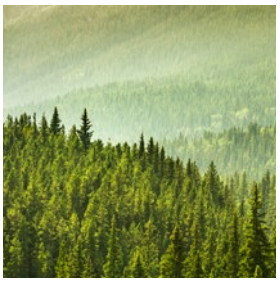
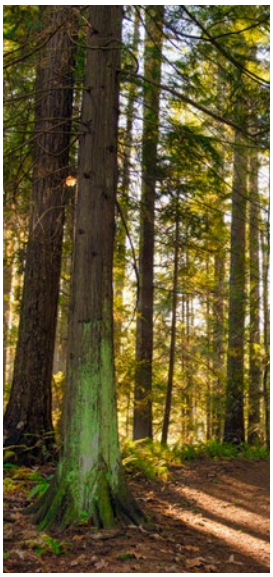
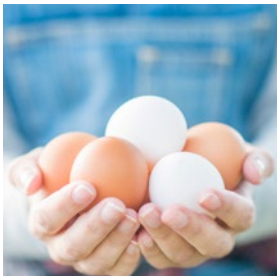



# Feast or Famine:

## Impacts of climate change and carbon pricing on agriculture, agri-food and forestry

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Senate Committee on Agriculture and Forestry

The Honourable Diane F. Griffin, Chair
The Honourable Ghislain Maltais, Deputy Chair

DECEMBER 2018

SENATE
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# Members

The honourable
**Diane F. Griffin**
Chair

The honourable
**Ghislain Maltais**
Deputy Chair

## THE HONOURABLE SENATORS

**Salma Ataullahjan**

**Wanda Elaine Thomas Bernard**

**Douglas Black**

**Robert Black**

**Jean-Guy Dagenais**

**Norman E. Doyle**

**Terry M. Mercer**

**Julie Miville-Dechêne**

**Victor Oh**

**Ex-officio members of the committee:**
The Honourable Senators Peter Harder, P.C. (or Diane Bellemare or Grant Mitchell), Larry W. Smith (or Yonah Martin), Joseph A. Day (or Terry M. Mercer), Yuen Pau Woo (or Raymonde Saint-Germain)

**Other Senators who have participated from time to time in the study:**
The Honourable Senators Lynn Beyak, Pierre-Hugues Boisvenu, Patricia Bovey, Nicole Eaton, Raymonde Gagné, Marc Gold, Frances Lankin, P.C., Mary Jane McCallum, Sabi Marwah, Paul E. McIntyre, Kelvin Kenneth Ogilvie (retired), Ratna Omidvar, Chantal Petitclerc, André Pratte, Bob Runciman (retired), Scott Tannas, Claudette Tardif (retired), Yuen Pau Woo

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**Senate Committees Directorate:**
Kevin Pittman, Clerk of the Committee
Annie Trudel, Administrative Assistant

# Order of Reference

Extract from the *Journals of the Senate*, Thursday, March 9, 2017:

The Honourable Senator Maltais moved, seconded by the Honourable Senator Dagenais:

That the Standing Senate Committee on Agriculture and Forestry be authorized to examine and report upon the potential impact of the effects of climate change on the agriculture, agri-food and forestry sectors and the actions undertaken to increase adaptation and emissions reduction strategies, as well as to know more about the opportunities within their sectors that come with climate change. The emphasis will be placed on:

(a)The measures for the adaptability and resilience of the agriculture, agri-food and forestry sectors; including the opportunities and risks associated with climate change in terms of the expansion of farmland, grazing land, and forestry production;

(b)The repercussions of the establishment of carbon pricing mechanisms on the competitiveness of stakeholders in the agriculture, agri-food and forestry sectors;

(c)The role that the federal, provincial and territorial governments can play in meeting the target for the reduction of greenhouse gas emissions; and

That the committee submit its final report to the Senate no later than June 30, 2018, and that the committee retain all powers necessary to publicize its findings until 180 days after the tabling of the final report.

After debate,

The question being put on the motion, it was adopted.

Charles Robert
*Clerk of the Senate*

Extract from the *Journals of the Senate*, Thursday, June 14, 2018:

The Honourable Senator Griffin moved, seconded by the Honourable Senator Dean:

That, notwithstanding the order of the Senate adopted on Thursday, March 9, 2017, the date for the final report of the Standing Senate Committee on Agriculture and Forestry in relation to its study on the potential impact of the effects of climate change on the agriculture, agri-food and forestry sectors be extended from June 30, 2018 to December 21, 2018.

The question being put on the motion, it was adopted.

Richard Denis
*Clerk of the Senate*

# Foreword

The changing climate is of great concern to all Canadians, including farmers and foresters. The Committee, therefore, directed its efforts to answering the following questions: How is climate change affecting our farms and forests? Do these changes offer any potential benefits? If so, how can we take advantage of them? What can we do to make farms and forests more resilient? How can we reduce harm?

This report is the fruit of the discussions held during our study. The first part of the report offers context for the current challenges, including an overview on the impacts of climate change on agriculture and forestry, data regarding Canada's greenhouse gas emissions, and an overview of the different legislative and policy frameworks that seek to address climate change. The second part of the report examines adaptation and resilience in agriculture and forestry, including what's already being done and areas for further study and support. The third part of the report examines carbon pricing and its impact on competitiveness in agriculture and forestry. Finally, the fourth section of the report explores the roles of federal and provincial governments and suggests areas for action.

The Committee would like to thank the witnesses who testified or who provided written comments. We hope that the findings and recommendations in this report help show a path forward as Canadians continue to tackle the challenges posed by our changing climate.

We thank our colleagues who participated in the study as well as staff from their offices, from the Library of Parliament, and from the Committees and Communications directorates. We also thank the translators, stenographers, pages, and technicians who make our work possible.

The honourable
**Diane F. Griffin**
Chair

The honourable
**Ghislain Maltais**
Deputy Chair

# Acronyms and Abbreviations

| | |
|---|---|
| **CAP** | Canadian Agricultural Partnership |
| **CFS** | Canadian Forest Service |
| **EFP** | Environmental Farm Plan |
| **GHG** | Greenhouse gas |
| **OECD** | Organization for Economic Co-operation and Development |
| **PCF** | Pan-Canadian Framework on Clean Growth and Climate Change |
| **UNFCCC** | *United Nations Framework Convention on Climate Change* |

# Executive Summary

Climate change is transforming Canada's agriculture, agri-food and forestry sectors — key economic drivers that employ millions of Canadians.

While climate change can bring some benefits, it is also the source of significant risks. The Senate Committee on Agriculture and Forestry heard evidence that agriculture would be one of the sectors most damaged by climate change; dryer, hotter weather has also sparked an increase in wildfires, which makes forests more likely to become a source of environmentally damaging carbon dioxide.

At the same time, Canada has committed to reduce its greenhouse gas emissions and the federal government is imposing carbon pricing on provinces and territories that do not already have similar measures in place. Agriculture alone is responsible for 10% of Canada's greenhouse gas emissions; carbon pricing may put increased pressures on producers and raise prices for consumers.

Given the rapidly changing reality for Canada's agriculture, agri-food and forestry sectors, and the impending carbon pricing regime, the committee chose to investigate so as to make strong, evidence-based recommendations that will support workers in these sectors and Canadian consumers.

## OVERVIEW: AGRICULTURE AND AGRI-FOOD

Canada's agriculture and agri-food sector accounted for one in eight jobs in Canada in 2014, employing 2.3 million people. Figures for 2016 value exports in this sector at $56 billion; it generated nearly $112 billion or 6.7% of Canada's gross domestic product (GDP) in that year.

But producers across the country report struggling with the effects of climate change. In Nova Scotia's Annapolis Valley, the weather is drier and the winter harsher. In Ontario, 25% of crop insurance claims came as a result of greater than expected rainfall. Fruit growers in British Columbia have been flooded out due to melting mountain snowpacks, and livestock owners have noted a rise in parasitic infestations.

As one sheep farmer told the committee, "wet and warm equals worms."

The committee, however, also heard evidence that climate change could have some benefits. For instance, more frost-free days are expected in Manitoba, which could be beneficial for livestock wintering, and farmers would be able to grow new crops and take advantage of a longer growing season.

Half of this sector's greenhouse gas emissions come from livestock, with the rest coming from crops and on-farm energy and transport. The committee heard that producers are already using innovative techniques to reduce their carbon footprint.

Animal genetics, for instance, have been used to breed livestock that require less food. Some farmers, particularly in the Prairies, are using different techniques that keep carbon in the soil. One witness estimated the value of this trapped or "sequestered" carbon at $1 billion, if carbon dioxide were valued at $15 a tonne.

Crop diversification and organic farming are also yielding beneficial results.

## OVERVIEW: FORESTRY

Between 2015 and 2016, growth in the forestry sector outpaced Canada's economic growth, surging by 2.4% compared to the Canadian economy's 1.2% increase. It contributed $23.1 billion to Canada's nominal GDP, or 1.4%.

Forests absorb carbon from the atmosphere, making them carbon sinks rather than carbon sources when they're thriving. However, a substantial increase in the annual total area burned by wildland fires and a spike in insect activity has made some of Canada's forests sources of carbon, because carbon is released when trees burn or decay after dying.

Given the long-term nature of forestry, producers are focusing on building long-term resilience to climate change by adjusting the types of trees they plant and adapting forest management techniques to reduce the risk of fire, insect damage and disease.

Some witnesses suggested building up a strong "value-added" industry — using forest resources to create products and materials with smaller carbon footprints than the alternatives. Canada is already using more wood in buildings, for example, and research and development continues on other products.

## THE EFFECT OF CARBON PRICING

Carbon pricing may make groceries and forestry products more expensive, though not all witnesses agreed on this point.

Producers will, however, pay more for fertilizer, packing, transportation and fuel; greenhouse growers are expected to be particularly affected because their operations require a lot of energy. And while organic farming has the potential to use 45% less fossil fuel energy than a conventional farm, consumers already know well that organic goods cost more.

Canada's international competitiveness could also suffer. Witnesses noted they would be competing on the international market with producers who do not bear these additional, carbon-related costs. However, a study of the effects of British Columbia's carbon tax — which launched in 2008 — suggested the province's international competitiveness was not diminished.

Witnesses suggested the government could mitigate the effects of carbon pricing by offering incentives and subsidies to producers.

## KEY RECOMMENDATIONS

The committee is keenly aware of the importance of combating climate change, but senators also worry that producers and consumers will suffer hardship from the imposition of carbon pricing.

The committee makes several recommendations to strike an appropriate balance between protecting the environment and supporting the foundation of Canada's economic well-being — Canadian workers and consumers.

For example, senators want to shield producers in the agriculture and forestry industries, as well as consumers, from being unduly affected by carbon pricing. The committee makes several recommendations to that effect including:

- **That Environment and Climate Change Canada consider exempting fuel costs for farm heating and cooling systems from carbon pricing, as well as propane and natural gas used in farming activities, and**

- **That Environment and Climate Change Canada develop offset protocols to agricultural and forestry producers to receive income through carbon credits.**

Senators were impressed by innovative approaches already being implemented by agriculture, agri-food and forestry producers. Their ingenuity is to be encouraged. To that end, the committee recommends:

- **That the federal government ensure research funding is available to determine the most effective and economical investments in climate change action, and**

- **That the government encourage the use of new, less carbon-intensive materials, and new technologies that trap carbon.**

The committee urges the government to act on these recommendations so that Canada's producers and consumers are insulated from carbon price-related costs as they do their part to combat climate change.

# Recommendations

**1** **That the Department of Innovation, Science and Economic Development and Natural Resources Canada further incentivize research and innovation to expand the forest products coming from forests in Canada.**

**2** **That the Government of Canada, in collaboration with provincial and territorial governments:**

a. support community forests and Canada's 400,000 private woodland owners to build resilience in their forests; and

b. support the development of water-management infrastructure by provinces, territories and municipalities to help address anticipated extremes of water availability.

**3** **That Agriculture and Agri-Food Canada, Natural Resources Canada and universities:**

a. increase investment in research related to longer-term adaptation and resilience-building; and

b. ensure that research results are shared with agricultural producers and forest owners/managers.

**4** **That Agriculture and Agri-Food Canada and Natural Resources Canada work with provincial and territorial counterparts and universities to enhance extension services related to adaptation in agriculture and forestry.**

**5** **That Agriculture and Agri-Food Canada, Environment and Climate Change Canada, and Natural Resources Canada:**

a. ensure that information that will build resilience in farm and forest land, such as predicted precipitation data and floodplain maps, is collected, analysed and made available to Canadian agricultural producers and forest owners/managers; and

b. expand and further develop incentives that recognize and reward resilient practices and the provision of ecosystem services.

**6** **That Environment and Climate Change Canada and Natural Resources Canada develop systems for better monitoring of biodiversity to provide early warning indicators of biodiversity loss and to support resilience.**

**7** **That Environment and Climate Change Canada re-examine exemptions permitted for agricultural activities under the *Federal Greenhouse Gas Pollution Pricing Act*, with special attention to competitiveness for producers and food affordability for Canadians. In particular, the department should consider the following exemptions from carbon pricing:**

a. exempt the fuel costs for machinery that heats or cools a building used for farming by including "property that is used for the purpose of providing heating or cooling to a building or similar structure" in the definition of *eligible farming machinery*; and

b. exempt propane and natural gas under the definition of a *qualifying farm fuel* for all farming activities.

**8** That Environment and Climate Change Canada, building on existing provincial models, develop offset protocols that would allow agricultural producers and forest owners/managers in provinces applying the federal carbon pricing backstop to receive additional income through carbon credits.

**9** That Agriculture and Agri-Food Canada, the Department of Innovation, Science and Economic Development through its granting councils, Environment and Climate Change Canada and Natural Resources Canada, undertake and/or support research that will help to establish baseline levels of soil organic carbon to support the development of offset protocols for carbon sequestration across Canada.

**10** That Agriculture and Agri-Food Canada, Environment and Climate Change Canada and Natural Resources Canada work together and with their provincial/territorial counterparts to implement policies that promote greenhouse gas emissions reductions in agriculture and forestry.

**11** That the Government of Canada fully implement the policy measures contained in the Pan-Canadian Framework and seek additional measures to ensure that Canada meets its international commitment on greenhouse gas emissions reductions.

**12** That the Department of Innovation, Science and Economic Development expand the amount of research funding available for applied climate change research and multi-disciplinary research.

**13** That the Government of Canada:

a. ensure that research funding is available for high-level assessment to determine the most effective, economical investments in climate change action; and

b. continue to implement programs and initiatives that reduce greenhouse gas emissions by encouraging the use of new materials, such as advanced bioproducts, and new technologies to sequester carbon, like constructing tall buildings with wood.

**14** That Agriculture and Agri-Food Canada, in collaboration with its provincial and territorial counterparts:

a. enhance extension services to help farmers reduce greenhouse gas emissions; and

b. support those already using lower-emissions approaches, including organic farming.

**15** That Agriculture and Agri-Food Canada, Environment and Climate Change Canada and Natural Resources Canada work with their provincial and territorial counterparts to ensure that there are incentives available across Canada for beneficial management practices.

**16** That Environment and Climate Change Canada work toward a Clean Fuel Standard that includes an increased blend mandate for ethanol in gasoline, to lower its carbon intensity.

