel K. Yiridoe, David Thibodeau, and Verna Mitura

Beneficial management practices (BMPs) are common strategies with potential for mitigating environmental quality problems from agriculture, and are also accepted techniques for helping to comply with environmental regulations. Structural BMPs are particularly important because they are not only useful by themselves, but also because such BMPs can affect adoption and performance of non-structural BMPs. Farmer investment in agricultural BMPs is of much policy interest and relevance, partly because of growing concerns with the impacts of agriculture on the environment. More importantly, because farmers are users of natural resources and farm inputs, knowledge of their on-farm BMP investment behaviour can help policy makers understand what influences such farm environmental protection investments, and what agri-environmental policies might promote more widespread investment. Policy makers are also interested in (prioritizing) programs and strategies that can induce producers to participate in and/or implement BMPs with high environmental quality improvements. In addition, while farm investments in BMPs for environmental protection across Canada are substantial, it is not clear what factors influence investment decisions (among investors), nor the factors that distinguish between investors from non-investors. The farmer investment decision considerations in on-farm environmental protection in Canada have become more important when considered in the context of growing federal and provincial budgetary constraints.

An objective of this study was to assess the determinants of farmer expenditure on selected structural agricultural BMPs, using a flexible specification of the double-hurdle model to capture observed zero investments among a of sample Canadian farmers. The three BMPs studied reflect farmers' investments in: i) manure storage construction or major renovation (MS); ii) pesticide, chemical, or fuel storage or major renovation (CS); and iii) environmental protection improvements in shelterbelts, windbreaks, buffer-strips and fencing (VS). Given the potential agri-environmental policy relevance of this study, a second objective was to evaluate the effects of explanatory variables in the on-farm investment decision process by calculating and decomposing elasticities. A third objective was to compare the determinants in investment behaviour for crop versus livestock farmers. The analysis was based on data on farm environmental protection investments obtained from the 2005 Farm Financial Survey for a sample of 3919 crop farmers and 5902 livestock farmers, collected by Statistics Canada.
The study investigated both the discrete decision to invest or not, and the continuous level of investment. Initially, four alternative specifications of the DH model were estimated, including the standard DH, heteroscadastic DH, inverse hyperbolic sine (IHS) DH, and the IHS heteroscadastic DH models. Likelihood ratio tests of restrictions were used to identify the DH model specification that best fit each BMP data set.

Farm family income, government payments, and farms in provinces with more stringent environmental regulations are among the significant determinants of investments in the three BMP categories. For example, among farmers willing to invest in MS, those located in Quebec were both more likely to invest, and tended to invest more than in other provinces. In addition, a percentage point increase in a farmer's age decreases the probability of investing in MS by 1.46%, consistent with a hypothesis that younger farmers who plan to stay in farming longer are more willing to revamp and, therefore, likely to invest more than producers expecting to soon retire. The findings also support the DH decision approach used. For example, although farmers with higher income were more likely to invest in MS, for example, among those that did invest, the

amount invested was influenced by factors linked to region/location, social/demographic factors, and government program payments, and less so by farm profitability. The results provide policy makers with a basis for prioritizing and targeting farm environmental stewardship programs and incentive schemes.

FLP 506: A Farm Simulation Model of BMP Adoption for Improvements to Off-Farm Water Quality

Peter C. Boxall, Wanhong Yang, Marian Weber, Yu Deng and Danyi Yang

The Farm level Policy Network provided seed funding for our research team to undertake research on the costs of BMP adoption at the farm level. We examined four BMPs being tested in South Tobacco Creek, Manitoba, for this project; although only one BMP (zero-till) was specifically examined using the FLP funding. The FLP funds provided a good start for this broader research effort and further funding from the Watershed Evaluation of Beneficial Management Practices (WEBs) provided significant funds to develop the comprehensive economic research on all four BMPs.

In particular, the FLP funded preliminary examination of the development of production (yield) functions for five crops: wheat, canola, flax, oats and barley in the study area in southern Manitoba. These functions included crop rotations, tillage practices, fertilizer inputs Preliminary results suggest that for this soil zone in Manitoba, the adoption of the zero-till BMP generates costs for producers – thus if producers are expected to adopt this BMP significant positives costs will be incurred and compensation may be required. This finding has been supported through discussions with various producers in the watershed who feel that in their watershed zero-till is not a management practice that can generate positive returns for producers.

This preliminary examination has allowed us to recently generate cost functions for the South Tobacco Creek producers for adoption of: zero-till, holding ponds, forage conversion, and riparian area management BMPs. These functions have been linked to a hydrologic model of the watershed (undertaken in a separate WEBs funded research effort) to generate non-point source pollutant abatement cost functions for each farm in the watershed. These abatement cost functions are being used in experimental economic treatments of the adoption of these BMPs under various policy scenarios in the laboratory at the University of Alberta. In particular, we have used experimental auctions to examine the adoption of these BMPs under potential policy goals of maximum participation of producers, maximum coverage of production elements that contribute to non-point source pollution (i.e. livestock), and maximum abatement of phosphorus in the watershed.

A final report on the complete research effort will be available by August 2008.

FLP 507: Price Risk Management of Canola in Western Canada

Ximena Amoroso, Jim Unterschultz and Tomas Nilsson

Increasing demand for Western Canada's Canola has led to high prices. Farm price risk is related to the changes of returns in an operation; changes that are caused by unpredicted variation in input and/or output prices. The present study examines the use of futures markets and hedging as tools for reducing the price risk in Western Canada's canola production. Future contracts usually give traders (Canola producers) two advantages: price-shifting and pricing; hedging on futures markets is a method to shift risk. Canola producers could lock-in a price (future price) that will cover costs and return a profit while the Canola is still in the field or in storage. Hedging can reduce price risk caused by price volatility. Different tests have been conducted to determine the strength of the relationship between canola cash prices and canola or soybean futures prices. Strong short-run and long-run relationships are required for hedging to work as a risk management tool. .Weekly regional data from 1998 until 2007 (469 observations), that comes from the WCE and other source are used in time series Vector Regression models to test for Unit Roots and Co-integration; measures of price relationships. . Preliminary results show a close relationship between Canola cash price and Canola future prices and a relationship between Soybean cash prices and Soybean future prices. The results also indicate a co-integration between these commodities; U.S. Soybean prices tend to lead Canola prices. Estimation results indicated that futures prices lead cash prices which is important for hedging.. Next steps will be to specify hedging models to achieve our main objective; evaluate canola hedging strategies.

This research is coordinated with the research of Dr. Derek Brewin, U. of Manitoba, Dr. Jared Carlberg, U. of Manitoba and graduate student Janelle Mann (U. of Manitoba). They are looking at spatial efficiency issues in Canola pricing.

FLP 509: The Effect of Land-Use Restrictions on Agricultural and Residential Land Values

Brady J. Deaton and Richard J. Vyn

On February 24, 2005, the Greenbelt Act became law. However, the Greenbelt initiative and corollary restrictions on land uses date back to December 2003, when the Minister of Municipal Affairs and Housing restricted the development of land (for certain uses) in what was then known as the Greenbelt study area. The stated goal of the Greenbelt plan was to enhance urban and rural areas and, thereby, improve the quality of life in Ontario. A primary means of achieving this objective was to disallow the use of prime agricultural land (as designated in municipal official plans) for non-agricultural uses. Alternatively put, the goal is to reduce urban development and sprawl, which is seen by many to diminish the quality of life in Ontario. The Greenbelt was not a trivial legal change; the Greenbelt area is expansive, covering over 1.8 million acres of land (much of which is in agricultural use), and located near one of the fastest growing metropolitan areas in North America: the Greater Toronto Area (GTA).

Almost immediately there was debate over the distributive consequences of the Greenbelt. Part of the debate essentially boiled down to concern over who benefits, who loses, and the magnitude of those gains and losses. Some individuals and organizations perceived themselves as winners: beneficiaries of the Greenbelt. Others perceived themselves as losers: bearing the costs of the Greenbelt without ample compensation. Winners, for example, include Ontario residents who enjoy the amenity benefits of open spaces secured by the Greenbelt. These effects may be capitalized into land values and, thereby, enhance the wealth of some land owners. Winners also include agricultural land owners and farmers who believe the Greenbelt protects their long term agricultural interests and investment. Others were less enthusiastic because they perceived themselves as being in worse position after the Greenbelt became law. For example, some agricultural land owners believe the Greenbelt reduced the value of their land by prohibiting its potential for residential use.

Concern about the property value effect looms large in the debate surrounding the Greenbelt. Farmland accounts for a sizeable portion of wealth in the farm sector. (In the United States farmland accounts for nearly eighty-percent of farm assets in the farm sector.) Hence, any change in the value of land which is clearly a prominent asset will, no doubt, influence the landowner's perception of whether or he or she is, or is not, a Greenbelt beneficiary.

Theoretical approaches to assessing the effect of a greenbelt on property values lead to mixed conclusions. On the one hand, some economists think that the prices of farmland will fall. The logic behind this thinking is fairly straight forward. First, economists tend to think that the price of farmland will reflect the present value of future agricultural and development rents. Initially, when land is in agricultural use, the development rents are lower than the agricultural rent. However, at some point the urban pressure increases the value of development rents relative to agricultural rents; and it becomes lucrative to transform the land into urban uses. Hence, when future development rents are significant, legislative change that disallows development diminishes the selling price of restricted farmland. There is empirical evidence to back this position. For example, economists examined the effect of Quebec legislation that disallowed development of agricultural land in a number of areas including an

urban-fringe area of Montreal. Their statistical results suggest that the restricted land was worth between 14.7% and 30.5% less than unrestricted land.

On the other hand, economists have provided reasons for believing that, at least for some agricultural land, restricting future development uses of farmland may not significantly reduce agricultural land values. Indeed, in some situations, economists have argued that restricting non-agricultural land uses may improve agricultural land values. One reason given by some economists is that non-agricultural land uses may have a negative effect on nearby farm operations. For example, an increasing residential population may make it harder for farmers to move equipment along the road because of increasing levels of traffic. In these scenarios, some economists have argued that land use restrictions, like those included in the Greenbelt, segregate conflicting uses of the land and generate benefits for farming operations that are capitalized in land values. An alternative argument is that agricultural rents increase as their proximity to urban areas increases and this may diminish the property value effect of restrictions. A recent article published in the American Journal of Agricultural Economics found that farms located near urban agricultural areas had a much higher proportion of high-valued crops.

There is also empirical evidence supporting the alternative view that agricultural land use restrictions won't necessarily reduce land values. For example, an empirical examination of agricultural zoning in Wisconsin (USA), found that agricultural zoning had both positive and negative effects on the price of restricted agricultural land. The location of the restricted farmland parcel played an important role in determining whether the land use restriction enhanced or diminished land values. The research findings suggest that large agricultural land parcels, further removed from urban areas, experienced slight increases in land prices as a result of the zoning restrictions.

Given the importance of the Greenbelt and the many conflicting viewpoints, we believe it is important to carefully and continually analyze its effects. Brady Deaton, Assistant Professor at the University of Guelph, initiated an effort to empirically examine the effect of the Greenbelt on farmland property values in Ontario. He and his colleagues at the University of Guelph, which include Richard Vyn (a Ph.D. student), have partnered with the Municipal Property Assessment Corporation (MPAC), to empirically examine the Greenbelt's effect on farmland property values. (MPAC has provided the data to the University of Guelph in an effort to support research. However, any opinions, findings, conclusions or recommendations expressed are solely those of the authors and not necessarily the views of the Municipal Property Assessment Corporation.) .

We have collected information on thousands of farmland sales in Southern Ontario between the years 2002 and 2006 and we are using statistical approaches to examine the change in the price of farmland that resulted from the Greenbelt legislation. The preliminary results suggest that property values of farmland in the Protected Countryside zone of the Greenbelt have been affected by the legislation. However, not all properties appear to be effected equally or the same way. The value of farmland properties in very close proximity to the Greater Toronto Area (GTA) appear to have fallen but this negative property effect lessens as the distance between the farmland and the GTA increases. Indeed, for distant farms – farms located furthest from the GTA (in the Protected Countryside) – some property values appear to increase. However, these results are very preliminary and will now be subject to a number of

additional statistical tests. At this point in the research we can not make definitive statements about the magnitude of the overall property effect. However, we are reasonably comfortable with the conclusion that the effect of the Greenbelt legislation is not the same for all farmers: presumably these differences reflect differences in the development pressure being experienced by farmers in the Protected Countryside prior to the legislation.

This empirical approach poses many challenges but we believe it contributes information to the ongoing debate about the distributive consequences of the Greenbelt. We are not advocating the position that changes in farmland prices are the full measure of the Greenbelt's social value. Rather, we suggest that it is an important consideration that needs to be continually examined. We are hopeful that our analysis will be used eventually by individuals and groups to help inform the ongoing discussion of the Greenbelt; and that the study's results will assist efforts to plan for the future. Additional studies that better measure the non-farm benefits of the Greenbelt are also needed.

FLP 515: Understanding Non-Agricultural Entrepreneurial Activities by Canadian Farmers

Julio Mendoza, Spencer Henson and Andreas Boecker

The promotion of entrepreneurial activities is considered a critical way in which to revitalize economic activities in rural communities. While it is recognised that farm-based value-added activities (VAD) and non-farm businesses (NFB) are some of the strategies farmers undertake to cope with income problem, there is a scarcity of information on the types of businesses pursued, factors affecting the decision to start such businesses and the problems faced. We also know little about the characteristics of farm-based value-added activities in Canada. The aim of this study is to provide empirical evidence on the entrepreneurial activities of Canadian farmers based on a nation-wide survey of 332 producers.

The first element of the study aims to determine the entrepreneurial characteristics of Canadian farmers by calculating indices of locus of control (LOC), entrepreneurial self-efficacy (ESE) and entrepreneurial alertness (EA), as well as eight latent entrepreneurial factors derived from the LOC and ESE scales. The results indicate that farmers in the sample exhibit internal LOC and moderately high ESE and EA. A comparison between *diversified* farmers (that are engaged in non-agricultural entrepreneurial activities, such as NFB or VAD) and n*on-diversified* (that are not involved in such activities) indicates that those that are diversified exhibit higher levels of ESE and EA but similar levels of LOC to non-diversified farmers. Furthermore, the diversified farmers show higher scores for the latent entrepreneurial factors related to confidence in developing tasks involving *Innovation and Market Development* but score lower for *Strategic Management*. Both groups exhibit similar levels of confidence with respect to developing tasks related to P*lanning, Marketing and Sales* and *Decision-making*.

The second objective of the study aims to assess the factors influencing the probability of farmer participation in non-agricultural entrepreneurial activities. For this purpose two probit models are estimated. A binary probit model is used to analyse the factors that affect the decision to participate in entrepreneurial activities *per se*, while a second bivariate probit model assesses the factors determining the decision to diversify into NFB or VAD. Thus, the analysis examines four possible choices: participation in VAD, participation in NFB, participation in both VAD and NFB and participation in neither of these activities (that is non-diversified). The explanatory variables relate to entrepreneurial characteristics (the eight entrepreneurial factors defined above), personal characteristics of the farmer, characteristics of the farm, and the nature of the business environment.

The results from the binary probit model indicate that *Innovation and Market Development* has a positive effect on diversification while *Strategic Management* has a negative influence. Farmer characteristics related to *University Education*, *Previous Business Experience* and *Organization* have a positive effect on the decision to diversify, while being a *Full-time Farmer* and the level of *Farming Experience* has a negative effect. Being involved in *Fruit and Vegetable* production has a positive impact on the decision to diversify.

The results from the bivariate probit model indicate that *Innovation* and *Market Development* have a positive marginal effect on the probability that a farmer participates in VAD and NFB

and VAD alone, and a negative marginal effects on the probability that they participate in none of these activities. The variable *Strategic Management* has a negative effect on the probability of engaging in VAD, and a positive effect on the probability of engaging in NFB and of not engaging in either VAD or NFB. With respect to farmer characteristics, *University Education* has a positive marginal effect for engagement in VAD and a negative marginal effect for both NFB and engaging in neither VAD nor NFB. Being a *Fulltime Farmer* has a negative marginal effect on the participation in VAD and/or NFB and positive effect on participation in neither. Conversely, having previous *Business Experience* affects positively participation in VAD and/or NFB and reduces the probability of participation in neither. Additionally, *Off-Farm* employment affects positively the probability of participation in VAD and NFB and NFB, but has a negative impact on participation in VAD. Proximity to urban areas also had an appreciable impact on the diversification decisions of farmers; *Distance* greater than 50 km from the farm to a city has a negative effect on the probability of engaging in VAD but positively effects the decision to undertake an NFB.

