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# ACT

ADAPTATION TO  
CLIMATE CHANGE TEAM

## BRIEFING PAPER FOR DECISION MAKERS CLIMATE CHANGE ADAPTATION AND CANADA'S CROPS AND FOOD SUPPLY

For additional details, resources, data and information please refer to the accompanying Executive Summary and Background report, available at: [www.sfu.ca/act](http://www.sfu.ca/act)

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# BRIEFING FOR DECISION MAKERS



The impacts of climate change will be increasingly complex, affecting not only food production, but also the entire food supply chain from field to table.

## INTRODUCTION

Over the past several decades, Canadian agriculture has demonstrated a remarkable capacity to improve productivity under wide ranging and seasonally fluctuating growing conditions as well as to recover from extreme events such as floods and droughts. This capacity has been supported through relatively high public sector investments (in some cases supported by the private sector) in supply chain innovation, infrastructure and extension services and insurance and disaster relief. It has also been aided by a long period of relative climate stability. Recently, however, the level of this public sector support has been reduced at the very time that it should be strengthened.

Climate change now presents an unprecedented challenge to this adaptive capacity. The frequency and magnitude of extreme climate events will increasingly lie outside the range of natural variability that has been the norm, a situation known as “non-stationarity.” Floods of a magnitude that we once expected to occur once in a hundred years will occur far more frequently, while long, hot, dry summers will become the norm; some regions in Canada are already experiencing major droughts and floods in the same year. Warmer temperatures will also facilitate the spread of new pests.

The resulting impacts will be increasingly complex, affecting not only food production, but also the entire food supply chain from field to table.

This briefing outlines the current and anticipated impacts of projected climate changes of climate change on Canadian agriculture and food security; the inter-relationship between food, water, energy and biodiversity; and proposals for adaptation measures that can capitalize on opportunities and reduce or avoid the impacts of a changing climate.

## CLIMATE CHANGE AND CANADIAN FOOD PRODUCTION—SHORT AND LONG TERM IMPACTS

Food production and security is not only critical to human health, it is also a significant economic driver essential to the wellbeing of communities and regions across Canada. With export sales of \$40.3 billion, Canada is the world’s sixth largest exporter of agriculture and agri-food products. Primary agriculture alone accounts for some \$22.2 billion dollars (or 1.7%) of Canada’s gross domestic product.

In 2011 primary agriculture and food, beverage and tobacco processing directly employ more than 571,800 people (or 3.3% of the employed labour force). Moreover, the wider “food sector” (including sub-sectors such as food and beverage processing, food service, and food retail and wholesale), in which primary agriculture plays an important role, has been linked to as many as 1 in 8 jobs in Canada.<sup>1</sup>

The changing climate in Canada will have two key impacts on food production:

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1 AAFC. (March 2013)



“Business as usual in our globally interconnected food systems will not bring us food security and environmental sustainability. Several converging threats from climate change, population growth and unsustainable use of resources are steadily intensifying pressure on humanity and world governments to transform the way food is produced, distributed and consumed.”

Commission on Sustainable Agriculture and Climate Change,  
November 2011



- Regional shifts in temperature and precipitation, which will result in long term changes to productivity and location of food production.
- Increased variability and extremes in floods, droughts, pest outbreaks and fires with short-term impacts on production.

Below is a summary of some of the recent impacts of flooding and prolonged droughts in the Canadian Prairies and the American mid-west.