# Introduction

The Canadian landscape, defined by its iconic forests, farmland, prairies, mountains, and coastlines, is changing. As climate change brings increasingly noticeable impacts, such as more extreme weather, changing ranges of crops, trees, and pests, and rising sea levels, solutions are needed to help Canadians adapt quickly, build resilience and adaptive capacity, and slow or prevent further climate changes.

The agri-food sector is the largest manufacturing sector in Canada and contributes more than $110 billion, or about 6.7%, to Canada's gross domestic product (GDP).[1] Agriculture and agri-food provided one in eight jobs in Canada in 2014, employing over 2.3 million people,[2] while the forestry sector employed 288,700 people.[3] These sectors also contribute to Canada's environmental sustainability, in particular through carbon sequestration. Forests provide ecosystem services such as water and air purification, nutrient cycling, and wildlife habitat.[4] Agricultural landscapes can also provide significant ecosystem services, depending on how they are managed.[5] The Canadian agri-food and forestry industries have an excellent reputation for high quality and environmental responsibility globally;[6] continuing to build this trust is a key part of many producers' business plans.[7]

Canada is one of over 40 countries around the world that are implementing or planning to implement carbon pricing in order to slow climate change by reducing greenhouse gas (GHG) emissions.[8] Understanding and addressing the impacts of climate change and climate change policies on the agriculture, agri-food, and forestry sectors are an important part of ensuring that these sectors can adapt, build resilience, and continue to contribute significantly to Canada's economic growth in future.

1 Invest in Canada, Agri-food, 2018.

2 Agriculture and Agri-Food Canada, *An Overview of the Canadian Agriculture and Agri-Food System 2016*.

3 Natural Resources Canada, Statistical Data, 2017.

4 Natural Resources Canada, Forest ecosystem products and services, 28 February 2017.

5 Statistics Canada. Section 3: Ecosystems goods and services from agriculture, 27 November 2015.

6 Senate, Standing Committee on Agriculture and Forestry - AGFO, Evidence, 1st Session, 42nd Parliament, 28 September, 2018 (Robert Larocque, Senior Vice-President, Forest Products Association of Canada); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 8 February, 2018 (Leah Olson, President, Agricultural Manufacturers of Canada); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 29 March 2018 (Chris White, President and Chief Executive Officer, Canadian Meat Council).

7 For example, Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 11 May, 2017 (Tim Lambert, Chief Executive Officer, Egg Farmers of Canada).

8 World Bank and Ecofys. 2018. "State and Trends of Carbon Pricing 2018 (May)". World Bank, Washington, DC.

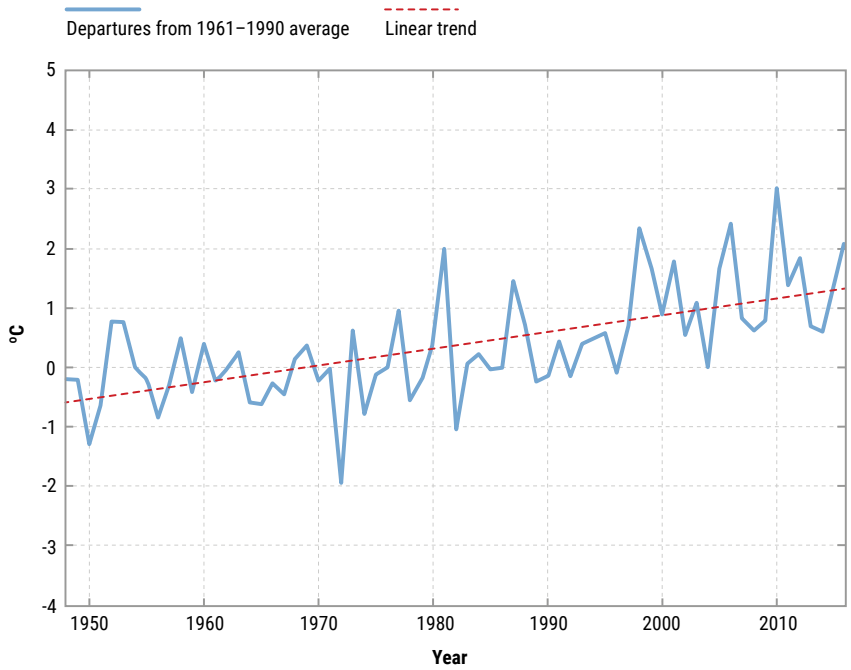
# Context and Background

## Climate change in Canada: Overview

The committee heard from all witnesses that they have observed and experienced the effects of climate change. Their experience is consistent with international and Canadian scientific evidence. Globally, numerous studies show evidence of climate change, and all climate models show comparable patterns.[9] Reports of the Intergovernmental Panel on Climate Change (IPCC) have indicated higher atmospheric and ocean temperatures, reduced amounts of snow and ice, higher GHG concentrations, higher sea level, and more frequent extreme weather events.[10]

Measurements from Environment and Climate Change Canada show a gradual rise in average temperatures across Canada over the past 69 years. Warming in winters has been the greatest change, with winter temperatures averaged across the country increasing by 3.4°C.[11] Summer warming has averaged 1.5°C over the past 69 years, and spring warming has averaged 1.7°C over the same time period. Measurements also show increased precipitation overall across the country. While the impacts differ in different parts of the country, witnesses all reported more temperature extremes; more frequent and severe weather events, flooding and drought; and more unpredictability in general.

**Figure 1 – Annual national temperature departures and long-term trend, 1948-2016**




Note: The time series graph shows that, when averaged across the country, annual temperatures have fluctuated from year to year over the period 1948-2016. The linear trend indicates that annual temperatures averaged across the nation have warmed by 1.7°C over the past 69 years.

Source: Government of Canada, Annual 2016: Climate Trends and Variations Bulletin.

9 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 20 March, 2018 (Kathy Martin, Professor and Senior Research Scientist, Department of Forest and Conservation Sciences, University of British Columbia).

10 Intergovernmental Panel on Climate Change, Climate Change 2013: The Physical Science Basis, Summary for Policymakers.

11 Government of Canada, *Climate Trends and Variations Bulletin: Winter 2016/2017*.

## FORESTRY: IMPACTS OF CLIMATE CHANGE

Canada is the fourth-largest forest product exporter in the world by value, behind the United States, China and Germany. It is also the leading exporter of newsprint and softwood lumber. The forest industry contributed over $23.1 billion (1.2%) to Canada's nominal GDP in 2016, and the industry grew by 2.4% from 2015 to 2016, more than the rate of the Canadian economy, which grew just 1.4%.[12] Most of Canada's forest product exports go to the United States, followed by China, Japan, and the European Union.[13]

Canada's forest industry consists of the following main subsectors: solid wood product manufacturing (44% of the forest sector's contribution to the Canadian economy); pulp and paper product manufacturing (36% of the forest sector's contribution to the Canadian economy); and forestry and logging (20% of the forest sector economy).[14]

As Werner Kurz explained, "Climate change impacts on forests will be both positive and negative. We will see enhancements of growth and changes in mortality rates. We will also see, as we have already seen, changes in disturbance rates."[15]

Forests are experiencing greater severity and frequency of disturbances (such as drought, fires, severe storms, and insect and disease attacks).[16] Climate change is expected to impact temperature, precipitation, vegetation type, wood moisture, and lightning patterns.[17] Furthermore, increases in insect outbreaks and wind and ice storms due to climate change could increase the amount of dead wood present to burn in a forest fire.[18] Natural Resources Canada expects climate change to result in more frequent fires in Canada's boreal forests, resulting in severe environmental and economic consequences.[19]

### WORLD'S LARGEST FOREST PRODUCT EXPORTERS BY VALUE

1. United States
2. China
3. Germany
4. **Canada**

12 Natural Resources Canada, State of Canada's Forests Report: Indicator: Gross domestic product, 11 September 2018.

13 Natural Resources Canada Statistical Data, Trade, 27 September 2017.

14 Natural Resources Canada, Overview of Canada's Forest Industry, 2018. Based on 2013 statistics.

15 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 20 March, 2018 (Werner Kurz, Researcher, Pacific Institute for Climate Solutions, University of Victoria).

16 Natural Resources Canada, Climate change and Canada's forests: from impacts to adaptation, 2009. Williamson, T.B., et al. Canadian Forest Service Publications.

17 Natural Resources Canada, Climate change and fire, 27 March 2017.

18 Ibid.

19 Ibid.

As temperatures increase, forest composition is expected to change, with fewer conifers and more early successional species such as aspen, birch and jack pine, which are much less valuable than existing trees.[20] Changes in productivity, and age-class distribution are also expected. Moisture and temperature are expected to affect productivity, which will decrease in areas that are now or will become drier, and will increase, at least in the near term, in northern areas currently limited by cold temperatures.[21]

With rising temperatures, forest species gradually shift northward and into higher elevations. This puts pressure on species that live in the northern and high elevation forests, whose habitat is shrinking.[22] In addition, much forestry work occurs in winter when the ground if frozen; if the winters are shorter and warmer, operating times will decrease, putting further pressure on the industry.[23]

20 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 19 March, 2018 (John L. Innes, BC Chair in Forest Management, Faculty of Forestry, University of British Columbia).

21 Natural Resources Canada. Climate change and Canada's forests: from impacts to adaptation. 2009. Williamson, T.B., et al. Canadian Forest Service Publications.

22 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 20 March, 2018 (Kathy Martin, Professor and Senior Research Scientist, Department of Forest and Conservation Sciences, University of British Columbia).

23 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 19 March, 2018 (John L. Innes, BC Chair in Forest Management, Faculty of Forestry, University of British Columbia).

## AGRICULTURE AND AGRI-FOOD: IMPACTS OF CLIMATE CHANGE

Canada's agriculture and agri-food exports were valued at $56 billion in 2016. In that same year, the agriculture and agri-food system generated $111.9 billion of GDP and accounted for 6.7% of Canada's total GDP.[24] Canada is among the world's largest exporters of pulses, flaxseed, canola, oats, and durum wheat.[25] The United States is the biggest market for many of Canada's agricultural exports; for example, 74% of Canadian beef exports go to the United States, with China and Hong Kong receiving 8% of the total, followed by Japan at 7% and Mexico at 4.5%.[26]

Guillaume Gruère described research from the Organization for Economic Co-operation and Development (OECD) that indicates that, without adaptation action, agriculture is projected to be the second most economically damaged sector from the effects of climate change.[27] Witnesses in this sector were concerned by higher numbers of high-heat days, more drought and extreme heat, and a less stable climate in general.[28] Several witnesses pointed out that while the overall increase in average temperature does matter, major impacts may come from extreme and unpredictable weather, including increasing frequency and severity of droughts, extreme heat, rising sea levels, and rising and falling Great Lakes levels.[29]

The specific impacts of climate change experienced differ across the country; for example, some prairie producers reported having experienced record precipitation, flooding, and drought in the last 10 years.[30] The Annapolis Valley in Nova Scotia experienced weather effects ranging from drier than normal conditions to impacts of tropical storms and harsh winter weather.[31] In Ontario, 25% of crop insurance claims were due to excessive precipitation.[32] British Columbia fruit growers reported having experienced flooding due to melting of the snowpack at higher elevations; disease spread due to high humidity from spring flooding; frequent periods of rain during the ripening period for tree fruit; wind and sunburn damage to fruit; and smaller fruit due to heat stress and drought.[33] For livestock, climate change has been implicated in increased parasitic infections; as one sheep farmer explained it, "wet and warm equals worms," especially in the Maritimes and British Columbia.[34]

Climate change can also have benefits. For example, more frost-free days are expected in Manitoba, which could increase opportunity for outdoor livestock wintering, and it has become possible to grow a range of new crops and explore new markets because of higher temperatures and longer growing seasons. More precipitation is expected in three of four seasons, which could be a benefit if it can be stored and managed despite the fact that it is expected to fall primarily during high precipitation storm events.[35]

24 Agriculture and Agri-food Canada, An Overview of the Canadian Agriculture and Agri-Food System 2017.

25 Agriculture and Agri-food Canada, We grow a lot more than you may think, 10 April 2018.

26 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 29 March 2018 (John Masswohl, Director of Government and International Relations, Canadian Cattlemen's Association).

27 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 30 November, 2017 (Guillaume Gruère, Senior Policy Analyst, Trade and Agriculture Directorate, Natural Resources Policy Division, Organisation for Economic Co-operation and Development).

28 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 March, 2018 (Dan Mazier, President, Keystone Agricultural Producers of Manitoba).

29 For example, Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 19 October, 2017 (Barry Smit, Professor Emeritus, Department of Geography, University of Guelph); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 28 November, 2018 (Wendy Zatylny, President, Association of Canadian Port Authorities).

30 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 March, 2018 (Todd Lewis, President, Agricultural Producers Association of Saskatchewan).

31 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 2 October, 2017 (Hon. Keith Colwell, M.L.A., Minister of Agriculture, Government of Nova Scotia).

32 For example, Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 19 October, 2017 (Barry Smit, Professor Emeritus, Department of Geography, University of Guelph).

33 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 19 March, 2018 (Pinder Dhaliwal, President, BC Fruit Growers' Association).

34 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 6 April, 2017 (Corlena Patterson, Executive Director, Canadian Sheep Federation).

35 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 March, 2018 (Dan Mazier, President, Keystone Agricultural Producers of Manitoba)

# Canada's greenhouse gas emissions

At the Paris Climate Conference in December 2015, Canada and 194 other parties to the United Nations Framework Convention on Climate Change (UNFCCC) reached the Paris Agreement.[36] In this agreement, Canada committed to lowering greenhouse gas GHG levels to 30% below 2005 emissions levels; that is, to reducing emissions to 517 megatonnes (Mt) of carbon dioxide equivalent by 2030.

Canada's emissions were about 600 Mt in 1990, and generally increased until the global financial crisis of 2008, when they dipped. Emissions then began to increase again until another decrease was shown in 2015. Canada's GHG emissions have been declining since then, and were estimated at 704 Mt in 2017.[37]

Canada was ranked as the world's ninth-largest emitter in 2013, generating about 1.6% of GHG emissions in that year. As of 2013, the three largest emitters of GHGs were China with 25.9%, the United States with 13.9%, and the European Union with 9.3% of global GHG emissions. Figure 2 shows total global GHG emissions in 2005 and 2013, and those of the world's 10 highest emitters.