The third objective of the study was to provide a broad characterisation of VAD by Canadian farmers. The most frequent VAD activities are related to direct selling through farmers' markets, pick your own operations and/or farm shops. On the other hand, there is a low rate of participation in activities related to accommodation and educational activities. Most of the sales from VAD activities are undertaken at the farm and/or through direct selling. The main competitors faced by farmers undertaking these activities are wholesalers and supermarkets. The main problems experienced at start-up are lack of marketing skills and managerial abilities and regulations. Most VAD are started with relatively low levels of investment, relying mainly on the farmer's own financial resources. Thus, VAD are mostly family-owned businesses and managed by the farmer and/or their spouse. Most farmers have received training in VAD activities and use computers.

The results indicate that VAD businesses are initiated mainly with the objective of complementing the farm/household income, to assure the survival of the family business and/or to improve the farmer's position in the market. The study results suggest that farmers had achieves most of these initial objectives and had contributed to the enhancement of farm/household income. Almost three quarters of the businesses in the survey had undertaken at least one form of innovation, mostly by developing new products and services and by penetrating new markets. Only a small percentage of farmers had ceased a VAD activity, although where this had occurred was due to sickness, lack of time or low profitability of the operation.

The results obtained of this study demonstrate that, in general, Canadian farmers have significant entrepreneurial potential with respect to VAD and NFB and that these activities can contribute to the enhancement of farm/household incomes and other business objectives. Policies and programs aimed at exploiting this entrepreneurial potential among farmers need to take into account the particular characteristics of farmers as entrepreneurs and the nature of their farms, as well as the enabling business environment. Farmers pursue such opportunities for different reasons and can face distinct problems and challenges. Policies and programs need to be sufficiently flexible to address such differences.

Keywords: Entrepreneurship, Farmers, Canada, Value-added, Non-farm business.

FLP 517: An Econometric Model of Multivariate Stochastic Production Functions for Manitoba Crop Agriculture

Barry Coyle, Lina Zhu

The primary objective of this research is to formulate and estimate an econometric model of crop production emphasizing the impact of input decisions on yield covariances as well as variances. This study addresses a major shortcoming of empirical stochastic production functions, which largely ignore impacts on yield covariances. Following Just and Pope, studies of stochastic production functions have ignored production impacts on yield covariances, with a few minor and unsatisfactory exceptions.

AAFC has a strong ongoing interest in simulating impacts of programs such as CAIS and Production Insurance (PI) on farm production decisions, and AAFC recognizes that such impacts depend critically on perceived yield risk, price risk and risk preferences. Theory of decision making under risk emphasizes the importance of risk covariances as well as variances, so these extensions should be of considerable interest to AAFC. Indeed this research is closely related to an ongoing study of CAIS and PI by the author for AAFC.

Building on insights in recent multivariate GARCH (MGARCH) literature (especially Engle), this paper first presents a more satisfactory approach to modeling production impacts on covariances of yield risk. We first note, directly from this literature, a relatively simple method of estimating multivariate stochastic technology models under constant correlations.

Then we consider two approaches to modeling more general nonconstant correlations of yield risk in multivariate technologies. First, we specify a flexible representation of covariances without imposing positive definiteness (pd) of the covariance matrix. A simple extension of feasible generalized least squares (FGLS) can provide consistent estimators of coefficients, so that asymptotically covariance estimates approach pd. Second, we propose a restrictive model of nonconstant correlations that can impose pd in a relatively simple manner and is relatively easy to estimate. This model is related to but not identical to models in the MGARCH literature.

These models of multivariate stochastic production functions are applied to a large farm level panel data set on yields (for the five primary crops) and physical levels of four fertilizer inputs (nitrogen, phosphorous, potassium, sulfur) provided by the Manitoba crop insurance agency. The empirical study begins by obtaining more robust estimates of Just-Pope-type stochastic variance equations than in most of the literature. Then multivariate technologies under constant correlations are estimated, using merged data sets for each pair of crops. The hypothesis of constant correlations is rejected.

Then more general correlation equations were estimated for all ten correlations between the five primary crops, ignoring the issue of pd. As anticipated for such cross section data sets, R_2 is low. Nevertheless elasticities with respect to nitrogen are sizable, ranging from + 26 % to + 65 %. The hypothesis that correlation is independent of fertilizer levels is rejected, except for models of correlation of oats and flax.

The final section of the paper estimates nonconstant correlation models imposing pd. This section is not yet complete. Preliminary results indicate that the approach is tractable.

FLP 519: An Evaluation of Moral Hazard Risks in Government of Canada Farm Business Risk Management Safety Net Programs

Scott R. Jeffrey

Safety net programs (i.e., production insurance and CAIS) are key components of the business risk management pillar within the Agricultural Policy Framework (APF). The federal government has conducted a review of current agricultural policy, looking ahead to the next generation APF (AAFC 2006, 2007). From this have come four new proposed programs to replace the current public safety nets. While full details for all of these new programs (i.e. AgriInvest, AgriStability, AgriRecovery and AgriInsurance) are not yet available, AgriInvest and AgriStability appear to be similar to NISA and CAIS, respectively.

The focus of economic analysis on public safety nets has been on effectiveness of these programs. Limited evidence exists (e.g., Mussell and Martin 2005) to suggest that there may be "side effects" associated with participation in these programs. It may be the case that participating in these programs will impact on production management decisions. Public safety nets may also affect the incentives to utilize alternative risk management tools by creating redundancies or at least affecting the optimal "suite" of risk management strategies. Ideally, risk management tools should be neutral in terms of impact on production. If participation leads to riskier production patterns, there may be negative implications for cost and effectiveness of programs. Public safety net programs should also complement other risk management tools. If not, this raises question of whether safety nets are needed?

As the federal government is developing a revised suite of safety net programs, there is an opportunity to assess these programs early in their life, rather than after the fact. Insights into these issues surrounding the impact of safety net participation on production management would be of value to producers, as it would provide information useful in deciding how best to use these new programs. Currently, however, there is little information available from a Canadian perspective to assess and quantify these effects. The objective of this project is therefore to examine the impact of public safety net programs on optimal production behaviour under alternative safety net scenarios.

The research employs firm-level analysis to achieve the study objective. Specifically, stochastic dynamic simulation techniques are used to model the performance of representative farm operations. Firm performance is modeled with and without participation in Federal Safety net programs. For each risk management scenarios, alternative production plans are to be modeled. Risk efficiency criteria (e.g., stochastic dominance) are used to determine optimal production management with and without safety net participation in order to determine if there is likely to be any effect on producer decision making.

There are several "deliverables" from this project. The study will deliver information in terms of the production "neutrality" of the safety net programs. Along with this, information will be generated in terms of how producers may best utilize these programs.

FLP 520: Revenue insurance, support programs and catastrophic risk for cow-calf producers

Brandon Schaufele, Tomas Nilson.
Vic Adamowicz (U of A) and Jim Unterschultz are a part of the supervisory committee for B. Schaufele. Other funding for this research is from the Alberta Prion Research Institute in Alberta.

Introduced in 2003, the Canadian Agricultural Income Stabilization (CAIS) program was designed to mitigate the downside risks of the agricultural sector. It provides producers with two benefits. First, it increases an enterprise's expected income. Second, it reduces the variance of the income distribution. The combination of higher expected income and lower distributional variance improves the expected utility of farmers. Yet, CAIS is a voluntary program and it is not costless. Enrollment in the program requires the payment of a fee, which, in the absence of risk, reduces expected income. Consequently, reductions in income variability may be off-set by the cost of the program. A producer must consider both the potential benefits and the costs of her participation decision. Further, recent experience has demonstrated that output prices are susceptible to sudden, "catastrophic" declines, which are independent of "ordinary" price movements. The potential for negative, catastrophic shocks exacerbate the unpredictability of farm incomes. Albertan cow-calf producers are vulnerable to these unexpected livestock price movements. CAIS is designed to protect against both ordinary production and price risk and the prospect of catastrophic shocks. However, there has been minimal research into the benefit that it provides both with and without the potential for catastrophic price shocks.

This research provides insights into four areas. First, it provides insight into the long-term CAIS program participation decision for a risk-neutral and a risk-averse Albertan cow-calf enterprise. Next, if participation is assumed, outcomes under several Elected Protection Levels are assessed. These provide some guidance for coverage level decisions. The benefits (costs) under varied protection, risk-aversion and discounting levels are calculated. Third, catastrophic price risk is introduced. The change in producer welfare from two scenarios (with and without the prospect of large, negative price declines) is computed – i.e., the welfare loss (gain) from the introduction of (potential) catastrophic shocks is determined. Finally, some initial simulations of producers' willingness to pay for supplementary catastrophic risk revenue insurance are presented. A simulation capital budgeting model is built. For simplicity, only price risk is considered. Two scenarios are examined: with and without the potential for catastrophic risk. The representative Albertan producer is assumed to have constant relative risk averse (CRRA) preferences. Four methods are used to evaluate this paper's objectives: a) stochastic dominance, b) the coefficient of variation for producer income, c) certainty equivalence welfare analysis and d) willingness to pay calculations.

The results demonstrate that there is a substantial welfare gain to producers' decision to participate in the CAIS program. Further, the gains are increasing as the Elected Protection Level increases. The greatest gain in producer welfare occurs when the enterprise opts for full CAIS protection These results support the conclusion that Albertan cow-calf produces should select full coverage – a 100% Elected Protection if available. Even with the CAIS program, some cow-calf operations may be willing to pay for supplementary insurance to guard against

large negative shocks. Events like the BSE crisis can be severely detrimental to Albertan livestock producers. As a consequence,
some producers may want greater risk protection than that provided by the CAIS
program. The results indicate that there may be noticeable producer welfare gains from the purchase of catastrophic revenue insurance. Further research would be required to determine whether this class of insurance contracts would even be of interest to cow-calf producers. Nevertheless, the willingness to pay estimates suggest that this is a topic that should be further researched.

FLP 521: Beef Industry Competitive Benchmarking Study: Measuring the Production Efficiency Alberta Cow-calf Operations

Sudarma R. Samarajeewa, Getu Hailu, Maury M. Bredahl and Scott R. Jeffrey

The purpose of this study is to examine the production efficiency (i.e., technical, allocative and economic) of cow-calf farms in Alberta. Production efficiencies are measured using an econometrically estimated stochastic Cobb-Douglas production frontier and analytically derived stochastic cost frontier. The study uses repeated cross-section data of samples of 333 Alberta cow-calf farms from 1995 to 2002. The results reveal that mean technical, allocative and economic efficiencies for sample cow-calf farms are approximately 83, 78, and 67 percents, respectively. All other things being equal, such degrees of production efficiency suggest that Alberta cow-calf producers could increase output and/or save cost by reallocating resources with the existing technology. Improvement in allocative efficiency appears to be relatively more important than technical efficiency as a source of gains in production efficiency for the sample cow-calf farms. The results suggest that herd size and biological efficiency have positive effects on production efficiency; government supports and production efficiency are negatively related; and there is variation in production efficiency across cow-calf farms in different locations.

Keywords: Production Efficiency; Cow-calf farms; Biological Efficiency; Farm Size; Location; Stochastic Frontier

JEL Codes: D24, Q12, C13

FLP 526: The Evolution of the Canadian Prairie Grain Handling System

James Nolan, Derek Brewin

Recent changes in the Western grain elevator system have been driven by factors at both the industrial and the farm level. While a link exists between farm level policies and the supporting elevator network, the extent to which these policies affect the structure of the grain elevator system is not well understood. To address this question, an agent-based simulation model of the Prairie grain elevator network has been designed to examine the effects on the elevator network of potential alternative agricultural and/or transportation policy scenarios.

The model consists of randomly located farms operating on a stylized agricultural landscape of farmers, elevators and a rail network. These farmers produce wheat subject to random output shocks. Subsequently, farmer agents deliver grain to the least cost elevator. In addition, grain elevators may choose to close if too little grain is handled for too long. Under these assumptions, preliminary work has shown that changes in relative delivered prices generate unmistakable “tipping points” with respect to elevator closure. Across a range of elevator sizes and rail costs, the simulation generates either very stable or sudden collapses in the number of grain elevators. The latter case means that handling capacity is concentrated in just a few very large elevators. The observed collapses in elevator numbers depend less on the amount of grain handled than on the magnitude of farm to elevator transportation costs.

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Measures and Causes of Divergent Productivity Growth in the Livestock and Crops Sectors: Prairie Provinces 1940-2004

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1.0 Background

Productivity growth is responsible for sixty-four percent of the considerable growth in Prairie agricultural output from 1940 to 2004 (increases in input use are responsible for the remaining thirty-six percent). This study focuses on measuring the productivity growth that has occurred in Prairie agriculture from 1940 to 2004, and the policy implications of these results.

1.1 Changes in Prairie Agriculture Over the Past 65 Years

The measurement of productivity growth in Prairie agriculture requires the construction of a comprehensive data set of agricultural inputs and outputs. Beyond its use in measuring productivity growth, the data set also shows trends in Prairie agricultural production.

In terms of input use, Prairie agriculture has been strongly labour saving and materials using (Figure 1). This is a reflection of the rapid mechanization of agriculture, gains in labour productivity, and the increasing use of pesticide, fertilizer, and energy inputs. Agricultural outputs have also changed substantially over time. The Prairie crops sector typically produces in excess of sixty percent of the total value of Prairie agricultural production; although the livestock sector has increased its share of total agricultural production from the 1980's onward (Figure 2). Figure 3 shows a decline in the share of traditional crops being produced (e.g. wheat, flaxseed and rye). In contrast, canola and specialty crop production (e.g. lentils, sugar beets) has expanded considerably.

