Adaptation to Climate Change
Challenges and Opportunities:
Implications and Recommendations for the
Canadian Agri-Food Sector

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Brief Prepared for the Senate Standing Committee on Forestry and Agriculture,

1 C-CIARN Agriculture stands for Canadian-Climate Impacts and Adaptation Research Network for
Agriculture. It has operated out of the University of Guelph, Guelph, Ontario since March 2002.
1. **Adaptation is Part of the Response to Climate Change**
   There are two distinct responses to climate change. One is to reduce (mitigate) greenhouse gas emissions in an attempt to moderate climate change. The other is to adapt, both to the risks or vulnerabilities that result from changes in climate, and to any opportunities climate change presents. In the agri-food sector, substantial resources have been directed to greenhouse gas mitigation. However, adaptation to climate change risks has been largely neglected, yet it offers producers and others in the agri-food sector direct and immediate benefits.

2. **Canada is Committed to Promoting Adaptation**
   As a signatory to the *United Nations Framework Convention on Climate Change*, Canada has agreed to develop and implement climate change adaptation measures. This commitment is acknowledged in *Climate Change Plan for Canada* and in the agreement by federal and provincial ministers of Environment and Energy to develop and implement a *National Adaptation Framework*. Despite these commitments, there has been little action directed to agricultural adaptation to climate change in research funding and government programs.

3. **There are Serious Risks from Climate Change for the Canadian Agri-food Sector**
   There appear to be some opportunities for agriculture from longer growing seasons and increased heat units. However, climate change is more than global warming—it includes changes in the frequency and severity of droughts and other extreme climatic conditions that present serious challenges to the agri-food sector.
   - These conditions threaten the economic viability of farms, agri-businesses, rural communities, and insurance and support programs.
   - Significant risks are being felt now.
   - Producers have identified risks related to drought, storm damage, floods, and extreme temperatures.
   - Many producers are already adapting to these risks, but their experiences are largely unknown to the policy and research communities; nor are their practices being effectively communicated to other producers in similar situations.

4. **Agricultural Adaptations are Necessary and Possible**
   Adaptation refers to adjustments in production and management to deal better with climate change. Adaptation to climate change is a type of risk management. Adaptation can take many forms, and can be adopted at the level of farm, industry or governments. For the Canadian agri-food sector, research into the numerous elements and implications for adaptation to climate change risk has just started. There is much yet to accomplish—producers and others in the sector need answers now.
5. **There is a Need for Research on Adaptation in the Agri-food Sector**

There is very little research on adaptation options to address vulnerabilities or opportunities in the Canadian agri-food sector. There is little documentation, analysis and evaluation of:

- current vulnerabilities to climatic variations;
- the effectiveness of existing risk management strategies;
- probable changes in risk;
- potential adaptation options to manage climate-related risks;
- incorporation of climate risks into management practices and agricultural programs.

There is poor communication of adaptation lessons and success stories within the agri-food sector.

6. **Recommendations**

- Research into agricultural adaptations to climate change be supported by, and actively involve, Agriculture and Agri-Food Canada, provincial ministries of agriculture, agribusiness, and producer organizations.
- Communication about effective adaptation strategies be promoted and facilitated among researchers, policy-makers, and producers.
- Climate change risks be considered in government programs and policies.
Adaptation to Climate Change Challenges and Opportunities: Implications and Recommendations for the Canadian Agri-food Sector

1. Adaptation is Part of the Response to Climate Change

Figure 1 identifies two distinct responses to concerns over climate change. One is mitigation which attempts to slow down climate change by moderating greenhouse gas emissions (that contribute to climate change). The other response is adaptation, aimed at adjusting resource uses and economic activities so they are not so vulnerable to climate change damages or so they can realize climate change opportunities.

Substantial resources from the federal and provincial governments have been directed to greenhouse gas Mitigation, supporting public education, research, and programs designed to curb emissions or enhance sinks. The agri-food sector continues to emphasize this mitigation aspect of climate change as well.