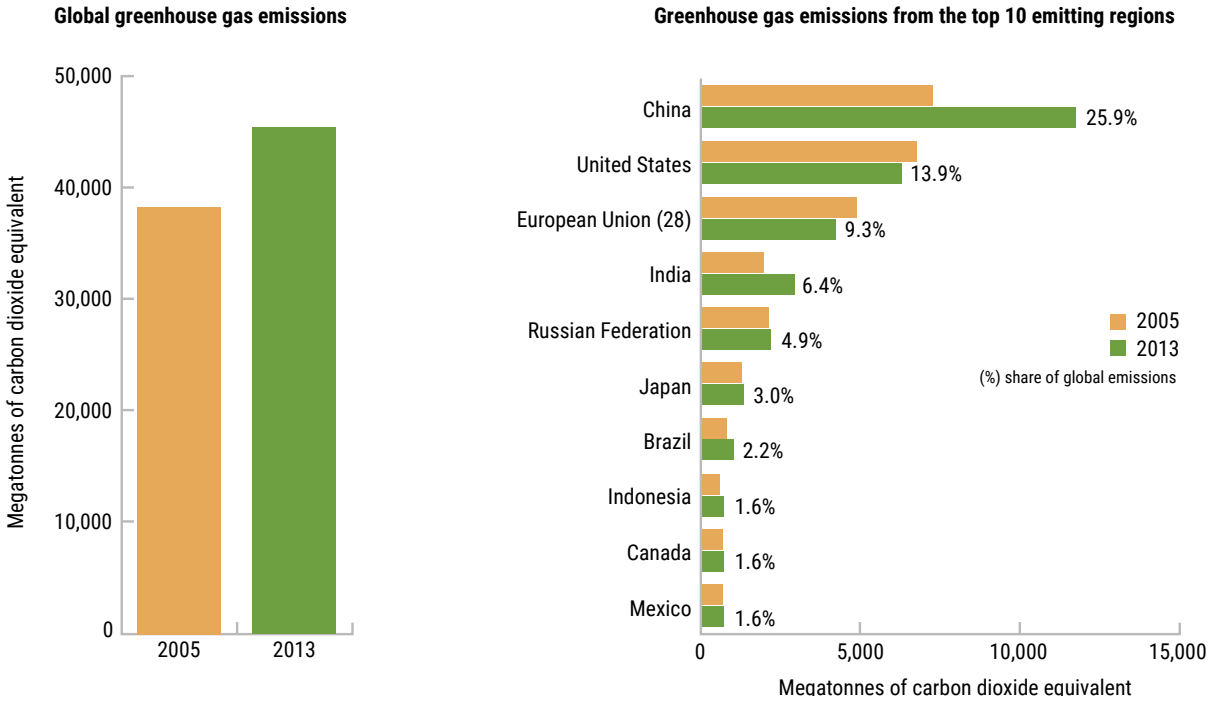
The situation was similar in 2017. According to the World Resources Institute,[38] with Canada still the ninth-largest emitter, generating about 1.7% of global GHG emissions, and the three largest emitters the same: China, the United States, and the European Union.

36 Government of Canada, The Paris Agreement, 2016.

37 Government of Canada, Greenhouse Gas Emissions, 6 June 2018.

38 World Resources Institute: Graphic by Johannes Friedrich based on work by Duncan Clark, Kiln, Mike Bostock and Jason Davies, Explore the World's Greenhouse Gas Emissions, April 2017.

**Figure 2 – Global Greenhouse Gas Emissions and Top 10 Emitting Countries and Regions, 2005 and 2013**



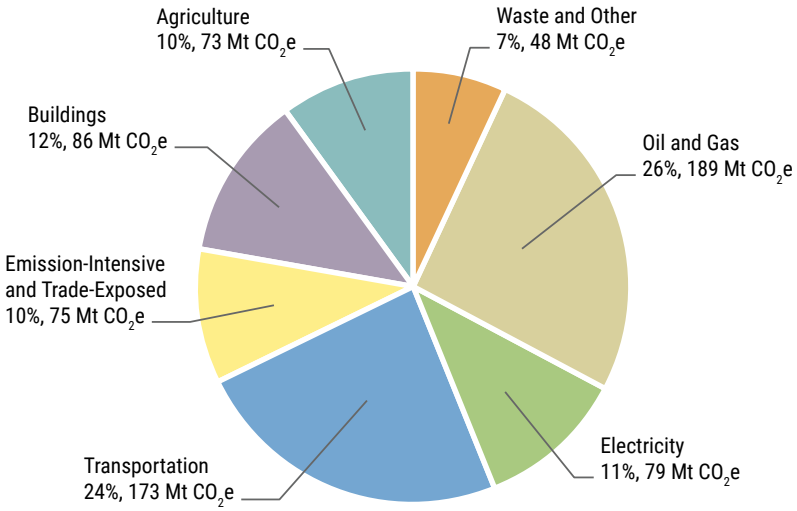

Notes: a. Historical and projected greenhouse gas emissions are based on 2014 emission data presented in National Inventory Report 1990–2014: Greenhouse Gas Sources and Sinks in Canada, Environment and Climate Change Canada, 2016.

b. Estimates of greenhouse gas emission reductions from measures outlined in the Pan-Canadian Framework on Clean Growth and Climate Change are based on the National Inventory Report 1990–2015: Greenhouse Gas Sources and Sinks in Canada, Environment and Climate Change Canada, 2017.

Source: Environment and Climate Change Canada, *Global greenhouse gas emissions*, 10 May 2018.

GHG emissions result from all of Canada's economic sectors, as illustrated in Figure 3.

**Figure 3 – Canada: Greenhouse Gas Emission Breakdown by Economic Sector, 2015**




Source: Figure prepared by the authors using data obtained from Environment and Climate Change Canada Data, *B-Tables-Canadian-Economic-Sector-Canada*.

Note: "Mt $CO_2e$" means megatonnes of carbon dioxide equivalent. Emissions from generating electricity are shown separately from the economic sectors that subsequently used the electricity. Agriculture emissions includes on-farm fuel use, animal production, and crop production. Emissions from the Forestry Economic Sector were 1 Mt $CO_2e$ (0.14% of total national emissions) and are included in "Waste and Other".

## GREENHOUSE GAS EMISSIONS FROM AGRICULTURE

Approximately 10 percent of Canada's GHG emissions came from agriculture at the most recent assessment. These emissions come primarily from livestock (5%), crops (3%), and on-farm energy and transport (2%).[39]

As shown in Figure 3, agriculture is responsible for about 10 percent of Canada's GHG emissions.

Agriculture produces three main GHGs: Methane ($CH_4$), nitrous oxide ($N_2O$), and carbon dioxide ($CO_2$). In 2016, agriculture accounted for 30% of national $CH_4$ emissions and 77% of national $N_2O$ emissions.[40] As can be seen in Table 1, methane and nitrous oxide have greater global warming potential than $CO_2$, and last different lengths of time in the atmosphere.

**Table 1: Global Warming Potentials of Greenhouse Gases Emitted from Agriculture**

| Greenhouse Gas | Chemical Formula | Global Warming Potential over 100 years in $CO_2$ equivalent | Atmospheric Lifetime (years) |
|---|---|---|---|
| Carbon Dioxide | $CO_2$ | 1 | Variable (5 to 200 years) |
| Methane | $CH_4$ | 25 | 12 +- 1.8 |
| Nitrous Oxide | $N_2O$ | 298 | 114 |

Sources: Environment and Climate Change Canada, 2018, National Inventory Report 1990-2016: Greenhouse Gas Sources and Sinks in Canada. English available from: https://unfccc.int/documents/65715; IPCC, 2012, Fourth Assessment Report - Errata; IPCC, 2013, Fifth Assessment Report - Working Group I: The Scientific Basis.

Notes:
a. The global warming potential of methane includes both direct effects and indirect effects from enhancements of ozone and stratospheric water vapour.
b. GHGs are reported in $CO_2$ equivalents, in comparison to the global warming potential of $CO_2$, therefore the global warming potential of $CO_2$ is set at 1. This means that methane traps 25 times as much heat as the same amount of $CO_2$; nitrous oxide traps 298 time as much heat as the same amount of $CO_2$.

Methane emissions come largely from animal production. It is produced by herbivores during their normal digestive processes, known as enteric fermentation, with ruminant animals such as cattle generating the most methane. In 2016, emissions from livestock digestion (enteric fermentation) accounted for 41% of total agricultural emissions.

Carbon dioxide is released during soil cultivation and by decomposition of organic materials. Both methane and nitrous oxide are emitted from manure management (e.g. handling, storage, and application). Nitrous oxide is also directly and indirectly emitted from agricultural soils.[41] As shown in Figure 4, the application of inorganic nitrogen fertilizers accounted for 22% of total agricultural emissions.[42]

39 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 9 November, 2017 (Jean-Denis Fréchette, Parliamentary Budget Officer, Office of the Parliamentary Budget Officer).

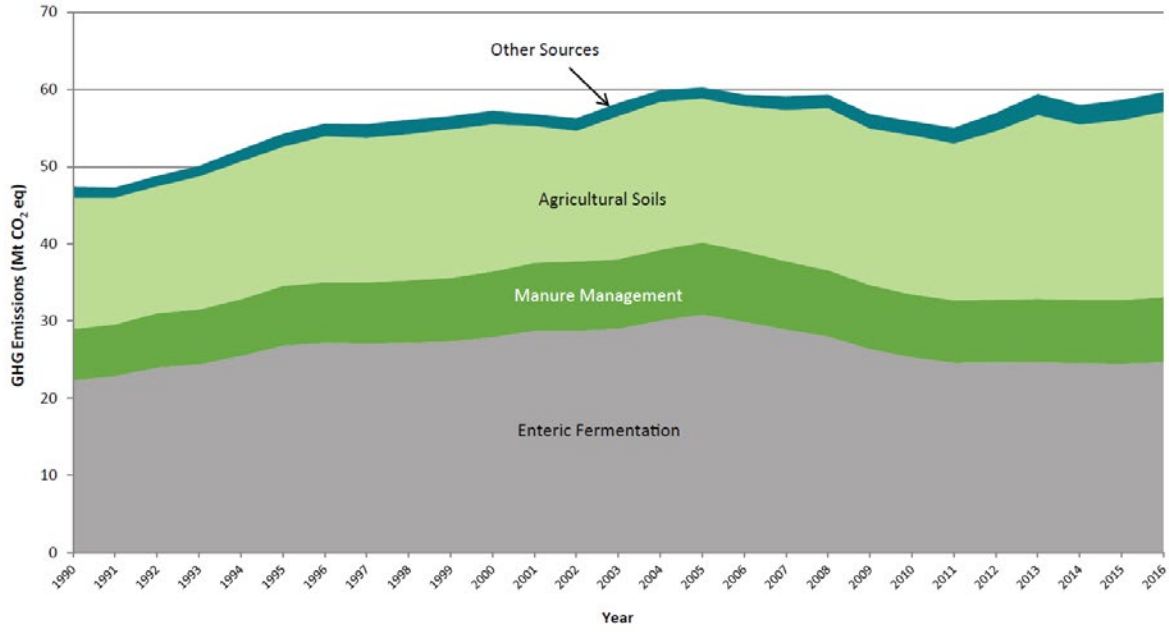
40 Environment and Climate Change Canada, 2018, National Inventory Report 1990-2016: Greenhouse Gas Sources and Sinks in Canada. English available from: https://unfccc.int/documents/65715. Note that Canada's most recent submission to the UNFCCC (2018) uses 2016 emissions data.

41 Government of Canada, Greenhouse Gas Emissions Inventory, 2018.

42 Canada's 2018 National Inventory Report to UNFCCC 1990-2016, part 1.

The main causes of changes in emissions from the Canadian agriculture sector from year to year are the fluctuations in livestock populations and the application of inorganic nitrogen fertilizers to agricultural soils in the Prairie provinces.[43]

**Figure 4 – Trends in Canadian GHG Emissions from the Major Agricultural Sources (1990-2016)**




Source: Environment and Climate Change Canada, 2018, National Inventory Report 1990-2016: Greenhouse Gas Sources and Sinks in Canada.

Notes: a. "Other Sources" includes crop residue burning and lime and urea application.
b. The most recent year for which there is data (2016) showed 60 Mt $CO_2$ equivalent total agriculture emissions, consisting of: 25 Mt $CO_2$ equivalent from Enteric Fermentation (41.7% of total emissions); 8.4 Mt $CO_2$ equivalent from manure management (14.0% of total emissions); 24 Mt $CO_2$ equivalent from agricultural soils (40.0% of total emissions); 2.5 Mt from lime and urea application (4.2% of total emissions); and 0.05 Mt from crop residue burning (0.1% of total emissions).

## CANADA'S GHG EMISSIONS FROM AGRICULTURE

**5%**
Livestock

**3%**
Crops

**2%**
On-farm energy and transport

43 Ibid.

## GREENHOUSE GAS EMISSIONS FROM CANADA'S FORESTRY SECTOR

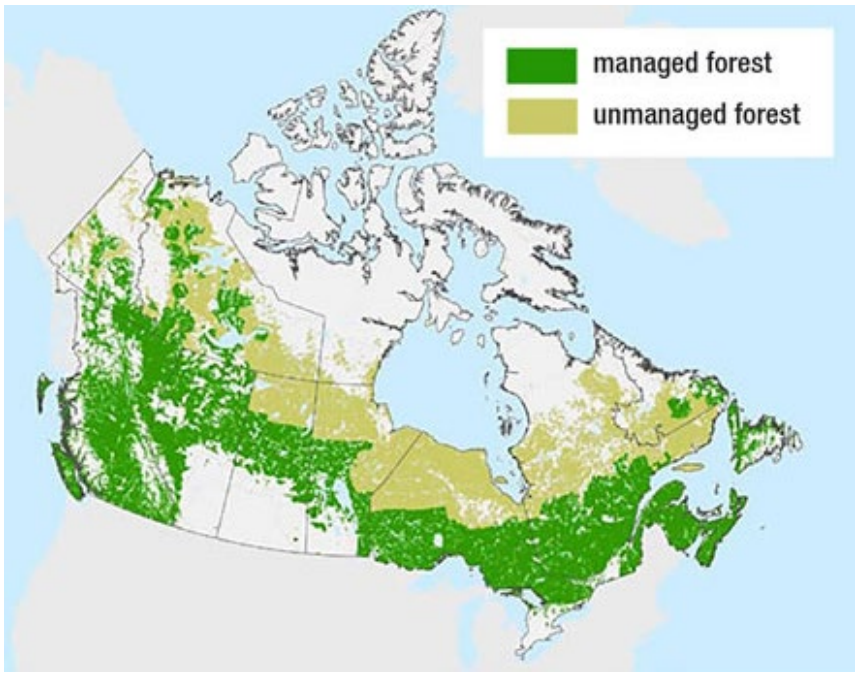
GHG emissions from the extraction and transformation of forestry resources were 1.3 per cent of Canada's emissions in 2015 and have been declining slightly as a result of a drop in demand for forest products.[44]

Carbon is sequestered in forests when it is absorbed from the atmosphere through photosynthesis and deposited in forest biomass. Forest carbon is released when trees burn or decay after dying, including from insect attack. Forests act as a carbon source if they release more carbon than is absorbed, and act as a carbon sink if they absorb more carbon from the atmosphere than is released.

For the past century, Canada's managed forests (see Figure 5) have represented a significant carbon sink. However, in recent decades, some of Canada's forests have become carbon sources, due to the following factors.[45]

- A substantial increase in the annual total area burned by wildland fires;
- Unprecedented insect outbreaks; and
- Some years of increased annual harvest rates in response to economic demand.

