

Agricultural Adaptation in a Changing Climate

SUMMARY REPORT for

C-CIARN AGRICULTURE WORKSHOP

March 1, 2002
Cutten Club,
Guelph, Ontario

C-CIARN AGRICULTURE

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Canada 



Foreword

C-CIARN Agriculture (Canadian Climate Impacts and Adaptation Research Network for Agriculture) officially began its operations in November, 2001 with a five year mandate. The office is hosted by the University of Guelph and is part of a national effort to assist those interested in climate change impacts, vulnerabilities, risks, and adaptation in agriculture. It is one of thirteen C-CIARN sectors and regions across Canada that have been established through Natural Resources Canada and Canada's Action Plan 2000. There are several dimensions to C-CIARN Agriculture. A Local Steering Committee and Scientific Director advise the Co-ordinator in the day to day operations of the office which is situated in the faculty of Environmental Sciences. Research and other assistance is provided by a number of University of Guelph students working in different research programs. More long term guidance and support come from a National Advisory Committee made up of representatives from industry, policy, and the research community across Canada. (see Appendix A).

C-CIARN Agriculture maintains a web site at: <http://www.c-ciarn.uoguelph.ca>. We invite you to join our network and make good use of the resources we offer. These include:

- *Databases of information about climate change impacts, adaptation, and vulnerabilities relevant for the agri-food sector;*
- *Connections to those working in the climate change impacts and adaptation field and what they have accomplished;*
- *Potential funding opportunities for research;*
- *A network of individuals working to improve the ability of Canada's agri-food sector to deal with climate change.*

One of the objectives for C-CIARN Agriculture is to provide opportunities for all stakeholders involved in climate change impacts, vulnerabilities, risks, and adaptation for agriculture to collaborate on research endeavour and integrate research results. Annual workshops are one way to meet this objective. C-CIARN Agriculture hosted an inaugural workshop on March 1, 2002 at the Cutten Club, close to the University of Guelph, Guelph, Ontario. Participants included representatives from the agri-food sector, policy and program divisions of several government ministries, university researchers, and other interested parties. They took part in question and discussion periods and were also invited to submit (in writing) their views on research gaps and priorities related to climate change impacts and adaptation issues for agriculture. The National Advisory Committee (NAC) for C-CIARN Agriculture held its first meeting directly after the workshop. This report summarizes the main points from the presentations, discussion/question periods, written comments submitted by the participants, and issues raised during the NAC meeting.

We are grateful for support from the following sponsors: Government of Canada; Faculty of Environmental Sciences and Department of Geography, (University of Guelph), and Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA);. We also appreciate the efforts from students, Delia Bucknell, Susanna Reid, Cecilia Fernandez, and Ellen Klupfel. Additional thanks go to the speakers and participants who shared their knowledge and opinions in an informative and challenging manner.

Local Steering Committee for C-CIARN Agriculture,
Tony Hunt, Terry Gillespie, Barry Smit, Ellen Wall, Alfons Weersink, and Oswald Zachariah

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Executive Summary

The inaugural C-CIARN Agriculture workshop, *Agricultural Adaptation in a Changing Climate* took place on March 1, 2002 and had as the main goals:

- to assess progress on the latest climate change and agriculture impacts and adaptation research and identify main gaps and needs in the field;
- to provide opportunities for those from the agri-food sector, policy development, and the research community to interact and explore opportunities for future collaboration on the issues related to agricultural impacts, adaptation and vulnerabilities associated with climate change;
- to disseminate information about agricultural impacts, adaptation and vulnerabilities to climate change; and
- to introduce the new C-CIARN Agriculture office at the University of Guelph.

A total of twenty-one brief presentations were made from three different perspectives reflected in three panels. Agricultural producers and their organizations comprised one panel while another had speakers from both federal and provincial ministries. Representatives from academic research institutions were on the third panel. Each speaker was asked to report on his or her organization's contributions to research on climate change impacts and adaptation for agriculture.

All participants took part in three question and answer style discussion periods during the workshop. As well, they were invited to submit written comments on the research gaps and priorities related to climate change impacts and adaptation issues and agriculture. Several relevant points were identified in the presentations, related questions and discussion, written submissions and the National Advisory Committee meeting that followed the workshop. Among the most important is **INTEGRATION**. Stakeholders from industry, policy, and research all agree that integration must be a priority in the following areas:

- Management strategies for climate change adaptation on the farm must build on past and existing practices while recognizing that impacts will affect the whole farming system. Practical solutions will result from assessing risk in the context of other vulnerabilities.
- Policy and Program development must be harmonized across regions, departments, agencies, and ministries (both federal and provincial) to ensure efficient and effective results.
- Research into impacts and adaptation must integrate producers' views and experience. At the same time, those views must be understood within the context of a broader societal context.
- Impacts, vulnerabilities, and adaptation research is multidisciplinary by nature.