- In 2001–2002, droughts in the Prairie Provinces caused \$3.6 billion in lost production and resulted in over 40,000 people being out of work. <sup>2</sup>
- In 2011, floods in Manitoba’s Red River Basin caused \$936 million in direct damages. <sup>3</sup> Subsequent First Nation lawsuits total an additional \$1.15 billion. <sup>4 5</sup>
- In 2010/11, extreme precipitation during harvest of vegetables in the Fraser Valley, British Columbia resulted in \$6.3 million in losses. <sup>6</sup>
- In 2012, drought and high temperatures in the American mid-west reduced corn and maize crop production, spiking food costs worldwide and sending some UK pig farmers out of business due to the price of feed. Recent spring rains have relieved the drought in some parts but it still rated exceptional in the High Plains. <sup>7</sup>
- In late 2012, concerns were raised about post-drought water levels making the Mississippi River impassible for barges north of St Louis, which could lead to \$7 billion in lost trade and higher food prices resulting from increased rail transportation costs. The US Army Corps of Engineers was tasked with using explosives to deepen the riverbed. <sup>8</sup>
- BC imports more than half of its food, including most of its salad vegetables from California. The availability of these foods will be affected by climate changes in those production areas. <sup>9</sup>

The box below provides a snapshot of the potential impacts of a changing climate on several of Canada’s iconic foods. It is fair to assume that, without significant efforts to adapt, each of these foodstuffs faces an uncertain future by mid century in light of predicted increases in average temperatures and water shortages/floods.

2 Wheaton et al. (January 2005)

3 Province of Manitoba. (March 8, 2012)

4 CBC News Manitoba. (April 5, 2013)

5 Paul, Alexandra. (May 8, 2013).

6 BC Government, Climate Action Initiative. (2012).

7 U.S. Drought Monitor, (May 2013)

8 Goldenberg, Suzanne. (December 14, 2012)

9 Crawford, Erica and Rachelle Beveridge (May 2013)

## IMPACTS ON CANADA'S ICONIC FOODS

**BC salmon** are subject to warming temperatures in rivers and streams as well as greater variation in hydrology. Productivity will shift to northern rivers such as the Skeena from the Fraser. Protection of environmental flows in key spawning habitats will require new legislation. Salmon aquaculture may be required to fill an increasing share of future demand, with new science and management practices developed to reduce environmental risk.

**Western Canadian beef and grain** will face severe water shortages, requiring new approaches to integrated watershed management and possible relocation of production into more northern basins. In the medium term, there could be increases in grain production due to warming temperatures, but increased frequency of extreme rainfall events will create short-term impacts such as the mobilization of pathogens into water supplies from beef facilities and the threat of inundation of large-scale cattle farms with emergency relocation posing major problems.

**Ice wine and maple sugar** production will face warming winters and shifts to more northerly locations with disruptions to established support infrastructure and major impacts on small-scale local economies.

**Food imports** of fruits and vegetables will also be affected by global changes in the food-water-energy nexus resulting in major changes in diet.

## KEY MESSAGES 1

- Climate change is increasing the range, frequency and intensity of extreme events such as flooding and droughts compared with the normal pattern over the past 50 years—known as non-stationarity – increasing uncertainty about the future, and calling for new approaches to prepare for food security, economic development and extreme weather disaster risk reduction.
- The changing climate is creating real economic costs that will only increase over the coming decades without adaptation measures.
- Climate change is creating potential opportunities for expanding food production into regions that were previously too cold or wet. However, actual achievement of this potential will depend on soils, water availability and infrastructure development.
- Climate change is affecting areas of the world from which Canada imports large amounts of its food and we need to increase our own production to meet the needs of Canadians and to provide replacement food sources to former exporters no longer produce foods to meet their own needs.

## FUTURE CLIMATE CHANGE SCENARIOS

There is general agreement that the average global temperature has risen by 0.8 C since pre-industrial times.<sup>10</sup> There is much less agreement on the scale of global warming we can expect to see over the coming decades. The 2007

<sup>10</sup> IPCC. (2007).