**Figure 5 – Managed forest area in Canada.**

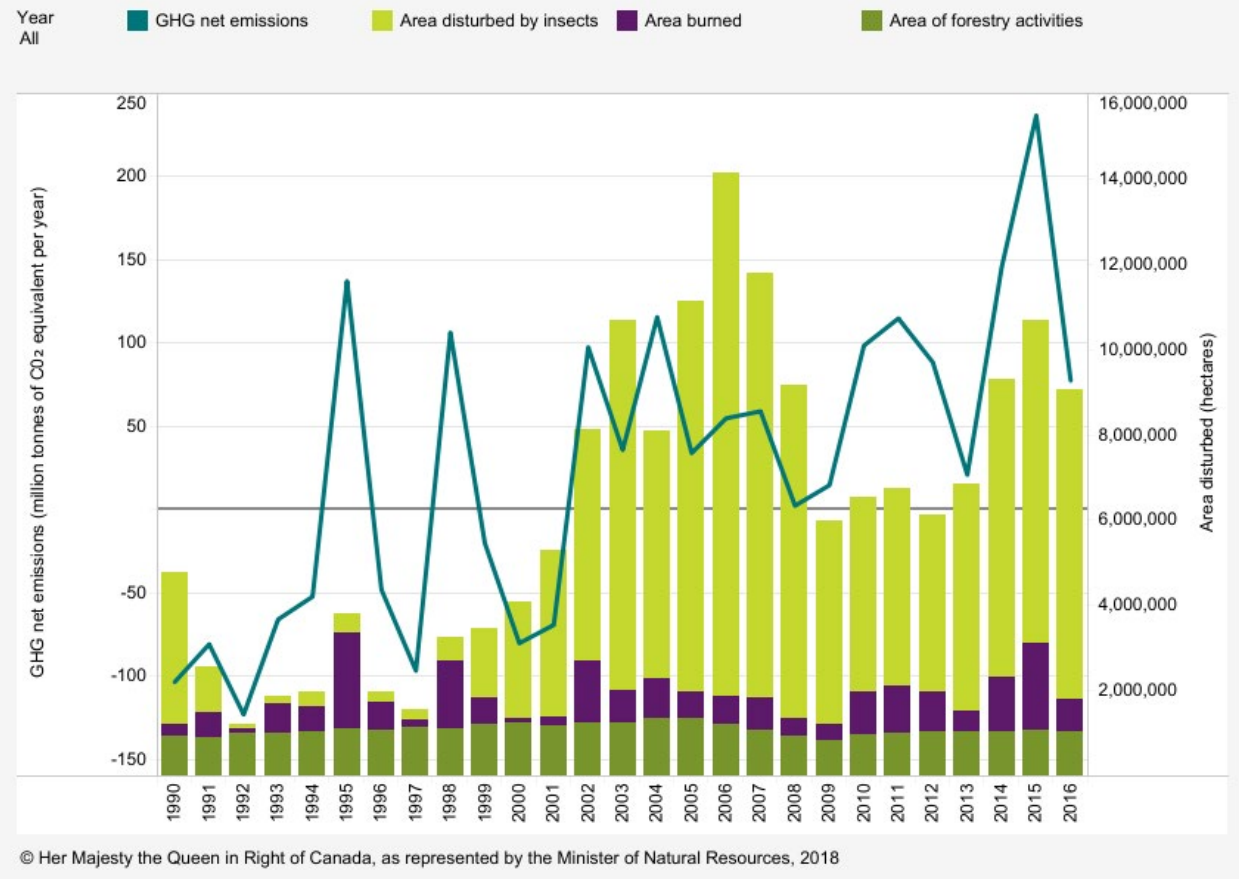



Source: Natural Resources Canada, 2018, Inventory and land-use change.

44 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 1 March, 2018 (Matt Jones, Assistant Deputy Minister, Pan-Canadian Framework Implementation Office, Environment and Climate Change Canada).

45 Natural Resources Canada, Forest Carbon, 2016.

**Figure 6 – Net Carbon Emissions in Canada's Managed Forest: All Areas, 1990-2016**




Source: Natural Resources Canada. *State of Canada's Forests 2018*. Indicator: Carbon emissions and removals.

# Legislative and policy frameworks

## THE PAN-CANADIAN FRAMEWORK ON CLEAN GROWTH AND CLIMATE CHANGE

The Pan-Canadian Framework on Clean Growth and Climate Change (Pan-Canadian Framework or PCF), agreed to in December 2017 by most Canadian provinces and territories, sets out steps to be taken to reduce Canada's GHG emissions.[46] The PCF is built on four pillars: carbon pricing; complementary mitigation actions in all sectors of the economy; adaptation and resilience; and clean technology, innovation and jobs.

The PCF outlines planned actions across all sectors of the Canadian economy. As an Environment and Climate Change Canada official noted, "The Pan-Canadian Framework is the most comprehensive climate change plan that has ever been produced in the country. It's the first time the majority of jurisdictions have agreed on a collaborative way forward."[47]

46 Note: Saskatchewan and Manitoba did not initially sign on to the Pan-Canadian Framework on Green Growth and Climate Change, but Manitoba later did sign on in February 2018. At the time of writing, Alberta was planning to step back from the joint plan, and Ontario's new government, elected in June 2018, tabled Bill 4, the *Cap and Trade Cancellation Act, 2018*, in July of that year. Saskatchewan and Ontario have each filed constitutional reference cases with their respective provincial Court of Appeals to challenge the federal government's right to impose a price on carbon, a key component of the plan.

47 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 1 March, 2018 (Matt Jones, Assistant Deputy Minister, Pan-Canadian Framework Implementation Office, Environment and Climate Change Canada).

**Carbon pricing**

Carbon pricing is a central element of the PCF. The PCF outlines a federal benchmark for pricing carbon pollution. Provinces and territories can implement their own price-based system or cap-and-trade system, based on the needs and requirements in that jurisdiction. Each province or territory's system must meet the federal benchmark, or the federal backstop system will apply, taking effect in 2019.[48] The federal government's price-based system will return most of the revenues directly to households in each province or territory in which it applies. The federal system will include 1) a carbon levy applied to fossil fuels, which will come into effect in 2018; and 2) an output-based pricing system for industrial facilities that emit above a certain threshold. This system is designed to support emissions-intensive, trade-exposed industries to prevent carbon leakage.[49]

To implement its carbon pricing system, the federal government introduced the *Greenhouse Gas Pollution Pricing Act* in February 2018 (Part 5 of Bill C-74).[50]

The PCF outlines numerous regulatory and other actions to reduce GHG emissions. One such action agreed on in the Pan-Canadian Framework is the development of a clean fuel standard by the federal government, in collaboration with provincial and territorial governments, industry, and other stakeholders. The clean fuel standard is intended to reduce emissions from fuel used in transportation, industry, and buildings by increasing the proportion of fuel from renewable sources, which is believed to have lower carbon emissions over its lifecycle than fossil fuels.[51] The clean fuel standard is expected to promote the use of clean technology and lower carbon fuels, and promote alternatives including biogas.[52]

In addition to initiatives resulting from the PCF, other federal legislative and policy frameworks are in place that address climate change adaptation as well as mitigation.

## FEDERAL CLIMATE CHANGE ADAPTATION POLICY FRAMEWORK

- At the 1992 Earth Summit in Rio de Janeiro, countries adopted the *United Nations Framework Convention on Climate Change* (UNFCCC) as a way to negotiate climate change issues at the global level.[53] Under this convention, countries commit to reducing their GHG emissions as part of global efforts to limit the increase in the world's average temperature. They also commit to adapting to ongoing and anticipated impacts of climate change.[54]

- Canada's national climate change management strategy originates with the UNFCCC. Environment and Climate Change Canada, the federal lead on climate change issues, has directed the implementation of the 2011 Federal Adaptation Policy Framework for climate change, which provides guidance for the Government of Canada's departments and agencies to address adaptation to the impacts of climate change.[55] The Framework sets out a vision of adaptation in Canada, responsibilities for the federal government, and criteria for setting priorities for action. The framework reflects the need to integrate adaptation planning and programming into ongoing federal activities, as climate change impacts are already being observed across a range of federal services, programs, policies, and regulations.

48 Government of Canada, *Ministers' letter to provinces and territories on next steps in pricing carbon pollution*, 20 December 2017.

49 Environment and Climate Change Canada, *Technical Paper on the Federal Carbon Pricing Backstop*, 18 May 2017, p. 5.

50 Greenhouse Gas Pollution Pricing Act (S.C. 2018, c. 12, s. 186)

51 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 4 April, 2017 (Jack Froese, President, Canadian Canola Growers Association).

52 Pan-Canadian Framework on Clean Growth and Climate Change.

53 Government of Canada, "*United Nations Framework Convention on Climate Change (UNFCCC)*".

54 2017 Fall Reports of the Commissioner of the Environment and Sustainable Development to the Parliament of Canada, *Report 2—Adapting to the Impacts of Climate Change*.

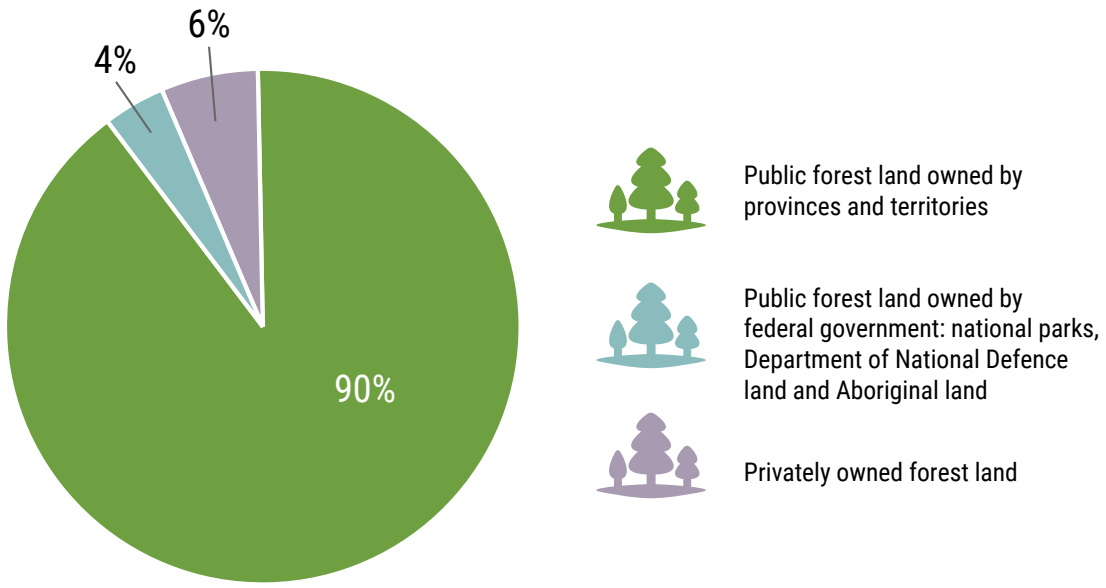
55 Government of Canada, *Federal Adaptation Policy Framework for climate change*, 12 August 2016.

## CANADA'S REGULATORY AND POLICY FRAMEWORK FOR FOREST MANAGEMENT

The *Constitution Act, 1867* gives provinces jurisdiction over lands and resources, including forests, that fall within their borders. The federal government, in turn, is responsible for forests situated on federal lands. Provincial governments have historically leased the rights to harvest forests on public lands to private companies in exchange for stumpage fees for trees harvested and payment for the right to access the land.

Approximately 90% of Canada's forest land is publicly owned by provinces, approximately 4% is publicly owned by the federal government (national parks, national defense lands, Aboriginal lands), and the remaining 6% is privately owned.[56] A notable exception is in New Brunswick, where approximately 50% of forests are privately owned. Privately owned forests across Canada are mainly owned by forest companies, but also include some small family-owned woodlots. Ten percent of timber harvested in Canada comes from private lands.[57]

**Figure 7 – Overview of forest land ownership in Canada**




Source: Natural Resources Canada, Forest Land Ownership, 2017.

The Canadian Council of Forest Ministers is a forum that promotes cooperation between provincial, territorial, and federal governments on issues impacting the forest sector, including demonstrating Canada's international leadership in sustainable forest management.

The Canadian Forest Service (CFS), part of Natural Resources Canada, provides science and policy expertise and advice on national forest sector issues. The CFS collaborates with provinces and territories on questions for forest health and sustainability, supports sector competitiveness, and engages in research related to climate change[58]. For example, the CFS is currently working with provinces, territories, universities and industry to develop decision support tools for managers and policy-makers that will help them address challenges related to climate change."[59]

56 Natural Resources Canada, Forest Land Ownership, 2017.

57 Ibid.

58 Natural Resources Canada, About the Canadian Forest Service, 26 July 2017.

59 Natural Resources Canada. Climate Change, 13 July 2018.

## CANADIAN AGRICULTURAL PARTNERSHIP

The *Canadian Agricultural Partnership* is a five-year (2018 to 2023), $3-billion investment by federal, provincial, and territorial governments intended to strengthen the agriculture, agri-food and agri-based products sectors. The partnership is cost-shared at a rate of 60:40 between the federal government and each provincial or territorial government.[60]

The current partnership builds on three previous iterations: The Agricultural Policy Framework (2003-08), Growing Forward (2008-13) and Growing Forward 2 (2013-18). Under this partnership, the government wants to enhance Business Risk Management programs designed to help farmers manage significant risks to the viability of their farms, and make them easier to access than in the past. Programs in the CAP are designed to "help give farmers the tools they need to continue to reduce agricultural greenhouse gas emissions, protect the environment and adapt to climate change."[61]


60 Agriculture and Agri-food Canada. Canadian Agricultural Partnership, 14 February 2018.

61 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 8 February, 2018 (Hon. Lawrence MacAulay, P.C., M.P., Minister of Agriculture and Agri-Food).

# Adaptation and Resilience in the Agriculture, Agri-food, and Forestry Sectors

Witnesses described extensive adaptation to the impacts of climate change that is already taking place in forestry, agriculture, and agri-food. For example, forest managers use future climate modelling to determine which tree species will fare best in replanting.[62] Producers are experimenting with growing non-traditional crops that suit new climate conditions;[63] and they are implementing new water management approaches to address changes in flow.[64]

In addition to adapting to climate change itself, producers and forest managers must adapt to changes in policy that result when jurisdictions attempt to reduce GHG emissions to prevent further climate change. This may include mechanisms like carbon pricing, or, for example, regulations like emissions controls for pollutants.[65]

Work by the OECD has suggested that without adaptation action, agriculture would be one of the sectors most damaged by climate change.[66] Meanwhile, the record scale of pest damage and forest fires in recent years has highlighted that the forestry sector is vulnerable to climate-related disasters as well.

Witnesses all agreed that producers need to adapt to succeed economically.[67]

Witnesses noted that, in adapting to current and anticipated impacts of climate change, many producers and retailers are taking measures that increase both the efficiency and the sustainability of their operations,[68] thus enhancing competitiveness and building resilience. As one witness noted, "[i]t would be difficult for us to pinpoint exactly the cost of those adaptations or purchases that we've made to lessen our impact on climate change, partly because some of those decisions are made simply to better our operation or the bottom line."[69]

62 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 19 March, 2018 (Hannah Horn, Manager of Special Investigations, Forest Practices Board).

63 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 March, 2018 (Kevin Serfas, Chair, Government and Industry Affairs Committee, Alberta Canola).

64 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 19 October, 2017 (Barry Smit, Professor Emeritus, Department of Geography, University of Guelph).

65 Ibid.

66 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 30 November, 2017 (Guillaume Gruère, Senior Policy Analyst, Trade and Agriculture Directorate, Natural Resources Policy Division, Organisation for Economic Co-operation and Development).

67 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 4 April, 2017 (Jack Froese, President, Canadian Canola Growers Association).