Besides an emphasis on integration, workshop participants also recognized that there is a distinct need for **IMPROVEMENT** in the research related to:

- Institutional barriers to adaptation strategies;
- Understanding the "coping range" for agricultural operations;
- Impacts from policy decisions;
- Climate scenarios, modeling, and prediction; and
- Probability of variability and extreme events.

The impacts and vulnerabilities for agriculture from climate change are being felt throughout Canadian farming systems and the environment within which they operate. From the producers' perspective the crucial dimension is **economics**. Climate change matters to them in terms of its impacts on the financial success of their enterprises. Producers recognize that their business depends on a number of other factors (including those related to the **environment, policy, infrastructure, and social issues**). These can be summarized in the following table.

ECONOMIC IMPACTS

- Crop/livestock losses due to extreme events
- Crop/livestock losses due to altered levels of soil moisture
- Crop/livestock losses due to change and severity of pests
- Crop/livestock losses due to increased variability in weather
- Costs of current risk management and crop insurance strategies
- Increased opportunities for growing new varieties and finding new markets

ENVIRONMENTAL IMPACTS

- Soil and water depletion
- Air quality

POLICY IMPACTS

- Suitability and viability of current income stabilization and safety net programs
- Cross Compliance of policy and programs both within and between ministries and their various departments/agencies.
- Effectiveness of current land use policy and resource management programs

SOCIAL IMPACTS

- Community conflict over scarce water and land resources
- Community conflict over changes in land use management

Written submissions included a greater variety of concerns that can be categorized into needs for better research into adaptation, impacts, and greenhouse gas mitigation. (See Appendix B for a full list of the key research issues identified). Among those listed for Adaptation and Impacts are:

- The need to provide viable and practical options for farmers
- The need to look beyond agriculture (i.e. competition for scarce water resources)
- The need for more research on coping strategies and coping ranges
- We need more research on impacts in the local/regional context
- The need to have a better understanding of post-harvest impacts (including the impacts on storage facilities, process and transportation)
- The need to assess climate change impacts in the context of other vulnerabilities

Agricultural Adaptation in a Changing Climate

Introduction

C-CIARN Agriculture used the workshop on March 1, 2002 as an opportunity to launch its new office at the University of Guelph and to provide a venue for those interested in climate change impacts and adaptation issues to meet one another and discuss common concerns.

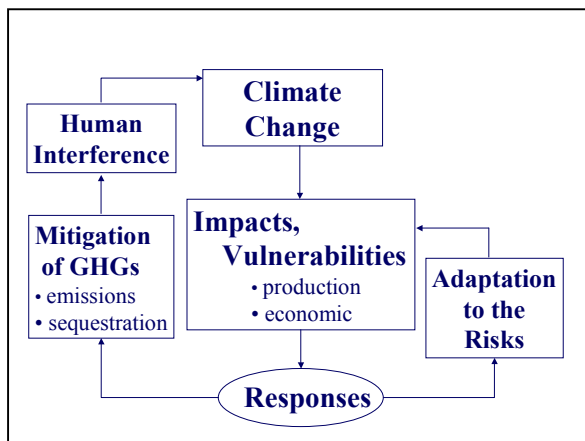
The 86 individuals who registered for the 2002 workshop came from diverse backgrounds as the information in Table 1 demonstrates. A participant list is available in Appendix “C”.

Affiliation of participants at the March 1, 2002 C-CIARN
Agriculture workshop (Total number 86)

Stakeholder group	Percentage
Agri-food sector	21
Policy/government	25
Research/Academia	33
Other (eg. Media, consultants)	14

The workshop programme (found in Appendix “D”) lists each speaker and his or her affiliation.

Our first presentation was by way of a welcome and overview of issues from Barry Smit, Scientific Director for C-CIARN Agriculture. According to Smit, climate change (including variation and extremes) has various impacts on agriculture which has certain vulnerabilities (including production and economic). Human response may take the form of mitigation of greenhouse gases or adaptation to the change so the impact is moderated. Another response is to focus on **adaptation** which involves producers, the agri-food sector, government, biotechnology companies, and many others. It involves estimating impacts and postulating adaptation to the impact.



Climate change impact studies in Canadian agriculture have focused primarily on agro-climatic properties, production areas, crop development and yields, regional production and economies, and farm economics. Adaptation research is important – if we ignore it, and adapt after the changes have taken place, it could be very costly, so adaptation strategies should be started as soon as possible.