IPCC report stated that “the equilibrium climate sensitivity (over the coming decades)...is likely to be in the range of 2°C–4.5°C, with a best estimate of about 3°C, and is very unlikely to be less than 1.5°C. Values higher than 4.5°C cannot be excluded.” Recently, independent scientists verified the forecasts of IPCC.<sup>11</sup>

The World Bank recently released a report predicting a 2°C rise in global temperatures by mid-century and 4°C by the end of the century. A summary of climate predictions<sup>12</sup> indicated that global temperature rise was flattening out compared with IPCC predictions. However, a more recent peer-reviewed article presented new analysis that predictions of temperature rise over the past 15 years have proved to be remarkably accurate.<sup>13</sup>

International organizations have clarified global climate trends. The World Meteorological Organization has noted that the year 2012 was the ninth warmest year since records began in 1850. The WMO also noted that 2012 was the the twenty-seventh consecutive year that the global land and ocean temperatures were above the 1961–1990 average and the years 2001–2012 were all among the top 13 warmest years on record.”<sup>14</sup>

The United Nations Environment Program has noted that carbon dioxide (CO<sub>2</sub>) in the atmosphere exceeded the symbolic 400 parts per million (ppm) threshold. This milestone spotlights the constantly rising levels of this greenhouse gas, mainly from man-made sources, and which remains in the atmosphere for thousands of years.<sup>15</sup>

Though the specific trajectory of future climate change is uncertain, current impacts of extreme weather and warming are well documented. Crop and food supply areas and chains in Canada and around the world are experiencing production and distribution impacts from increasingly frequent and intense flooding and droughts, wetter springs with earlier flowering periods, and hotter, drier summers. Glaciers that have historically provided irrigation water supplies are receding and essential groundwater supplies are being depleted rapidly for a variety of uses and are at risk of pollution from a wide range of human activities, including agriculture.<sup>16</sup>

In addition, climate change is compounding the impacts of relentless population growth and development pressures on land and water resources, which are in turn disrupting the capacity of our natural systems to sustain intrinsic biodiversity values known as ecosystem services that bestow a host of benefits including buffering against the impacts of extreme weather.

Canada is not an island. It is part of an interwoven global commerce in agriculture so the changing climate will not only impact Canada’s agriculture but also have global implications:<sup>17</sup>

- Agriculture consumes 70–80% of all water currently used globally.
- By 2050, the global population of nine billion will require close to all the available freshwater for domestic, urban, agricultural and industrial needs to survive.
- There will therefore be little capacity for water to meet ecosystem needs in many developed regions without significant improvements in water use and conservation.
- Energy is essential across the food supply chain, mostly relying on fossil fuels.
- An average of seven to ten calories of input is required to produce one calorie of food. This energy requirement varies between three calories for plant foods to 35 calories for beef production. This energy balance is not sustainable in the long term.
- Due to poor practices across the entire food supply chain, 30–50% of all food produced is wasted.<sup>18</sup>
- Extreme weather events are already causing significant disruption of food supplies and world food prices. For example, the 2012 drought in the American mid-west affected 80% of agricultural lands and drove up the price of staple foods, and continues to drive up the price of beef as a ripple effect.

11 Rahmstorf, S., et al. (2012)

12 *Economist*, March 27 2013

13 *Nature Geoscience*, (2013)

14 World Meteorological Organization. (April 29, 2013)

15 UNEP News Centre. (May 14, 2013)

16 Pederson et al. (May 2013).

17 Commission on Sustainable Agriculture and Climate Change. (November 2011 and 2012)

18 Institution of Mechanical Engineers. (2013)



In the longer term, this global food supply chain will have to deal with a ‘perfect storm’ by 2030:

- Water demand will increase by 30%
- Food demand will increase by 50%
- Energy demand will increase by 50%

## EXPANDING THE SCOPE OF AGRICULTURAL ADAPTATION

In the face of these far-reaching and multifaceted concerns, the judicious management of crop and food production in Canada will contribute to food security and conserve over the coming decades not only on food security, but also on water resources, as climate change causes significant shifts in precipitation patterns. Adaptation measures require long-term attention to whole systems, rather than short-term, narrowly considered fixes that may result in potentially irreparable, unintended consequences.

These measures cannot be undertaken once and for all to solve the problem; they will have to be incrementally and systematically developed over the long term and become part of the culture of private and public sector institutions.

