

***Risks and Opportunities
from Climate Change
for the Agricultural Sector***

FINAL REPORT

C-CIARN-AGRICULTURE WORKSHOP

March 1 and 2, 2001

Arboretum Centre
University of Guelph
Guelph, Ontario

C-CIARN Workshop Steering Committee,
Farming Systems Research
University of Guelph
March 28, 2001

Canada

Foreword

The Farming Systems Research Project (FSR) at the University of Guelph hosted the C-CIARN (Canadian Climate Impacts and Adaptation Research Network) Agriculture workshop on March 1 and 2, 2001 at the Arboretum Centre, University of Guelph, Guelph, Ontario. Approximately 90 people registered for the event, entitled: *Risks and Opportunities from Climate Change for the Agricultural Sector*. Participants included representatives from the agri-food sector, policy and program divisions of several government ministries, government and university researchers and other interested parties.

The main goals for the workshop were to determine the level of interest and support for establishing an agricultural sub-network within the C-CIARN initiative and to describe what form and function such a sub-network might have. In order to meet these objectives, the workshop organizers designed the venue to feature detailed information sharing on climate change related topics. A total of fourteen presentations sparked rich debate and discussion from the participants, especially from the panel of agricultural producers who constitute an important stakeholder group. This workshop report summarizes the main points from the presentations, general discussion, and small group exercises held on March 2, where suggestions regarding the C-CIARN-Agriculture network were put forth.

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Guelph, Ontario
March 25, 2001

Table of Contents

Foreword i

Executive Summary iii

Workshop Summary 1

INTRODUCTION 1

THURSDAY, MARCH 1, 2001 2

A CHANGING CLIMATE: WHAT'S UP WITH THE WEATHER?
DAVID PHILLIPS, ENVIRONMENT CANADA 2

HOW IS CLIMATE CHANGE RELEVANT TO FARMERS?
BARRY SMIT, UNIVERSITY OF GUELPH 2

ADAPTATION AND RISK MANAGEMENT STRATEGIES FOR AGRICULTURE
PETER DZIKOWSKI, ALBERTA AGRICULTURE RESEARCH
INSTITUTE 3

*PRODUCER PANEL COMMENTS ABOUT THE
MORNING PRESENTATIONS* 3

*UPDATE ON KYOTO: NATIONAL IMPLEMENTATION STRATEGY FOR
GREENHOUSE GAS EMISSIONS*
ALRICK HUEBENER, AAFC 4

ONTARIO FARMING SYSTEMS AND GREENHOUSE GAS MITIGATION
KEITH REID, OMAFRA 5

CARBON CREDIT TRADING
JERRY HAGGARTY, EMISSIONSXCHG.COM 5

*PRODUCER PANEL COMMENTS FOR THE
AFTERNOON PRESENTATIONS* 6

FRIDAY MARCH 2, 2001 6

THE PROPOSED C-CIARN
ERIC TAYLOR, NATURAL RESOURCES CANADA 6

*WHAT HAS BEEN ACCOMPLISHED IN AGRICULTURAL IMPACTS AND
ADAPTATION RESEARCH AS IT RELATED TO CANADA?*
BARRY SMIT, UNIVERSITY OF GUELPH 7

STAKEHOLDER PRESENTATIONS 7

JOHN VAN HERK, W.G. THOMPSON AND SONS 7

BOB AUMELL, FOUNDATION FOR RURAL LIVING 7

BEN BRADSHAW, SIMON FRASER UNIVERSITY 8

ROGER STREET, ENVIRONMENT CANADA 8

CAL TURVEY, UNIVERSITY OF GUELPH 8

DAVE ARMITAGE, ONTARIO FEDERATION OF AGRICULTURE
8

INFORMATION GAPS AND RESEARCH NEEDS 9

CONCLUSION 11

Appendix A 13

Executive Summary

MAIN WORKSHOP FINDINGS/CONCLUSIONS

1. Climate change has two related but distinct implications for the agri-food sector and agricultural policy as the Deputy Minister of Agriculture, Food, and Rural Affairs, noted in his welcoming address: “ Our goal is to help the agriculture industry reduce **greenhouse gas emissions** and minimize the economic impacts associated with **climate change adaptation**”.

a) Greenhouse Gas Emissions: Considerable attention has been given to the contributions the agricultural sector might make to reducing the greenhouse gas emissions and promoting carbon sequestration via soil conservation and other management practices. This component of the climate change-agriculture issue was the focus of the Agriculture Table in the National Climate Change Implementation Strategy, and is the focus of several CARD (Canadian Adaptation and Rural Development Fund) initiatives as well as other research programs. The scientific community and agricultural producers are well aware of the programs in place at federal, provincial, and regional levels.

b) Climate Change Adaptation: Climatic variations, particularly deviations from “normal” conditions, represent significant and recurring risks to agricultural producers. They also have major implications for crop insurance, disaster aid programs, and the viability of rural communities. Climate change has the potential to alter these risks (e.g. increases in the frequency or magnitude of “non-normal” climatic conditions or weather). It also has the potential to create opportunities (e.g. longer growing seasons or greater cumulated heat). Adaptations to climate risks and opportunities could involve innovations in farm management practices, crop breeding, weather forecasting, farm financing, crop insurance, and government relief programs. **These impacts and adaptation issues are NOT well addressed in current research programs and little information exists on their implications for the agri-food sector.**

2. Impacts of Climate Change (especially variations from year to year and extreme events) are not experienced in isolation from other stresses on a farming system (for instance depressed market prices and increased input costs) which has an impact on the ability of producers to deal effectively with Climate Change risks and opportunities. **Research directed at understanding the multiple factors influencing decisions and support programs is lacking.**

3. There is significant capacity to deal with climate-related risks in the agri-food sector but these adaptive strategies are not being realized to the extent that they might be. **For instance, the potential for planned adaptation to reduce risks and enhance benefits from new opportunities has not been adequately explored.**

Much of the workshop discussion confirmed that applied research in the field of impacts and adaptation of agriculture to climate change is needed. The participants identified the following list of information gaps and specific research issues.