Figure 1: Input cost as share of total input cost: Prairie Agriculture 1940-2004

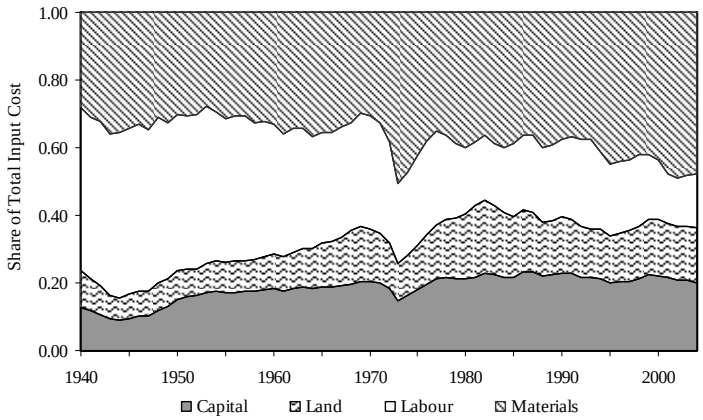


Figure 2: Share of total Prairie agricultural output, by province and sector 1940-2004

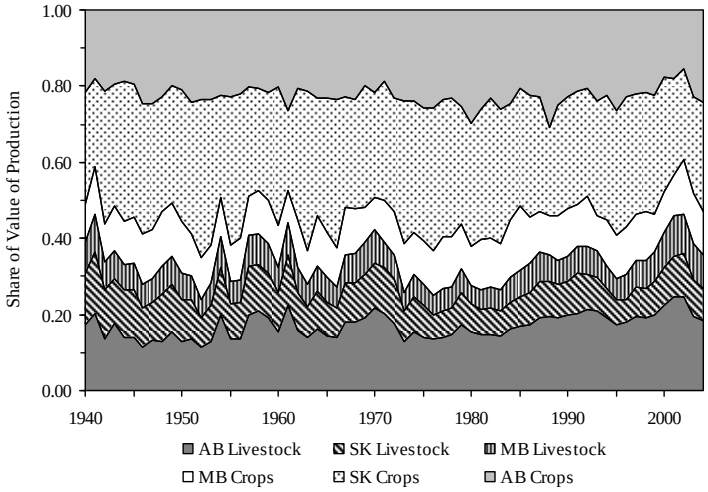


Figure 3: Shares of Prairie crop outputs 1940-2004

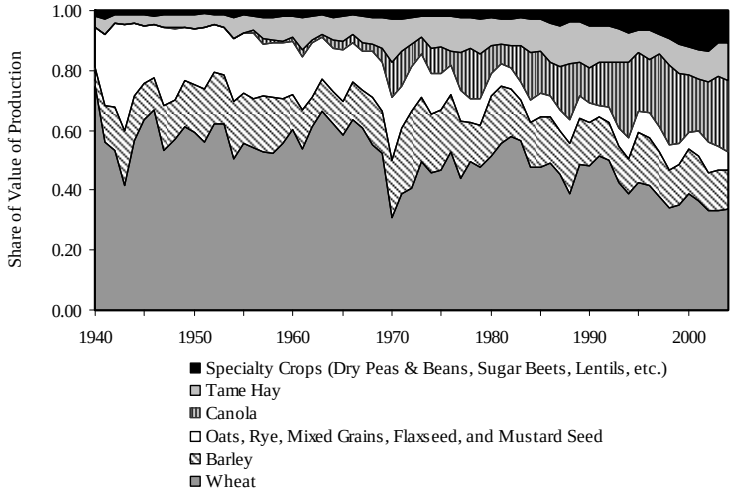
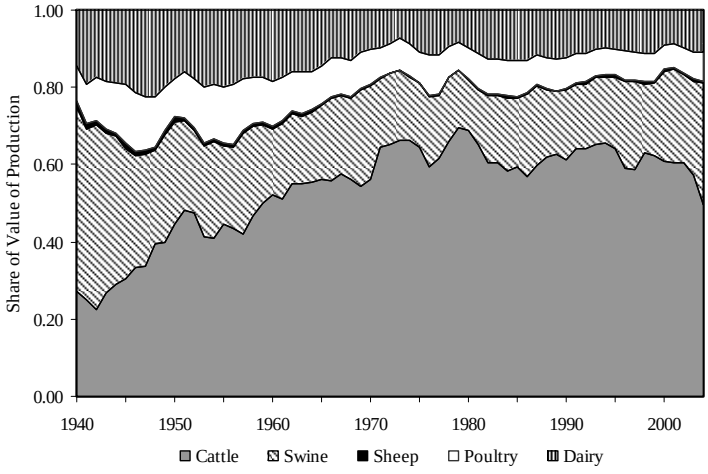


Figure 4: Shares of Prairie livestock outputs 1940-2004



The expansion of cattle's share in total Prairie livestock production from 1940 to 1980 can be seen in Figure 4. By 1980 cattle's share begins to stabilize and then declines somewhat as swine production expands (principally in Manitoba).

2.0 Productivity Growth and its Measurement

Productivity growth is the growth in outputs (e.g. heads of cattle or bushels of wheat) not explained by a growth in inputs (e.g. labour, feed or seed). Prairie agriculture displays strong overall productivity and output growth of 1.56 and 2.43 percent per annum respectively over the 1940 to 2004 period (Table 1). Input growth is more modest at only 0.86 percent a year. However, growth rates measured over the sub periods indicate substantial variation over time.

Table 1: Average annual compound percentage growth rates for Prairie aggregate agricultural inputs, outputs and productivity: 1940-2004

	1940-2004	1940-1959	1960-1979	1980-2004	1990-2004
Productivity Growth	1.56	1.25	1.48	1.80	1.46
Inputs Growth	0.86	-0.03	1.45	0.57	0.21
Outputs Growth	2.43	1.22	2.95	2.38	1.67

To assess the aggregate productivity growth measures in more detail estimates are also obtained at the provincial and sectoral (i.e. crops and livestock) levels. A number of noteworthy trends can be discerned from Table 2. First, productivity growth in the crops sector is substantially higher than in the livestock sector. Second, productivity growth in Manitoba agriculture is considerably higher than in Alberta or Saskatchewan. Third, while crops productivity growth declines over the final fifteen years of the study, livestock productivity growth accelerates over this period (particularly in Manitoba and Saskatchewan).

Table 2: Average annual compound productivity percentage growth rates for Prairie provinces by crops and livestock sectors

	Crops		Livestock	
	1940-2004	1990-2004	1940-2004	1990-2004
Alberta	1.65	-0.05	0.54	0.90
Saskatchewan	1.76	0.40	0.59	3.61
Manitoba	2.12	1.75	0.97	4.21

3.0 How Productivity Growth Happens

Causal explanations for productivity growth can be grouped into one of the three categories: technology development and adoption (e.g. improved genetics), increases in the degree of technical efficiency in production (e.g. better seed placement), and greater economies of scale in production (e.g. more effective use of capital in larger farms).

Productivity growth can be decomposed to reveal the respective roles of technology and economies of scale in productivity growth. Efficiency changes are grouped with measurement errors (i.e. residual). For Alberta, Saskatchewan, and Manitoba respectively, 94.7, 84.5 and 80.4 percent of the recorded crop productivity growth is generated by technology (Table 3). In contrast, the livestock sector has been more effective in generating increasing returns to scale over time. The recent slowdown in crops productivity growth may be largely attributed to limited technological advances in this sector. The accelerating livestock productivity growth may be

attributed in part to technological gains accruing to the sector, but more importantly to the economies of scale realized from the rapid increase in livestock output over the final fifteen years.

Table 3: Components of productivity growth over the 1940 to 2004 period by Prairie province

	Crops (1940-2004)			Livestock (1940-2004)		
	Technology	Scale	Residual	Technology	Scale	Residual
Alberta	94.7 %	4.9 %	0.4 %	37.3 %	51.0 %	11.7 %
Saskatchewan	84.5 %	16.9 %	-1.5 %	57.4 %	62.4 %	-19.8 %
Manitoba	80.4 %	16.5 %	3.1 %	53.2 %	36.0 %	10.8 %

4.0 Testing Causal Explanations for Productivity Growth

In addition to the three general categories of causes (technological, scale, and efficiency) of productivity growth, specific explanations for productivity growth and its variability can be advanced. The following list briefly summarizes a number of explanations applicable to Prairie agriculture: Geoclimatic Differences; Research and Development (R&D) Expenditures; Productivity Differences Inherent in the Biology and/or Production Processes of Specific Outputs; Economic Pressures and Producer Support; Education and Extension; Structural Change.

It is desirable to assess empirically the causal explanations of productivity growth. A number of variables are tested including: domestic R&D, terms-of-trade, farm specialization, farm size, education, extension, off-farm labour, farm/manufacturing wage ratio, and support payments.

For both livestock and crops, Canadian research and development displays the largest positive impact on productivity growth. This finding points to the positive fundamental role that past domestic research and development investments play in productivity growth in both the crops and livestock sectors. Terms-of-trade (growth in output prices minus growth in input prices) is a measure of cost price pressures with a negative number indicating that input costs have increased at a faster rate than output prices. The crop sector and the livestock sector terms-of-trade were -2.57 and -0.29 respectively over the 1940-2004 period. The crops sector in particular and livestock sectors have faced consistently declining (negative) terms-of-trade, an indication of the cost price squeeze faced by Prairie agriculture. The results indicate producers have responded to the cost-price pressures by increasing productivity growth through increased technological adoption. Farm size, as measured by output quantity produced per farm, has increased in both the crops and livestock sectors. Structural change, in terms of increasing farm size, plays an important role in generating positive productivity growth in the livestock sector. Finally, product specialization in swine has been more productive than beef. This result may explain the higher livestock productivity growth in Manitoba over the past fifteen years; a province characterized by rapidly expanding swine production.

5.0 Policy implications

The exact causes of variation in productivity growth between the livestock and crops remain an open question. However, the foregoing results do provide a starting point for assessing the likely causes of Prairie productivity growth and point to a number of policy implications.

First, domestic public and private research and development plays an important role in productivity growth. Consequently, the productivity growth slowdown in crops may be mitigated by long term investments in research and development. The long term nature of the investments is critical due to the long time lags typically involved between research investments and their productivity payoffs. Research and development expenditures are also important for the livestock

sector. Although much of the livestock sector's past productivity gains can be attributed to its swine and cattle output expansion, it is not clear that it can continue to expand in the future at past rates, thus future productivity growth in livestock will likely need to come increasingly from technology, rather than scale of production.

Second, cost price pressures encourage productivity growth in Prairie agriculture. This suggests that producers in both the crops and livestock sectors respond to increasingly competitive economic conditions by increasing productivity. Policy that contributes to producers' flexibility in adopting novel technologies, business structures and management strategies should help ensure productivity growth in the future. This study was not able to directly assess the impact of institutions and regulations on Prairie agriculture productivity growth.

Third, farm size is an important determinant of productivity growth in the livestock sector. Consequently, policy that promotes smaller livestock farm size (e.g. for niche livestock products or rural development policies may involve a trade-off with higher productivity growth.

Fourth, some outputs appear inherently more productive than others (e.g. swine); in this context, increased industry specialization may be desirable. It may also be desirable to focus R&D expenditures on these inherently more productive agricultural outputs. Conversely, to pursue a more diversified productivity strategy, R&D could be earmarked for less productive outputs.

Acknowledgements

Farm Level Policy briefs are summaries of studies funded by the FLP. As such, the briefs omit many of the details and references contained in the longer reports. This brief is based on research work by Bryce Stewart at the University of Alberta. Funding for this project was provided by the FLP and the Alberta Agricultural Research Institute. FLP is funded by Agriculture and Agri-Food Canada. The views expressed in this paper are those of the authors and should not be attributed to the funding agencies.

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Externalities and Valuation of Farmland in the Urban Fringe

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1.0 Objectives and Background

Canada's agricultural land is under pressure at the intensive margin – the rural-urban fringe. This is particularly true in British Columbia, even though agricultural land in the Province is protected under the Province's 1973 Agricultural Land Reserve (ALR) legislation. At the rural-urban fringe, agricultural land has become fragmented with farmers unable to take advantage of economies of scale, and land prices have become inflated due to non-agricultural values, so farmers are unable to realize reasonable returns to land. Increasing pressure from urban encroachment results in externalities that are bi-directional. Urban complaints about off-farm externalities such as smell, noise, and pollution of waterways has necessitated 'right-to-farm' legislation – the BC Farm Practices Protection Act (1995) – that reduces the ability of urbanites to complain about agricultural practices, while requiring 'normal farming practice'. At the same time, farmers have difficulty moving equipment from one field to another and must tolerate trespass and vandalism associated with their proximity to urban development. The response to these externalities has been threefold:

1. Landowners permit their stock of farm capital or farm improvements to deteriorate because they lack the incentive and finances to undertake new investments. In essence, farming is slowly being abandoned.
2. Agricultural producers switch to specialty 'products', including market garden crops that cater to the nearby urban market, organic production and/or very intensive agriculture (viz., greenhouses in Delta municipality). Intensive agriculture near urban areas has often been opposed by environmentalists and others, although it may be one means to ensure an adequate income for agricultural producers. Alternatively, food safety concerns have made consumers increasingly wary about where food originates, and thus they have been willing to drive to nearby farms to purchase locally and often organically produced farm products directly. Farmers near urban centers may be able to command a price premium by producing organically or eliminate the marketing chain, thereby enabling them to earn an adequate income and continue farming. However, little is known about the success and ability of these farming approaches to maintain agricultural land at the rural-urban fringe.
3. Landowners may subdivide land to the smallest size permitted under the ALR zoning ordinance, selling the land much like single-family lots to those willing to treat it as a sub-urban 'ranchette'. The land may be taken out of agricultural production entirely, and allowed to deteriorate, or rented out for livestock use or production of forages.

The main objective of the research is to determine the factors that result in landowners being classified into one of the three categories identified above. We want to know how factors such as off-farm income, proximity to urban centres/markets, government support, and regulations affect the continuation of farming in areas within a certain distance (perhaps 50-100 km) of urban

centres, and how they affect the adoption of organic farming, market-garden operations, and other specialty farms that facilitate the continuation of agriculture. We want to know what characterizes landowners who go into intensive agriculture (e.g., greenhouse production) in urban areas. The focus of the research will be on BC's attempt to control urban growth through the ALR.

The current research seeks to answer some of the questions related to agricultural activities near large urban centers. The particular focus is British Columbia's Agricultural Land Reserve and its success in retaining land near the urban centers in the lower mainland (Vancouver and suburbs), Okanagan Valley and Saanich Peninsula (southern Vancouver Island near Victoria). Because land prices are the major determinant of farmers' abilities to retain financially viable operations, the particular objective of the current research is to examine how land prices are impacted by the rural-urban interface. To do so, we examine farmland and residential values in the Saanich Peninsula.

2.0 The Nature of Rural-Urban Conflict in British Columbia

Agriculture in BC generates approximately $2.2 billion in farm gate sales and creates jobs for more than 30,000 British Columbians in primary agriculture alone. Using only 2.7% of the provincial land base (about half of the total ALR land), BC agriculture provides about 50% of provincial food requirements. While agriculture serves as a key component in a network of working farms, forests, parks and natural spaces that contain urban growth, the fastest-growing towns and cities in BC are typically located adjacent to prime agricultural land, creating pressure for the conversion of farms to other uses.

The challenges inherent in managing growth and supporting a viable agricultural industry are exemplified on Vancouver Island. As in other regions of BC, the Island's small areas of fertile soil, along with a moderate climate, are the basis for world-class agricultural productivity. Urban growth places tremendous pressure on the Island's prime farmland; agriculture and development for recreation, retirement homes and other urban needs compete for the same lands in the Victoria-Nanaimo-Campbell River corridor. Community and environmental values need to be balanced with the need for housing and industrial development. In the Regional District of Comox-Strathcona (RDCS, which lies within the corridor), for example, the ALR accounts for just two percent of the land. The RDCS's 445 working farms reported over $26 million in gross receipts in 2001, while helping to provide a healthy and secure food supply and contributing nearly $6 million in wages to the local economy. Yet, this land is under pressure from retirement development and recreation, some of which is associated with the increasing recognition of Mount Washington as a world-class ski destination.

As the urban fringe is pushed out, there is increasing fragmentation of the surrounding farmland and intensification of the externalities associated with farmland and development. These externalities flow in both directions. On the negative side, there are nuisance complaints from neighboring urban residents who object to the sounds and smells of farming operations, and the added traffic congestion caused by slow-moving farm equipment traversing from one field to another some distance away. Of course, this spatial fragmentation adds to farming costs, as do vandalism and trespass. Nonetheless, urban residents enjoy living near open spaces that facilitate wildlife viewing, provide pleasant agrarian landscapes during commutes and recreational amenities. Indeed, real estate brokers include farmland views and proximity to natural areas as selling features of houses. One of the properties included in our sample was listed for sale in 2007 with the following description: "Central Saanich – Victoria: This .28 acre view property is priced to sell and move in today. Overlooking the Marindale Valley and farm fields, the property has some distant water views and close to Island View Beach…. Only 15 minutes from downtown and 10 minutes from ferry and airport…." That people are willing to pay more for a house with these amenities, including nearness to agricultural lands, has been demonstrated by a number of empirical studies.

We investigate the value of open space (farmland and parkland) using a hedonic pricing model of residential properties to derive shadow prices for lands in the ALR and other open space (e.g., parks, nature reserves) – to determine the premium that open space and other non-market amenities add to residential property values. Most researchers have estimated open space premiums using a proxy variable to represent its various attributes. One such proxy is the percentage of open space within a specified buffer zone around each property, while another is an index that allows the value of the open space amenity to decrease in a nonlinear fashion as distance increases. The contribution of open space to property values in a region falls to zero once an 'outer ring' is reached, with the distance to this outer ring determined endogenously in the statistical model. The problem with distance measures is that large and small open space areas are treated equally; the problem with area percentages is that arbitrary buffer zones around each property have to be specified and open space outside those boundaries is not taken into account. We addressed this issue by explicitly combining the distance and percentage measures using a Reilly index. In this way, all nature areas, parks and farmland areas are taken into account, insuring that both the size and distance measures are represented.