68 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 22 March, 2018 (Vern Baron, Research Scientist, Sustainable Production Systems, Lacombe Research and Development Centre, Science and Technology Branch, Agriculture and Agri-Food Canada); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 March, 2018 (Todd Lewis, President, Agricultural Producers Association of Saskatchewan); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 6 April, 2017 (Corlena Patterson, Executive Director, Canadian Sheep Federation); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 11 April, 2017 (Jason McLinton, Vice President, Grocery Division and Regulatory Affairs, Retail Council of Canada).

69 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 March, 2018 (Carmen Sterling, Vice-President, Saskatchewan Association of Rural Municipalities).

Resilience is described in Canada's *Federal Adaptation Policy Framework for climate change* as "the capacity of people and systems to absorb negative impacts and respond to changing climate conditions."[70] A resilient system – food system, forest ecosystem, or agricultural system – would be able to withstand and adapt to the wide variety of physical, economic, or societal shocks or changes that could be caused by climate change.

The sections below describe the many ways that Canadian producers are adapting and building resilience to the impacts of climate change.

# Adaptation and resilience in agriculture and agri-food

## IMPROVED CROPS AND ANIMALS

Scientists from Agriculture and Agri-Food Canada are working on developing improved crop varieties more resistant to extreme weather and new pests and diseases.[71] Other researchers are working on developing perennial cultivars of rye, wheat, and barley that would help retain soil carbon and moisture.[72] As Dennis Prouse of CropLife noted, "[t]here are new traits in the pipeline now that will provide improved disease, insect and weed control. Others are designed to improve drought tolerance, saline tolerance and nitrogen use efficiency."[73]

> "There are new traits in the pipeline now that will provide improved disease, insect and weed control. Others are designed to improve drought tolerance, saline tolerance and nitrogen use efficiency.[73]

Animal genetics are also being improved to create more efficiency, which means fewer resources are used over each animal's lifetime. The feed ratio for chickens has improved by 15% over the past 25 years,[74] and the pork feed conversion rate has improved by 33% over the past 50 years, along with reductions in water use and other inputs.[75]

## GOOD MANAGEMENT PRACTICES

**Building soil organic matter**

Organic matter makes soils resilient by helping increase their ability to hold water and nutrients, and providing a habitat for soil organisms. It is the source of nutrients for soil organisms and for the plants growing on the soil.[76]

Many farmers, especially in the prairies, have been building soil health by using limited-till or no-till farming, which, along with cover crops, can reduce the fertilizer input required, while building soil organic matter (or "soil organic

70 Environment Canada, Federal Adaptation Policy Framework for climate change, 12 August 2016.

71 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 8 February, 2018 (Hon. Lawrence MacAulay, P.C., M.P., Minister of Agriculture and Agri-Food).

72 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 22 March, 2018 (Guillermo Hernandez Ramirez, Assistant Professor, Department of Renewable Resources, University of Alberta).

73 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 30 May, 2018 (Dennis Prouse, Vice President, Government Affairs, CropLife Canada).

74 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 11 May, 2017 (Jessica Heyerhoff, Communication and Policy Coordinator, Chicken Farmers of Canada).

75 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 6 April, 2017 (Norman Martineau, Second Vice-Chair, Canadian Pork Council).

76 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 3 October, 2017 (David Burton, Professor, Department of Plant, Food and Environmental Sciences, Faculty of Agriculture, Dalhousie University).

carbon") and reducing erosion. Cam Dahl of Cereals Canada estimated the value of the carbon sequestered in soil by Canada's crop sector at $1 billion dollars (if $CO_2$ were valued at $15 a tonne).[77] Another witness estimated the sequestration at 12 Mt per year, noting that this was achieved without any carbon pricing.[78] Agriculture and Agri-food Canada's interactive map of changes in soil organic carbon levels from 1981 to 2011 highlights increases in the Prairies and decreases in central Canada, where pasture is being converted into cropland. Appendix A shows the changes in the most recent years for which data are available.

**Water management**

To deal with the changes in precipitation and availability of ground and surface water that result from climate change, some producers are implementing new water management approaches to address changes in flow.[79] For example, some are using tile drainage to remove water from farmland that is now chronically wet,[80] and in Nova Scotia, increased provincial funding is supporting farmers to improve well and pond management, in order to be better prepared for variations in rainfall.[81]

**Diversification**

Some witnesses noted the importance of supporting producers to grow a diversity of crops.[82] As part of reducing summer fallow, which was known to deplete soil organic carbon, some farmers have added numerous new crops.[83] They are experimenting with growing non-traditional crops that suit new climate conditions; warmer and longer seasons in the Prairies, for example, have allowed farmers to grow soy, corn, and pulses.[84]

During a fact-finding mission, senators learned that researchers at Dalhousie University produce organic "agents" from algae to help plants grow faster and be more resilient. These technological advances could be an alternative to fertilizers and pesticides, as well as a better way to implement an integrated approach to combating climate change.

77 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 30 March, 2017 (Cam Dahl, President, Cereals Canada).

78 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 March, 2018 (Kevin Serfas, Chair, Government and Industry Affairs Committee, Alberta Canola).

79 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 19 October, 2017 (Barry Smit, Professor Emeritus, Department of Geography, University of Guelph).

80 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 March, 2018 (Dan Mazier, President, Keystone Agricultural Producers of Manitoba).

81 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 2 October, 2017 (Hon. Keith Colwell, M.L.A., Minister of Agriculture, Government of Nova Scotia).

82 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 3 October, 2017 (Lord Abbey, Assistant Professor, Amenity Horticulture, Department of Plant, Food and Environmental Sciences, Faculty of Agriculture, Dalhousie University); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 22 March, 2018 (Vern Baron, Research Scientist, Sustainable Production Systems, Lacombe Research and Development Centre, Science and Technology Branch, Agriculture and Agri-Food Canada).

83 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 22 March, 2018 (Vern Baron, Research Scientist, Sustainable Production Systems, Lacombe Research and Development Centre, Science and Technology Branch, Agriculture and Agri-Food Canada).

84 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 March, 2018 (Kevin Serfas, Chair, Government and Industry Affairs Committee, Alberta Canola).

### Environmental Farm Plans

Environmental Farm Plans (EFPs) were generally seen as useful tools to help farmers adopt practices that address the risks they face; improve their environmental sustainability; and connect with government funding programs that might help them.[85] Because the program is administered by provinces and territories, it can be tailored to local priorities. In Alberta, it was seen as underused,[86] but in Prince Edward Island it was widely used because several large processors required their suppliers to have a plan in place.[87] The potential of the EFP as a tool for tracking carbon in future was discussed.[88]

### Agro-ecological and organic farming

Organic agriculture is a sustainable agricultural practice that enhances soil health and fertility and retains soil carbon, without reliance on external inputs.[89] A representative from Équiterre told the committee that organic farming has the potential to use 45 per cent less fossil fuel energy than a conventional farm, and also makes agriculture more resilient to climate change.[90] Agro-ecological and organic farms help preserve biodiversity, which contributes to resilience.[91] A recent study showed that organic farms could have relatively higher profitability and employment.[92] While acknowledging the efficiencies of scale of large farms, several witnesses noted the value of small-scale farms that don't use chemical fertilizers, and that can more easily protect and improve the quality of the soil.[93]

Senator Ghislain Maltais uses a microscope to get a closer look at a wood core sample while Senators Raymonde Gagné and Diane F. Griffin listen to students at British Columbia's Forest Sciences Centre.

### Nutrient management

Clyde Graham, Senior Vice-President of Fertilizer Canada, described the trademarked 4R Nutrient Stewardship approach to fertilizer use that helps growers to match fertilizer to their specific conditions and to reduce unnecessary fertilizer application: "the right fertilizer source, used at the right rate, at the right time and the right place."[94]

85 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 2 October, 2017 (Robert Godfrey, Executive Director, Prince Edward Island Federation of Agriculture).

86 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 March, 2018 (Lynn Jacobson, President, Alberta Federation of Agriculture).

87 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 2 October, 2017 (Robert Godfrey, Executive Director, Prince Edward Island Federation of Agriculture).

88 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 March, 2018 (Lynn Jacobson, President, Alberta Federation of Agriculture; Carmen Sterling, Vice-President, Saskatchewan Association of Rural Municipalities).

89 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 9 May, 2017 (Ashley St Hilaire, Director of Programs and Government Relations, Canadian Organic Growers).

90 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 5 October, 2017 (Claire Bolduc, Member of the board of directors, Équiterre).

91 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 26 September, 2017 (Genevieve Grossenbacher, Program Manager, Policy and Campaigns, USC Canada).

92 Ibid.

93 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 3 October, 2017 (Gabriela Sabau, Associate Professor, Economics/Environmental Studies, Higher Education, Grenfell Campus, Memorial University of Newfoundland).

94 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 6 June, 2017 (Clyde Graham, Senior Vice President, Fertilizer Canada).

# Adaptation and resilience in forestry

Canada's forest sector has long been adapting to climate change. Forest managers use simulation models to "forecast different scenarios of management for adaptation in different severities of climate change."[95] They can then choose which trees to replant with based on the predicted climate conditions. For example, the Tree Improvement Program of Nova Scotia's Department of Natural Resources has been testing the adaptive capacity of tree species across climate zones for several decades. Working with industry and with provincial partners in neighbouring New Brunswick, the program aims to ensure that there are genetically diverse breeding populations available for the region, across environmental and climatic gradients.[96]

Because of the long-term nature of forestry, where most trees need decades of growth before they can be harvested, witnesses from this sector generally spoke less about adaptation and more about building long term resilience to climate change.

Witnesses noted that Canada has some of the strictest policies when it comes to sustainable forest management and is the global leader in forest certification.[97] Careful forest management can reduce the incidence of fire, insect damage and disease by limiting tree mortality and the subsequent emission of carbon by harvesting at optimal levels.[98]

Several managers of small woodlots described how silviculture, "the nurturing of a forest at integral stages of its growth for many resource uses",[99] is used to help develop healthy forest ecosystems, which respond better to climate change impacts. Management practices such as selection harvesting improve the health of the forest and preserve biodiversity.

"Canada has some of the strictest policies when it comes to sustainable forest management and is the global leader in forest certification.

Several witnesses mentioned the importance of diversifying the forest products industry and creating value-added products. Making better use of forest resources could increase financial returns from forests and could help make it more affordable to manage forests carefully for resilience. An expanded set of products, potentially with smaller carbon footprints

95 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 3 October, 2017 (James Steenberg, Post-doctoral fellow, School for Resource and Environmental Studies, Dalhousie University).

96 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 2 October, 2017 (Hon. Margaret Miller, M.L.A., Minister, Department of Natural Resources, Government of Nova Scotia).

97 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 26 September, (Dana Collins, Executive Director, Canadian Institute of Forestry).

98 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 2 October, 2017 (Susannah Banks, Executive Director, New Brunswick Federation of Woodlot Owners).

99 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 2 October, 2017 (Stacie Carroll, Executive Director, Federation of Nova Scotia Woodland Owners).

than the alternatives,[100] could include "species that exist now but are new to the product world,"[101] biofuels, lumber for an expanded wood building sector,[102] and more. FPInnovations, a not-for-profit company partially funded by industry and by federal and provincial/territorial governments, provides research, development, and technology transfer in the sector, acting as an innovation hub.[103]

Expanding the use of bioproducts was seen by several witnesses as one way that the forestry industry could innovate, adapt to climate change, and contribute to reducing GHG emissions.[104] It could also improve the economic outlook of forestry:

> "To me, it's not very exciting that we participate in the global market for low-end commodities. We need to find ways that we can make more unique things out of the wood we have and maybe then we won't be price takers. As such small players in the global market, we are nothing but price takers and when pulp and 2x4s don't command a very good price, we take the price.[105]

In the PCF and elsewhere, policies exist to support the development of bioproducts. In addition, in 2017 the Canadian Council of Forest Ministers released the Forest Bioeconomy Framework for Canada, designed to promote the use of forest biomass for advanced bioproducts and advanced innovation in the forest sector.[106]

Given that the jurisdiction of forest management lies primarily with the provinces and territories, witnesses noted that the role of the federal government could relate to providing incentives related to innovation and research, and to assessing inventory.[107]

## Measures to support adaptation and resilience

Many suggestions were made about ways to promote the adaptation and resilience building already underway in these sectors.

### RESEARCH AND EXTENSION

Although some witnesses mentioned the value of being involved in roundtables and research projects,[108] many witnesses mentioned a desire for better information about how best to adapt and reduce GHG emissions. Some wanted to see greater investments in research.[109] Tony Shaw, Professor of Geography at Brock University, highlighted the need for government, institutions and the

100 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 5 October, 2017 (Patrick Lavoie, Senior Scientist, FPInnovations).

101 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 20 March, 2018 (Lisa Wood, Assistant Professor, Ecosystem Science and Management, University of Northern British Columbia).

102 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 26 September, (Dana Collins, Executive Director, Canadian Institute of Forestry); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 3 October, 2017 (Peter Duinker, Professor and Acting Director, School for Resource and Environmental Studies, Dalhousie University); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 5 October, 2017 (Pierre Lapointe, President and CEO, FPInnovations).

103 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 5 October, 2017 (Pierre Lapointe, President and CEO, FPInnovations).

104 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 1 March, 2018 (Hon. Jim Carr, P.C., M.P., Minister of Natural Resources; Matt Jones, Assistant Deputy Minister, Pan-Canadian Framework Implementation Office, Environment and Climate Change Canada); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 28 September, 2018 (Robert Larocque, Senior Vice-President, Forest Products Association of Canada).

105 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 3 October, 2017 (Peter Duinker, Professor and Acting Director, School for Resource and Environmental Studies, Dalhousie University).

106 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 1 March, 2018 (Hon. Jim Carr, P.C., M.P., Minister of Natural Resources).

107 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 20 March, 2018 (Werner Kurz, Researcher, Pacific Institute for Climate Solutions, University of Victoria); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 26 September 2017 (Jonathan Lok, Past President, Canadian Institute of Forestry).

108 E.g. Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 2 October, 2017 (Chris van den Heuvel, President, Nova Scotia Federation of Agriculture).

109 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 28 March, 2017 (Ron Bonnett, President, Canadian Federation of Agriculture).

universities to bring a long-term climate perspective.[110] Witnesses felt government could help them respond better to impacts of climate change by providing improved weather and climate forecasting,[111] and modernizing the Canadian weather radar network by increasing computing power and using cutting edge climate models.[112] Producers in several different sectors felt that more specific information related to their sector and how best to adapt would be helpful.[113]

Witnesses showed an appetite for increased extension services. Some suggested that tools could be developed and disseminated to help farmers make good adaptation decisions.[114] One researcher investigated the programs of major agricultural universities and assessed the rural extension services as "decimated."[115] Several witnesses involved in small woodlot management wanted to see more support for extension services and education in forestry.[116] Witnesses noted that provincial extension services were smaller than they had been in the past, and that the knowledge transfer to bring information from research to implementation could be improved.[117]

One representative of the organic sector suggested that:

> "When creating policies like carbon pricing, which will force a shift in agricultural practices, it is critical that the government prioritize research, knowledge transfer, and on-farm extension services, which include organic techniques, so farmers can gain the skills they need to operate energy efficient, profitable farm businesses without passing on the cost to consumers.[118]

Stephane McLachlan, Professor in the Department of Environment and Geography at University of Manitoba, noted a disconnect between the growing ranks of new farmers (many of whom are young, ex-urban, and female) practicing organic and agro-ecological farming and the education and extension opportunities provided by Canada's agricultural universities, suggesting that their programming could improve to better meet the needs of new farmers.[119]

110 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 September, 2017 (Tony Shaw, Professor of Geography, Brock University).