INFORMATION GAPS AND RESEARCH NEEDS

1. Sensitivities of agriculture to climatic variability and risks

- a) What climate parameters have the most impact on agriculture across Canada (heat, frosts, drought, precipitation patterns, etc.) and how does the agri-food sector currently deal with them?
- b) How will the frequency and intensity of agriculturally significant climatic conditions change? What form are they taking? Will the detrimental effects of climate change on other regions in the world have positive or negative effects on Canadian agriculture?
- c) At what points do acknowledged impacts represent unmanageable impacts?-for agricultural producers?- for the agri-food sector?
- d) How do climate-related risks interact with other risks to influence the viability of agriculture and prospects for adaptation?
- e) What are the climate change related pest and disease risks for agriculture in Canada, including frequency and intensity?

2. Assessment of adaptation strategies relative to agricultural producers' risk management

- a) How can Climate Change be recognized and exploited for new opportunities and possibilities?
- b) What adaptation options are technically feasible and economically viable?
- c) How do agricultural producers adapt now to variability and extremes? How successful are they in adapting?
- d) What are the proposed adaptation strategies for climate-related pest and disease risks and what impacts could these strategies have environmentally and economically?
- e) What is the production feasibility and timetable of producing alternate crops in different areas of Canada as the climate changes?
- f) What factors constrain adaptation? How do climate risks relate to the diverse and urgent pressures that agricultural producers currently face? What opportunities exist for co-benefits?
- g) How can Climate Change adaptation issues be integrated into other agriculturally related research (eg. Best Management Practices).
- h) What cross-compliant adaptation technologies and management strategies could be used for Climate Change and agriculture policy and programs?

3. Analysis of the role and effectiveness of public programs

- a) What strategies might be developed to ensure the cost of adaptation is spread among all beneficiaries?
- b) What roles can crop insurance and support programs play in adaptation to climate change for the agri-food sector?
- c) What will be the impacts of future trade agreements on agriculture and how will these affect the ability of agriculture to adapt to climate change now?

A C-CIARN -Agriculture sub-network can address a number of these significant information gaps and research issues. Workshop participants also provided details on how the sub-network might be structured. These comments are summarized on the following page.

POSSIBILITIES FOR C-CIARN -AGRICULTURE

1. There is a need to stimulate research in the field of Impacts and Adaptations to Climate Change to complement Greenhouse Gas Mitigation research. A C-CIARN-Agriculture sub-network would be useful in promoting collaboration on Impacts and Adaptations to Climate Change involving stakeholders (agricultural producer representatives, policy-makers, and researchers), and disseminating research results.

2. However, a C-CIARN-Agriculture sub-network should note:

- The network should not duplicate a function currently undertaken by some other agency or institutional arrangement.
- Possibilities for incorporating the network into an appropriate existing body should be explored.
- To be effective, the sub-network and Climate Change Impacts and Adaptation research must have serious, long term financial support.
- A C-CIARN-Agriculture sub-network could be set up (as has been done with other C-CIARN sector and regional sub-networks) but there is utility in exploring options within existing structures.

3. The Canadian Agri-Food Research Council (C.A.R.C.) was identified as possible institution within which a C-CIARN-Agriculture sub-network might fit because:

- It includes representatives from federal government, provincial governments, academia, and the agricultural community.
- It has established credibility.
- It has a structure (eg. expert committees) that would be suitable for co-ordinating and overseeing Climate Change Adaptation research.

4. For accommodation of a C-CIARN-Agriculture sub-network within an existing institution, certain conditions should be met:

- New and sufficient funds for supporting C-CIARN-Agriculture within the institution would have to be guaranteed.
- If C.A.R.C., a distinct expert committee to focus on Climate Change Impacts and Adaptation research should be struck within the institutional structure.
- If C.A.R.C., research expertise on an expert committee should include relevant social science perspectives given their importance for Impacts and Adaptation research.
- If C.A.R.C., the committee should make a special effort to ensure dissemination of findings to agricultural producers, agribusiness interests, and decision-makers.
- Given the newness of this field and the interest from Natural Resources Canada in sponsoring such a sub-network, there may be value in having a C-CIARN-Agriculture sub-network secretariat within the selected institution's structure to launch the initiative and ensure communication with stakeholders.

Workshop Summary

INTRODUCTION

The Farming Systems Research Project (FSR) at the University of Guelph hosted the C-CIARN (Canadian Climate Impacts and Adaptation Research Network) Agriculture workshop on March 1 and 2, 2001 at the Arboretum Centre, University of Guelph, Guelph, Ontario. The 90 individuals who registered for the workshop came from diverse backgrounds as the information in Table 1 demonstrates. A participant list is available in Appendix A .