In adaptation research, it is important for producers to identify the most problematic areas of climate for researchers to determine the probability of occurrence. We need information from climate change science on the probability of extremes such as drought, for example. We need to start with an understanding of the farming system and then work at the adaptation

needed. We need to understand the way climate stresses interact with other things – social, economic, etc. Previous adaptation studies were naïve for ignoring how the system works in order to come up with realistic adaptations. Farmers make choices about implementing adaptations depending on the elements that matter to them.

Smit summarized the changes in climatic extremes for North America and noted that agriculture is particularly sensitive to drought – the 2001 drought disaster can be compared to the dust bowl of the 1930s (B. Friesen, CFA 2001). Knowing about these issues can help us adapt and manage risk with a more confidence – remembering that climate is never certain – variation over time is inevitable. It is important to gear research to the changes needed (eg. put more effort into developing crops that have a broader climatic range).

Changes in Climatic Extremes

- More frequent summer droughts
- More frequent heat waves; more hot days
- Less frequent cold waves
- More frequent intense precipitation events
- More intense storms
- More frequent hail
- Fewer frost days

A useful approach to dealing with the challenges and opportunities associated with these changes includes adaptive strategy planning. Otherwise, producers become caught in reacting to changes and thereby having less control of the situation. Among other factors, planned adaptation includes modifying technology (eg. improving weather and climate information systems); building appropriate subsidy and income support programs; changing farm production practices (eg. those related to irrigation systems); and ensuring crop insurance systems can handle future conditions.

The key messages from Smit were:

- Climate change includes climatic extremes;
- Agriculture is vulnerable;
- Reactive adaptation is costly;
- There are opportunities for planned adaptation;
- Adaptation involves governments, agri-business and producers; and
- Adaptation needs to be considered in the light of on-going management decisions.

Directly following these introductory comments, each panel made presentations. Details from them are summarized in the following pages.

Workshop Presentations

PANEL 1 Agricultural Producers and Organizations

A SUMMARY OF CONDITIONS AND DECISIONS ON HIS FARMING ENTERPRISE DURING THE 2001 SEASON

Don McCabe, Ontario Corn Producers' Association

The primary driving force for farmers to address climate change issues is economic. Because it has been difficult to predict the weather, there were many problems with crops this year (in Lambton county, for example where weather was highly variable in the small scale). This means that crop insurance has become a primary means of adaptation. Government programs and crop insurance in Ontario have been great, although they are not working well in the West because of difficulties in design. There are lots of opportunities in biotech development.

CLIMATE CHANGE: AN NBSCIA SUMMARY

Brian O'Neill (New Brunswick Soil and Crop Improvement Association)

OPPORTUNITIES

- Climate change may allow us to grow alternate, higher yielding crops. Research is needed in the areas of drought resistance, salt tolerance, crops which require greater heat units and longer growing days.
- Life science economy-novel food and non-food uses for our products. eg. bio-fuels, nutraceuticals, pharmaceuticals, bio-products.
- Value-added products-variety evaluation will be needed to determine the best varieties for new uses. Eg. Ethanol

Climate change is not a major issue with NB farmers but it is increasingly being incorporated into association activities and into the back of farmers' minds (who may be making changes to make more money). The summers are getting longer, heat units are increasing, and farming conditions are good. Some of the NBSCIA's current research activities that may have some impact on climate change include research

into crop adaptation, nutrient management, on-farm demonstration sites, manure management, nutrient remote sensing, and greenhouse gas emission research projects. Climate change is also being incorporated in the Environmental Farm Plan.

RISK MANAGEMENT WITH CROP INSURANCE

Mike Vlcek (Agricorp)

Vlcek feels that farmers should purchase crop insurance. Ontario, in particular, has the best program that offers the highest crop insurance for the most affordable price in the world, and producers are in a position where they need to manage risk. For the past season (2001), \$258 million was paid out in Ontario – the highest since 1966.

Agricorp has purchased re-insurance – insurance for insurance companies so they can cover years such as this one, with a high number of claims. This is helpful for confidence and stabilization. Agricorp is the first insurance organization in the world to offer an agricultural weather-derivative. It is successful because the process is simple, transparent, predictable, responsive, and timely (i.e., 'no rain, no hay').

Agricorp uses GIS – all 20,000 customers are mapped and any data can be attached to a point on a map to adjust claims. They will try to take advantage of the next level of technology, whatever that may be.