The dependent variable in our hedonic pricing model is the value of residential properties sold during the period 1974-2006. We examine both actual market values and assessed property values, but use the same explanatory variables in both models. By using actual and assessed property values, we can compare estimates of shadow prices of the characteristics of interest. If they are similar, this suggests that it might be valid to use assessed values as dependent variables in hedonic pricing studies. If the results indicate that it is equally valid as an approximation to use assessed values as the dependent variable in hedonic price studies, this would facilitate non-market valuation since assessed values are much more widely available, at least in jurisdictions where properties are assessed annually for tax purposes.

Our primary objectives are to evaluate the effect that public open space (e.g., parks) has on residential property values compared to privately-held agricultural land (both inside and outside the ALR), and to determine whether use of assessed as opposed to actual market values yield similar estimates of amenity values. Since obtaining exclusions from the ALR is a time-consuming and uncertain process, (private) farmland can be viewed as quasi-protected. This is similar to other studies that categorize open space according to whether it is privately-owned and developable, privately-owned but protected from development, or publicly owned. A third objective is to test the hypothesis that expectations about development likelihood should be reflected in its price. If buyers of residential properties expect farmland to in agriculture, an open space premium should be observed. However, if buyers expect that neighbouring land will be developed in the future, no such premium should exist.

3.0 Data and Variables

We focus on the Saanich Peninsula located on southern Vancouver Island, near Victoria, British Columbia, Canada. Properties in Victoria are not included because the research focuses on the rural-urban, where conflict between agricultural and urban land uses is greatest, and this occurs north of Victoria. The data consist of actual transactions of residential properties for the period 1974 to 2006 and assessment data for the period 2000 to 2006 in three municipalities – North Saanich, Central Saanich and Saanich.

The LandCor database we purchased records 208,273 transactions for the period 1901 to 2006, but we select only transactions since 1973 when the ALR was introduced. Further, only 'single-cash' transactions were included, because we felt transactions that did not involve cash or involved the sale of multiple properties at once were unsuitable for hedonic price analysis. We incorporated only detached family dwellings in the analysis; strata blocks, duplex buildings, seasonal dwellings and apartment blocks were excluded to focus the analysis on more

homogeneous properties. Further, since we could only analyze properties for which all of the variables of interest were available, other properties were filtered out.

A variety of databases was used to construct the explanatory variables used in the hedonic pricing model. Relevant characteristics were obtained by linking properties using their identification numbers (so-called jurols) or spatial location (in GIS). Distance data were constructed using spatial location information from GIS. An overview of all the variables included in the hedonic pricing model can be found in Table 1. All of the databases used to construct these variables are listed in Table 2. More detailed description of the variables can be provided upon request.

4.0 Preliminary Results

Not surprisingly, we find evidence of open space premiums in the sales prices of residential properties that border parks and farmland, especially farmland in the ALR. While we were quite confident that parks would have a positive effect on residential property values, we could not be entirely sure that this would be the case for farmland. On the one hand, theory predicts that residential properties bordering ALR land should have a premium over other residential land, because open space is valued by homeowners; on the other, there are negative externalities that agriculture imposes on neighboring residential properties (dust, noise and smell). If properties located nearer farmland have a premium, this indicates that open space is valued more than the negative externalities associated with agriculture, and that buyers of residential properties have confidence that farmland will remain in agriculture and not be developed in the future. Although we find this to be the case, there is slight evidence in our preliminary analysis suggesting that nearness to farmland is negatively related to residential property prices. This might indicate that negative externalities dominate the open space premium and/or that residential property owners do not have confidence that the farmland will remain in agriculture, or even worse, that they are concerned that farmland could be developed into a land use that is undesirable (e.g. shopping center, high-rise apartment, industrial park). Clearly, this needs to be investigated further.

Further, we find that distance to Victoria is inversely related to residential property prices as people value a shorter commute to work. We also find that house prices decline with age but increase with developed area, size of lot, number of bedrooms and bathrooms, and the presence of a garage, as intuition would dictate.

5.0 Conclusions for Agricultural Policy Makers

In an attempt to determine the prospects of agricultural producers in the rural-urban fringe, where farmers are under tremendous pressure to convert their lands to urban uses and high land values create a situation that often makes farming an untenable land use from a financial perspective, we have thus far only investigated how farmland and other factors affect residential property values. The preliminary analysis that we have conducted to date indicates that farmland is valued by residents for the non-market (extra-farm) amenities that it provides. As a result, a case can be made to somehow provide subsidies to farmers located in the rural-urban fringe, subsidies that enable them to continue farming despite the higher costs resulting from the location of farms in or near urban areas.

Designing policies that facilitate such subsidies pose a particular challenge, because not all farms are affected equally. That is, not all farmlands encounter the same development pressure or incur the same costs of operating in the urban shadow. One potential tool that might be considered is the use of transferable development rights. Such rights could be issued whenever the Agricultural Land Commission decides to exclude some land from the ALR, or they could be issued by municipalities with ALR land before they permit the development of land that is currently designated for future development. Whatever policy is chosen, it is important to act soon.

Table 1: Variables included in hedonic pricing model

Variables	Database nr*
Dependent variables	
Sale price property corrected with New Housing Price Index (in Can $)	1, 18
Assessed value property corrected with New Housing Price Index (in Can $)	2, 18
Housing characteristics	
Lot size (in square metres)	3
Effective year – year of last major renovation	3
Foundation type (basement, crawl, slab)	3
Finished area – area with finished ceilings and floors (in square metres)	3
Stories (Number of floors)	3
Number of 3- and 4-piece bathrooms	3
Number of 2-piece bathrooms	
Number of bedrooms	3
Garage (dummy = 1 if multi or single car garage is present, 0 otherwise)	3
Car port (dummy = 1 if a car port is present, 0 otherwise)	3
Pool (dummy = 1 if pool is present, 0 otherwise)	3
Other buildings (dummy = 1 if there are other buildings on the lot than the main house, 0 otherwise)	3
Corner lot (dummy = 1 if the house is on a street corner, 0 otherwise)	3
Waterfront lot (dummy = 1 if the house is on the water front, 0 otherwise)	3
Water on lot (dummy = 1 if there is water on the lot, 0 otherwise)	3
Open space	
Reilly index for nature parks	7
Bordering nature park (dummy = 1 if property is bordering a nature park, 0 otherwise)	7
Reilly index for farm land	5, 6
Nearest distance to ALR boundary (if property is outside the ALR, 0 otherwise)	11
ALR (dummy = 1 if property is located within the ALR, 0 otherwise)	11
Bordering ALR boundary (dummy = 1 if property is on the outside of the ALR boundary, 0 otherwise)	11
Reilly index for golf courses	8
Bordering golf course (dummy = 1 if property is bordering a golf course, 0 otherwise)	8
Other land uses - distance variables	
Nearest distance to Swartz Bay ferry terminal (in km)	8
Nearest distance to Victoria airport (in km)	8
Nearest distance to Victoria City Hall – city centre (in km)	8
Nearest distance to Patricia Bay highway (in km)	12
Nearest distance to school (in km)	8
Nearest distance to recreational centres (in km)	8
Elevation levels	
Elevation level (maximum elevation level in metres)	9
Elevation difference (difference between maximum and minimum elevation level in metres)	9
Macro-economic variables	
Interest rates	13
Mortgage rates	14
Population	15
GDP	16
Income	17

* For a description of the databases see Table 2; the number in this column refers to the corresponding database number in Table 2.

Table 2: Data sources

Nr	Name database	Data source	Year data
1	Sales history	LandCor	1974-2006
2	Assessment information	LandCor (originating from BC Assessment)	2000-2006
3	Property information	LandCor	2006
4	Actual use codes	BC Assessment	2006
5	Cadastral information	Capital Regional District (CRD)	2005
6	Cadastral information	Ministry of Agriculture	2004
7	Nature parks	Capital Regional District (CRD)	2006
8	Points of interest (schools, airport, Victoria city centre, golf courses, ferry terminal, recreational centres)	Capital Regional District (CRD)	2005
9	Elevation data	Municipalities (North Saanich, Central Saanich, Saanich)	2005
10	Soil classes	BC Assessment	2005
11	ALR	BC Assessment (originating with the Agricultural Land Commission)	2005
12	Road Network	Statistics Canada	2005
13	Interest rates Canada	Bank of Canada	1935 - 2005
14	Mortgage rates Canada	Bank of Canada	1951 - 2005
15	Population by municipality (Saanich peninsula)	BC Statistics	1976 - 2006
16	GDP annual data Canada	Statistics Canada	1961 - 2005
17	Income by municipality (Saanich peninsula)	Statistics Canada	1971, 1981, 1986, 1991, 1996, 2001
18	New Housing Price Index (Victoria)	Statistics Canada	1981 - 2006

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Examining Farmland Loss in Ontario

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1.0 Objective and Background

The issue of farmland loss in Ontario is non-trivial. Ontario is home to 52% of Canada's class 1 agricultural land[1] (Statistics Canada 2000). Agriculture and the agri-food sector are, together, the second largest sector in Ontario's economy (Ontario Election 2003).

The objective of this policy brief is to illustrate the effect of analytical criteria (spatial and temporal) on public perception of farmland loss in Ontario. Depending on the criteria used to evaluate land loss, different conclusions on the importance of land loss can be drawn from the results. The issue of the importance of farmland loss in Ontario is discussed.

1.1 The Ontario Greenbelt Plan

In February 2005, Ontario's Greenbelt legislation set forth a set of rules aiming to protect the provincial agricultural land base and valuable ecological features. A stated objective of the Greenbelt legislation is to preserve Ontario's agricultural land.

The goal of the Ontario Greenbelt Plan is to enhance the quality of urban and rural communities by protecting viable agricultural land and preserving natural heritage features. Together with the Places to Grow Act, the visions of the Greenbelt Plan are to protect the land from urban sprawl and to provide the proper tools for healthy provincial planning. The Places to Grow Act was passed in November of 2005 and consists of a provincial growth plan with goals such as where to grow and at what density in order to accommodate Ontario's increasing population.

The Greenbelt legislation added 4,047 km^2 to land that has been preserved through the Oak Ridges Moraine Conservation Plan (ORMCP) and the Niagara Escarpment Plan (NEP). Covering a total of 7,284 km^2, the greenbelt envelops the Greater Golden Horseshoe, one of the fastest growing metropolitan regions in North America. The Greenbelt Plan builds upon the existing Niagara Escarpment Plan and Oak Ridges Moraine Conservation Plan designating the corridors

[1] Class 1 agricultural land is designated by the Canadian Land Inventory and includes land that is not hampered by severe constraints for crop production, is of the highest quality and is found in the best climatic regions.

of land linking these two areas as the Protected Countryside, which is the land it mainly governs. Presently, Ontario continues to add agricultural land to the protected greenbelt.

2.0 Public Support for Farmland Preservation

Four factors that motivate public support for farmland preservation include food security, urban planning, environmental protection and local economic benefits of agriculture. Understanding the relative importance of these motivations is significant when setting the standards for implementing a farmland preservation program.

For example, preserving class 1 agricultural land may be the most important criteria for a farmland preservation program, motivated primarily by a concern about Ontario's capacity to sustain high levels of agricultural productivity. Alternatively, a more targeted preservation program may be needed if the public wants to preserve a specific area of regional importance (Deaton *et. al*, 2003).

Public motivation for farmland preservation is influenced, in part, by perceptions of farmland loss, agricultural productivity, urban growth, environmental quality, and farmer well being. For this reason, statistics of farmland loss frequently accompany arguments for farmland preservation. However, the use of statistics with respect to farmland loss can be highly selective. For example, a recent publication stated that over the past half century, farmland in central Ontario declined by 49% and in southern Ontario it was reduced by 13% (Centre for Land and Water Stewardship 2004). The above statistic is highly selective in that it is based on both a spatial restriction (i.e. central Ontario) and a temporal restriction (i.e. past half century).

3.0 Characterizing Farmland Loss in Ontario

Analysis of data from the Census of Agriculture illuminated three key points pertaining to farmland loss in Ontario: (1) trends in farmland loss depend on the point of time reference chosen by the analyst; (2) the total number of census farms in Ontario is decreasing but the average land area of those farms is increasing; and (3) the difference between absolute levels of urban area and farmland area in Ontario help explain why percentage increases in urban area will be higher than percentage decreases in farmland.

3.1 Reference Period

Total farm area and census farm numbers[2] in Ontario over an eighty-year period are presented in Figure 1. Both total farm area and census farm numbers display declining trends but the degree of the decline varies depending on the timeline chosen to analyze the data. When evaluating total farm area in Ontario from 1921 to 2001 the decline is 40%. However, from 1981 to 2001, the decline in farm area is 9.5%, and from 1991 to 2001, farm area actually increases by 0.27%[3].

[2] Total farm area is the total area of land found on a census farm. A census farm is defined as an agricultural operation that produces at least one of the following products intended for sale: crops (hay, field crops, tree fruits or nuts, berries or grapes, vegetables, seed); livestock (cattle, pigs, sheep, horses, game animals, other livestock); poultry (hens, chickens, turkeys, chicks, game birds, other poultry); animal products (milk or cream, eggs, wool, furs, meat); or other agricultural products (Christmas trees, greenhouse or nursery products, mushrooms, sod, honey, maple syrup products).

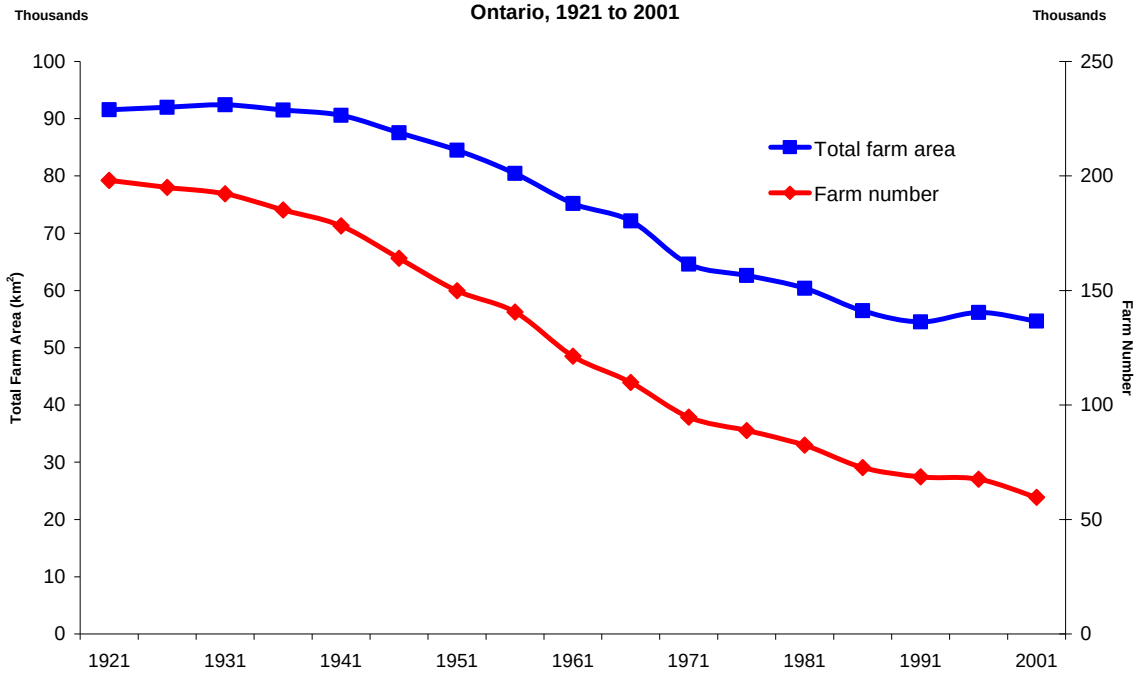
[3] Calculated using data from the Census of Agriculture (Figure 1), the difference in total farm area between 1991 (54, 513 km^2) and 2001(54, 662 km^2) divided by the total farm area of 1991.