Table 1: How Different Constituencies were represented at the C-CIARN -Agriculture Workshop (N=90)

Representation	Percentage
food producers, processors and their representatives	20%
policy makers	12%
research scientists (government)	14%
research scientists (academia)	19%
students	19%
other (media, consultants, etc.)	16%

With 20 per cent of participants coming directly from the agricultural sector, 35 per cent representing the scientific community and 12 per cent policy-makers, a good balance among the practical, theoretical, and political aspects of Climate Change and Agriculture was attained. Strong representation from agricultural producers was evident in the discussion and question periods. The regions were also well reflected with individuals coming from Atlantic, Central, and Western Canada and the Prairies. Workshop activity occurred over two days under the general topic of *Risks and Opportunities from Climate Change for the Agricultural Sector*.

March 1st presentations raised awareness regarding changing weather patterns and effective adaptation strategies to deal with climate related risks which included their implications for crop insurance and disaster relief programs. The latest information regarding Greenhouse Gas Mitigation was also presented. A producers' panel offered immediate responses to the presentations, thereby assuring that a realistic and practical assessment was provided.

March 2nd promoted ongoing information exchanges and stakeholder input into research agendas. This was accomplished by developing a framework for a Canadian network dealing with the climate impacts and adaptations in the agricultural sector, activity related to **C-CIARN (Canadian Climate Impacts and Adaptation Research Network)**.

The workshop programme, which is found in Appendix “B”, reflects a wide variety of perspectives and insights into climate change and agriculture issues. It is the result of the work of a steering committee made up of stakeholders across Canada. Their names and affiliations are also found in Appendix “B”.

Details from each presentation are summarized in the following pages to provide an overall description of workshop activity.

THURSDAY, MARCH 1, 2001

***A CHANGING CLIMATE: WHAT'S UP WITH THE WEATHER?* DAVID PHILLIPS, ENVIRONMENT CANADA**

More than just climatologists are now talking about climate change. In fact, eighty-five percent of Canadians think the climate is changing - faster than it used to - and that humans have something to do with it. Climatology is a science in its infancy, and public expectations cannot be raised beyond those warranted by the science. We do know for certain that the amount of carbon dioxide in the atmosphere is rising (it is now higher than it has been in the last 20 million years), that changing the chemistry of the atmosphere changes the energy transmission, that the climate in cities is different from rural areas, and that changes in landscape result in a change in climatology. We have evidence of changes in growing seasons, global temperature changes (climate models suggest that there will be a 1.5 - 5.8 degree Celsius increase in global temperature over the next 100 years), and weather extremes that cannot be explained only by natural forces. The type of slow, relentless climate change that is occurring probably means very little, but the threat lies more in the variability and weather extremes. We do not yet have sufficient global information on observational patterns and variability, and there is some debate over whether the changes we are seeing are part of a long-term trend or just a bout of bad luck. However, the rate of change is unprecedented, and adaptation needs to be strongly considered - mitigation and adaptation need to be seen as opportunities. Climate change is certain - we are just now seeing the fall-outs and the victims. This is a global issue, and the impacts are felt in local livelihoods.

***HOW IS CLIMATE CHANGE RELEVANT TO FARMERS?* - BARRY SMIT, UNIVERSITY OF GUELPH**

Mitigation involves changing the impact of humans on climate change, and has received most of our attention, especially in agriculture. Adaptation involves adapting the nature of agriculture so that the changes are less of a problem, and the opportunities are realized. We know that climate change is happening, but does anyone care?

Scientists and policy makers believe that there are serious implications of climate change for agriculture, but farmers and business people seem less concerned (there are other things that are more important) although there is some interest in carbon sequestration. However, it has already been indicated by the farm community that weather conditions result in large financial losses to producers. Daily temperature variations can be greater than the slight global increase expected over the next 50 years, and farmers are constantly adapting. Adaptation could include technological, management, and financial measures, which should be examined as part of the discussions in the agri-food sector. However, although farmers adapt well to variations, the average temperature is rising, and we hardly ever experience the average. This may mean that actual conditions are beyond the current coping range. Adaptation measures would be needed at

all levels, and would involve enormous costs that could be avoided if the issues were thought about in advance. There are opportunities for planned adaptation.

ADAPTATION AND RISK MANAGEMENT STRATEGIES FOR AGRICULTURE - PETER DZIKOWSKI, ALBERTA AGRICULTURE RESEARCH INSTITUTE " 13

There are changing environmental, market, and economic conditions that require adaptation. We have many tools for adaptation and risk management, but need to learn how they will work. Are some tools better than others? How do we know that the adjustments are optimal? What are the measures or indicators? Can we use them effectively? It is important to realize that comments about adaptation can apply negatively when considering mitigation options. C-CIARN could be an important link between the information and the choices we make.

Some important research questions include: How does the individual decision-maker assess how any technology can help to be better adapted, year-to-year? Can an adaptation measure or indicator be used at the farm level? Does a strategy of being continually well adapted to climate variability inevitably help climate change problems?

A mixture of adaptation and mitigation measures is crucial. Some additional questions include: Who bears the financial cost? What happens if we do not adapt? Does policy limit adaptive capacity? What does research offer? Who needs to adapt? Research needs to go beyond the obvious results and view agriculture as the client.