IMPACTS OF CLIMATE CHANGE FOR THE PROCESSED VEGETABLE INDUSTRY

Bill Thomas (Thomas Canning Ltd., Maidstone, Ontario)

Thomas offered an example of processing tomatoes to demonstrate the significance of climate change to the canning industry. Tomatoes are very climate sensitive and Ontario producers need to compete with California so all production factors are very important. The significant criteria for processing tomatoes are yield and quality, both of which are dependent on climate. Growers have contracts to sell a certain tonnage, and can sell more if there is more available. This past summer was not as productive as others.

Climate change is not a research priority for the industry, but it needs to head in that direction; there is interest. They can provide some input into plant breeding (i.e. drought tolerant varieties). The industry is looking for a sense of direction on climate change to make decisions about adaptation. Adaptations such as drip irrigation to manage drought, for example, work well but require a huge investment. The options are limited, but there are adaptive strategies.



MARKETING AND MAXIMIZING GRAIN RETURNS IN A CHANGING CLIMATE

Guy Ash (Canadian Wheat Board)

Marketing and maximizing grain returns will be a challenge this year. Production is related to weather and market trends, but will variability increase in a changing climate? There was record dryness this past year.

Adapting to climate change is not within the organization's mandate, as it works on a 5-10 year scale. Some important figures for Canadian wheat: Revenues have fluctuated between \$3.8 – 5.95 billion over the last five years, the harvested area has increased from 24.7 million acres to 34.3 million acres and production has increased from 19.9 million tonnes to 31.2 million tonnes.

Assuming that climate change takes place there are some important questions to be asked:

- Will there be longer growing season? More useful heat? Increasing yields?
- Will ecozones change?
- Will new varieties be developed?
- Will there be more winter wheat?
- Will disease and pests become more of an issue?
- Will there be changes and costs associated with grain storage and handling?
- What will be the incidence of severe weather?
- What will the moisture regime look like?

In summary, adaptation has always and will always continue to be a part of the farming picture. The challenge is to investigate the variables and quantify the impact on producers' ability to market and maximize grain returns.

CLIMATE CHANGE ISSUES AND ONTARIO AGRICULTURE

Dave Armitage (Ontario Federation of Agriculture)

The greenhouse gas side of the Environmental Committee has not been very active this last year, but the organization is hoping to re-instate it and look at the adaptive component as well.

The Canadian Federation of agriculture (CFA) has resolved to lobby the federal government for more research on gaps in climate change knowledge and is asking the OFA to work in conjunction with them.

Over 70 reports from the University of Guelph Resource Management and Environment program have been reviewed over the last year. Only three have looked at climate change, and have dealt only with greenhouse gas reductions. There is a need for more emphasis on adaptation.

There is an intention to introduce climate change into the Ontario EFP, but not as a separate module, but to make connections in existing modules.

Adaptation is not driven by climate change. Day to day operations impact climate change in some way, but the connection is not explicit.

Climate extremes would strike fear with farmers – the current variability and magnitude is already enough – more in the future is a real concern.

There is some research that looks at the development of adaptive production strategies (i.e., pest management, barn construction). There is a need for better short and long-range weather forecasts.



QUESTIONS/COMMENTS FOR PANEL 1

Is there any activity in tomatoes or wheat that looks at improving the stock of genetic material? – *Tomato research deals only with yield and quality; there is nothing looking at temperature windows for production, for example. There is lots happening with corn and biotechnology; also some research that looks at stomatal impact on water sensitivity.*

We expect that crop development is a likely way of addressing these conditions, but how come crop insurance claims are so high? – *It's the combination of extremes (heat, pests, water) that is the problem.*

How do we design a crop insurance system that encourages adaptation? – *It should work on the premise of good management. Currently, producers are covered on past yields and risk – it's a system that works. The Ontario program is subsidized 50% provincially, 50% by producers, and delivered by the federal government. The financial stability of the crop insurance program depends on re-insurance and lots of modelling.*

How do we separate weather/climate and technology? – *Measurement is a problem – it's important but difficult. It's difficult to divide things on a farm-scale level – a holistic problem. Technology is brought in to help farmers adapt to increasing consumer demand. It's difficult to know what could have been done with deal with the massive drought – if farmers plant a drought hybrid, there is the risk of it raining all the time.*

Climate change is an economic issue – is this a way to convince farmers to adapt rather than the environmental issue? (YES)

Variability and extreme events have been considered mostly from a production point of view, but they also lead to more environmental problems – to what extent will the government regulations constrain farmers? – *Greenhouse gases are a good example - sequestering organic matter will also reduce soil erosion. Society needs to learn more about agriculture to avoid regulations being put in place without proper consultation. OFA advocates that management is best left at the farm-level; it's difficult to determine at the provincial level what best practices are on the farm. Maintaining the environment is an important part of production.*