By contrast, Adaptation research, policy, and programs continue to lag behind, often appearing as an afterthought rather than a central theme. This trend persists, despite the pressing need for analysis and action to improve the adaptive capacity of the agri-food sector and of many rural Canadian regions.

Figure 1. Responses to Climate Change Impacts (from Smit and Pilofosova, 2001)

This lack of attention to climate change Adaptation continues, despite Canada’s formal commitments to develop and communicate adaptation strategies and despite the demonstrated vulnerabilities to climate change risks in the agri-food sector.

2. Canada is Committed to Promoting Adaptation

In late 2002, Canada ratified the Kyoto Protocol, thereby affirming commitments in the United Nations Framework Convention on Climate Change. Most of these deal with greenhouse gas emissions reduction and carbon sequestration. However, Article 10 commits parties to “formulate, implement… and regularly update… programs containing measures … to facilitate adequate adaptation to climate change.”
The Climate Change Plan for Canada (November 2002) is mostly about emissions reductions, but includes a commitment to “develop and research approaches to adaptation planning and tool development” and to “develop increased awareness of the impacts of climate change and the need to address them in the future through adaptation”.

Federal and provincial Ministers of Environment and Energy (Charlottetown, PEI, May 2002) agreed to support the development and implementation of a National Adaptation Framework with the following elements:

- Raise awareness of Adaptation
- Facilitate and strengthen capacity for coordinated action on adaptation;
- Incorporate adaptation into government planning processes;
- Promote and coordinate research on adaptation;
- Support networks to share knowledge; and,
- Provide methods for adaptation planning.

Despite clear statements on the importance of adaptation to climate change risks and notwithstanding the adaptation initiatives in CCAF (Climate Change Action Fund) and C-CIARN (Canadian Climate Impacts and Adaptation Research Network), there has been little action in agricultural adaptation research funding and government programs.

3. There are Serious Risks from Climate Change for the Canadian Agri-food Sector

It is clear that there are substantial risks and some opportunities from climate change for the agri-food sector across Canada. Depictions of climate change often feature a gradual rise in temperature, suggesting the main effect will be gradual warming.

3.1 Gradual warming provides some opportunities for agriculture

For some Canadian regions there are production opportunities from an extended growing season and increase in available heat units. More heat and a longer season should allow for increased flexibility in timing of operations and choice of crops or varieties, particularly on northern margins. Already with the development of new hybrids and varieties, Quebec producers have been able to grow more grain corn and are told to expect potential increases in soybean production in northern regions of the province (Terre de Chez Nous, January 2003). Although the opportunity to extend agricultural production northward is appealing, soil quality constraints may impede such developments.

3.2 Climate change is more than global warming

Emphasizing global warming tends to mask the significant and serious risks associated with other aspects of climate change. Climate is naturally variable. Figure 2 shows the inter-annual variations in an agriculturally-relevant climate attribute (drought severity). Agricultural systems have evolved to cope with modest variations in drought severity (within the coping range), but they are vulnerable to the extremes. With climate change, a 1 in 10 year drought may now become a 1 in 3 year drought.
The IPCC (Intergovernmental Panel on Climate Change) has confirmed that climate change includes alterations in such extremes as droughts, hot spells, and intense precipitation events and storms.

**Figure 2: Climate Change includes Changes in Extremes** (From Smit et al. 2002)

While increases in heat may represent a benefit in some areas, many agricultural regions are clearly vulnerable to climate risks associated with more frequent and severe droughts, heat waves, violent storms, and flash flooding. These conditions currently represent hazards to the agrifood sector, likely already being exacerbated by climate change, so their risk management (adaptation) is something that requires attention now.

### 3.3 Vulnerabilities in the agri-food sector

The climate change risks facing producers are not just environmental concerns of depleting water and soil resources. Climate change poses risks for the financial viability of:

- individual farming enterprises;
- regional agricultural sectors;
- rural communities depending on agricultural activity;
- agri-business firms that supply inputs, process outputs, and supply services; and
- institutions that fund support programs related to agricultural production.