PRODUCER PANEL COMMENTS ABOUT THE MORNING PRESENTATIONS

The biggest risk with global warming is uncertainty, and there is more than enough uncertainty in farming. Farmers would like agreement from researchers and direction from policy-makers. Where does this issue sit on the policy agenda? Where is OMAFRA and the extension process? Is the Province going to work with the Federal Government? Is society going to benefit from changes on the farm, and is it going to be enough to provide some incentive? The economic impacts of climate change are insignificant in the scope of the industry. Risk is inherent to farming. Agriculture is willing to adapt, but with low margins, there needs to be an economic benefit to farmers. It is not appropriate to talk only about climate change and keep all other things constant. Credit for Early Action could acknowledge measures that have already been taken, such as no-till, windbreaks, and the Environmental Farm Plan. There is some debate within the farm community whether it is acceptable to sell carbon credits - carbon sequestration does not necessarily translate into environmental improvements. Research is needed, but has to involve producers in setting priorities and in understanding the complex inter-relationships on the farm.

The farm community has funding available for projects (including environmental) that are important to producers.

Some considerations: Perhaps the research community needs to look at things more holistically with the questions coming from the producers. Can we re-direct research to look at what the consumer wants, not the agri-food industry? There should be more public research on these types of issues.

UPDATE ON KYOTO: NATIONAL IMPLEMENTATION STRATEGY FOR GREENHOUSE GAS EMISSIONS - ALRICK HUEBENER, AGRICULTURE AND AGRI-FOOD CANADA

Most of the greenhouse gas emissions in Canada come from burning fossil fuels, and do not fall under agriculture's mandate. However, Canada's growth in greenhouse gas emissions (a significant amount of which is in the Prairies) exceeds that of other OECD (Organization for Economic Co-Operation and Development) countries. Although our excess nitrogen rate is much lower, the rate of growth of the nitrogen balance also exceeds that of other OECD countries.

Carbon sequestration is consistent with the universal principles of soil and water conservation. Most of the discussion around soils as sinks has been in the forestry sector, and it is important to make sure that agriculture is included in these discussions. There are some uncertainties around measurements of carbon in the soil and how long the carbon will stay there. What will happen if practices change? There is a growing acceptance of agricultural soils as sinks, and a recognition of multiple secondary benefits and linkages to international sustainable development. Sinks are a major concern for many countries, mostly for reasons of inclusion rather than for science or other criteria. There is also international awareness of carbon trading. A question arises around how to extend the adoption process so that early credits are not just implemented to meet Kyoto targets, but so that they can be sustained.

There is a need for more research, and a need to move beyond research. There are many things that reduce greenhouse gases but are difficult to quantify, and we are unaware of the co-benefits and trade-offs and what the credit is actually worth. It is important to consider that if something is good for reducing greenhouse gases, is it good for other measures of sustainability, as well.

A recent survey demonstrates that our awareness of climate change is low. Agriculture and Agri-Food Canada's strategy involves:

- " working on producer awareness;
- " engaging agricultural universities and stimulating research networks;
- " building climate change into current environmental programs to begin engaging producers;
- " building departmental knowledge;
- " establishing baselines of producer and public attitudes;
- " early action on mitigation; and
- " developing the science to quantify mitigation measures.

Program objectives include enhancing shelterbelts, furthering biofuels, gathering data from research model farms, and developing mitigation programs.

ONTARIO FARMING SYSTEMS AND GREENHOUSE GAS MITIGATION - KEITH REID,
ONTARIO MINISTRY OF AGRICULTURE, FOOD, AND RURAL AFFAIRS " 13

The Ministry of the Environment takes the lead on climate change issues in Ontario. OMAFRA's role is in the assessment and mitigation of agriculture-related greenhouse gas emissions, looking at sequestration to offset non-agricultural emissions, and developing agricultural adaptation strategies. OMAFRA's projects build on the national: developing an emissions model, looking at the potential for best management practices and carbon sequestration, and greenhouse gases from the food industry.

OMAFRA's findings suggest that the Kyoto target is achievable under the IPCC (Inter-Governmental Panel on Climate Change) definition of agriculture. Management practices will be critical, and sinks are essential. Southern and western Ontario account for more than 70% of Ontario's agricultural emissions and would account for more than 70% of the costs and benefits.

An analysis of BMP shows that by the year 2010, agriculture will have unintentionally reduced greenhouse gas emissions, but in the absence of financial incentives, BMP are unlikely to be continued. Sinks present an important opportunity, but the issue of pricing in carbon trading is an important one. There are still some challenges to carbon trading related to international uncertainty about implementation. OMAFRA is also involved in awareness and technology transfer activities related to climate change and greenhouse gases. The next steps are to verify the emissions co-efficients in the GEEMO (model, verify carbon sequestration opportunities, increase the prediction of the impacts of climate change, and determine adaptation strategies to climate change.

CARBON CREDIT TRADING - JERRY HAGGARTY, EMISSIONSXCHG.COM " 13

Emissionsxchg.com is a web-based exchange for global gases, such as greenhouse gases. The trading process is still in its infancy and needs a science base for credibility. The Kyoto Protocol has accepted carbon trading, but the rules still need to be established. There are some similar programs that have worked well (sulphur dioxide trading in the U.S., and the Great Lakes Water Quality Trading Network). There are now two trading pilots underway in Canada: PERT (Pilot Emission Reduction Trading Project) in Ontario, and GERT (Greenhouse Gas Emission Reduction Trading Project), federally. The eligibility criteria for PERT stipulate that the emissions must be real, quantifiable, surplus, verifiable, and unique. The rules include setting a protocol, establishing baselines, understanding credit life, establishing credit ownership and transfer, user liability, registry, monitoring and related documentation, audit and verification, and penalties.