How will changes in production because of climate change in other parts of the world impact upon Canadian agriculture? – *This will depend on each individual country's policies on climate change. There will be effects. Argentina, Brazil and Australia are all stepping up production. China has just entered into the WTO, and overall wheat production is going down.*

PANEL 2 Government and Policy Representatives

DEVELOPING PREDICTIVE POLICY PROCESS MODELS: EXPERIENCES FROM THE PRAIRIES

Adam Wellstead (Canadian Forest Service)

There are two approaches to policy research: results-based and process-based. Results-based research looks at the impact of policy X (or changes in climate y) on the social or economic fabric of an area. Most policy analysis is conducted in this manner. Process-based research questions how policies actually change and what the probability is that a policy will become part of an agenda. It is difficult to measure, and there is little research of this type in Canada.

The CFS is conducting research with PARC that is predicting policy response in the Prairie agricultural, forestry and water sectors by employing process models and quantitative methods. Information on the study is available at <http://nofc.cfs.nrcan.gc.ca/parc/>. Preliminary results suggest that perceptions are similar over the sectors, that forestry is more concerned about perceived policy problems in other sectors. A minority sees impacts and adaptation as not their responsibility.

LINKING ANALYSIS ON MITIGATION TO AN ASSESSMENT OF THE IMPACTS OF CLIMATE CHANGE AND THE DEVELOPMENT OF ADAPTATION STRATEGIES

Bob MacGregor (AAFC, Strategic Policy Branch)

AAFC research and policy has been looking mostly at mitigation, and less at impacts and adaptation. This focus has taken form in the Agriculture and Agri-Food Table Options, the AMG (Analysis and Modelling Group) process, towards Kyoto AP2000, CCAF activity, AMG II, TMCG, BSAWG, DETWG, and other activities. An objective is to develop methods for quantitative analysis of impacts and adaptation strategies.

AAFC is now looking at an integrated analysis (integrating environmental and economic modelling). It should develop regional models at the economic level, interfaced with ecozones. Some of the work is looking at climate scenarios, and draws on science and quantitative analysis. Most of the impacts and adaptation work in the policy community is yet to come.

NOVA SCOTIA AGRICULTURE: CLIMATE CHANGE IMPACTS AND ADAPTATIONS

Rob Gordon (Nova Scotia Agricultural College)

To date, NS producers have not really recognized the potential ramifications of climate change. One wet season has stalled strategic thinking because it broke the pattern of dry seasons. However, data indicate that 12 of the past 15 growing seasons have exceeded the 50% probability level in terms of heat units, and 4 out of 5 have been exceedingly dry. There has been a northern migration of corn production in NS and NB, an increase in soybean production throughout the region, and an increased adoption of weather sensitive crops.

At the provincial level, the impact of drought is at the level of \$30-40 million, annually. NS has established the AWARD program to facilitate farm level adaptive research, and there has been the development of the NS Growers' Water Group. It is producer-driven, but has significant government and NGO involvement. It takes a strategic approach to water sourcing that includes educating farmers on the development of new systems. PFRA has a new presence in the Atlantic provinces. They are drawing on PFRA's experience in the prairies for water allocation planning.

Other activities in NS include a Senior climate change research Chair at the NS Agricultural College (NSAC), and NSAC is also allocating a Chair to integrated water management. The NS Federation of Agriculture is initiating a climate change planning committee.

There is a need for future climate data to be integrated with existing agricultural models.

L'ENGAGEMENT DU MAPAQ FACE AUX CHANGEMENTS CLIMATIQUES/ THE MAPAQ'S PARTICIPATION IN THE CLIMATE CHANGE ISSUE

Nancy Lease (MAPAQ)

MAPAQ is involved in climate change research through internal studies and through its participation in Ouranos activities (a climate change consortium that looks at four ecozones: permafrost, forest, oceanic and urban and rural impacts). The goal of MAPAQ's internal studies is to conduct an analysis of the organization's agro-environmental programs to determine the impact of greenhouse gas reductions (i.e., manure storage structures). *Ouranos* has 3-year financing to look at climatology, characterization and sensitivity analysis, and impacts and adaptation. They are seeking studies to examine the vulnerability and adaptation of rural southern Quebec using a watershed approach.

Gaps and priorities include greenhouse gases and an assessment of vulnerability and current state of production systems that would be adapted to risk.