These figures illuminate the extent to which data on farmland loss are influenced by a chosen reference point.

A similar but less surprising result occurs with changes in farm numbers. From 1921 to 2001, Ontario farm numbers fell by about 70%. Between 1981 and 2001 there was a 28% decline and from 1991 to 2001 the number of farms declined by 13%.

Reductions in census farm numbers are not necessarily good indicators of farmland loss. The number of census farms in Ontario has generally been falling more quickly than the area of farmland in the province; hence the land area of the average farm has been increasing. Other measures of size have exhibited a similar trend. For example, the number of farms in the Ontario dairy industry decreased by 50% from 1981 to 2001, but the average number of dairy cows per farm increased by 54%. In addition, productivity per cow has also been increasing. From 1984 to 2004, the number of litres of milk sold per cow per year has increased by 27% (Ontario Dairy Summary 2004). Census data indicates that between 1981 and 2001, the average acreage per farm in Ontario has increased by 25%. Consistent with the above trends, the number of farms of 560 acres or more has increased by 27% while the number of farms below this size decreased by 30%. Hence, statistics regarding reductions in the number of farms are unlikely to be good measures of farmland loss.

Figure 1 Total farm area and number of Census farms Ontario, 1921 to 2001

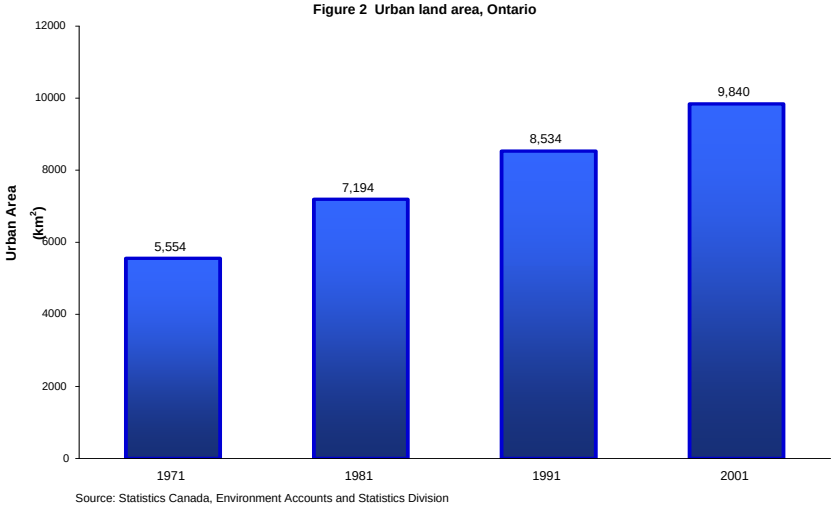


Source: Statistics Canada, Census of Agriculture, 2001.

High rates of urban growth may also be associated with perceptions of farmland loss. The majority of Ontarians live in urban areas[4] and may witness the transformation of farmland into urban land uses. The total amount of urban land in Ontario in 2001 was 9,840 square kilometres, which is 18%[5] of Ontario's total farm area of 54, 662 square kilometres.

The discrepancies between the absolute levels of urban land and farmland helps to explain why a high percentage increase in urban land use does not translate into a high percentage decline in farmland use. For example, a 50% increase in urban land is not associated with a 50% decline in farmland (Figure 2). Data from Statistics Canada indicates that between 1981 and 2001, the urban land area in Ontario grew by 36%. During this same time period, total farm area decreased by 9.5%. This point is of interest if statistics that characterize percentage changes in urban growth are perceived to be symmetric with the percentage changes in farmland (Figure 3). With respect to class 1 farmland, in 1981, 7.6% was occupied by urban area in Ontario whereas in 2001 that area grew by 3.6 percentage points (Figure 3).

Figure 2 Urban land area, Ontario

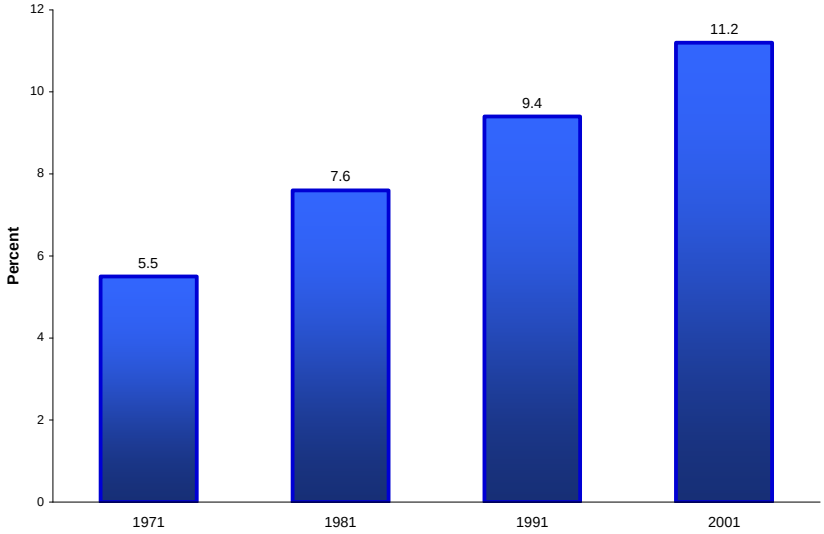


Source: Statistics Canada, Environment Accounts and Statistics Division

[4] Urban area has a minimum population concentration of 1,000 persons and a population density of at least 400 persons per square kilometer

[5] This figure was calculated by dividing the amount of farmland in 2001 by the amount of urban land in 2001 and multiplying it by 100. The source of total farmland in Ontario was the 2001 Census of Agriculture.

Figure 3 Percent of class 1 farmland occupied by urban area,



Source: Statistics Canada, Environment Accounts and Statistics Division

Quite logically, the statistics of farmland loss vary depending on the spatial unit analyzed. From 1981 to 2001, counties encompassing the Greater Toronto Area (GTA) such as Durham, York, Peel and Halton, lost 11.6%, 25.0%, 23.7% and 23.5% of farmland, respectively. The county of Wellington, just to the west of the GTA, lost only 5.9% of its total farm area.[6]

4.0 Policy Implications

The use of statistics describing farmland loss and urban growth influences public perception and, in turn, may affect public policy. For this reason, the "facts of the matter," matter. However, the "facts of the matter" are sensitive to the analysts' point of reference. Statistics surrounding farmland loss depend on a variety of choices including both the time and area under consideration. Moreover, the size of farms, on average, has been increasing. Hence, the statistics on the decline in farm numbers will only partially explain farmland loss. Finally, the area in farmland is far greater in magnitude than the area in urban use and it was demonstrated how this difference affects the way farmland loss and urban expansion can be characterized. While the aforementioned points will not be surprising to some, we believe our analysis helps illuminate just how sensitive these statistics can be.

Due to variations in point of reference and area under consideration, policy implications are few, if any. Depending on how the data are analysed, different conclusions on the importance of agricultural land loss in Ontario may be drawn and therefore, totally different policy implications may result.

[6] These data were obtained from the Census of Agriculture by identifying the Census division of each region. To obtain the figure for each region, total farm area in 1981 was divided by the difference in total farm area between 1981 and 2001 and then multiplied by 100.

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Do Farmers Waste Fertilizer?

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1.0 Objectives and Background

Farmers in many jurisdictions apply nitrogen at levels that exceed crop nutrient needs, despite the apparent costs of over-application (Agriculture and Agri-food Canada, 2000). Recommendations that account for crop requirements and relative prices are publicly available to farmers from government extensions services, yet farmers tend to apply more than suggested. Sheriff (2005) argues that there are several reasons why farmers are apparently applying more fertilizer than a crop can use: (1) perception that the general recommendations are not appropriate for their individual situations (2) uncertainty about soil quality, nitrogen content and about weather, (3) effect of chemical fertilizer substitutes (i.e. manure) and complements (i.e. irrigation), and (4) hidden opportunity costs of farmer time and equipment.

Since over-application can lead to environmental damages, either the recommendations need to be modified to more accurately reflect individual site characteristics or farmers have to be better informed about the appropriateness of the agronomic advice and the consequences of applying more than the crop needs. In order to assess the empirical basis for differences in farmer perceptions of agronomic advice, this policy brief examines the differences in *ex-post* optimal and *ex-ante* recommended application rates of nitrogen to corn on 6 field trials over several years in southwestern Ontario. The results suggest farmers are not "wasting" fertilizer and that their over-application is a rational economic response.

2.0 Sources of Differences Between Farmer Rates and Agronomic Advice

2.1 Farmers Perception of Agronomic Advice

Farmers may apply more than the recommended rate of fertilizer if they feel the recommendations are too conservative for their individual situation. Over-application may result from differences in the perception of how a crop on an individual field actually responds to fertilizer. The relationship between fertilizer application and crop yield is generally represented by either a plateau or a polynomial function. Variations in the *ex post* optimal nitrogen rate (i.e. Maximum Economic Rate of Nitrogen or MERN) due to differences in the form of the assumed yield response function may explain the tendency for farmers to over-apply nitrogen if certain functional forms consistently suggest higher MERN levels than recommended.

Even if there is agreement on the functional form of the relationship between nitrogen application levels and corn yield, a farmer may feel this relationship holds for the average situation. A comparison of optimal N-rates across time for a given site would show whether the year-specific MERN tends to be higher than the recommended rate on average. However, being correct on average does not imply that over-application is unjustified. If the distribution of the differences between the *ex post* MERN and the *ex ante* recommended rates is either widely

dispersed or skewed, farmers may be hesitant to apply the recommended amount. A wide distribution would suggest a low degree of confidence in the general recommendations while a non-symmetric distribution would indicate that the *ex post* optimal rates can be generally higher than the recommended rate even when the recommended rate is equal to the long term average *ex post* optimal rate.

2.2 Uncertainty

The range in the optimal rate between years (and locations) underlies the affect of weather and soil on the efficiency of nitrogen. For example, good weather can increase the impact of nitrogen since water is a complementary input to fertilizer while fertilizer may not by taken up by the crop in poor growing conditions. The inherent uncertainty about weather may induce even risk neutral farmers to apply more than the average if the expected gains from applying a bit more in the good years outweighs the expected cost of this extra nitrogen that is unused by the crop in the poor years.

Risk averse farmers are worried not only about average returns but also about the variability. Risk averse farmers would thus apply more than the recommended rate of fertilizer if the over-application reduced profit variability. In addition, the possibility of unfavourable weather not allowing for side-dress application may induce risk averse farmers to use pre-plant application, which increases nutrient losses and thus requires higher rates.

2.3 Other Reasons

The opportunity cost of farmer time and equipment at the time of fertilization in spring may be high. Given the time constraints at planting, it may be worthwhile to fertilize in the fall when the need for farmer time and equipment is lower if this covers the loss of nutrients due to an early fertilization. Similarly, high opportunity cost of transporting manure to distant fields can lead to manure being treated as a “waste product” and disposed in excess on nearby fields. In some instances manure may be the main source of excess nitrogen.

Finally, there is also a benefit to the farmer of having a good looking crop that results from an application rate higher than the one that maximizes profits. The intrinsic value to the farmer may be greater than the loss in profits and thus justify the higher application rate. The higher crop yields may also be important to the landlord whose field the farmer is growing the crop and with whom the farmer has to negotiate continued rental agreements.

3.0 Assessing the Reasons for Over-Application using Nitrogen Field Trials

3.1 Data and Methods

Seven randomized complete block nitrogen trials, conducted in five counties in southwestern Ontario, Haldinand-Norfolk, Elgin, Middlesex, Kent, and Essex, were selected from the dataset used in Janovicek *et al*. (2004). The experiments were conducted between 1989 and 2001 with the time period overlapping in six experiments from 1990 to 1992. Two of the experiments contained multi-year data (i.e. 9 and 6 years). Corn heat units within the experimental area ranged from 3000 to 3400. There was also some heterogeneity in terms of soil texture, which included sand, loamy sand, sandy loam, loam, and clay loam. Fields in all seven experiments were planted in corn in the previous year and there were no cover crops. A moldboard plow was used in the fall of the previous year in five of the experiments and mulch-tillage in the other two trials. Each site had 5 or 6 application rates of anhydrous ammonia (six sites) or urea-ammonium-nitrate (one site) between 0 and 262 kg N per hectare. Yield was recorded for each rate. There were 8 replications per treatment in one experiment and 4 in the other six experiments.

The application rates and yield levels were used to estimate a yield response for 4 commonly-used functional forms: (1) a linear function with a plateau; (2) a quadratic function; (3) a quadratic function with a plateau; and (4) the Mitscherlich production function. The *ex post* profit maximizing nitrogen rate (MERN) was calculated for each site and each year under the four alternative functional forms using current prices. The MERN values for each site by year and functional form were also compared to the rate that would have been recommended for the location by extension personnel. The *ex ante* recommended N-rate is calculated by using The Ontario Nitrogen Calculator, which is an online read-only Excel spreadsheet with pre-entered formulae that take into account general growing conditions on a farm, such as corn heat units, previous crop, soil texture, as well as corn and nitrogen prices (OMAFRA, 2006). A quadratic-plateau functional form is assumed as the underlying relationship between nitrogen and corn yield for OMAFRA nitrogen recommendations.

3.2 Farmers Perception of Agronomic Advice

None of the functional forms produced MERN values consistently higher than the recommended rate. The *ex post* MERN estimated with a quadratic-plateau, which is the underlying response model in the recommendation, was higher than the recommend rate on half of the 6 sites but lower on the other half. Even with the quadratic function that generated the highest MERN on average, the *ex ante* recommendations were higher than the MERN on 2 of the 6 sites. Thus, differences in the underlying relationship between nitrogen rate and corn yield is not a reason for over-application.

The spatial variation in MERN values is expected, and the recommended rates do vary by site depending on yield potential. The differences between the recommended and MERN were correlated with the yield potential to determine if the basis for the recommendation should be adjusted. The correlations tend to be positive, which suggests that the recommended rates are lower than the *ex post* MERN on lower yielding sites. While the average difference between the recommended and MERN values is not large, the range in differences across sites is significant. The range in differences averages 215 kg/ha in 1990 and 114 kg/ha in 1991. The skewness of the distribution is negative and given that the recommended rate is higher than the *ex post* MERN for many of the situations in those two years, the result is due to a few large differences. If the recommended rate is lower than the *ex post* MERN in a given year, it tends to be much lower.

Approximately half of the years result in the recommended rate being higher than the *ex post* MERN values across functional forms with the exception of the quadratic. However, in those other years when the recommended rate is lower than the MERN, it is much lower since there is potential for large yields in good growing conditions with sufficient nitrogen that is not adequately captured by the recommendations based on average yield potential.

The temporal variation in MERN has two implications on why farmers may not apply the recommended rate. First, is the extremely large variation in the *ex post* MERN across seasons, particularly for less productive sites. While the recommended rate may be close to the MERN on average, the large variability could erode a farmer's trust in a single nitrogen recommendation value, and induce them to follow their own judgment. Second, is the symmetry of the distribution of MERN relative to the recommended rate. A symmetric distribution would imply that the years in which optimal N-rate is above the recommended rate is equal to the number of years for which the optimal rate is lower than the recommended rate. The skewness parameter is generally negative; implying that the recommended rate is more likely to be greater than the *ex post* MERN. However, it still may be beneficial to apply more than recommended if the profit gains in those years when the *ex post* MERN is higher than recommended overweigh the cost of wasted nitrogen in the other years when the MERN is lower. This especially applies to risk-neutral farmers, who are indifferent to the higher probability of losing profit as long as the gain in those

few years is large enough to offset the losses. The profitability of such a strategy is examined in the next section

Across all sites and years, the reduction in profit from following the recommended rate instead of applying the *ex post* optimal rate was approximately $50/ha. The reduction is slightly less on average if more than the recommended rate is applied suggesting that there may be a payoff to applying more for the good years. The difference between the MERN and recommended rate is less than $10/ha on approximately one-third of the trials. The largest differences in profit between the MERN and recommended occur when the recommended is lower than the *ex post* optimal as opposed to being too high. This under-application in good years tends to be associated with the less productive sites but also happens on the highest yielding site. The reductions in profit when the recommended is above the *ex post* MERN on 3 of the 6 sites are not as great as from under-application on the other 3 sites.