Some technical issues around trading include: establishing a baseline, banking, and monitoring, assessing the government's and industry's roles, understanding the potential for increased emissions, global equity and/or pollution, credit for early action and additionality, the issue of profit, and incomplete research findings. The risks for agriculture involve unsubstantiated claims, tax targets, and lost opportunities. The opportunities for agriculture include a revenue stream, and environmental, social, and economic co-benefits.

PRODUCER PANEL COMMENTS FOR THE AFTERNOON PRESENTATIONS

Carbon trading is attractive in tough economic times, but public perception is important - farmers need to consider whether they are improving the environment or just selling what they're already doing right. There is also the risk of selling carbon credits before an appropriate price has been established (it's already significantly risen). Farmers should also proceed with caution in selling carbon credits, lest they should find out they're in a nitrogen deficit position.

FRIDAY MARCH 2, 2001

THE PROPOSED C-CIARN - ERIC TAYLOR, NATURAL RESOURCES CANADA

C-CIARN is a network of researchers and stakeholders who identify the impacts of climate change and provide information. The key objective is to improve the co-ordination of research, increase the visibility of climate change, provide mechanisms for stakeholder involvement, and

provide information on impacts and adaptation research to communities, governments, business and industry. C-CIARN also aims to involve a broader range of researchers in the climate change area, and assist in the co-ordination of climate change vulnerability assessments. There is a network of regional (British Columbia, Prairies, Ontario, Quebec, Atlantic Canada, and Northwest Territories) and sectoral (including water resources, forestry, coastal zone, agriculture, health, landscape and fisheries) nodes to C-CIARN across the country. The question is whether there should be an agricultural component. If so, how might it best be structured and facilitated, and who would be a part of it?

Each node is facilitated by a one-person office located at an academic institution or government agency, and is directed by a regional or sectoral C-CIARN advisory committee. Possible roles of the office are to promote and facilitate research, increase stakeholder involvement in research planning, develop an inventory of research and data sources, organize workshops as needed, communicate information, assist in research priority setting, identify funding opportunities, and become the C-CIARN point of contact. There is up to \$125,000 available annually for some support for workshops, travel, and salary, although C-CIARN is not a funding agency. Governance involves a national advisory board, a national co-ordinator, regional and sectoral advisory committees, and an annual review for continued funding.

WHAT HAS BEEN ACCOMPLISHED IN AGRICULTURAL IMPACTS AND ADAPTATION RESEARCH AS IT RELATED TO CANADA? - BARRY SMIT, UNIVERSITY OF GUELPH

Types of impacts and adaptation research that have evolved include climate-scenario based studies (looking at agro-climatic properties, production areas, crop development and yields, regional production, economic potential, and farm economic impacts) and vulnerability adaptation studies (looking at associated risks, farmer perceptions and adaptation, the role of public programs, and planned adaptation). Research also needs to include an understanding of the sensitivities and vulnerabilities of agriculture to climatic variability and risks, an assessment of adaptation strategies relative to producer risk management, and an analysis of the role and effectiveness of public program.

The opportunities for an agricultural node of C-CIARN are to promote and facilitate research, enhance relevance, promote collaboration and information sharing and aid decision-making. Resources and the involvement of key stakeholders are important.

STAKEHOLDER PRESENTATIONS

JOHN VAN HERK, W.G. THOMPSON AND SONS

Plant breeders develop a variety of traits in plants and seek to identify superior hybrids and breeds. This depends heavily on field trials, to test how the variations respond to weather. Gradual changes in weather patterns are manageable, and would favour varieties that are adapted to the patterns (such as hybrids with superior abilities to manage water as a response to temperature increase) but radical changes are difficult to deal with. An increase in carbon dioxide is generally positive for crops, but the most concerning impact of climate change is likely in the area of disease and insect management. Biotechnology may play an important role. Climate change may also see a change in the types of species used in agricultural production.

BOB AUMELL, FOUNDATION FOR RURAL LIVING

The changing rural demographics will have an important role on the adaptation to climate change, and economic viability is the overlying issue in agriculture. Questions arise: Who will be farming? Will there be adequate financing? How can lenders better understand the risks related to weather change? Why are more farmers not using risk management tools? How do we integrate risk management into lending?

BEN BRADSHAW, SIMON FRASER UNIVERSITY

It is hard to isolate climate change risks from other production and market risks (i.e., price variability, loss of markets, uncertain government policy). Proposed adaptations need to be better theorized and tested based on observance of actual decisions made by producers. Some important questions for C-CIARN include: How do climate change risks and opportunities relate to or fit with other risks? How do producers actually respond to these many risks and opportunities?

ROGER STREET, ENVIRONMENT CANADA

The goals of the Canadian Climate Impact Scenarios (CCIS) Project are to provide basic national climate change scenarios, a nationally consistent framework, and to involve the research community. The project will conform to the IPCC Guidelines and facilitate the use of Canadian research results. Currently it is possible only to make projections (not predictions) and therefore a multiple number of scenarios or models need to be used. The speed of the process has improved dramatically over the last few years.