Adaptation is not so much necessary to protect the environment as it is to protect the livelihoods of farming households and agricultural businesses and hence rural communities.
3.4 Climate change risks are already apparent
The pervasive nature of climate change risk is already evident. The drought of 2001 was estimated by a Canadian Wheat Board economist, to cost the Canadian agri-food sector $5 billion. The president of the Canadian Federation of Agriculture noted the need for drought relief or “farmers’ backs would break.” In Ontario, the crop insurance payout reached a record $258 million for 2001. For many areas, the 2002 drought was even more devastating. Lost crop production in Alberta and Saskatchewan alone cost $2.8 billion. Livestock ranchers were especially hit hard by drought.

While these droughts cannot be attributed only to climate change, such increased frequency and severity is exactly what can be expected with climate change. Furthermore, the serious economic and social costs of these recurring climatic extremes demonstrate the vulnerability of the sector and the need for adaptation strategies.

3.5 Producers have identified climate change risks for their farm businesses
A few preliminary studies of agriculture’s sensitivities to climate conditions have shown the importance of extreme conditions, especially those relating to moisture. A mid 1990s survey of Ontario farmers indicated drought and excessive rain are most problematic (Table 1). Ontario Outdoor Farmshow respondents identified drought, temperature extremes and flooding as the hazardous conditions (Table 2).

| Table 1: Problematic Climate Conditions Experienced (Smit et al. 1996) |
|-----------------|-----------------|
| CONDITION       | PER CENT AFFECTED |
| Drought         | 58               |
| Excessive Rain  | 58               |
| Hail            | 8                |
| Frost           | 7                |
| Wind            | 3                |

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>CONDITION</td>
<td>PER CENT AFFECTED</td>
</tr>
<tr>
<td>Drought</td>
<td>49</td>
</tr>
<tr>
<td>Temperature extremes</td>
<td>14</td>
</tr>
<tr>
<td>Flooding</td>
<td>11</td>
</tr>
<tr>
<td>Unpredictable conditions</td>
<td>5</td>
</tr>
<tr>
<td>Other</td>
<td>22</td>
</tr>
</tbody>
</table>

With climate change many of these conditions are expected to become more frequent and more severe. Growing seasons where these problematic conditions are experienced lead to losses in crops, forages, livestock, and income. Climate related losses are also expected with climate change induced increases in pests and diseases, including vector-borne diseases.

Climate change presents real and immediate risks to the agricultural sector and rural communities. Without adaptation, the viability of much of Canada’s agri-food sector is
under threat. The risks are substantial and there is a clear need for the development and promotion of adaptation options.

4. Agricultural Adaptations are Necessary and Possible

Adaptations, in the context of climate change, refer to adjustments in management strategies to actual or expected climatic conditions or their effects, in order to reduce risks or realize opportunities. Adaptations can take many forms (Table 3), can occur at different scales, and can be undertaken by different agents (producers, agribusiness, industry organizations, and governments).

Table 3: Bases for differentiating adaptations (Smit and Pilifosova, 2002)

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Examples of Terms</th>
</tr>
</thead>
<tbody>
<tr>
<td>System type</td>
<td>Natural-human</td>
</tr>
<tr>
<td></td>
<td>Public-private</td>
</tr>
<tr>
<td>Purposefulness</td>
<td>Autonomous-planned</td>
</tr>
<tr>
<td></td>
<td>Passive-active</td>
</tr>
<tr>
<td>Timing</td>
<td>Anticipatory-responsive</td>
</tr>
<tr>
<td></td>
<td>Proactive-reactive</td>
</tr>
<tr>
<td></td>
<td>furthermore, there is a need</td>
</tr>
<tr>
<td>Temporal scope</td>
<td>Short term-long term</td>
</tr>
<tr>
<td></td>
<td>Tactical-strategic</td>
</tr>
<tr>
<td>Spatial scope</td>
<td>Localized-widespread</td>
</tr>
<tr>
<td>Functions/effects</td>
<td>Retreat-accommodate-protect</td>
</tr>
<tr>
<td></td>
<td>Prevent-tolerate-spread-change-restore</td>
</tr>
<tr>
<td>Form</td>
<td>Structural-legal-institutional</td>
</tr>
<tr>
<td></td>
<td>Regulatory-financial-technological</td>
</tr>
<tr>
<td>Performance</td>
<td>Cost-effectiveness-efficiency</td>
</tr>
<tr>
<td></td>
<td>Implementability-equity</td>
</tr>
</tbody>
</table>