The average range of nitrogen rates below and above MERN for each site and year resulting in less than a $25/ha reduction in the maximum profit associated with the MERN is approximately 50kg/ha with the values fairly consistent within a given functional form. The amount is approximately one-third of the recommended rate across all sites. The result confirms a relatively flat payoff to soil testing and the low value of obtaining additional information, suggested by Pannell (2006).

3.3 Uncertainty

The effect of risk was examined using data on yield response to nitrogen from one site over 8 years and two different models: (1) certainty equivalent model and (2) risk-value model. The advantage of the risk value model is that it can account for non-normality in the distribution of profit and the reference point for measuring profit variability can be different from the average profit. The risk analysis based on the certainty equivalent model confirmed findings of Just and Pope (1979), Love and Buccola (1991), and Nelson and Preckel (1989) that additional nitrogen increases variance of profit and thus risk-averse farmers should apply less rather than more nitrogen than the average. However, risk neutral farmers using a plateau yield response would be justified to apply more than the average because the gain in profit in good years overweighs the cost of wasted nitrogen in bad years.

The risk analysis based on the risk value model produced results generally consistent with the certainty equivalent model. It only produced different results when the farmer's reference profit was much higher than the average.

4.0 Policy Implications

The results of our analysis suggest that farmers are not "wasting" fertilizer by applying more than the recommended rate. The difference is not due to farmers assuming their land is more responsive to nitrogen than the average (the Lake Wobeygon condition where everyone is above average). Instead, the over-application is due to uncertainty. There was a high degree of variability in optimal nitrogen rates, especially across years, due to differences in weather. The variability may cause farmers to have less confidence in a single, constant recommendation as suggested by Janovicek (2005) and Sheriff (2005). More importantly is that the benefits of over-application in the good years are greater than the costs of excess fertilizer in the poor years. The expected benefits and expected costs are not symmetric so it pays for risk neutral farmers to apply a little extra just in case. Uncertainty may also be a reason for over-application for a farmer concerned about risk if risk deals with the probability of low yields. While applying more nitrogen reduced the likelihood of poor yields, it does increase the variability of profits so does not reduce risk from a traditional economic definition.

The analysis also found that a relatively flat payoff functions to nitrogen, which suggests a low payoff to variable rate application technology. However, there does appear to be significant value to forecasting the likelihood of weather events during the growing season so that nitrogen rates can be adjusted accordingly. The flat payoff function also suggests that the other potential values from over-application such as the amenity value of a good-looking crop and the opportunity costs of time may justify the costs of applying more fertilizer than the recommended rate.

Even though the results of this study suggest there are private net benefits to a farmer from over-applying fertilizer, there are potential environmental consequences not accounted for by the farmer. For example, Gray *et al*. (2005) suggest relatively high total market and non-market benefits of voluntary Environmental Farm Plans. Thus, focusing on potential negative environmental consequences of nitrogen over-application, rather than lost profits, may be a more effective policy for reducing nitrogen use.

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Agricultural Biotechnology and Canola Meal: An Application of Real Options to Canadian Research Policy

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1.0 Objectives and Background

1.1 Canola

Canola is a major oilseed crop in Western Canada and is produced mainly for its high quality oil. Canola oil is used as an ingredient in many foods and is sold both commercially and by retailers. In the 2005/06 marketing year, Canada produced 9.7 million tonnes of canola on 5.4 million hectares of land and exported 1.5 million tonnes of canola meal (United States Department of Agriculture, 2007), the by-product of canola oil extraction. Canola meal is relatively high in protein. However, canola meal is low in protein (35%) (Canola Council, 2007) compared to soybean meal (48%) (National Grain and Feed Association, 2007). Canola meal is generally used in animal feed as a protein supplement.

Canola meal contains two naturally occurring compounds, sinapine and phytate, which have anti-nutritional factors (ANF). These compounds reduce the nutritional quality of the meal, as they cause poor uptake of essential nutrients. Sinapine, the most abundant small phenolic compound in canola, gives canola meal a bitter or astringent taste, usually reducing palatability. Sinapine also gives a 'fishy' odour to eggs (Selvarage, 2002), rendering them unacceptable. Phytate binds to minerals in the digestive tract, removing nutrients such as zinc, phosphorus, calcium and iron from food in the digestive tract. These minerals are generally excreted in the feces, resulting not only in compromised mineral absorption, but environmental consequences associated with an excess of phosphorus leaching into the waterways. The presence of ANF reduces the price of canola meal relative to soybean meal. Reducing ANF in canola meal should increase the value of canola meal protein relative to soybean meal protein.

1.2 Biotechnology and economics: reducing ANF in canola

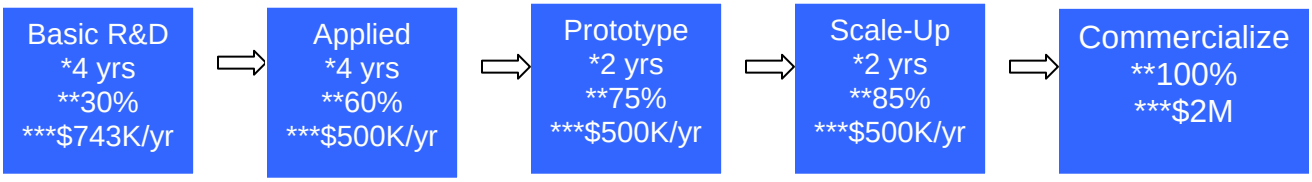
New biotechnology product development and commercialization requires investment decision-making, based on the analysis of the project and future cash flows. The Plant Biotechnology Institute (PBI) in Saskatoon, Saskatchewan is equipped with advanced technology for genomics research. PBI is a part of the government of Canada National Research Council (NRC). PBI engaged in research to develop canola seed producing canola meal with reduced ANF. The objective of our project was to evaluate *ex ante* the dollar value of the ANF canola research program and compare two different investment analysis approaches. A separate issue identified at the completion of the project was challenges with the NRC-PBI research funding model which required industry funds at later research stages before the PBI R&D program could continue.

2.0 NPV and RO Analysis in the Canola Meal Study

Two approaches - RO (real options) and NPV (net present value) were used to evaluate the reduced ANF R&D research project at PBI. The RO approach is a relatively new concept in which investment decisions are regarded as a series of opportunities or investment options. The RO framework is based on the realization that future investment opportunities are contingent on those in the past. Rather than adhering to a strict decision timeline, decision-makers are allowed to keep investment options open until new information arrives. In the case of R&D, ROs assist in valuing the flexibility of continuing or abandoning the R&D program at each stage in the research program (Figure 1).

NPV is the present value of net cash flows from the R&D program combined with the discounted future industry related profits. It is a standard method for determining the present value of a long term project. The standard NPV approach assumes the project must begin now or never. It further assumes that if the project commences, it is carried through to completion. Standard NPV models may have difficulties valuing projects where managers can be flexible in making decisions at later stages in the project.

PBI identified the various stages of the ANF project, the length of time to complete each stage, the estimated costs for each stage (i.e. dollars/year) and the probability of a successful research outcome in each stage. These research stages are illustrated in Figure 1. For example, if the applied research stage was completed and the research outcome was successful (e.g. move to prototype stage) the cost of the next stage, prototype, would be $500,000/year for two years and the probability of a successful research outcome (i.e. move to scale-up) is 75%. The end of each stage in Figure 1 represents a logical decision point to either continue or discontinue the research program. Hence, RO may have a useful role in evaluating this research program where managerial flexibility can be modeled at the end of each research stage. PBI can undertake Basic R&D using government funds but in general, industry/business co-funding is required before PBI can move to applied and the later research stages identified in Figure 1.



* Time to complete stage
** Probability of Completing Stage with successful research outcome suggesting continue to next research stage
*** Estimated cost to complete stage

Figure 1. PBI Research Model – Time, Success and Probability of Completing Each Stage and Associated Estimated Costs.

The following assumptions were used to apply the RO and NPV models to the reduced ANF project.

1. Technology risk and market risk are independent
2. Sequential investment decisions are made at the end of each R&D stage for RO analysis. At the end of each stage, the project is re-evaluated with the decision to continue to the next stage or abandon the research project.
3. The reduced ANF canola meal protein is directly substitutable with soybean meal protein. The value of the project is based on the price difference between improved canola meal and regular canola meal.
4. The private firm is able to design and enforce contracts that allow it to capture the benefits from canola, producing reduced ANF canola meal.

2.1 The RO approach in the canola meal study

Two scenarios were evaluated. Potentially, reduced ANF genetics could be incorporated into most of the canola grown in western Canada. The entire canola industry would potentially benefit from this outcome (scenario 1) and there would be no requirement for separate identity preserved supply chains for reduced ANF canola. Scenario 2 assumes a single firm co-funds the PBI research and if the R&D program is successful, the firm has the ability to profitability manage the supply chain for reduced ANF canola. Under scenario 2, the single firm manages the supply chain using contracts and produces about 225,000 tonnes of reduced ANF canola meal/year.

Table 1 summarizes key assumptions used to compare the two scenarios. The key differences are the increased tonnage of reduced ANF canola meal produced under Scenario1.

Table 1. Base Assumptions of the Canola Meal R&D Investment Analysis

Variable	Scenario 1: Industry	Scenario 2: Private
Reduced ANF meal tonnes/year	3.9 Million	225,000
Price Improved ANF Meal	$208/tonne	$208/tonne
Price Regular Meal	$160	$160
Volatility Meal Price	9%	9%
Risk Free Interest Rate	3.5%	3.5%

Table 2 and table 3 summarize the results from NPV and RO analysis of the R&D program assuming the analysis starts at the beginning of the Basic R&D stage or the Applied R&D stage (Figure 1). NPV showed a positive investment result under Scenario 1 (Table 2) at the basic and the applied stage. NPV analysis shows that the industry would benefit by undertaking this research. The RO analysis reached a similar conclusion for Scenario 1 but showed that the benefits of flexibility at each research stage increased the value of the project relative to NPV. Scenario 1 shows high benefits to the canola industry in western Canada if the project were successfully continued through each stage[1].

Under Scenario 2, the private firm, NPV analysis showed a negative investment return at the basic research stage (Table 3). This suggests the private firm should not begin the research project. Hence, a commercial firm may not be interested in undertaking the project at the basic R&D stage. However if the basic research stage has been completed successfully by other groups such as PBI, the NPV analysis is positive and indicates the firm should undertake

[1] This also assumes there are minimal negative issues associated with the genetic modification of the canola seed.

research starting at the applied stage. In contrast the RO analysis suggests that the project should be undertaken by the private firm at the basic or the applied stage. Valuing the flexibility of the R&D process increases the value of the project to the private firm.

Table 2. Scenario 1 Public (Industry) Benefits Analysis. Market Size = 3.9 M tonnes of meal

Approach	Basic R&D	Applied R&D
NPV	$104M*	$363M*
RO	$130M*	$378M*

* Million

Table 3. Scenario 2 Private (Firm) Benefits Analysis. Market Size = 225,000 tonnes of meal

Approach	Basic R&D	Applied R&D
NPV	$(0.7M)*	$15.9M*
RO Stage	$2.8M*	$17.3M*

*Million

At the applied R&D stage, the project is less risky (i.e. there is a higher probability of success) than at the basic R&D stage. Both NPV and RO under scenario 2 show potential benefits greater than $15M at the beginning of the applied R&D stage. The NPV and RO differ in their conclusions about the value of the research program for the private firm at the basic R&D stage. The NPV approach, on the other hand, may be favoured over the RO approach when valuing R&D type of investments at later research stages as there is less risk or flexibility involved in the research project.

3.0 Policy Implications

Analysis of R&D

A comparison of the RO and the NPV options shows the different results when flexibility is added to valuation approach. The RO approach may provide a better valuation model in the early stages of R&D research on a particular research project. RO can capture more of the flexibility inherent in the R&D process. Standard NPV analysis may reject starting R&D projects that would be accepted using RO analysis.

Co-funding Research Model

Despite the potentially high benefits identified by the investment analysis, the PBI reduced ANF canola research project has experienced difficulty finding commercial investors to move the R&D to the applied research stage. This may be due to factors such as:

1. commercial firms are undervaluing the economic benefits of the reduced ANF canola meal,
2. commercial firms are unable to identify profitable ways to capture the economic benefits from developing canola seed with reduced ANF meal,
3. The PBI basic research results thus far suggest the technology may not reach successful completion or
4. Commercial firms have alternative research investment opportunities that provide a superior expected return to the PBI reduced ANF project.

The analysis with both RO and NPV investment models suggest there may be a very large benefit to the canola industry to develop reduced ANF canola seed. The lack of private sector funding for the PBI project may be the result of point 2 above: commercial firms are unable to

identify ways to commercially and profitably manage a reduced ANF canola seed. If this is the case, it suggests that the PBI co-funding model may be missing R&D investment opportunities that would be of great benefit to the industry yet are not pursued due to the co-funding model. The reduced ANF canola meal R&D program analysis suggests that the research should go forward even if industry/firm co-funding is not available.

A NRC- PBI research funding model should be developed that evaluates the benefits and costs to the industry as well as to a private firm. The *ex ante* analysis of the society benefits-costs of the R&D program should be used to guide the PBI funding model and if the public benefits are sufficiently high, industry co-funding should be not be required before PBI can undertake the applied and later stages of research. The RO model approach may be helpful in *ex ante* analysis of R&D projects and directing public support to appropriate R&D projects.

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Agricultural Pollution Havens: Do They Exist in North America?

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1.0 Objectives and Background

Pollution havens are hypothesized to be locations where environmentally 'dirty' industries expand because of lax environmental regulations or tardy enforcement. A potential consequence of the existence of a pollution haven is a race to the bottom in which regions vying for industries to locate within their jurisdiction progressively lower their environmental regulations. The reduction in compliance costs may lure businesses away from a less stringent region which may be then forced to cut back on its environmental enforcement efforts. The resulting undervaluation of the environment occurring from pollution havens comes at a cost to the region.

This policy brief examines the influence of environmental regulation on livestock location. It examines the factors affecting location locally (southwestern Ontario), nationally (United States), and then comments on how farmers are pro-actively responding to environmental pressures by non-farm neighbours by voluntarily adopting environmental management systems.

2.0 Municipal By-Laws and Barn Building Location in Ontario (within region)

Federal, provincial, and lower tier governments all actively participate in the regulation of agricultural operations within Canada but the ultimate level of authority varies by province. Until the recent passage of Bill C-81, the establishment and operation of livestock production facilities within Ontario was authorized by the municipal government. This decentralized regulatory approach resulted in a range of environmental policies and legislation with some municipalities imposing caps on livestock numbers while neighbouring ones would have few restrictions (FitzGibbon, Hammel and Metrunec 2002). The differences create the potential for pollution havens in which farmers locate their operations in those municipalities with more lenient environmental standards and/or monitoring thereby creating geographic areas with relatively high concentrations of polluters.

2.1 Livestock Building Permits Issued

A survey of building permit documents for approximately 200 municipalities was carried out for the counties falling within the region of southwestern Ontario: Huron, Perth, Lambton, Middlesex, Elgin, Oxford, Wellington, Waterloo, and Grey (Weersink and Eveland, 2006).

Usable results were obtained for 42 municipalities located in the 8 counties. Of those municipalities that provided data, 1424 building permits were issued between 1996 and 2001 (Table 1 and Table 2).

Table 1. Number of New Barns and Additions by Sector in Ontario, 1996-2000

	Beef	Dairy	Poultry	Swine	Various	Total
New Barns	97	213	221	428	37	996
Additions	61	155	53	151	8	428
Total	158	368	274	579	45	1424

Table 2. Size of Building by Sector in Ontario, 1996-2000

Size	Beef	Dairy	Poultry	Swine	Various	Total
<100 L.U.*	129	252	152	220	37	790
>100 L.U.*	29	117	122	359	8	634
Total	158	368	274	579	45	1424

*Livestock Units

Over 40% of these permits were for swine facilities with approximately 26% for dairy barns and 19% for poultry operations. The majority of these permits (996) were for new barns while only 30% represented additions (Table 2). Over 75% of the permits issued for the swine (428) and poultry (221) sectors were for new barns. While the number of new barns is greater than barn additions for the two cattle sectors, the relative importance of additions is much greater than for hogs and poultry. The majority of permits for both new facilities and additions were for barns less than 100 LU (livestock units) (760 permits versus 664 for barns > 100 LU) but most of the permits issued for the swine sector were for facilities larger than 100 LU (Herath *et al,* 2005).