The web site for the project is at <http://www.ccis.uvic.ca/scenarios>

CAL TURVEY, UNIVERSITY OF GUELPH

Hedging crops addresses the question of how climate risks impact the agricultural economy and how new insurance and financial derivative products can be used to hedge weather risks. This considers the certainty of risk, and is a form of quantity insurance that is not linked to yields but to weather events. For example, a producer might insure him/herself on the basis of cumulative degree-days or specific temperatures. This approach focuses on the source of the problem, not the outcome.

DAVE ARMITAGE, ONTARIO FEDERATION OF AGRICULTURE

The emphasis of the climate change issue has been on greenhouse gas reductions rather than on the reality of climate change. Farmers, over the history of agriculture, have always adapted. Climate change has generally not been acknowledged in the farming community, but awareness activities and programs are taking place (through "Taking Charge" and the Environmental Farm Plan). The Agricultural Environmental Stewardship Initiative has listed climate change as a priority, but there has been a top-down approach, and farmers would probably have selected other priorities that have incidental positive impacts on climate change. The main interest is in the area of co-benefits.

During the March 2nd afternoon, workshop participants joined in large and small discussion groups to answer the following questions:

What are the most significant research topics related to agricultural impacts of, and adaptation to, climate change including variability and extremes?
Should there be a C-CIARN-Agriculture sub-network?
What form and function would a C-CIARN-Agriculture sub-network have?
Who would and should be involved?

Responses were recorded and appear in the following sections.

INFORMATION GAPS AND RESEARCH NEEDS

1. Sensitivities of agriculture to climatic variability and risks

- a) What climate parameters have the most impact on agriculture across Canada (heat, frosts, drought, precipitation patterns, etc.) and how does the agri-food sector currently deal with them?

- b) How will the frequency and intensity of agriculturally significant climatic conditions change? What form are they taking? Will the detrimental effects of climate change on other regions in the world have positive or negative effects on Canadian agriculture?
- c) At what points do acknowledged impacts represent unmanageable impacts?-for agricultural producers?- for the agri-food sector?
- d) How do climate-related risks interact with other risks to influence the viability of agriculture and prospects for adaptation?
- e) What are the climate change related pest and disease risks for agriculture in Canada, including frequency and intensity?

2. Assessment of adaptation strategies relative to agricultural producers' risk management

- a) How can Climate Change be recognized and exploited for new opportunities and possibilities?
- b) What adaptation options are technically feasible and economically viable?
- c) How do agricultural producers adapt now to variability and extremes? How successful are they in adapting?
- d) What are the proposed adaptation strategies for climate-related pest and disease risks and what impacts could these strategies have environmentally and economically?
- e) What is the production feasibility and timetable of producing alternate crops in different areas of Canada as the climate changes?
- f) What factors constrain adaptation? How do climate risks relate to the diverse and urgent pressures that agricultural producers currently face? What opportunities exist for co-benefits?
- g) How can Climate Change adaptation issues be integrated into other agriculturally related research (eg. Best Management Practices).
- h) What cross-compliant adaptation technologies and management strategies could be used for Climate Change and agriculture policy and programs?

3. Analysis of the role and effectiveness of public programs

- a) What strategies might be developed to ensure the cost of adaptation is spread among all beneficiaries?
- b) What roles can crop insurance and support programs play in adaptation to climate change for the agri-food sector?
- c) What will be the impacts of future trade agreements on agriculture and how will these affect the ability of agriculture to adapt to climate change now?

A C-CIARN -Agriculture sub-network can address a number of these significant information gaps and research issues, keeping in mind that our knowledge of the potential impacts of climate change on agriculture, i.e. specifically on crop performance, is often still very rudimentary and requires much more research to get better insight.

POSSIBILITIES FOR C-CIARN -AGRICULTURE

There is a need **to stimulate** research in the field of Impacts and Adaptations to Climate Change to complement Greenhouse Gas Mitigation research. A C-CIARN-Agriculture sub-network would be useful in **promoting** collaboration on Impacts and Adaptations to Climate Change involving stakeholders (agricultural producer representatives, policy-makers, and researchers), and **disseminating** research results. It is also important **to improve** two-way communication between the climate-modellers/scenario community and the end users, i.e. producers and impact and adaptation scientists.

2. However, a C-CIARN-Agriculture sub-network should note:

- The network should not duplicate a function currently undertaken by some other agency or institutional arrangement.
- Possibilities for incorporating the network into an appropriate existing body should be explored.
- To be effective, the sub-network and Climate Change Impacts and Adaptation research must have serious, long term financial support.
- A C-CIARN-Agriculture sub-network could be set up (as has been done with other C-CIARN sector and regional sub-networks) but there is utility in exploring options within existing structures.

3. The Canadian Agri-Food Research Council (C.A.R.C.) was identified as possible institution within which a C-CIARN-Agriculture sub-network might fit because:

- It includes representatives from federal government, provincial governments, academia, and the agricultural community.
- It has established credibility.
- It has a structure (eg. expert committees) that would be suitable for co-ordinating and overseeing Climate Change Adaptation research.

4. For accommodation of a C-CIARN-Agriculture sub-network within an existing institution, certain conditions should be met:

- New and sufficient funds for supporting C-CIARN-Agriculture within the institution would have to be guaranteed.
- If C.A.R.C., a distinct expert committee to focus on Climate Change Impacts and Adaptation research should be struck within the institutional structure.
- If C.A.R.C., research expertise on an expert committee should include relevant social science perspectives given their importance for Impacts and Adaptation research.
- If C.A.R.C., the committee should make a special effort to ensure dissemination of findings to agricultural producers, agribusiness interests, and decision-makers.
- Given the newness of this field and the interest from Natural Resources Canada in sponsoring such a sub-network, there may be value in having a C-CIARN-Agriculture sub-network secretariat within the selected institution's structure to launch the initiative and ensure communication with stakeholders.