Most assessments to date have focused on modification of farm practices to reduce the risks and/or realize the opportunities associated with anticipated changes in climate. The Canadian government has provided support for sector-by-sector, bottom-up, farm and community based adaptations through Regional Adaptation Collaboratives, or RACs.<sup>19</sup>



However, the scope of climate change now impacts on a broader base than the farmer’s field. Other jurisdictions and academia have begun to take a more strategic approach to adaptation based on better understanding of the nexus of agriculture, water, land use and energy in order to avoid unintended consequences.<sup>20</sup> These approaches prioritize sustainability and resilience largely by undertaking or recommending science- and economic-based watershed/landscape-level assessments of vulnerability and risk.

Results suggest that, with agriculture responsible for over 70% of current water consumption in Canada, more public and private sector resources must be allocated to assessing the security of future surface and

groundwater supplies; changing land use practices to protect water quality; and ensuring that ecosystem services are kept intact. There are many farmers who are practicing high levels of resource stewardship but even they will be challenged by the scope and scale of climate change in the future.

Where current agricultural practices lead to environmental decline on both water availability and water quality, such changes will have to be transformative rather than incremental.<sup>21</sup> As agricultural production intensifies, and factors such as increasing population, urban expansion, industrial development, global food crises and economic growth exert additional pressure, stresses on the environment will increase.

In some areas, withdrawing water for irrigation risks a reduction of base flows in rivers removing their ability produce ecological services. These minimum flows can have greater value than that provided by irrigation. Therefore, it is crucial for major water users to adapt to the additive and cumulative effects of climate change to protect the physical, chemical and biological integrity of the nation’s water resources.

<sup>19</sup> As discussed and recommended in Wall et al (2007) and Smit (2012).

<sup>20</sup> Council of Canadian Academies (2013); California (2011); UNFAO (2011).

<sup>21</sup> Foley et al. (2005).

High phosphorus concentrations on the Prairies are of particular concern in this context. Runoff from agricultural areas can cause blue-green algal blooms, which reduce access to already scarce water resources for agriculture. Recent research demonstrates that the toxin microcystin, a constituent of blue-green algae, has been now been detected in 246 water bodies across Canada at levels exceeding maximum guidelines for public health and the environment, with Alberta's lakes exhibiting particularly high levels. It is possible that microcystin will become ever more present in Canadian lakes as average water temperatures rise as a result of the changing climate and as agricultural activity intensifies in response to the need to feed rapidly growing human populations.<sup>22</sup>

## KEY MESSAGES 2

- The impacts of climate change are now affecting the broad nexus of food, water, biodiversity and energy.
- Canada's response to climate change will have to be considered in the global context, as climate will have an impact on global energy, water and agricultural resources.
- There will be increasing competition for water demanded by agriculture from urban expansion and industries yet the changing climate will result in prolonged droughts.
- In some regions of Canada, agriculture practices that are affecting water quality and further reducing access to suitable supplies need to be changed.

## TEMPERATURE

A warming climate will result in an earlier start to the growing season, which will also extend further into the fall. This will allow some crops to be grown in areas currently not suited temperature-wise, mainly in more northern latitudes – provided that soil, water and other environmental systems are able to support this, and that social and economic development systems are in place. However, in established agricultural regions there is evidence that crop yields may be reduced due to unseasonably earlier flowering and maturity, limitations on the availability of water for irrigation, and the effects of extreme heat events.

Increasing mean temperatures and higher concentrations of atmospheric CO<sub>2</sub> were expected to increase global production of wheat, corn, rice and soybeans, but this hope is proving unfounded. Though warming temperatures increase plant respiration, photosynthesis is most greatly affected by availability of light, nutrients and water. Carbon dioxide has less effect on plant productivity. For example, between 1980 and 2008, global production of wheat, corn, rice and soybeans did not increase and was, in fact, 1% lower than if warming had not occurred.