111 E.g. Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 3 October, 2017 (Samuel K. Asiedu, Professor, Department of Plant, Food and Environmental Sciences, Faculty of Agriculture, Dalhousie University).

112 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 March, 2018 (Dan Mazier, President, Keystone Agricultural Producers of Manitoba).

113 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 28 March, 2017 (Rebecca Lee, Executive Director, Canadian Horticultural Council).

114 For example, Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 28 March, 2017 (Ron Bonnett, President, Canadian Federation of Agriculture).

115 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 March, 2018 (Stephane McLachlan, Professor, Department of Environment and Geography, University of Manitoba).

116 E.g. Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 2 October, 2017 (Stacie Carroll, Executive Director, Federation of Nova Scotia Woodland Owners; Susannah Banks, Executive Director, New Brunswick Federation of Woodlot Owners).

117 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 6 April, 2017 (Corlena Patterson, Executive Director, Canadian Sheep Federation).

118 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 9 May, 2017 (Ashley St Hilaire, Director of Programs and Government Relations, Canadian Organic Growers).

119 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 March, 2018 (Stephane McLachlan, Professor, Department of Environment and Geography, University of Manitoba).

OECD analysts recommended the use of extension and training services to share climate information with producers. They suggested that governments should generate (through research and development) and disseminate information and knowledge about tools for assessing, monitoring, and responding to climate risks. They pointed out that adaptation actions need to be suited to local context, and that one way to operate is to organize hubs for research and extension that operate in regions that share similar needs.[120]

## MEASUREMENT AND MONITORING

Several witnesses stated that more data to inform their understandings of adaptation and resilience. Andrew Gonzalez, from the Quebec Centre for Biodiversity Science, recommended "implementing a biodiversity observation system for our agro-ecosystems and forests. […] This infrastructure could provide early warning indicators for the critical loss of adaptation and resilience in our agro-ecosystems,"[121] allowing responses to happen sooner.

In their spring 2016 report on mitigating the impacts of severe weather, the Commissioner of the Environment and Sustainable Development found that information summaries that help predict the intensity, duration and frequency of precipitation, had not been continually produced since 2006. "We also found that half of the floodplain maps in Canada had not been updated since 1996," noted the Commissioner.[122]

## INCENTIVES FOR SUSTAINABLE, RESILIENT PRACTICES AND ECOSYSTEM SERVICES

Many witnesses felt producers and forest owners should be incentivized or rewarded for good management practices[123] and for sequestering carbon in their soils, which would not only make them more resilient but also reduce their GHG emissions.[124] Measures like protecting natural wetlands, planting windbreaks, or maintaining riparian buffer strips would increase ecological diversity, reduce runoff from fields into water bodies, build soil organic carbon,[125] and contribute to system resilience."[126]

Producers could be inspired to change their management practices through incentives and program support, which could be provided by governments.[127] Others felt these services should be rewarded with income from a carbon tax.[128] Witnesses hoped for innovative ways to acknowledge the value of the ecosystem services provided by farmland and forests. [129]

Fertilizer Canada drew attention to the Nitrous Oxide Emissions Reduction Protocol (NERP), which employs the 4R principles to generate saleable offset credits and is used in Alberta's emissions reduction regime. With government support and broader adoption, it could bring real and measurable GHG emissions reductions.

120 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 30 November, 2017 (Guillaume Gruère, Senior Policy Analyst, Trade and Agriculture Directorate, Natural Resources Policy Division, Organisation for Economic Co-operation and Development).

121 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 5 October, 2017 (Andrew Gonzalez, Director, Quebec Centre for Biodiversity Science).

122 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 17 October, 2017 (Julie Gelfand, Commissioner of the Environment and Sustainable Development, Office of the Auditor General of Canada).

123 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 6 June, 2017 (Clyde Graham, Senior Vice President, Fertilizer Canada).

124 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 26 September, 2017 (Martin Entz, Professor, Faculty of Agricultural and Food Sciences, University of Manitoba; Genevieve Grossenbacher, Program Manager, Policy and Campaigns, USC Canada).

125 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 22 March, 2018 (William Shotyk, Bocock Chair for Agriculture and the Environment, Department of Renewable Resources, University of Alberta).

126 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 5 October, 2017 (Andrew Gonzalez, Director, Quebec Centre for Biodiversity Science); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 22 March, 2018 (Graham Gilchrist, Chief Executive Officer, Biological Carbon Canada).

127 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 28 March, 2017 (Ron Bonnett, President, Canadian Federation of Agriculture).

128 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 26 September, 2017 (Genevieve Grossenbacher, Program Manager, Policy and Campaigns, USC Canada).

129 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 19 March, 2018 (Che Elkin, Associate Professor, University of Northern British Columbia).

## MAINTENANCE OF BIODIVERSITY

Protecting or maintaining biodiversity was highlighted as important for resilience – in both forests and agriculture – by several witnesses.[130] One witness pointed out that "globally we have lost 75 per cent of […] agricultural biodiversity in the last 100 years,"[131] noting that monoculture systems are not resilient to climate stress. Another witness explained that mature, biodiverse ecosystems have greater insurance, or resilience, against environmental shocks, so they should be protected and developed:

> "Overall, we find that intact ecosystems, such as forests, mountains and deserts, have a strong moderating influence on the impacts of climate change. The … more a system is simplified, the greater the vulnerability of its habitat and wildlife to climate change impacts. Species show lower resilience in a degraded or altered ecosystem.[132]

## WATER MANAGEMENT SOLUTIONS

Water is shared by agricultural and urban users, so systems will need to be in place for prioritizing users and for managing extremes. One witness pointed out that "it's sensible that we enhance our capacity to even out the hydrological extremes so that farmers and whoever needs water can manage those extremes if and when they come".[133]

Because rainfall is increasingly expected across several major events, instead of being spread over a growing season, adaptation may require that producers have access to funds for capital expenses like water storage infrastructure and irrigation systems:

> "We need to invest in agriculture water management infrastructure. Examples of that might include supporting the construction of improved irrigation systems and flood structures such as dams, storage or other outlets.[134]

## STRENGTHENING OF RELATIONSHIPS THAT BUILD RESILIENCE

One witness found the small farmers in the Maritimes had "detailed, farm-specific plans for adaptation, but they didn't have a trusting enough relationship with governing institutions that might help to make those plans a reality."[135] He suggested there should be "more clear and open communication between agricultural producers and their supporting institutions."[136]

130 E.g. Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 30 May, 2018 (Dennis Prouse, Vice President, Government Affairs, CropLife Canada); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 5 October, 2017 (Andrew Gonzalez, Director, Quebec Centre for Biodiversity Science).

131 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 26 September, 2017 (Genevieve Grossenbacher, Program Manager, Policy and Campaigns, USC Canada).

132 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 20 March, 2018 (Kathy Martin, Professor and Senior Research Scientist, Department of Forest and Conservation Sciences, University of British Columbia).

133 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 March, 2018 (Danny Blair, Director of Science, Prairie Climate Centre).

134 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 6 April, 2017 (John Masswohl, Director of Government and International Relations, Canadian Cattlemen's Association).

135 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 26 October, 2017 (Bernard Soubry, Doctoral Candidate in Geography and Environment, Environmental Change Institute, University of Oxford).

136 Ibid.

Several witnesses mentioned that collaborative processes and a partnership-based approach were really important in working with farmers.[137] Angeline Gillis, Senior Director, Mi'kmaw Conservation Group, Confederacy of Mainland Mi'kmaq, noted that collaboration with all stakeholders was especially important in the development of policies, programs, and regulations. She wanted to see government, indigenous groups, environmentalists and industry come together and develop ideas together, not in individual silos.[138]


Representing the Mi'kmaw Conservation Group, Michael Benson and Angeline Gillis address the importance of combining local and traditional knowledge, as well as science, to tackle challenges related to climate change, from an Indigenous perspective.

## RISK MANAGEMENT SUPPORT

Many witnesses recognized the value of the suite of government-funded business risk management programs. In addition to helping producers deal with shocks, insurance should continue to give producers the confidence to take risks like trying new crops or equipment to take advantage of a changing climate.[139] One witness explained that for some in the Maritimes, climate resilience is driven by financial resilience: "adapting to climate change requires being solvent enough to build, for example, a greenhouse that will allow for season extension or the necessary irrigation systems to avoid damage from rainfall."[140]

Some producers suggested that agri-insurance could be more flexible to accommodate new crops they expected to be able to grow as the climate changes."[141] On the other hand, OECD analysts warned against excessive support for insurance that could encourage farmers to disregard risks.[142]

137 E.g. Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 28 March, 2017 (Ron Bonnett, President, Canadian Federation of Agriculture); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 March, 2018 (Dan Mazier, President, Keystone Agricultural Producers of Manitoba).

138 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 2 October, 2017 (Angeline Gillis, Senior Director, Mi'kmaw Conservation Group, Confederacy of Mainland Mi'kmaq).

139 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 28 March, 2017 (Ron Bonnett, President, Canadian Federation of Agriculture).

140 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 26 October, 2017 (Bernard Soubry, Doctoral Candidate in Geography and Environment, Environmental Change Institute, University of Oxford).

141 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 March, 2018 (Dan Mazier, President, Keystone Agricultural Producers of Manitoba).

142 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 30 November, 2017 (Guillaume Gruère, Senior Policy Analyst, Trade and Agriculture Directorate, Natural Resources Policy Division, Organisation for Economic Co-operation and Development).

## RECOMMENDATIONS

**1** **That the Department of Innovation, Science and Economic Development and Natural Resources Canada further incentivize research and innovation to expand the forest products coming from forests in Canada.**

**2** **That the Government of Canada, in collaboration with provincial and territorial governments:**

a. support community forests and Canada's 400,000 private woodland owners to build resilience in their forests; and

b. support the development of water-management infrastructure by provinces, territories and municipalities to help address anticipated extremes of water availability.

**3** **That Agriculture and Agri-Food Canada, Natural Resources Canada and universities:**

a. increase investment in research related to longer-term adaptation and resilience-building; and

b. ensure that research results are shared with agricultural producers and forest owners/managers.

**4** **That Agriculture and Agri-Food Canada and Natural Resources Canada work with provincial and territorial counterparts and universities to enhance extension services related to adaptation in agriculture and forestry.**

**5** **That Agriculture and Agri-Food Canada, Environment and Climate Change Canada, and Natural Resources Canada:**

a. ensure that information that will build resilience in farm and forest land, such as predicted precipitation data and floodplain maps, is collected, analysed and made available to Canadian agricultural producers and forest owners/managers; and

b. expand and further develop incentives that recognize and reward resilient practices and the provision of ecosystem services.

**6** **That Environment and Climate Change Canada and Natural Resources Canada develop systems for better monitoring of biodiversity to provide early warning indicators of biodiversity loss and to support resilience.**

# Impact of Carbon pricing mechanisms on competitiveness in the agriculture, agri-food, and forestry sectors

Under the *Federal Greenhouse Gas Pollution Pricing Act*, there will be a price on carbon across Canada by January 2019. Each province and territory will be able to determine its own carbon pricing approach, based on the needs of its jurisdiction.

While acknowledging the need for action to mitigate climate change,[143] agricultural producers were concerned about economic challenges that carbon pricing could cause for them. Both agricultural and forestry producers also saw potential benefits in the form of carbon credits and offset markets.

143 See, for example, Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 1 June, 2017 (Ron Maynard, Member of Board of Directors, Dairy Farmers of Canada).

# Economic importance of the agriculture, agri-food, and forestry sectors in Canada

The agriculture, agri-food, and forestry sectors together employ almost 2.6 million people in Canada,[144] and are at the heart of communities across the country.

The final report of the federal government's Advisory Council on Economic Growth, known as the "Barton Report," suggested that agriculture and agri-food could be a source of significant economic growth for Canada – potentially benefitting the Canadian economy as a whole. Witnesses wanted the government to ensure that the sectors could grow to their full potential, with Canada, as one witness said, benefitting by becoming the world's "trusted supplier of safe, sustainable food."[145]

# Carbon pricing mechanisms

Canada has an international obligation under the *Paris Agreement* to substantially reduce GHG emissions, and witnesses all agreed that GHG emissions need to be reduced. Several witnesses explained that putting a price on carbon is the most cost-effective way a country can reduce GHG emissions.[146] According to Nicholas Rivers, Associate Professor at the Graduate School of Public and International Affairs at University of Ottawa,

> "[e]conomists have long advocated for introducing a price on carbon emissions covering all emissions in the economy as the most cost-effective way to reduce greenhouse gas emissions. Such a policy provides incentives for all emitters to reduce their pollution without singling out particular firms or individuals.[147]

As opposed to regulatory measures to reduce GHGs, which also come at a cost, carbon pricing policies decentralize decision-making processes about which options to choose "so that emissions reductions occur where they are cheapest today."[148]

144 Agriculture and Agri-Food Canada, 2016, *An Overview of the Canadian Agriculture and Agri-Food System 2016*.; Natural Resources Canada, 2017, Statistical Data.

145 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 2 November, 2017 (Evan Fraser, Canada Research Chair in Global Food Security, Social Sciences and Humanities, University of Guelph).

146 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 26 October, 2017 (Dale Beugin, Executive Director, Canada's Ecofiscal Commission); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 September, 2017 (Brandon Schaufele, Assistant Professor in Business, Economics and Public Policy, Ivey Business School, The University of Western Ontario); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 19 March, 2018 (Sumeet Gulati, Associate Professor, Faculty of Land and Food Systems, Food and Resource Economics Group, University of British Columbia).

147 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 September, 2017 (Nicholas Rivers, Associate Professor, Public and International Affairs, Faculty of Social Sciences, University of Ottawa).

148 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 30 November, 2017 (Ben Henderson, Policy Analyst, Trade and Agriculture Directorate, Natural Resources Policy Division, Organisation for Economic Co-operation and Development).

One official from Environment and Climate Change Canada explained that pricing carbon "provides incentive to reduce emissions while encouraging innovation and sending long-term signals to investors and others about the low carbon economic transformation of the Canadian economy."[149]

In putting a price on carbon, Canada joins numerous other jurisdictions around the globe that have taken this approach to decrease their GHG emissions, including Norway, France, South Africa, and Argentina.

Some witnesses recommended using measures other than a carbon price. Pointing out GHG reductions that have already taken place, John Masswohl, Director of Government and International Relations at the Canadian Cattlemen's Association said, "we think we can make our greenhouse gas footprint even smaller. We don't think that the tax is the right tool to help us do that. We think there are incentives in innovation and research."[150]

Serge Buy, of the Agricultural Institute of Canada, emphasized Canada's potential to become a global leader in agricultural innovation, noting that government has an important role in incentivizing development and adoption of new, green technologies, and suggesting that "carbon pricing has the ability to become a key driver of innovation in Canada's agricultural sector."[151]

At the beginning of the committee's study, there was uncertainty about how carbon pricing would work in Canada. In December 2017 the Pan-Canadian Framework was released, providing more information about the federal government's planned approach to carbon pricing, including the flexibility afforded to provinces and territories to determine their own approaches, the federal government's plan to return all revenues from the federal carbon pricing backstop[152] to the province or territory they originated in. Over the course of the study and the preparation of this report, some provinces changed their approaches to carbon pricing.