CONCLUSION

This C-CIARN-Agriculture workshop successfully met its goals as set out by the Workshop Steering Committee. These objectives included:

- To identify the key issues regarding agricultural sector impacts of, and adaptation to, climate change including variability and extremes.
- To determine whether sufficient interest exists to support C-CIARN-Agriculture so that those concerns will be effectively addressed.
- To specify the options for structuring and operating C-CIARN-Agriculture including:
 - potential participants;
 - the means for communication, collaboration and co-ordinating;
 - resources for supporting C-CIARN-Agriculture endeavor
- To identify an initial list of key research needs that C-CIARN-Agriculture will promote to appropriate agencies.

Students from the School of Rural Extension, University of Guelph, evaluated the workshop with these goals in mind by compiling data from questionnaires given out to the participants. Their assessment, which was highly favourable, is available on request.

As the latest report from the Intergovernmental Panel on Climate Change indicates, there is no doubt that climate change will become an increasingly important feature for life in North America. The complexity of how the agri-food sector might be affected by continued weather extremes and variability was evident, based on the presentations and discussion during this workshop. Establishing an Agriculture sub-network with C-CIARN is one way to ensure that research related to addressing such issues and questions is carried out in an effective manner across Canada. The information contained in this Final Report will be a useful resource for planning and establishing a C-CIARN-Agriculture sub-network.

Appendix A

PARTICIPANT LIST

Adamson	Shona	University of Guelph
Armitage	Dave	Ontario Federation of Agriculture
Aumell	Bob	Foundation for Rural Living
Bartolic	Cathy	OATI
Bedggood	Bob	Christian Farmers Federation of Ontario
Bootsma	Andy	Agriculture and Agri-Food Canada
Bradshaw	Ben	Simon Fraser University
Brine	Paul	OMAFRA
Broad	Steve	Innovative Farmers
Brown	Jeremy	University of Guelph
Brown	Murray	Cambridge, Ont.
Bucknell	Delia	University of Guelph
Crouse	Kevin	Ontario Agri-Food Education
Cuddleford	Vijay	Freelance researcher/writer
De Jong	Reinder	AAFC, ECORC
De Kimpe	Christian	Agriculture and Agri-Food Canada
Deen	Bill	University of Guelph
Denhartog	Jenny	CFFO
Dolan	Holly	University of Guelph
Dzikowski	Peter	Alberta Agriculture Research Institute
Filson	Glen	University of Guelph
Gameda	Sam	AAFC, ECORC
Gardner	John	OMAFRA
Garr	Mary Lou	Ontario Federation of Agriculture
George	Wanda	University of Guelph
Gillespie	Terry	University of Guelph
Glass	Vimy	University of Guelph
Grahovac	Vicky	OMAFRA
Griffiths	Heather	OMAFRA
Haggarty	Jerry	EmissionsXchange.com
Haley	Les	CARC, Agriculture and Agri-Food Canada
Hayes	Adam	OMAFRA
Hoppa	Lau	University of Toronto
Huebener	Alrick	Agriculture and Agri-Food Canada
Joseph	Stanley	Guelph, Ontario
Junkins	Bruce	Agriculture and Agri-Food Canada
Junkin	Mark	Caygeon Consulting, Guelph, Ontario
Klupfel	Ellen	University of Guelph
King	Donald	Soil Resource Group
Kort	John	AAFC - PFRA
Leahy	Stephen	MEDIA
Leuty	Todd	OMAFRA
Lynch	Derek	Nova Scotia Agricultural College
MacDonald	Bruce	Guelph, Ontario
MacRae	Rod	World Wildlife Fund Canada
Malcolmson	Phil	OMAFRA
Maurer	Jeanne	Ryerson University

McCabe	Don	Ontario Corn Producers' Association
McCutcheon	Bill	Ontario Vegetable Growers Association
McGill	Larry	Organic farmer
McGinn	Sean	Agriculture and Agri-Food Canada
McKinnon	Bob	Innovative Farmers Association of Ontario
McLaughlin	Nicole	University of Guelph
Morley	David	EmissionsXchange.com
Muise	Betty	Enviros-RIS
Newcombe	Barry	Innovative Farmers Association of Ontario
Oelbermann	Maren	University of Guelph
Ogilvie	John	University of Guelph
Omielan	Joe	University of Guelph
O'Neill	Brian	New Brunswick Soil and Crop Improvement Association
Otis	Jude	Guelph, Ont.
Phillips	David	Environment Canada
Ponce	Raul	Trent University
Powell	Glenn	Ontario Farmer Publications
Profit	James	Jesuit Centre for Social Faith
Reid	Keith	OMAFRA
Rochette	Phillippe	Agriculture and Agri-Food Canada
Rop	Jayne	OMAFRA
Ross	Robert	Call Canada 99 Inc.
Rudy	Harold	Ontario Soil and Crop Improvement Association
Rutherford	Stephanie	University of Guelph
Salele	Wood	University of Guelph
Saunders	Bruce	Dairy Farmers of Ontario
Simkus	Gail	Agricorp
Smit	Barry	University of Guelph
Smithers	John	University of Guelph
Stanley	Joseph	University of Guelph
Stewart	Alan	Agriculture and Agri-Food Canada
Street	Roger	Meteorological Service of Canada
Sutherland	Karen	University of Guelph
Swanton	Clarence	University of Guelph
Taylor	Eric	Natural Resources Canada
Thevathasan	Naresh	University of Guelph
Thomas	Bill	Thomas Canning Ltd, Maidstone, Ontario
Thompson	Drew	University of Guelph
Townley-Smith	Lawrence	AAFC-PFRA
Turvey	Cal	University of Guelph
Van Herk	John	W.G. Thompson and Sons
Wagner-Riddle	Claudia	University of Guelph
Wall	Ellen	University of Guelph
Warland	John	University of Guelph
Waslander	Elanor	University of Guelph
Webb	Dave	University of Guelph
Weersink	Alfons	University of Guelph
Wellstead	Adam	Canadian Forest Service
Yiridoe	Emanuel	Nova Scotia Agricultural College