4.1 Adaptation options for agriculture

Our review of possible adaptation strategies (see Smit and Skinner, 2002) for the agri-food sector has identified four main categories:
- Farm Production Practices
- Farm Financial Management
- Technological
- Government Programs and Insurance
4.1.1 Farm production practices

Farm Production
- Diversify crop types and varieties, including crop substitution, to address the environmental variations and economic risks associated with climate change.
- Diversify livestock types and varieties to address the environmental variations and economic risks associated with climate change.
- Change the intensification of production to address the environmental variations and economic risks associated with climate change.

Land Use
- Change the location of crop and livestock production to address the environmental variations and economic risks associated with climate change.
- Use alternative fallow and tillage practices to address climate change-related moisture and nutrient deficiencies.

Land Topography
- Change land topography to address the moisture deficiencies associated with climate change and reduce the risk of farm land degradation.

Irrigation
- Implement irrigation practices to address the moisture deficiencies associated with climate change and reduce the risk of income loss due to recurring drought.

Timing of Operations
- Change timing of farm operations to address the changing duration of growing seasons and associated changes in temperature and moisture.

Farm operators have described the benefits of conservation tillage and shelterbelts for dealing with extended droughts by improving moisture levels and reducing wind erosion. Manitoba beef producers have successfully adapted with drought tolerant native prairie grasses and rotational grazing. Alberta producers have minimized risks by switching enterprises and reducing inputs. Others have adapted by increasing diversity of crops and varieties. Dairy farmers in Ontario are conserving water use in milking parlours by implementing water recycling systems.

4.1.2 Farm financial management

Crop Insurance
- Purchase crop insurance to reduce the risks of climate-related income loss.

Crop Shares and Futures
- Invest in crop shares and futures to reduce the risks of climate-related income loss.

Income Stabilization Programs
- Participate in income stabilization programs to reduce the risk of income loss due to changing climate conditions and variability.

Household Income
- Diversify source of household income in order to address the risk of climate-related income loss.
4.1.3 Technological developments

Crop Development
- Develop new crop varieties, including hybrids, to increase the tolerance and suitability of plants to temperature, moisture and other relevant climatic conditions.

Weather and Climate Information Systems
- Develop early warning systems that provide daily weather predictions and seasonal forecasts.

Resource Management Innovations
- Develop water management innovations, including irrigation, to address the risk of moisture deficiencies and increasing frequency of droughts.
- Develop farm-level resource management innovations to address the risk associated with changing temperature, moisture and other relevant climatic conditions.

4.1.4 Government programs and insurance

Agricultural Subsidy and Support Programs
- Modify crop insurance programs to influence farm-level risk management strategies with respect to climate-related loss of crop yields.
- Change investment in established income stabilization programs to influence farm-level risk management strategies with respect to climate-related income loss.
- Modify subsidy, support and incentive programs to influence farm-level production practices and financial management.
- Change *ad hoc* compensation and assistance programs to share publicly the risk of farm-level income loss associated with disasters and extreme events.

Private Insurance
- Develop private insurance to reduce climate-related risks to farm-level production, infrastructure and income.

Resource Management Programs
- Develop and implement policies and programs to influence farm-level land and water resource use and management practices in light of changing climate conditions.

4.2 Insights from early adaptation research

The few studies that have addressed agricultural vulnerabilities and adaptations directly by documenting and analyzing adaptive behaviour, (rather than assuming adaptations in modeling analyses) have identified some key insights.