Also, production of these crops increases as the temperature rises to about 30°C, but then falls sharply if the temperature keeps rising; just one day of +40°C temperatures will produce a 7% drop in the annual yield of corn, compared with its yield if the temperature stays at 29°C throughout the growing season.<sup>23</sup>

## KEY MESSAGES 3

- The thermal season for a number of crops in Canada has lengthened over the past couple of decades and the growing season is expected to expand further as the climate continues to warm.
- The projected lengthening of the growing season will allow a northern expansion of warm season crops into areas that were not previously suitable where crop-specific longer daylight, soil and water conditions are suitable and other social, economic and environmental conditions are supportive.
- Extreme heat events can significantly affect crop yields in established growing regions.

<sup>22</sup> Orihel et al. (2012).

<sup>23</sup> Dixon, T. (July 24th, 2012), Le Page, Michael. (November 17, 2012), Allen, M.R. et al. (March 2013). World Bank, Office of the Chief Economist. (September 2012).

## ROLE OF GOVERNMENT

Climate change poses a number of new challenges for government. It is impossible to predict now what future climate conditions we need to adapt to; however, there is enough evidence to prepare scenarios, develop options and evaluate the implications of these options. There are areas that require attention now to cope with the potential speed, scale and variability of climate impacts. Most adaptation measures will have to be undertaken by the private sector, e.g., farmers and suppliers. Government’s role is more one of providing an enabling framework. For example in the UK public sector roles include: <sup>24</sup>

- Providing information on key indicators to track trends in climate change and its impacts, for example crop-specific growing conditions, pest monitoring etc.
- Undertaking or supporting research into climate modeling.
- Undertaking or supporting monitoring of changes and reporting on their implications.
- Providing adaptation services as pilot projects to support ongoing adaptation programs.
- Enabling adaptation through policies and effective program tools (financial, regulatory and guidance on best practices).
- Promoting and supporting the preparation of comprehensive adaptation water/ agriculture nexus strategies from site through river basin scales.

The IPCC is scheduled to release its updated report of climate science in September 2013, which will add substantial new knowledge to our understanding of climate change. The IPCC report on impacts, adaptation and vulnerability, scheduled for release in 2014, will also include assessments of literature on agriculture, food systems, water, etc. Meanwhile, there are two useful strategies for tackling this uncertainty: tracking key indicators to assess change over years and decades, and undertaking ongoing research into climate change projections. The European Environment Agency has recently released a report on agriculture-based indicators, which provides a useful initial guide for such indicators. <sup>25</sup> The selected indicators are:



- Growing season for agricultural crops—suitability for growing crops based on average temperatures
- Agrophenology flowering, pollinating and maturity of crops—changes in the timing of the cycle of crop productivity
- Water limited crop production—changes in production caused by temperature, rainfall and atmospheric carbon
- Water requirements for irrigation- relationship between crop productivity and water availability
- Frequency of extreme temperature thresholds for specific crops where productivity declines

Although not listed by the EEA, tracking actual impacts of and losses due to extreme events should be added to help inform the inevitable need to adapt crop

insurance programs and other disaster risk reduction and recovery programs that are currently available to Canada’s producers to address increasingly extreme and more frequent and longer lasting damaging weather.

In addition to EEA’s approach to these indicators, on April 16, 2013 the European Commission reported to European governing bodies on an EU Adaptation Strategy, aimed at “enhancing the preparedness and capacity to respond to the

<sup>24</sup> UK (2013)

<sup>25</sup> European Environment Agency. (2012)

impacts of climate change at local, regional, national and EU levels, developing a coherent approach and improving coordination.”<sup>26</sup> The United States has also recently released a comprehensive report on climate and agriculture.<sup>27</sup>

Although all of these sources provide useful background for considering government roles for climate change adaptation in Canada, those dealing with intergovernmental engagement, insurance, financial risks and infrastructure provide timely insights and directions for all orders of government in Canada.