## Anticipated impacts of carbon pricing on competitiveness

Carbon pricing is expected to impact all Canadians. According to Rebecca Lee of the Canadian Horticultural Council, for producers, carbon pricing is anticipated to bring higher costs for fertilizer, packaging, transportation, and fuel.[153] Greenhouse growers are expected to be among the agricultural producers most impacted economically by a carbon tax because of their energy intensiveness.[154] One study suggested a likely contraction of 1-2% in the greenhouse sector under the effects of a $20 per tonne carbon price.[155]

Some witnesses suggested a carbon price would cause food prices to rise. One witness presented study results, however, that showed no discernable impact on food prices in Canadian jurisdictions when a carbon price was instituted.[156]

149 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 1 March, 2018 (Judy Meltzer, Director General, Carbon Pricing Bureau, Environment and Climate Change Canada)

150 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 6 April, 2017 (John Masswohl, Director of Government and International Relations, Canadian Cattlemen's Association).

151 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 28 September, 2018 (Serge Buy, Chief Executive Officer, Agricultural Institute of Canada).

152 The "backstop" is to be implemented in any province or territory that does not develop its own carbon pricing plan, and in any whose plan does not meet the standards set by the federal government.

153 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 28 March, 2017 (Rebecca Lee, Executive Director, Canadian Horticultural Council).

154 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 28 March, 2017 (Ron Bonnett, President, Canadian Federation of Agriculture); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 28 March, 2017 (Justine Taylor, Science and Government Relations Manager, Ontario Greenhouse Vegetable Growers).

155 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 September, 2017 (Nicholas Rivers, Associate Professor, Public and International Affairs, Faculty of Social Sciences, University of Ottawa).

156 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 September, 2017 (Brandon Schaufele, Assistant Professor in Business, Economics and Public Policy, Ivey Business School, The University of Western Ontario).

Witnesses also suggested that carbon pricing policies would make their products less competitive internationally,[157] as rising input costs could not be passed on to consumers.[158] A major concern was that in highly traded sectors such as cattle, wheat, or canola, domestic producers would have no way of passing on the additional cost of a carbon price, because prices are set globally,[159] resulting in lower incomes for producers. Said one representative:

> “We are price takers in a global marketplace. We cannot pass along any of these costs. We must compete internationally with farmers who operate their businesses in an environment that will not have these additional costs.[160]

Some were concerned that international competition would lead to production and processing moving to other jurisdictions – in particular to the United States. For example, the Canadian Meat Council expressed concern that some meat packing plants are close to the United States border and might find it worthwhile to avoid increased taxation, workforce challenges, and regulatory burden by relocating south of the border.[161]

Many witnesses noted the risk of carbon leakage – a decrease in production in Canada and an increase in production in other countries that don't have a price on carbon, resulting in no net change, or even an increase, in global emissions. This may occur in highly traded sectors where prices are set in a global market.[162] An output-based subsidy to emissions-intensive, trade-exposed industries, however, can be combined with a carbon price to reduce carbon leakage.[163]

A study of British Columbia's overall international competitiveness provided some counter-balance to these concerns; Brandon Schaufele, Assistant Professor at University of Western Ontario's Ivey Business School noted that "using the best data and methods available, we could not find an effect of British Columbia's carbon tax on that province's international competitiveness."[164]

Some producers were also concerned about inter-provincial competition, given the possibility for Canadian jurisdictions to design their own approaches, including different carbon prices or potential exemptions, such as on heating fuel for barns or greenhouses in one province but not in another.[165] Chicken farmers, for example, were concerned that they would not be able to pass additional carbon costs along to consumers given the nature of the contracts they work with:

157 E.g. Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 4 April, 2017 (Jack Froese, President, Canadian Canola Growers Association; Chris Vervaet, Executive Director, Canadian Oilseed Processors Association).

158 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 11 April 2017 (Rod Scarlett, Executive Director, Canadian Honey Council).

159 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 28 March, 2017 (Ron Bonnett, President, Canadian Federation of Agriculture); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 4 April, 2017 (Chris Vervaet, Executive Director, Canadian Oilseed Processors Association).

160 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 4 April, 2017 (Jack Froese, President, Canadian Canola Growers Association).

161 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 29 March 2018 (Chris White, President and Chief Executive Officer, Canadian Meat Council).

162 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 September, 2017 (Brandon Schaufele, Assistant Professor in Business, Economics and Public Policy, Ivey Business School, The University of Western Ontario).

163 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 26 October, 2017 (Dale Beugin, Executive Director, Canada's Ecofiscal Commission).

164 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 September, 2017 (Brandon Schaufele, Assistant Professor in Business, Economics and Public Policy, Ivey Business School, The University of Western Ontario).

165 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 11 May, 2017 (Mike Dungate, Executive Director, Chicken Farmers of Canada; Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 22 March, 2018 (Anna De Paoli, Consultant to the Alberta Greenhouse Growers Association, Alberta Greenhouse Growers Association).

> The chicken industry cannot pass on the costs of the carbon price. Due to the nature of national purchasing contracts, costs unique to a province cannot be added to the price paid by our customers, and it is therefore critical that if a carbon price is implemented, it's done so at a federal level. A provincial patchwork of programs will create inequity between our farmers because we have production in all provinces.[166]

Railway representatives recommended that the government consider transport by rail as a $CO_2$ offset because it is four times more fuel efficient than truck transportation.[167] Railways, major transporters of agricultural and forest-related products, were also concerned about competitiveness resulting from the variation in carbon pricing across provinces:

> We believe that linear companies like railways, which operate in multiple jurisdictions, have been an afterthought at best in provincial and federal carbon pricing strategies. For example, Class I railway companies are required to meet multiple and often overlapping administration and reporting requirements. Having different climate policies in each jurisdiction is onerous to railways that are required to meet multiple administration and reporting requirements. [168]

166 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 11 May, 2017 (Jessica Heyerhoff, Communication and Policy Coordinator, Chicken Farmers of Canada).

167 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 1 June, 2017 (Michael Bourque, President and Chief Executive Officer, Railway Association of Canada).

168 Ibid.

Dr. Nicholas Rivers noted that the impact of the carbon tax in agriculture would likely be much less than feared:

> “Changes in commodity prices for canola or pigs, or whatever it is, have much bigger impacts on the profits of a farm than any carbon prices being discussed ever will have, especially when you remember that carbon prices raise revenue for the government. One of the things the governments should and could do with that revenue is turn around and offer subsidies to affected sectors to maintain their international competitiveness.[169]

This perspective was shared by several witnesses, who emphasized the important role of governments in returning revenue from carbon pricing to industries to compensate for losses related to lower competitiveness resulting from carbon pricing.[170]

## Sustainability improvements that also increase competitiveness

Producers are always aiming to become more efficient – and more competitive. Troy Warren, of the Canadian Meat Council, pointed out the environmental improvements made in the sector over recent decades. He pointed out that the Canadian livestock and meat sector has an “already established trajectory of progressively reducing its environmental footprint.”[171] Another witness noted:

> “We’ve already been working for a lot of years, not with the express objective of reducing our greenhouse gas footprint, but with the objective of making ourselves more efficient producers, and that’s had the benefit of actually reducing our greenhouse gas footprint.[172]

Other industries have also made substantial improvements in efficiency sustainability and GHG reductions over recent decades and continue to work towards further improvements: crop producers reducing tillage and fertilizer use; and

169 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 September, 2017 (Nicholas Rivers, Associate Professor, Public and International Affairs, Faculty of Social Sciences, University of Ottawa).

170 E.g. Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 15 June, 2017 (Gérald Gauthier, Vice President, Railway Association of Canada); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 26 October, 2017 (Dale Beugin, Executive Director, Canada’s Ecofiscal Commission).

171 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 4 May, 2017 (Troy Warren, Chair of the Board of Directors, Canadian Meat Council).

172 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 6 April, 2017 (John Masswohl, Director of Government and International Relations, Canadian Cattlemen’s Association).

egg, chicken and pork producers improving feed efficiency and barn energy use, among others.[173] J.D. Irving Ltd. has done its own research into carbon sequestration, and estimates that overall its operations will absorb over one million tonnes of carbon per year for the next 50 years.[174]

As one witness pointed out, these kinds of changes in production practices "can be win-win, helping to achieve government's intended objectives of GHG reductions while improving producer competitiveness."[175] Some producers felt unfairly targeted by climate legislation considering that they have already been working hard and investing to improve their environmental performance.

## Reducing the impact of carbon pricing on the competitiveness of the sectors

Witnesses generally agreed on the need to find ways to eliminate unduly negative economic impacts of carbon pricing on producers. As one witness said, "the idea is not to be nice with producers but rather to enable them to be efficient and profitable so they can invest in emissions reduction measures."[176]

### EXEMPTIONS

Witnesses from many industries discussed the possibility of exempting producers from paying a price on carbon; for example, an exemption from taxation for on-farm fuel, or an exemption or reduction in tax for greenhouse growers. As noted earlier, however, witnesses were very clear that having different exemptions in different provinces could cause complications:

> "We need a consistent application across the country. B.C. has put carbon pricing in place, and they said they will exempt farmers. They exempt propane used for heating barns. In Alberta, they have exempted farm machinery from that, but not the propane and gas used to heat barns.[177]

This would mean that Alberta chicken farmers, competing in the same market, would be at a disadvantage compared with their BC counterparts. Quebec producers, who are not exempted from carbon pricing, would also be at a disadvantage.[178]

During its study of the *Greenhouse Gas Pollution Pricing Act* (Part 5 of Bill C-74), the committee heard from stakeholders who were concerned about the negative impacts of carbon pricing on agricultural businesses.

173 E.g. Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 11 May, 2017 (Tim Lambert, Chief Executive Officer, Egg Farmers of Canada).

174 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 24 October, 2017 (Greg Adams, Manager, Research and Development, J.D. Irving, Limited).

175 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 30 March, 2017 (Cam Dahl, President, Cereals Canada).

176 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 5 October, 2017 (Benoit Legault, Director General, Producteurs de grains du Québec).

177 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 11 May, 2017 (Mike Dungate, Executive Director, Chicken Farmers of Canada).

178 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 5 October, 2017 (Daniel Bernier, Agronomist, Research and agricultural policy department, Union des producteurs agricoles).

Ron Bonnett, President of the Canadian Federation of Agriculture, argued that all on-farm fuels should be exempt from carbon pricing, noting that "[n]atural gas and propane play a very important role in production, for example, in grain drying to maintain quality and avoid spoilage prior to marketing."[179] Dan Mazier, President of Keystone Agricultural Producers of Manitoba, noted: "[t]he irony is that as we adapt to climate change, we often invest in more carbon-intensive tools like grain dryers or irrigation systems."[180] Mark Wales of the Canadian Horticultural Council pointed out that because "property that is used for the purpose of providing heating or cooling to a building or similar structure" is excluded from the definition of eligible farming machinery in the *Act*,[181] "primary agriculture that relies on heat, such as greenhouses, livestock barns, grain dryers and the cooling of produce post harvest are therefore assumed ineligible despite being essential to the Canadian production of high quality food, feed and fibre."[182]

Based on this testimony, in its 12th report, the committee observed that the Government of Canada should:

- [e]xempt heating and cooling fuel costs related to farming from the carbon pricing levy in the *Greenhouse Gas Pollution Pricing Act*; and

- [s]pecifically include propane and natural gas under the definition of a qualifying farm fuel in the *Greenhouse Gas Pollution Pricing Act* to exempt those fuels from the carbon pricing levy.[183] [184]

Some witnesses in the present study maintained that the most cost-effective way to reduce GHG emissions is for governments to apply a price to carbon broadly, without exemptions, and to develop industry-specific subsidies that compensate for decreased competitiveness. Otherwise, other sectors must reduce by more, or emissions reduction targets will be less likely to be met.[185]

Some noted that exemptions give a sector no incentive to reduce GHG emissions, and instead push the burden of GHG reduction to the rest of economy, which will have to do more:

> "Given the ambitious targets we have, we cannot afford to leave sectors unaffected by carbon prices. We want to give everyone an incentive to reduce emissions. The suggestion would be to continue putting that carbon price on greenhouses but find other ways to support greenhouses in terms of competing internationally.[186]

179 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 3 May 2018 (Ron Bonnett, President, Canadian Federation of Agriculture).

180 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 8 May 2018 (Dan Mazier, President, Keystone Agricultural Producers of Manitoba).

181 Greenhouse Gas Pollution Pricing Act (S.C. 2018, c. 12, s. 186)

182 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 10 May 2018 (Mark Wales, Energy, Environment and Climate Change Working Group Member and Field Vegetable Grower, Canadian Horticultural Council).

183 Senate of Canada, Standing Senate Committee on Agriculture and Forestry, Twelfth Report, 31 May, 2018.

184 On 23 October 2018, the Government of Canada announced, in its Backgrounder: Targeted Relief for Farmers and Fishers, and Residents of Rural and Remote Communities, partial relief from the fuel charge (80%) for greenhouse operators who use propane or natural gas exclusively for the operation of a commercial greenhouse for the growing of any plant. Though this addressed concerns of greenhouse operators, there may still be negative economic impacts on other farm operators.

185 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 26 October, 2017 (Dale Beugin, Executive Director, Canada's Ecofiscal Commission); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 9 November, 2017 (Philip Bagnoli, Analyst-Advisor, Office of the Parliamentary Budget Officer).

186 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 September, 2017 (Nicholas Rivers, Associate Professor, Public and International Affairs, Faculty of Social Sciences, University of Ottawa).

Or, as Philippe Bagnoli from the Parliamentary Budget Office put it, if agriculture is exempt from carbon pricing,

> “[…] you are missing potentially inexpensive things that you could do within agriculture and making them more expensive outside of agriculture. This is the idea of a uniform carbon price. You take advantage of the cheapest opportunities where they exist.[187]

## ECO-SYSTEM SERVICES: RECOGNITION AND REWARD FOR THE MULTIPLE CONTRIBUTIONS OF AGRICULTURAL AND FOREST LANDSCAPES

Many witnesses recognized not just the economic, but also the ecological, recreational, and other values of agricultural and forest landscapes.[188] Witnesses felt it was extremely important to reward the ecological contribution of well managed agricultural and forest lands, especially given that there are costs involved with implementing these management practices.

One witness noted that the ecosystem services producers supply to society could be increased with a financial incentive, pointing out that “[p]runing, thinning, filling in gaps take from the farmer’s bottom line.”[189] Supporting the notion that it takes resources to enhance a forest’s ecosystem services, Angeline Gillis, of the Mi’kmaw Conservation Group, noted numerous actions that can be part of responsible forest stewardship, some of which include “leaving some areas of high density forest to provide cover for wildlife; introducing mandatory firebreaks in the form of wetlands and/or marshes that could also sequester carbon, filter runoff water and provide a host of beneficial ecosystems services; maintaining soil productivity and minimizing carbon loss from harvested sites, et cetera.”[190]

A few witnesses mentioned the ALUS program (Alternative Land Use Services), run by a national charitable organization, which pays farmers to take farmland out of production when this can provide ecosystem services like buffering for water areas.[191] This helps producers maintain financial viability while improving environmental sustainability.