Zachariah

Oswald

OMAFRA

Appendix B

WORKSHOP PROGRAMME

Thursday, March 1, 2001

- 07:45 Registration and coffee
- 08:20 **Welcome and Introduction to the Workshop - John Smithers**, Geography, Univ. of Guelph; **Mordechai Rozanski***, President, Univ. of Guelph; **Frank Ingratta**, Deputy Minister, Ont. Ministry of Agriculture, Food and Rural Affairs
- 08:45 **A Changing Climate: What's up with the Weather?** - **David Phillips**, Sr. Climatologist, Environment Canada.
- 09:25 **How is Climate Change Relevant to Farmers?** - **Barry Smit**, Geography, Univ. of Guelph
- 10:00 **Adaptation and Risk Management Strategies for Agriculture.** - **Peter Dzikowski**, Alberta Agriculture Research Institute
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- BREAK**
- 11:00 **Producers' Panel Response to morning presentations: PANEL:** Mary Lou Garr (Director, Ontario Federation of Agriculture); Bob Bedggood (President, Christian Farmers Federation of Ontario); Donald McCabe (Director, Ontario Corn Producers Association)
- 11:40 Moderated discussion on morning presentations
- 12:30 **LUNCH**
- 13:30 Introduction to the afternoon session.
- 13:40 **Update on Kyoto: National Implementation Strategy for Greenhouse Gas Emissions - Alrick Huebener**, Environment Bureau, Agriculture and Agri-food Canada.
- 14:10 **Ontario Farming Systems and Greenhouse Gas Mitigation.**, **Keith Reid**, Ont. Min. of Agr., Food and Rural Affairs.
- 14:50 **Carbon Credit Trading - Jerry Haggarty**, EmissionsXCHG.com
- 15:15 **BREAK**
- 15:45 **Producers' Panel Response to afternoon presentations** **PANEL:** as above
- 16:10 Moderated discussion on afternoon presentations
- 16:45 Summary of Day 1 - John Smithers

Friday March 2, 2001

- 08:00 Registration and coffee
- 08:30 **Welcome, introduction to Day 2 and summary of Day 1 - John Smithers**
- 08:50 **The Proposed C-CIARN (Canadian Climate Impacts and Adaptation Research Network).** Eric Taylor, National Coordinator, C-CIARN, Natural Resources, Canada
- 09:15 **What has been accomplished in agricultural impacts and adaptation research as it relates to Canada?** Barry Smit, Geography, Univ. of Guelph
- 09:45 **Presentations from stakeholders. Moderator: Peter Dzikowski**, (Alberta Agriculture Research Institute). **John Van Herk**, (W.G. Thompson and Sons) and **Bob Aumell**, (Foundation for Rural Living)
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- BREAK**
- 10:45 **Presentations continue: Ben Bradshaw** (Geography, Simon Fraser Univ.); **Roger Street** (Environment Canada, Adaptation and Impacts Research Group); **Cal Turvey** (Agricultural Economics & Business, Univ. of Guelph); **David Armitage** (Ontario Federation of Agriculture)
- 12:00 Discussion based on stakeholders' presentations
- 12:30 **LUNCH**
- 13:15 **Focused Discussion: Moderator: Alfons Weersink**, (Agricultural Economics and Business, Univ. of Guelph). What are the most significant research topics related to agricultural impacts of, and adaptation to, climate change including variability and extremes?
- 14:00 Preparation for small discussion groups
- 14:15 **Address the following questions in small groups:** What form and function would a C-CIARN-Agriculture sub-network have?
Who would and should be involved?
- 14:45 Small groups report and Workshop Summary

C-CIARN Workshop Steering Committee

Andrew Bootsma, Agriculture and Agri-Food Canada;

Ben Bradshaw, Simon Fraser University;

Chris Bryant, Université de Montréal;

Mary Lou Garr, Ontario Federation of Agriculture;

Terry Gillespie, University of Guelph;

Les Haley, Canadian Agri-Food Research Council;

Sean McGinn, Agriculture and Agri-Food Canada;

Brian O'Neill, NB Soil and Crop Improvement Association;

John Ogilvie, University of Guelph;

Barry Smit, University of Guelph;

Eric Taylor, Natural Resources, Canada;

Ellen Wall, University of Guelph;

Alfons Weersink, University of Guelph;

Oswald Zachariah, Ontario Ministry of Agriculture, Food and Rural Affairs