## KEY MESSAGES 4

- Because the scope of future climate change and its impacts is uncertain and hard to predict, a number of key indicators should be tracked systematically across Canada.
- The federal government, universities and research/innovation bridging organizations need to improve projections of future climate change based on agriculture-specific indicators, including attention to the sensitivity of plant and animal production to changes in these indicators.
- Governments’ and civil societies’ roles for tackling climate change adaptation are in transition in Canada. We can learn from some jurisdictions such as Europe and the U.S., which have begun to develop tools needed to support sustainable and resilient food chains.

## WATER NEXUS PILOT PROJECTS

Meeting the climate challenge will require agriculture and its supply chains to produce more food with less water, less land, less energy and less impact on the environment per unit of output. Provincial governments should encourage more efficient water use through improved irrigation technologies, pricing policies that encourage conservation, smarter joint use of surface and groundwater extractions, and protection of ecosystems such as wetlands, riparian vegetation and soil stability for their biodiversity values and their role as a natural buffer against extreme weather.

The outcomes of such planning need to provide for human wellbeing; ensure sufficient domestic water supplies for communities and livelihoods, including crops and food supplies; provide water for energy where opportunities exist; and provide guidance for disaster risk reduction strategies.

Although water jurisdiction is fragmented across federal, provincial, territorial agencies and First Nations in Canada, some areas within Canada, and elsewhere have found ways to undertake such a comprehensive approach to integrated watershed planning. In particular leading examples of best practices at basin through to site specific scales can be found in Canada, the United States, Australia and Europe.

Examples of watershed through site scale projects include Landscape and Infrastructure Assessment Planning in Saskatchewan,<sup>28</sup> and British Columbia is currently undertaking two initiatives to strengthen the agriculture sector’s ability to adapt to the changing climate.

The BC Agriculture & Food Climate Action Initiative has prepared a province-wide and regional BC Agriculture Climate Change Adaptation Risk & Opportunity Assessments,<sup>29</sup> that are being followed-up by regional adaptation strategies. A recent report prepared for the Pacific Institute of Climate Solutions (PICS)<sup>30</sup> recommends a review of governance, management and policy making structures in government to increase the sector’s adaptive capability; supports applied research into crop viability and new crop potential to bolster local food security and protect small farmers and enhanced training and support to encourage innovation by farm businesses. This work underlines the importance of collaborative approaches and farm-focused and watershed-based considerations, and as such these examples provide blueprintst for other regions across Canada.

26 European Union. (April 16, 2013)

27 USDA. (Feb 2013)

28 University of Saskatchewan et al. (2008)

29 Crawford, Erica and Emily MacNair et al. (2012)

30 Crawford, Erica and Rachelle Beveridge. (May 2013)



British Columbia is also drafting a Water Sustainability Act to replace the century-old provincial Water Act. The proposed Act would be consistent with many of the proposals in this paper, especially its promise to regulate groundwater use for the first time, retain ecological flows in streams, maintain watershed health and resiliency and focus on improved efficiency of water use notably in agriculture.<sup>31</sup>



In the United States and Australia, where drought conditions have created a stronger sense of urgency than has been the case so far in Canada, leading practices in integrated watershed and resource management planning (IWRMP) have explicitly added climate change adaptation and extreme weather disaster risk reduction priorities using climate and weather models based on plausible scenarios. These initiatives are both driven and informed by top-down direction, for example through a Presidential Executive Order in the United States,<sup>32</sup> and have resulted in the preparation of water basin strategies and theme specific guidance.<sup>33</sup> Other examples are available from California, Texas, Australia and Europe. These are described in the accompanying Summary and Background papers.