2.2 Reasons for Spatial Differences in Building Permits Issued

An important observation from this study was that most new barns noted in Table 1 were built in livestock intensive areas which also had the most elaborate environmental regulations. Within a given region (southwestern Ontario), no evidence was found that farmers were relocating to sub-regions with lower environmental regulation and taxes. Instead of locating to reduce environmental compliance costs, barns are being built largely where the livestock sector is concentrated suggesting the existence of agglomeration economies. The result suggests that the normalization of standards across the province through the new Nutrient Management Act will not significantly influence the location decisions of expanding or new livestock facilities which are largely determined by economic factors associated with livestock infrastructure support also known as agglomeration economies.

3.0 Environmental Regulations and US Livestock Inventories (across regions)

Although the differences in environmental regulation may not be affecting the location of livestock operations within southwestern Ontario, the result may occur across regions. The industrialization of the North American livestock sector has been associated with a geographic concentration of production in fewer regions and a shift in production to areas with little prior livestock experience.

Changes in the spatial distribution of US livestock production may be directly affected by differences in the stringency of environmental regulations across administrative regions. A disparity in regulatory stringency among states arose in the 1980s when the federal government delegated the function of devising regulatory regimes to state authorities. The potential differences in regimes could have created pollution havens where lenient regulations in some regions may attract livestock producers to build their facilities in such localities.

Another reason for the major shifts in livestock production within the US may be the increasingly important role of the processing sector and the integration of this sector back into production. Processing plants operating under economies of size are becoming larger and fewer, and scattered around the country with clusters of livestock farms around them. Such clusters tend to move to localities with better natural endowments, labor market conditions, and business environment due to agglomeration economies or tax policies.

3.1 Spatial Distribution of Livestock Operations in the U.S.

Regional changes in hog, dairy and fed-cattle inventories have changed over time in the U.S. There was been a large increase in hog production during the early 1980's. The largest concentration of hogs during this time was in the Great Lakes and Great Plains regions. While these regions continue to have the largest inventory levels, there have been significant shifts across states within the regions. The largest increase in hog production occurred in the Southeast and Southwest U.S. and in the Rocky Mountains, which were not traditional hog production areas with most of the increase concentrated in a few states (i.e North Carolina, Arkansas and Oklahoma). A similar situation has occurred in the dairy industry, with production rising in non-traditional areas mostly in the western states. In contrast, production levels in the fed cattle sector have increased over the last generation only in the three main producing states.

There are several possible causes of the regional shifts. Some of these are 1) larger and fewer processing plants (economies of scale), 2) natural endowments, 3) labour market conditions, 4) business environment (agglomeration economies, tax policies), and 5) environmental regulation (pollution havens).

3.2 Reasons for the Changes

To test the pollution haven hypothesis, it is necessary to gather data not only on environmental stringency but also on some of the factors affecting livestock production over time. With these factors, it may be possible to answer the question 'Are livestock operations moving to a different region due to lower environmental regulations and taxes, or are there other factors'?

Environmental Stringency: A unique aspect of the study was the construction of a relative index on the level of environmental regulations facing farmers in each state over a period of 40 years. The index was based on factors such as the level of expenditures on environmental quality control and the presence of laws such as right to farm legislation and the distance for minimum separation between a barn and a residence (or water course).

Relative Prices: The higher the relative output to feed price ratio in a state and consequently the profitability of livestock production in that state, the higher the relative production intensity expected. Similarly, decreases in relative input prices for production factors such as energy, labour and farmland, are expected to increase livestock numbers in a state.

Livestock Infrastructure: Market access and agglomeration economies are associated with livestock infrastructure support. Production shares are likely to increase in regions where the distance to market is smaller. Studies have shown that access to facilities is positively related to

the intensity of production. When there is a higher concentration of farms in a region, positive spillovers, known as agglomeration economies, can occur. Agricultural infrastructure may include supply facilities such as feed and fertilizer stores, manure disposal facilities, processing plants and livestock markets. With this infrastructure in close proximity and the community already 'farm-oriented', there are strong economic incentives to locate close to these support infrastructures and services. The importance of agriculture to the economy and the percentage of the population living in rural areas together influence agglomeration effects. In addition, livestock operations are assumed to experience less resistance in states with a greater percentage of the population tied to agriculture.

Business Climate: A region with a high unemployment rate is likely to have excess labour available to work in agriculture. There may also be incentive for livestock operations to locate to some areas as a means to generate employment. Public receptivity to farming operations and manure disposing capacity is influenced by state farmland area. Studies have indicated that nearly ¾ of large livestock operations did not have adequate land to dispose of their farm manure, leading to the conclusion that manure disposal cost is likely lower in states with more available farmland.

3.3 Results

The results of the analysis suggest that regional production shares for hogs, and to a less extent dairy, have increased in those regions with relatively more lenient regulatory regimes. In all sectors, livestock infrastructure support is a major determinant of changes in state production shares of national inventory levels. The observed clustering of production and processing has been supported by analysis for the hog sector but this study also finds market access in terms of processing capacity to be important for the dairy sector.

4.0 Adoption of an Environmental Management System (EMS) in Agriculture

An environmental management system (EMS) is an example of an environmentally-friendly practice. An EMS documents a firm's activities that affect environmental performance. It does not measure the actual impact of the practices on environmental quality. An EMS can be adopted for 3 major reasons: 1) improve farm profit 2) improve public image and 3) reduce the threat of mandatory regulation.

Adoption rates of EMS are higher for farms located closer to urban centres (Figure 1). The relative proximity of urban populations to farming activities contributes to a farmer's decision to adopt environmental-friendly production practices. This is because of municipal regulations and/or concerns about due diligence and/or social pressures. These direct and indirect pressures to adjust farmers' management practices may increase the cost structure of farms located in the urban milieu.

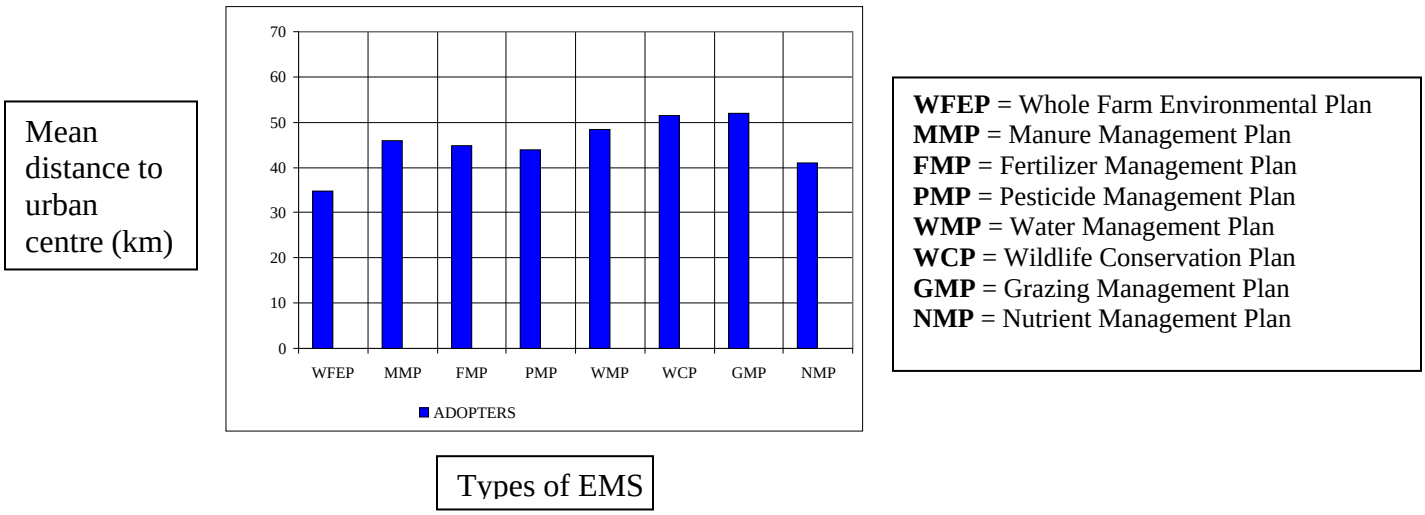

Figure 1. Mean distance of various types of EMS systems to urban centres

5.0 Policy Implications

The pollution haven hypothesis in agriculture was supported at a national scale (US) but not at the local level (southwestern Ontario). This suggests that differences in environmental regulation can alter the location of the livestock sector across regions. Tightening compliance requirements and enforcement can increase relative abatement costs to the point that livestock farmers may shift production to another location across the country. Coordinating environmental regulations and taxes across regions would minimize the migration of the livestock industry strictly for environmental reasons.

The major driver of livestock location, however, is livestock infrastructure, which includes processing capacity, agglomeration economies and farmland availability. The location decisions of the fewer, but significantly larger, processors have a major influence on the spatial production of the associated livestock sector and the creation of livestock clusters. These clusters tend to occur in agriculturally-intensive regions with available farmland.

Adoption of Environmental Management Systems (EMSs) is a voluntary, pro-active approach that can be used by farmers to avoid future regulations (Jayasinghe-Mudalige *et al*, 2005). Increases in proximity between farmers and non-farm residents are likely to increase the likelihood of conflicts and thus farmers' choices about their practices and land use decisions. We found the degree of urbanization was likely to affect farm management decisions as adopters of environmental management systems were, on average, located closer to urban areas than non-adopters. Expanding urban and ex-urban populations suggest that farm level practices will continue to be scrutinized by their urban counterparts. Policy makers will face the difficult challenge of advising government on how best to respond to the changing needs of farmers and urban residents. Recognizing, as this study does, that the degree of urbanization may already be precipitating changes in farm management practices provides an initial starting place for future inquiry.

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An Agent-Based Model of Regional Structural Change: A Focus on Saskatchewan Agriculture

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1.0 Background and Objectives

Over the past four decades, Saskatchewan agriculture has undergone many changes, including farm consolidation and other structural adjustments. Declining farm population is a major contributor to current economic difficulties in many rural areas. Structural change[1] is an important issue for the farm and for rural regions in general, but the process and underlying drivers of change are not well understood. Improving the understanding of the structural dynamics of the farm sector could lead to the development of policies to help mitigate some of the negative impacts of such changes on the rural Saskatchewan economy.

Changes in agricultural structure mean that farming activities and farm policy should have considerable flexibility. Policy may be implemented both to meet short-term objectives and to have a net positive effect on the long-term sustainability of the industry.

Agent based modeling (ABS) is a dynamic simulation framework used in this research to analyze structural change at the regional level. In our ABS model, individual farmer agents with differing demographic financial characteristics and entrepreneurial attitudes compete for farmland through both leasing and ownership markets. Ultimately, our research has the following objectives: 1) to replicate historical structural shifts that have occurred in Saskatchewan agriculture during the period from 1960-2000, assuming that technology and farming practices remain constant and 2) to estimate the structural evolution of the region under the assumption of zero government stabilization transfers.

1.1 Model drivers and structural change

Recently there has been much debate concerning the forces driving structural adjustment in agriculture. The primary drivers of this adjustment considered in this study are; 1) entrepreneurial behaviour and farm household expectations, 2) cost of production and production efficiency, 3) path dependency and the farm life-cycle and 4) government transfers.

[1] Structural change includes changes in characteristics which describe the number and size of farm units, demographic and economic characteristics of farm operators, methods of production and the mix of products produced by industry participants.

1.2 Aggregate models of structural change

Earlier research describing the dynamics of farm structural change has been largely inconclusive. The interactions between these factors are complex and difficult to incorporate into general modelling approaches. This has almost certainly led to significant inconsistency in policy recommendations.

2.0 Agent-Based Models

Agent-based economic modeling is a micro-level or 'ground up' simulation modeling approach that uses precise specifications of individual actions and interactions to generate aggregate outcomes. In contrast, current farm level policy tools are 'top down' approaches that focus on aggregate outcomes without detailed consideration of the individual actions that generated the aggregate outcome.

The base scenario constructed in this analysis simulated farm financial progress and growth of a synthetic farm population representing a typical rural municipality (RM) in Saskatchewan, Canada. The farm population was constructed based on the 1960 Census profile of farm size, wealth and operator ages. In addition, farms were randomly assigned a location within the RM and one of three distinct managerial types. Our model incorporated a series of individual equations that replicate the business environment of price and yield expectations, which along with risk attitude and financial constraints, form the basis for individual valuation of farmland. Agents expand their operations by buying farmland or obtaining leases if they "win" a farmland auction. In addition, agents are assumed to disregard government program payments in forming their expectations. In the simulation, agents stop farming either through forced exits or through retirement, while new agents enter as children of existing or exiting farmers. Our simulated farmers farm under risk and uncertainty but to better capture reality, prices and yields are based on actual yields, prices and government programs applicable to the study region. In this manner, the simulated farm population and associated individual characteristics are tracked over the period 1960 to 2000.

We examine two scenarios. The first (or base) scenario simulates this farm economy with actual government transfer payments applicable to the region, including payments from stabilization and ad-hoc farm programs. However, in order to assess the impact of government transfer payments on regional farm structure, a second scenario is delineated. In this scenario, all government program transfer programs are removed and agents receive zero transfer payments.

2.1 Comparison between simulated results and historical data

2.11 Base Scenario

The base simulation results closely mirrored historical trends in overall Saskatchewan farm structure, including variables such as farm size, numbers and debt as well as farmland values over the 40-year period between 1960 and 2000. The simulated decrease in farm numbers was 1.72% per year while the historical rate was 1.53%. Simulated mean farm size increased annually at a rate of 1.61-1.76% as compared to the historical rate of 1.58%. However, these changes were not quite as smooth as the historical record, where the latter is based on a much larger area (Figure 1). This effect is likely due to the relatively small population associated with an individual RM.

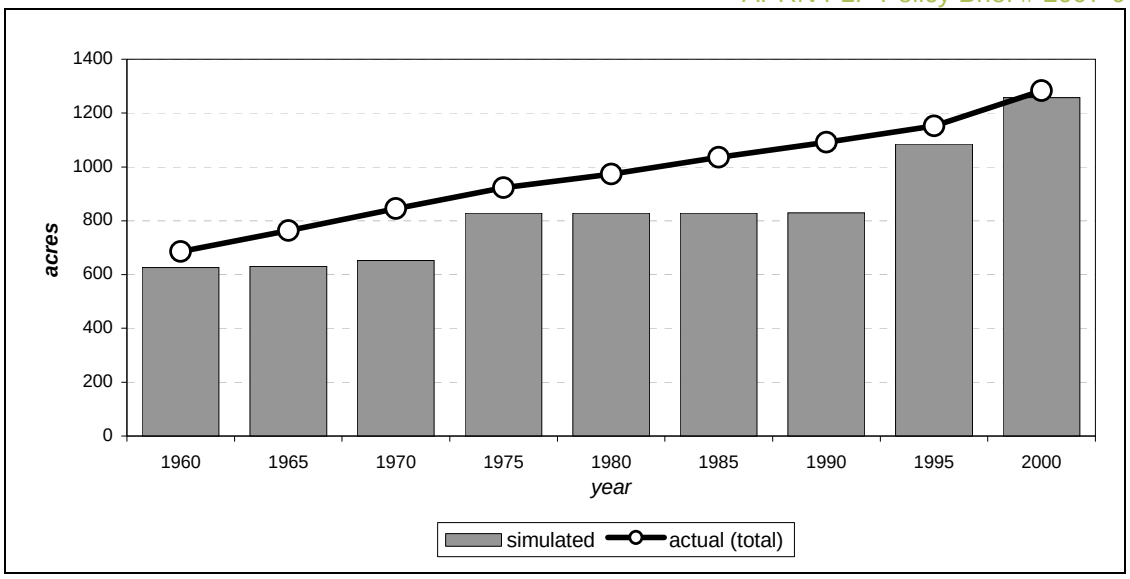

Figure 1. Simulation Results (base scenario) – Mean Farm Size (total acres).