COPING IN A CHANGING CLIMATE

Brian Abrahamson (Prairie Farm Rehabilitation Administration)

The long-term strategy is to increase coping range to adapt to climatic variability.

The future will present both opportunities and challenges. Adaptation is a continuous process – systems will continue to adapt around a ‘mean’. These means are expected to change – will we have more frequent excursions outside the coping range? Can we extend our thinking?


PFRA is developing knowledge to support sustainable production and manage risk in a changing climate (i.e., shelterbelts).

However, there is a great deal we still need to do assist producers and the agri-food sector with their adaptation strategies for the risks and impacts from climate change. Efforts need to be directed at determining the tools, policies, research, and infrastructure needed in the future.

ALBERTA VIEWS ON AGRICULTURE IMPACTS, VULNERABILITIES AND ADAPTATION TO CLIMATE CHANGE

Peter Dzikowski (Alberta Agricultural Research Institute)

There are various research projects that include developing tools and options for adaptation to different cropping systems, and ng at trends in weather extremes. A climate change adaptation strategy is being developed. AARI is funding projects in nitrous oxide production and greenhouse gas assessment at the farm level.



Information for Farm Level Decisions

- ▼ Does the information help the individual decision maker assess how a technology can help to be better adapted, year to year?
- ▼ Does an adaptation measure or indicator work at the farm level to provide feedback as part of a continuous improvement model?

Priorities include environmental sustainability and developing strategic research networks which provide partnership opportunities and integrated collaborative R&D.

Does a strategy of being continuously well-adapted to climatic variations inevitably lead to being well-adapted to climate change? We need to look at continuous improvement models. The problem with best management practices is that it encourages people to stop at the lowest level of compliance.

Needs and gaps include measures of indicators and adaptation, and information on farm-level decisions. What information do decision-makers need? How is it reflected in inventories? How is coping range defined? How are farm-level decisions made?

CLIMATE CHANGE ADAPTATION IN BC WHERE ARE WE AT?

Geoff Hughes-Games (British Columbia, Ministry of Agriculture)

The climate has changed – it is measurable but not noticeable. The severity of events is noticeable, and they are greater than historical events.

The B.C. Ministry of Agriculture offers information on the internet at www.farmwest.com that provides farmers with tools for decision-making using ‘T-sum’. The ministry is not doing any direct adaptation research, but is doing research and is doing adaptation (i.e., drainage, irrigation, manure management, cropping).

‘Other’ climates that need to be considered are business and markets, technology, politics, and urbanization.

QUESTIONS/COMMENTS FOR PANEL 2

AMG values for agriculture are inaccurate (i.e., sinks). Provincial activity needs federal data especially on soil resources. *-The group is trying to improve its information on sinks and develop integrated models on a small scale to see the impact on soil of adapted practices. Scenarios are bringing attention to the resource base.*

Why aren't ordinary land-use perspectives considered adaptive measures? *They are.*

How will other sectors (urban, for example) impact upon or magnify agriculture's impacts? *-We need to look at the issue on a watershed basis. This depends on who can influence policy agenda. How do we assess risks of climate change relative to other stressors on the system (i.e., vulnerability studies of climate jointly with other things)? There seems to be a consensus that these things need to be developed relative to these other processes. It is important to take into account competition over diminishing water resources, for example. Agriculture is losing political influence. The industry needs to be sure that its issues are addressed.*

PANEL 3 Research Community

CARC AND CLIMATE CHANGE RESEARCH IN CANADA

Norris.W. Hoag (Canadian Agri-Food Research Council)

CARC includes four Canada committees and 23 expert committees, including a natural resources committee.

The Climate Change Funding Initiative in agriculture involves \$4 million over four years. CARC is the delivery agent. Next month, researchers will be meeting to talk about the results so far. There are four main components to the program. Component 1 supports human resource development in our 8 agricultural colleges.. Components 2 and 3 involve 15 research projects that address crop nutrient management, livestock nutrient management, manure management, and carbon sequestration. The activities report 2000-2001 and the CARC-CCFIA workshop held last year highlighted some of these projects. Details available at: <http://www.carc-crac.ca/>

CLIMATE IMPACTS AND ADAPTATION RESEARCH AT PARC (PRAIRIE ADAPTATION RESEARCH COLLABORATIVE)

Dave Sauchyn (PARC)

PARC is the Prairie region office for C-CIARN, where the impacts of climate change on agriculture will be the most severe. Some of it has already been realized. PARC's stakeholders include agriculture, forestry, energy, communities, and water resources. PARC has given out \$1.25 million in research funding, one-third of which has been to agriculture; many others also have an agricultural implication. Many of the projects have documented the impacts of climate change. The results have been synthesized and a report will be released three weeks from now.