All of these jurisdictions are dealing with non-stationarity (i.e., changes from average historical conditions) relating to water supply, water use and water risk deliberations by involving advisors, stakeholders, the public, and decision makers from governments and their agencies. This process is referred to as robust decision-making in California, and is embedded in the IWRMP approach.<sup>34</sup> Another example is Texas, which is meeting the challenge of uncertainty through the use of technical and science-based best practices and stakeholder involvement based on approaches developed by the US National Academy of Sciences.<sup>35</sup> In addition to these examples, the European Commission and European Environment Agency provide guidance on how to approach the determination of climate change impacts and how to adapt to these through the use their Adaptation Support Tool and related guidance sources.<sup>36</sup>

These approaches avoid basing decisions on one outcome. They explicitly account for uncertainty, track outcomes in relation to changing conditions over time, and have a built-in capacity to proactively anticipate and then adapt to changes as they occur.

## KEY MESSAGES 5

- Canada has begun to undertake pilot projects at the local scale to adapt to the changing climate, and these need to be expanded.
- The US has undertaken comprehensive, integrated river basin analyses and strategies, which address climate changes and link the water, energy, biodiversity and agriculture nexus for future decision making.
- Canada and the Provinces need to experiment with more innovative approaches to climate adaptation over the next five years to broaden the range of tools.

31 BC Ministry of Environment. (Dec. 2010)

32 White House. (2011)

33 See homepages (Retrieved on June 12, 2013) for USEPA Federal and EPA Adaptation Programs and USDOJ WaterSmart (<http://www.usbr.gov/WaterSMART/>)

34 California Department of Water Resources. (October 2011)

35 Texas Water Development Board. (January 2012)

36 See home page for European Climate Adaptation Platform. (Retrieved on June 12, 2013 from: <http://climate-adapt.eea.europa.eu/web/guest/adaptation-support-tool/step-1>)



## THE LONG TERM: A SYNERGISTIC APPROACH TO ADAPTATION

The changing climate is laying bare a number of systemic challenges for the crops and food sector, which in the long term will have to be addressed synergistically:

- Globally, the sector contributes up to 30% of global emission in GHGs due to changes in land use, deforestation, and transportation across the food supply chain, refrigeration and fertilizer use.
- The sector will have to work collaboratively with public and private institutions to identify and undertake actions to reduce emissions.
- As climate continues to change, there will have to be new research into flood-, heat/drought- and pest-resistant crops and production systems that both realize new opportunities for shifting production and reduce impacts in established areas.
- Current food supply systems result in significant amounts of waste, which must be significantly reduced to meet future global food demands.
- Intensive agriculture practices, generally associated with large scale operations can result in environmental effects such as water pollution, loss of soil productivity, and increased exposure to flooding by poorly designed drainage systems, together with loss of natural habitats such as wetlands, which can buffer impacts of both flooding and droughts.

It is essential that these broad statements of global considerations be addressed at planning and operational scales where they can be assessed and effectively tackled in an integrated manner. For example, integrated watershed management will protect natural ecosystems such as wetlands and functioning riparian areas, which not only make them more resilient to flooding and droughts but will also sequester carbon. Similarly, reduction in food waste will have synergistic improvements in water and energy use, thus reducing GHG emissions.

There must also be integration between off-farm and on-farm adaptation initiatives. For example in British Columbia's Lower Mainland, some high value farmland is threatened by potential sea level rise. Senior governments must take the lead responsibility to constructive adaptive off-farm infrastructure in conjunction with producers undertaking more localized measures on their farms.<sup>37</sup>

### Road Map for Resilient Agriculture and Agri-Food Systems in Canada by 2020

There is little doubt that, as atmospheric carbon continues to accumulate, there will be increasing impacts on temperature, precipitation and frequency of extreme events outside historical norms. Without focused attention, these factors will have an increasing impact on Canada's economy and food security. To avoid foreseeable losses and support Canada's growth and wellbeing, the federal, provincial and territorial governments must start developing a collaborative, integrative set of actions across the nexus of agriculture, water, energy, biodiversity and other land and resource uses. Canadian governments and stakeholders have the ability to adopt and undertake thoughtful and effective climate adaptation policies and programs, but time, political will and financial support are of the essence. Canada's governments, like others facing climate changes, will be most effective if they collaborate. In addition, the agriculture sector must be intimately involved with bridging organizations including academia and civil society (i.e., organizations and individuals representing private and public interests).