The distribution of farms also provides insight as to the nature of structural changes. Our simulated distribution in farm size after 40 years is displayed in Figure 2. These results match the historical distribution of most farm sizes, with the notable exception of the less than 400 acre class. Our inability to correctly estimate this farm size class is likely caused by the omission of off-farm labour markets because in the model, off-farm income is fixed.

While the base simulations revealed certain limitations of the modeling environment, we generally found a good statistical match between the model and the distribution of the observed data over the 40-year study period. The simulated output matches the historical data closely enough to give us confidence that our agent based simulation is capturing many aspects of individual farm level behaviour in the study region.

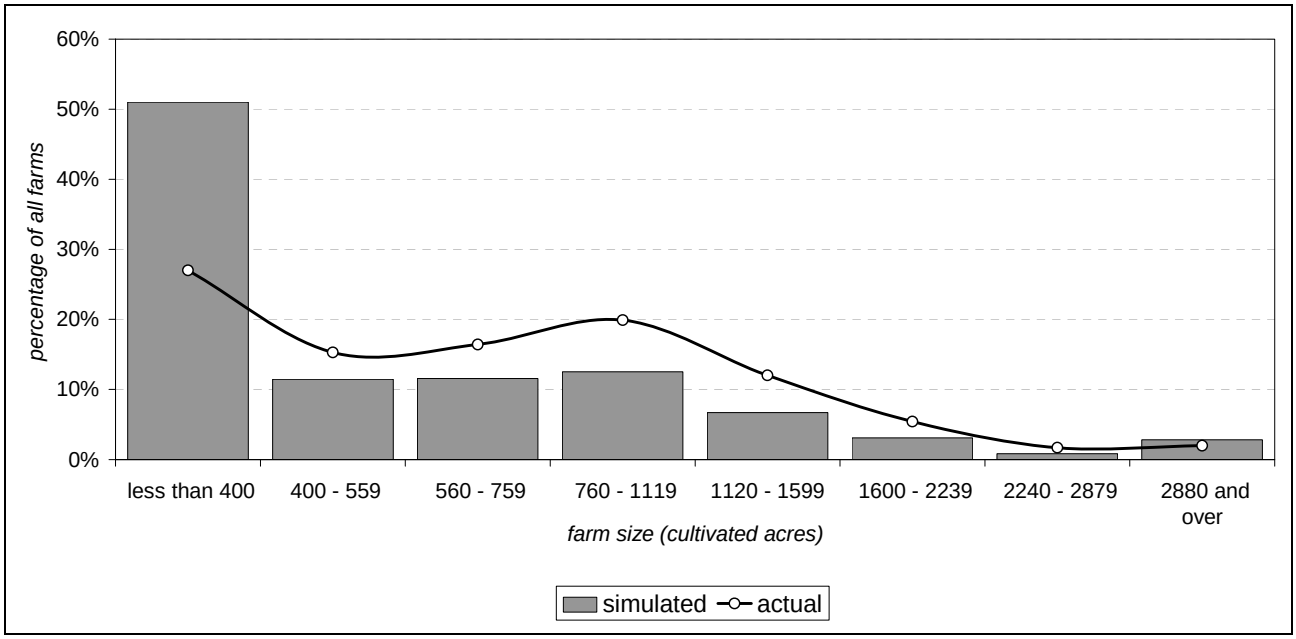

Figure 4. Simulated Distribution of Farm Size, base scenario, 2000 (year 40)

2.2 Zero transfer scenario

In the zero transfer government payment scenario, the characteristics of the same 1960 farm population are tracked over time using the same prices and yields as the base scenario but farm agents receive no government transfers - ie. no stabilization programs or ad-hoc stabilization program payments. Every 5 years, farm numbers, as well as size and farmland values were compiled and compared to the base scenario.

There were few government payments prior to 1987 and hence, there was no difference between the two scenarios up to that point. In the post-1987 time period, the base and zero transfer scenarios began to diverge considerably due to transfer payments. Under the zero payment scenario, simulated farm numbers decreased significantly while mean farm size increased significantly. Interestingly, small farms were affected more - small farms continued to exist in this scenario, but the overall size distribution shifted towards an increasing proportion of larger farms.

2.3 Insights

We observed several interesting phenomena within the simulations. The first is that the elimination of government transfers resulted in slightly decreased farmland prices even though government payments were not explicitly included in gross margin expectations. We speculate that this is likely due to the deterioration of free cash and/or increased debt over the economically depressed years of the 1980's. The result would suggest that even if programs are decoupled so they do not directly influence farmers' expectations, programs can indirectly affect farmland prices. A second and related phenomenon is that the elimination of government payments encouraged farmer agents to lease rather than purchase additional farmland.

In reality by 1991, government transfers diminished considerably. Thus, by the end of 2000, farm structure across the two scenarios started to converge. This suggests that the impact of government program payments on farm structure might not persist for long unless the programs are maintained.

3.0 Policy Implications

The base simulation model closely matched farm sector structural adjustments that occurred in Saskatchewan over the study period. This suggests at least a 'proof of concept' for this type of modeling. We believe that agent based modeling could yield a framework for future research focusing on structural dynamics and policy analysis.

Even with government transfer payments included, farm structure was still characterized by an evolution towards more large farms with fewer farms overall. While we found that government payments reduced the rate of change in farm structure, when government transfers were removed, farm structure tended to rapidly catch up with the no transfer payment scenario. In addition, we found that government stabilization programs and ad-hoc payments may have had unanticipated consequences on farming in the region by encouraging expansion through farmland purchases rather than leasing and driving an increase in farmland prices.

Finally, we note that farming is an inherently complex system generating large-scale effects that are difficult to predict using traditional aggregate models. It has been difficult to predict structural outcomes in agriculture based on the analysis of individual system components. However, agent based farm level models may be superior in this respect to traditional models in assessing long run structural change because they incorporate individual agent interaction through markets,

while also allowing individual heterogeneity in location, demographics and behavior. Because of this heterogeneity and complex individual interaction, they can help identify emergent (or inherently unpredictable) farm level behaviour.

Acknowledgements

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Value Added Processing to Mitigate Disease Outbreak Impacts: The PVYn and Potato Wart Disease Outbreaks in Prince Edward Island

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1.0 Background

The Prince Edward Island (PEI) seed potato industry was battered by two important disease outbreaks during the last twenty years: the Potato Virus Y Necrosis (PVYn) outbreak of 1989-92 and the potato wart outbreak in 2000. As a result of both disease outbreaks, the US border was closed to PEI seed potatoes; two years due to the PVYn disease outbreak and nine months due to the potato wart disease outbreak. Both outbreaks disrupted traditional established links in seed potato trade between PEI and the US.

1.1 PVYn and Potato Wart Viruses

Potato virus Y (PVY, type species of the genus *Potyvirus*) is an economically important virus. PVY is transmitted by aphids and infects several *Solanaceae* crop species (Tribodet et al., 2005). The most common of the PVY potato strains are PVYn, and PVYo. Neither strains of PVY are harmful to humans. In the case of potatoes, the viral infection induces mild mottling with occasional necrotic leaves, but has little or no damaging effect on the quality of the potato tuber. It also has some minimal effect on potato yields. By comparison, because PVYn is lethal to tobacco, it is important to contain the spread of the disease. PVYn is particularly important in the seed potato sector because the disease can be transmitted to successive crops through seed tubers. In the beginning of the PVYn disease outbreak in 1989, the US (and until then, Canada) was assumed to be disease free, and therefore PVYn could be quarantined under the WTO agreement on Sanitary and Phytosanitary Measures (WTO, 1995). It was only in 1992 that Canada was able to demonstrate, through testing of US potatoes entering Canada, that PVYn existed in the US at least to the same extent as Canada, and all remaining import restrictions resulting from PVYn were lifted on seed potatoes entering the US.

Potato wart is similar to PVYn in that it is not dangerous to humans. In contrast to PVYn, it renders potato tubers worthless. While the potato wart discovered was limited to a single site in PEI in 2000, (with two further discoveries in 2002 and 2003) it can potentially have a serious long-term impact on potatoes; lasting up to 40 years on the site

where it is discovered. Therefore, the PEI field where potato wart was found was taken out of production and strict controls were placed on PEI potatoes to help contain the disease. Potato wart is considered to be an extremely dangerous disease by the US, being a plant disease listed as a potential disease of agro-terrorist threat (e.g. Monke, 2006). The US eradicated potato wart in 1992 and therefore potato wart can be quarantined under the WTO agreement on Sanitary and Phytosanitary Measures (WTO, 1995).

1.2 Objectives

This brief provides a summary of a study by Clark et al. (2007) on the effects that these disease outbreaks have had on the PEI seed potato industry. The objective of this policy brief is to provide information on the two major diseases affecting the PEI potato industry in recent years (Potato Virus Y Necrosis (PVYn) and potato wart) as well as analysis on the impact these diseases have had on the PEI seed potato and processed potato markets.

2.0 Analysis

The PEI seed potato industry never fully recovered the seed potato market lost during the PVYn crisis from 1989-92. This is demonstrated in Figure 1, a plot of the value of seed potato exports into the US. The figure illustrates that the value of seed potatoes exported into the US has been declining over time. From approximately $6 million before the PVYn crisis in 1989, the value of the PEI seed potato export market into the US fell to below $1 million by the crop year 2004/05. The figure also illustrates shocks to the PEI export market into the US resulting from both PVYn (1991/92 crop year) and potato wart (crop year 2000/01) when the value of exports of seed potatoes into the US fell to virtually zero. The figure also illustrates that the PEI seed potato industry did not recover from the PVYn crisis of 1989/90 as a significant player in the US seed potato market. Furthermore, the shock to the PEI seed potato industry resulting from the potato wart disease outbreak was approximately one third of the shock to the seed potato industry resulting from the PVYn disease outbreak.

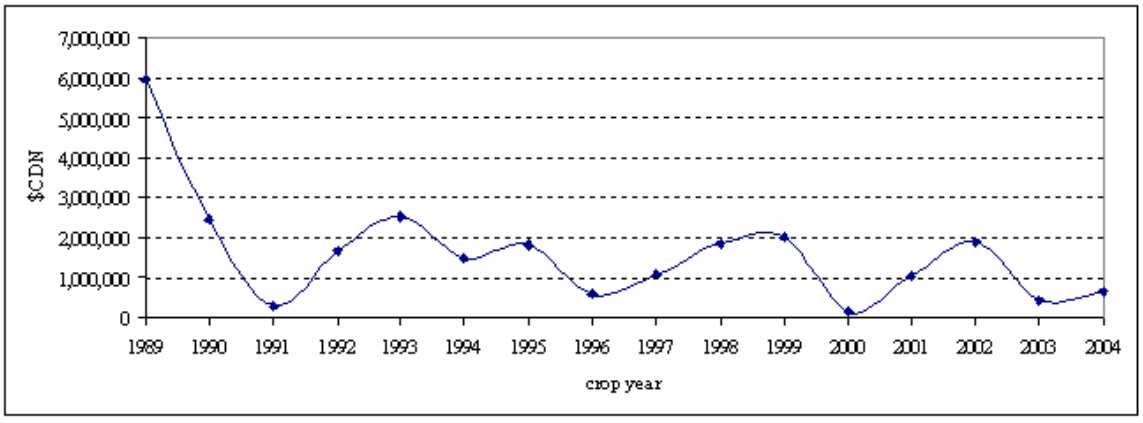

Figure 1: Value of exports of PEI seed potatoes exported to the US (Source: Industry Canada 2006).

At the same time, there has been an expansion of the potato industry as a whole in PEI, especially processed potatoes. This is illustrated in Figure 2, a plot of seeded area of

potatoes in PEI. Seeded area grew from approximately 70,000 acres in 1988 to approximately 110,000 only ten years later in 1999. Notice that, in contrast to the Figure 1, neither PVYn nor potato wart show any appreciable impact on total seeded area. That is, while both PVYn and potato wart had an impact on the PEI seed potato market, neither disease carried over to the overall PEI potato market.

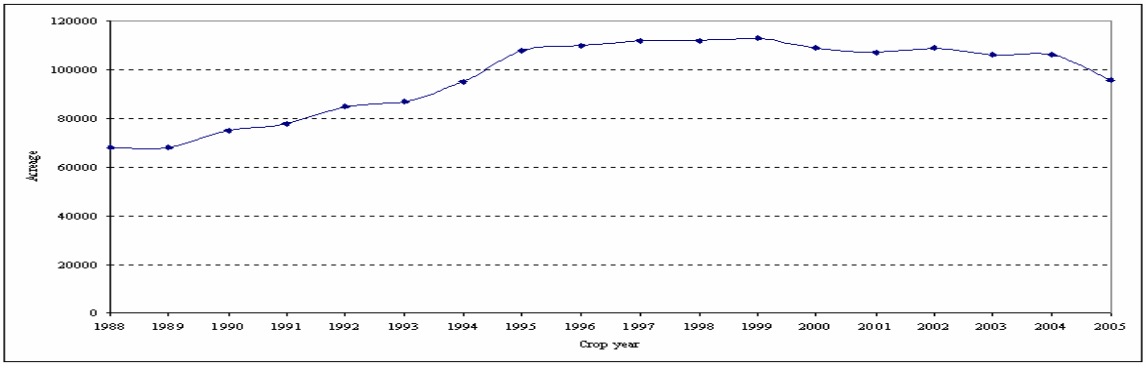

Figure 2: Total acreage seeded to potatoes in PEI (Source: Statistics Canada 2006)

The expansion of the processed potato sector in PEI has little to do with PVYn or potato wart outbreaks. This assertion is partly because there has been little or no incentive for PEI producers to re-establish the seed potato market, stemming from the establishment of additional processing capacity in PEI in the 1990s. There are three markets for potatoes: tablestock, seed and processing. Among the three, the tablestock market is the lowest valued. By comparison, the seed and processing market command price premiums, as long as producers provide the quality attributes required.

The expansion of the potato market in PEI has been fuelled by an expansion in the processing potato market. Between 1990 and 1999, McCains Foods established a new processing plant in PEI and Cavendish Farms expanded an existing plant. This greatly expanded the opportunities in the processing market to PEI potato producers. From approximately 25% of the overall market in PEI during the mid to late 1980s the processing market currently accounts for approximately 60% of total potato production in PEI (DeHann 2006).

This resulted in price premiums paid to PEI producers for processing potatoes. Thus, the new (higher) premiums processed potatoes made the PEI seed potato market less competitive. The new processing facilities also decreased the marketing risk of processed potatoes compared to seed potatoes, and increased the value of processed potatoes in PEI.

Processed potatoes offer PEI potato producers the opportunity to enter a high valued market for their potatoes without the risk of the seed market resulting from disease outbreaks. A disease outbreak like PVYn would have no impact on the processing potato market because the disease is destroyed by processing. At the same time, there was little or no incentive to re-enter the seed market lost during the PVYn and potato wart outbreaks. Processed potatoes have replaced seed potatoes as a high valued, high quality

market for PEI potatoes. Superior managers have switched their talents from seed to processed potatoes.

3.0 Conclusions

An important outcome of the changes in the PEI seed potato market is that a new disease outbreak would not likely have as dramatic an impact on the PEI potato industry as did the PVYn and potato wart disease outbreaks. In the case of a new disease outbreak similar to PVYn, the impact would be minimal because the processing of potatoes would destroy the PVYn virus during processing, thereby making disease-induced trade restrictions on (processed) potatoes unnecessary. In the case of a new disease outbreak similar to potato wart, the large areas of quarantine applied by the US to the seed potato market would be largely irrelevant to the processing market. Thus, value-added processing can largely mitigate the negative impacts of disease outbreaks in potatoes. In other words, if the raw product is what is at risk in disease outbreaks, one strategy to mitigate disease outbreaks is to abandon the raw product in favour of further-processed, value-added product.

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