- Reactive adaptation is costly. Waiting until losses continue to undermine the industry and rural communities is wasteful and unnecessary. There are numerous opportunities for efficient and effective planned adaptations.
• Adaptation is driven more by vulnerabilities to climatic variations and extremes than by trends in average conditions. Producers respond to conditions that they know represent risks to their operations. They do not need nor expect certainty.

• Adaptation measures are specific to particular locations and situations. Thus adaptation practices need to be tailored to each case and developed to fit each farming situation.

• Adaptation to climate change is essentially a risk management strategy. Climate related risks are among the many factors that producers take into account when making management decisions. Thus adaptations need to be considered (both in research and outreach) as part of the on-going, economic risk management decisions of producers and agribusinesses.

• Adaptation in agriculture includes government programs. Crop insurance and safety net programs are part of climate risk management. Government programs can facilitate adaptation, and they can also work against adaptation.

• Building adaptive capacity in the agri-food sector to deal with current climate-related risks will reduce vulnerability to future climate change.

5. There is a need for Research on Adaptation in the Agri-Food Sector

While there are good reasons for promoting adaptation in the agri-food sector, the knowledge base is far from sufficient to ensure that adaptation initiatives are well-founded, are not counter-productive, are efficient, effective, and practical. There is a desperate need for substantive research on adaptation itself. In particular, there is a need to document, analyze, and evaluate:

• current agri-food sector vulnerabilities to climate variations and conditions,
• the effectiveness of existing risk management strategies,
• probable changes in agriculturally relevant risks, given climate change,
• potential adaptation options to minimize losses and realize opportunities,
• incorporation of climate risks in management practices,
• incorporation of climate risks in government programs.

There is a need to improve the communication about climate change risks and opportunities (including lessons and success stories) in the agri-food sector. This communication first requires research. This research on agricultural adaptation will necessarily involve the participation of producers and agri-food business representatives. Such engagement of stakeholders will ensure the research is relevant and useful, and will help with communication of research findings.

To date, there has been only modest support for research on agricultural adaptation via CCAF and C-CIARN. It is remarkable that the lead agricultural agencies (AAFC and provincial ministries of agriculture) have yet to establish or support a research program addressing adaptation to climate change in Canadian agriculture.
6. Recommendations

Agricultural adaptation to climate change requires support in three areas: research, communications/extension, and government programs and policies.

6.1 Research
Agricultural agencies, particularly AAFC, need to establish and support targeted research programs for agricultural adaptation to climate change. It is ideal for such research into agricultural adaptation to be established and supported by federal agencies, provincial ministries of agriculture, and agribusiness and producer organizations. There is also a role for the Canadian research granting councils (SSHRC, NSERC, CIHR).

6.2 Communications and extension
Communication about climate risk management and effective adaptation strategies needs to promoted and facilitated among researchers, producers, and policy makers. Some researchers are beginning to tap into the wealth of knowledge producers, but there is much to learn. Some research findings about climate risks and adaptation opportunities filter to policy makers, agribusiness, and producers, but most does not.

6.3 Programs and Policies
Climate change and management options need to be considered in government programs and policies. This will ensure that government initiatives do not perpetuate or exacerbate climate-related damages, but encourage timely and effective adaptations in the agri-food sector. Such action may not require creating new programs and policies focusing on climate change, but may simply entail having climate change risks and adaptations incorporated (where appropriate) in existing programs or program reviews.

A National Adaptation Framework, as developed my federal and provincial ministers, is certainly an excellent vehicle for providing tools and approaches to the analysis and practice of adaptation across Canada, and for policy communication (if not co-ordination) to minimize redundancies or inconsistencies across jurisdictions. With AAFC developing the comprehensive Agriculture Policy Framework (APF) an excellent opportunity exists to incorporate climate change adaptation into Canadian agricultural policy. The APF represents an ideal vehicle to promote sustainability of the agrifood sector with proactive climate change adaptation strategies.
Selected bibliography