37 Crawford and MacNair et al. (2012) Fraser Valley & Metro Vancouver snapshot report.

# ACT'S RECOMMENDATIONS



Serious water conservation measures must be put into place immediately to reduce the risk of water scarcity, and additional measures ... to ensure that water quality and allocation issues related to reduced supply can be effectively managed.

## NEXT FIVE YEARS

Canada's federal, provincial and territorial governments, in collaboration with the agricultural sector, academia and civil society, should:

1. Develop regional and national scenarios for projected climate change impacts on crops and food supply systems to identify opportunities for new agricultural development resulting from regional shifts in climate, manage impacts on food systems in established areas and identify staple import foods that we may have to replace, and do so locally if possible.
2. Establish and monitor a set of specific indicators to understand the nature and trends in climate change and reduce uncertainty in climate forecasts.

### **Leads for 1 and 2: Federal government and leading agricultural research institutions**

3. Support pilot studies to assess the effects of the changing climate on the ground in a variety of food producing areas (as has begun in British Columbia) to develop practical tools for adaptation and increase the capacity of the farming community to respond to climate change by delivering these tools and increasing capacity through extension services.
4. Build capacity to deliver effective adaptation policies and tools to deal with extreme events outside the range of normal variation.
5. Encourage water conservation, especially for irrigated agriculture and identify new sources of secure supply. The Province of British Columbia should pursue its proposed Water Sustainability Act with its stated goals of conserving water use, regulating groundwater, and retaining health of watersheds
6. Undertake integrated watershed assessments and prepare strategies using approaches drawn from best available science. Such strategies should encourage producers who are innovative and environmentally sensitive in their practices

### **Leads for 3 to 6: Federal and provincial governments and agricultural federations**

7. Invest in off-farm infrastructure to manage sea level rise, flood control in highly developed areas and new water supply systems and collaborate with producers with on-farm infrastructure designed to accommodate extreme weather events that lie outside historic range of variation.

To avoid foreseeable losses and support Canada's growth and wellbeing, the federal, provincial and territorial governments must start developing a collaborative, integrative set of actions across the nexus of agriculture, water, energy, biodiversity and other land and resource uses.



#### **Lead for 7: Build Canada and provincial governments**

8. Associated with infrastructure investments recommended above, the public and private sectors should collaborate on a joint risk-based insurance. In some cases, high-risk areas should be returned to natural systems. Where the insured are not willing to undertake risk management voluntarily, clear steps should be put in place to transition from high-risk exposure to an acceptable level. Where this is not possible, insurance (where currently available) and/or public recovery funding should be reviewed and potentially withdrawn accompanied by appropriate economic transition strategies.

#### **Lead for 8: Federal Government, insurance corporations and agricultural federations**

### **YEARS 5-8: CONTINUOUS IMPROVEMENT**

Canada's federal, provincial and territorial governments and farming communities should consolidate their learning and develop information systems and extension programs to share knowledge and information about successful adaptation. This includes developing integrated decision making frameworks, local implementation capacities and intergovernmental coordination. This will require a collaborative and comprehensive set of actions across the nexus of agriculture, water, energy, biodiversity and other land and resource uses.

### **CONCLUSION**

The current weaknesses in governance of food and crop security – lack of integration of policies across water, energy, land use and agriculture; reduced water security; and weak monitoring systems – will increase exposure to the growing threats of a changing climate, which will also drive global food availability and price crises. For example, the United States and the European Union are reforming their policies and programs to address these challenges. Although these initiatives have yet to be fully implemented, they provide the basis for forward-looking climate change adaptation and disaster risk reduction decisions in the coming years. It is now time that Canada prepared its food system for what lies ahead.

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