PARC also facilitates research – it has an internet map server on its web site with geo-referenced research results. (<http://www.parc.ca/>)

POTENTIAL IMPACTS OF CLIMATE CHANGE ON AGRICULTURE IN EASTERN CANADA: A SUMMARY OF SOME RESEARCH RESULTS AND FUTURE PLANS IN AAFC

Andy Bootsma (AAFC, Eastern Cereal and Oilseed Research Centre)

There are three current projects that look at the potential impacts of climate change on crop performance. The first of the project is looking at impacts on agriculture in the Atlantic region. The results suggest that corn and soy yields and acreage are likely to increase, barley yield will not change and acreage will decrease, and that the water deficit is not likely to impact yields.

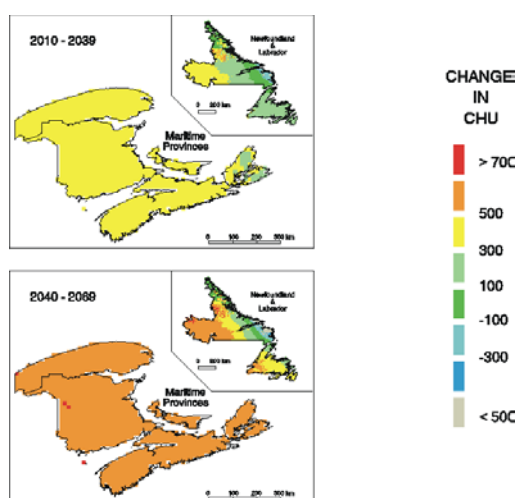
The second project looks at crop yields and yield variability. It suggests not much change in barley, canola and spring wheat, some reduction in corn, and some increase in potatoes, soy, and winter wheat. The variation will tend to increase.

The third project looks at the risk of crop injury in Eastern Canada. There is an increased risk of damage to forage crops, and a decreased risk of damage to fruit trees.

Some research gaps and needs include:

- for results for multiple GCM experiments;
- improving downscaling procedures;
- Better and improved impact models;
- Including change in climate variation; and
- Procedures to update results

Future plans include developing better models.



CLIMATE CHANGE ON THE PRAIRIES - IMPACT ON THE AGROCLIMATE Sean McGinn (AAFC Lethbridge Research Centre)

AAFC is looking at climate change on the Prairies, especially the impact on agroclimatic indices. The first phase involves scenario-building. A total of 5 gridded scenarios have been developed looking at temperature, precipitation, and historic solar information using a 30-year baseline data set. The second phase looks at the soil/water balance. It is important to look at the impact of the interaction between climate and the soil on soil water balance. There can be dramatically different results depending on the conditions used in the scenarios and between the old and new versions of the model.

Directions for agricultural research should include building temporal-spatial scenarios, predicting shifts in insects, weeds, and diseases, the impact of carbon dioxide fertilization on crop growth, predicting Prairie surface hydrology, and adaptations such as diversification.

**WEATHER & ENVIRONMENTAL PREDICTION (WEP) –
RESEARCH FOR SCIENTIFICALLY SOUND INFORMATION**
Quentin Chiotti (Meteorological Service of Canada)

The Meteorological Service of Canada is looking at weather and environmental prediction. It is important to have scientifically sound information on vulnerabilities to atmospheric change, variability and extremes, environmental health, social and economic risks and impacts, and adaptive responses that incorporate linkages between scientific methodology and practical needs. The Air group MSC is involved in adoptive strategy development, assessment and implementation. Projects include generating Okanagan stakeholder views on adaptation – the dialogue is just beginning. Information on this project is available at <http://www.sdri.ubc.ca/> publications. The climate models at www.cics.uvic.ca/scenarios which encourage the use of multiple scenarios to represent the range of future climate are recommended.

Adaptation varies across the country. The Air group can't carry the load and needs research partnerships. C-CIARN provides these types of partnerships.

Research priorities include:

- A quantitative assessment of the sensitivity, adaptive capacity and vulnerability of agriculture and climate change
- An assessment of possible thresholds;
- An assessment of the effectiveness and costs of adaptation; and
- Will there be more winter wheat?
- Integrative assessment and risk assessment.

“Lessons Learned” from Case Studies

Since scenarios of atmospheric change will be outside of historical frames of reference, adaptation requires:

- re-evaluating prevailing management principles and adaptation strategies
- identifying barriers to adaptation
- a dialogue process that engages more stakeholders to identify potential impacts & associated adaptation choices
- improved assessment of potential adaptation choices and their acceptance and implementation

Issues tend to use a stovepipe approach – there are not enough linkages between agriculture and water and health, for example. It is also important to link mitigation and adaptation.

ONTARIO FARMING SYSTEMS AND CLIMATE CHANGE **Keith Reid (Ontario Ministry of Agriculture, Food, and Rural Affairs)**

The Ministry of the Environment is the lead agency on climate change issues for the province. OMAFRA has a role in assessment and mitigation of agriculture-related greenhouse gas emissions, sequestration to offset non-agricultural greenhouse gas emissions, and developing agricultural adaptation strategies to climate change.

Climate change activities in Ontario have mainly focussed on emission reductions. Farmers can adapt to gradual change if supported by risk management tools. Some climate change could even be beneficial.

The Ontario Agricultural Services Coordinating Committee is part of the process to identify research needs and gaps. Impacts and adaptation research has been identified as a priority, but is competing with many other priorities. There is an opportunity to combine greenhouse gas mitigation with adaptive strategies.

The next steps are to verify emission co-efficients in the GEEMO model, verify carbon sequestration opportunities, improve the prediction of impacts of climate change, and develop adaptive strategies to climate change.

THE MANDATE AND MODUS OPERANDUM OF CSALE **Roger Cohen (Centre for Studies in Agriculture, Law and the Environment)**

CSALE started in 1996 as a cooperative venture between the law and agricultural colleges at the University of Saskatchewan in response to the relationship between agriculture and the environment where regulation is playing an increasing role. The three focus areas are sustainable agriculture, trade and the environment, and institutional reform. CSALE has funded 40 research projects, involved 25 graduate and 40 undergraduate students, and works with the Canadian Energy End-Use Analysis Centre to help farmers budget energy usage.

Climate Change at CSALE

During the last few decades, concern has been growing internationally over increasing concentrations of greenhouse gases in the atmosphere that may potentially change the climate in ways detrimental to social and economic well-being. Abundant data have demonstrated that global climate has warmed during the past 150 years. The long-term trend is one of net global warming with the ten warmest years since 1880 all having occurred in the 1980s or 1990s.

CSALE is actively involved in researching climate change and the environment in regards to agricultural issues in order to provide information and policy options.

RAISING AWARENESS OF CLIMATE CHANGE IN AGRICULTURE IN ATLANTIC CANADA

Gordon Fairchild (Eastern Canada Soil and Water Conservation Centre)

The Atlantic regional office was established in 1991 and works with the ministries of agriculture, AAFC, soil and crop improvement associations, federations of agriculture and the agricultural industries. It primarily offers technical information and expertise.

Its primary role in climate change is raising awareness of climate change in agriculture in the Atlantic provinces through the CCAF Awareness Partnership Program and the Taking Charge project by providing producers with information on climate change and emphasizing the link between soil and atmospheric stewardship. It is also involved in other programs and networks, such as C-CIARN.

QUESTIONS/COMMENTS FOR PANEL 3

The function of C-CIARN is to network across sectors – *the idea is not to 'stovepipe'*.

To what extent do we believe that risk management strategies are key? – *There is concern over carbon sequestration/trading, that the risk is transferred from emitters to farmers. There has to be a systematic framework for adaptation; risk assessment is an obvious one. Biophysical scientists generally aren't able to create the right context for adaptation. (PARC is holding a workshop in Regina, March 21-22 that attempts in particular to bring in social scientists and give a lower profile to biophysical scientists). Climate scenarios have limited predictive ability – risk assessment makes sense.*

The challenge of integration is to define the areas where we can work together.

Technology/climate change road maps are important. Impacts, adaptation and mitigation need to come together.

Are all scenarios technological?

Workshop Summary

Barry Smit, C-CIARN Agriculture, University of Guelph

1. C-CIARN has benefited from diversity from real stakeholders in the industry;
2. In the agricultural industry, climate change is not seen as important, in most part because of the way it's described, not as a matter of economic impact;
3. Most are aware of recent climate, especially extremes, because they are pertinent to those in the business. This type of awareness doesn't usually come for people unless they've experienced:
 - a. Climate attributes that are pertinent; and
 - b. Translation into money;
4. Research needs and opportunities include:
 - a. Identifying sensitivities and vulnerabilities;
 - b. Documenting the way in which climate risks are managed now; and
 - c. Estimating the costs and benefits of adaptation options (especially relating them to current decision-making);
5. There are many people doing work that relates directly or indirectly – each finds what he/she is doing or where it is being done the most important. We should see them as equally important but different. Researchers would like to see more of a commitment from government departments to sponsor, fund or initiate research.