187 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 9 November, 2017 (Philip Bagnoli, Analyst-Advisor, Office of the Parliamentary Budget Officer).

188 E.g. Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 2 October, 2017 (Hon. Margaret Miller, M.L.A., Minister, Department of Natural Resources, Government of Nova Scotia).

189 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 2 October, 2017 (John Russell, Environmental Farm Plan Coordinator, Agricultural Alliance of New Brunswick).

190 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 2 October, 2017 (Angeline Gillis, Senior Director, Mi’kmaw Conservation Group, Confederacy of Mainland Mi’kmaq).

191 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 2 October, 2017 (John Russell, Environmental Farm Plan Coordinator, Agricultural Alliance of New Brunswick); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 2 October, 2017 (Chris van den Heuvel, President, Nova Scotia Federation of Agriculture).

## STAYING COMPETITIVE THROUGH BUILDING REPUTATION AND PUBLIC TRUST

Many witnesses commented that agricultural and forest producers are responsible stewards of the land, committed to long-term environmental sustainability.[192] One witness noted that surveys of international customers have repeatedly shown that the Canadian forest products industry has the best environmental reputation in the world.[193] The high level of environmental responsibility exhibited by Canada's agriculture and forestry sectors was highlighted by several witnesses as a valuable part of their brand. Many also noted the importance of public trust.[194]

In the agriculture sector, many witnesses acknowledged the importance of environmental measures in maintaining their social licence. Speaking about egg farmers' environmental initiatives, Tim Lambert noted that they were "embracing this as part of public trust and social licence, not only at an organizational level nationally and internationally, but right down to the farm level. Really, for us, we've built it into the core of our business plan."[195]

One witness pointed out the importance of trust, citing case studies that show that a focus on more than just profitability can make a business more efficient, profitable and resilient: "You have better and stronger brands and better public trust. You're more likely to have people buy your products because they connect to you on your values."[196]

## CARBON CREDITS

There was broad recognition among witnesses that many activities undertaken by producers and forest managers actually reduce emissions of GHGs into the environment. Producers wanted to be recognized for this contribution, and many witnesses proposed that receiving carbon credits in some form, to be sold as carbon offsets, could reward GHG-reducing actions and compensate for impacts on competitiveness potentially caused by carbon pricing.[197]

192 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 28 March, 2017 (Rebecca Lee, Executive Director, Canadian Horticultural Council); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 4 April, 2017 (Jack Froese, President, Canadian Canola Growers Association); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 6 April, 2017 (Bob Lowe, Chair, Environment Committee, Canadian Cattlemen's Association); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 11 May, 2017 (Mark Davies, Chair, Turkey Farmers of Canada; Jessica Heyerhoff, Communication and Policy Coordinator, Chicken Farmers of Canada); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 1 June, 2017 (Ron Maynard, Member of Board of Directors, Dairy Farmers of Canada).

193 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 28 September, 2018 (Robert Larocque, Senior Vice-President, Forest Products Association of Canada).

194 For example, Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 28 March, 2017 (Rebecca Lee, Executive Director, Canadian Horticultural Council; Ron Bonnett, President, Canadian Federation of Agriculture); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 9 May, 2017 (Ashley St Hilaire, Director of Programs and Government Relations, Canadian Organic Growers); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 11 May, 2017 (Tim Lambert, Chief Executive Officer, Egg Farmers of Canada); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 13 February, 2018 (Karen Beauchemin, Research Scientist, Sustainable Production Systems, Lethbridge Research and Development Centre, Science and Technology Branch, Agriculture and Agri-Food Canada).

195 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 11 May, 2017 (Tim Lambert, Chief Executive Officer, Egg Farmers of Canada).

196 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 15 June, 2017 (Cher Mereweather, Executive Director, Provision Coalition).

197 E.g. Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 6 April, 2017 (John Masswohl, Director of Government and International Relations, Canadian Cattlemen's Association); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 2 October, 2017 (John Rowe, President, PEI Woodlot Association); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 19 October, 2017 (Barry Smit, Professor Emeritus, Department of Geography, University of Guelph); Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 22 March, 2018 (Guillermo Hernandez Ramirez, Assistant Professor, Department of Renewable Resources, University of Alberta; William Shotyk, Bocock Chair for Agriculture and the Environment, Department of Renewable Resources, University of Alberta).

One witness explained that carbon credits could promote sustainable management choices:

> “The opportunity to sell carbon credits through the carbon market structures would ensure forests are set aside for longterm growth to sequester carbon and promote high-value forest products, also increasing their ability to support the change in flora and fauna.[198]

Guillermo Hernandez Ramirez, Assistant Professor in the Department of Renewable Resources at University of Alberta, pointed out that a carbon credit “can send a clear signal to implement management practices, not only to reduce greenhouse gases emissions but also to favour positive beneficial management practices.” Benoit Legault of the Producteurs de grains du Québec stated: “we are requesting protocols that enable us to trade carbon offset credits for farm businesses more efficiently and profitably.”[199]

Graham Gilchrist, Chief Executive Officer of Biological Carbon Canada, described the success of Alberta’s carbon pricing and offset systems, which have been in place since 2007. Since then, he noted, 46 Mt of carbon offsets have been sold, 14.3 Mt of which come from agriculture and were purchased for over $180 million. He stressed that carbon markets really work, noting that “the market, the $180 million that has been traded between our final emitters and our farmers, creates jobs, creates emission reductions, and builds new technologies to do the work that’s required for verification and other requirements […].”[200]

In their report “Four things you should know about carbon offsets,” the Ecofiscal Commission highlights two considerations to be made in determining when to offer carbon credits – additionality and permanency. To assess additionality, one asks whether the reduction in emissions would have happened anyway, even without a policy to recognize and reward it. If it would have happened anyway, spending money to reward the reductions is not an efficient use of funds. To assess permanency, one asks how long the reduction will last. If it can be easily undone, fewer real emissions reductions can be associated with the credit.[201]

Some witnesses were concerned that producers would not be fairly rewarded. For example:

> “If we […] only talk “additionality,” it doesn’t already credit woodlot owners for the benefits that are currently there, or the carbon that’s currently there. So it would be good if the baseline somehow gives them credit for what they’ve already done.[202]

Witnesses acknowledged several challenges to overcome in establishing carbon credit systems; quantifying emissions and sequestration from agriculture and forestry is technically challenging, and reaching agreement on what baseline to compare against is difficult. Certification or verification would also be needed. Some jurisdictions, however, such as Alberta, have already developed a suite of offset protocols for use by agricultural producers.

198 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 2 October, 2017 (Stacie Carroll, Executive Director, Federation of Nova Scotia Woodland Owners).

199 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 5 October, 2017 (Benoit Legault, Director General, Producteurs de grains du Québec).

200 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 5 October, 2017 (Graham Gilchrist, Chief Executive Officer, Biological Carbon Canada).

201 Ecofiscal Commission. Four things you should know about carbon offsets 23 September 2015.

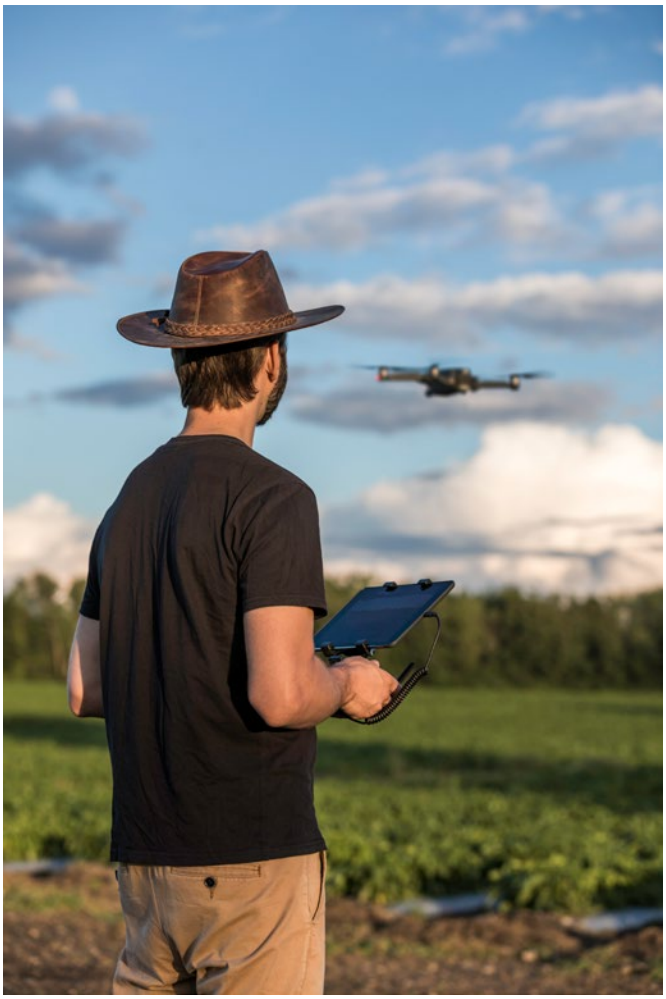
202 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 2 October, 2017 (Susannah Banks, Executive Director, New Brunswick Federation of Woodlot Owners).

Chris van den Heuvel, President of the Nova Scotia Federation of Agriculture, suggested that offset credits should be expanded to provide incentives to producers and increase their knowledge of how to reduce GHG emissions. He suggested that governments should consult with producers during design of an offset credit mechanism.[203] Dr. Guillermo Hernandez Ramirez would like to see higher prices for carbon credits. He noted their importance in carbon sequestration, and pointed out the transaction costs involved in obtaining carbon credits, including for an intermediary, who may be needed for bulking or compiling the credits to sell to a market.[204]

Many producers felt that there should be recognition and reward for those who have already been reducing their emissions by investing in measures that sequester carbon, like no-till farming, or enhancing riparian buffers that reduce runoff and soil erosion.[205] As one witness said:

> “
>
> […] farmers have a history of rapidly adopting new technologies to reduce their environmental footprint while protecting their profitability, and they will continue to do so. But farmers have already gone to a great deal to reduce their impact, and this must be recognized.[206]

Representatives from the province of Saskatchewan, which has not signed on to the PCF, were in favour of retroactive recognition, and expressed concern that “under a carbon tax plan there is no way that there is credit given for the early action that’s already been taken by industry.[207] In contrast, the Parliamentary Budget Officer, Jean-Denis Fréchette, argued against trying to give credit for past actions.[208]



203 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 2 October, 2017 (Chris van den Heuvel, President, Nova Scotia Federation of Agriculture).

204 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 22 March, 2018 (Guillermo Hernandez Ramirez, Assistant Professor, Department of Renewable Resources, University of Alberta).

205 E.g. Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 2 October, 2017 (Chris van den Heuvel, President, Nova Scotia Federation of Agriculture).

206 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 March, 2018 (Kevin Serfas, Chair, Government and Industry Affairs Committee, Alberta Canola).

207 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 17 April, 2018 (Hon. Dustin Duncan, Minister of Environment, Government of Saskatchewan).

208 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 9 November, 2017 (Jean-Denis Fréchette, Parliamentary Budget Officer, Office of the Parliamentary Budget Officer).

## RECOMMENDATIONS

**7** **That Environment and Climate Change Canada re-examine exemptions permitted for agricultural activities under the *Federal Greenhouse Gas Pollution Pricing Act*, with special attention to competitiveness for producers and food affordability for Canadians. In particular, the department should consider the following exemptions from carbon pricing:**

a. exempt the fuel costs for machinery that heats or cools a building used for farming by including "property that is used for the purpose of providing heating or cooling to a building or similar structure"[209] in the definition of *eligible farming machinery*; and

b. exempt propane and natural gas under the definition of a *qualifying farm fuel* for all farming activities.

**8** **That Environment and Climate Change Canada, building on existing provincial models, develop offset protocols that would allow agricultural producers and forest owners/managers in provinces applying the federal carbon pricing backstop to receive additional income through carbon credits.**

**9** **That Agriculture and Agri-Food Canada, the Department of Innovation, Science and Economic Development through its granting councils, Environment and Climate Change Canada and Natural Resources Canada, undertake and/or support research that will help to establish baseline levels of soil organic carbon to support the development of offset protocols for carbon sequestration across Canada.**

209 Greenhouse Gas Pollution Pricing Act (S.C. 2018, c. 12, s. 186)

# Meeting Canada's emissions-reduction targets: Roles of federal and provincial/territorial governments

## Federal and provincial/territorial responsibilities

Canada's federal government is responsible for ensuring that Canada meets its international obligation on climate change mitigation. Most of Canada's provinces and territories have climate action plans and some have emissions reduction targets.[210] Some of the plans lay out actions to help the agriculture and forestry sectors reduce emissions.

Provinces and territories have jurisdiction over their forests, while the federal government is responsible for forests on federal lands, which make up 4% of Canada's forests. Provinces and territories develop and enforce laws, regulations, and policies related to their forests. As noted earlier, federal and provincial governments share jurisdiction over agriculture.

Given the shared responsibilities in agriculture and forestry, federal departments and provincial/territorial jurisdictions must coordinate in the development of policies that help to decrease GHGs emitted in these areas.

210 See, for example, Manitoba's Climate Change and Green Economy Action Plan, 2015; Toward a Greener Future: Nova Scotia's Action Plan, 2009; British Columbia: Climate Planning and Action, 2016.

## Federal-provincial/territorial collaboration for mitigation

The Pan-Canadian Framework on Clean Growth and Climate Change (PCF) lays out Canada's plan for addressing climate change broadly and for reducing GHG emissions. It does not specify emissions-reduction targets by province/territory or by sector; it focuses on the overall planned reduction.

The PCF is an agreement between Canadian jurisdictions and requires collaboration in order to be implemented effectively, both across jurisdictions and across the federal government. Environment and Climate Change Canada works closely with Natural Resources Canada and Agriculture and Agri-Food Canada to help the agriculture and forestry sectors reduce emissions and adapt to the impacts of climate change.[211] Matt Jones, Assistant Deputy Minister in the Pan-Canadian Framework Implementation Office, described progress to date and funding dedicated as of March 2018 to four primary measures in the PCF that impact the agriculture and forestry sectors:

(1) enhancing carbon storage in forests, wetlands, and agricultural lands: The Low Carbon Economy Fund announced by the federal government in June 2017 supports, among other things, new and expanded provincial and territorial actions in these areas;

(2) supporting the increased use of wood for construction: $40 million is invested over 4 years in the Green Construction through Wood Program;

(3) generating fuel from bioenergy and bioproducts: In 2017 the Canadian Council of Forest Ministers released their Forest Bioeconomy Framework for Canada to promote the use of forest biomass for advanced bioproducts and advanced innovation in the forest sector; and

(4) advancing innovation: Investments of almost $125 million across several initiatives will cover science and innovation related to climate change and soil and water conservation, and innovative projects to help farmers reduce GHG emissions, along with other things.[212]

211 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 1 March, 2018 (Matt Jones, Assistant Deputy Minister, Pan-Canadian Framework Implementation Office, Environment and Climate Change Canada).

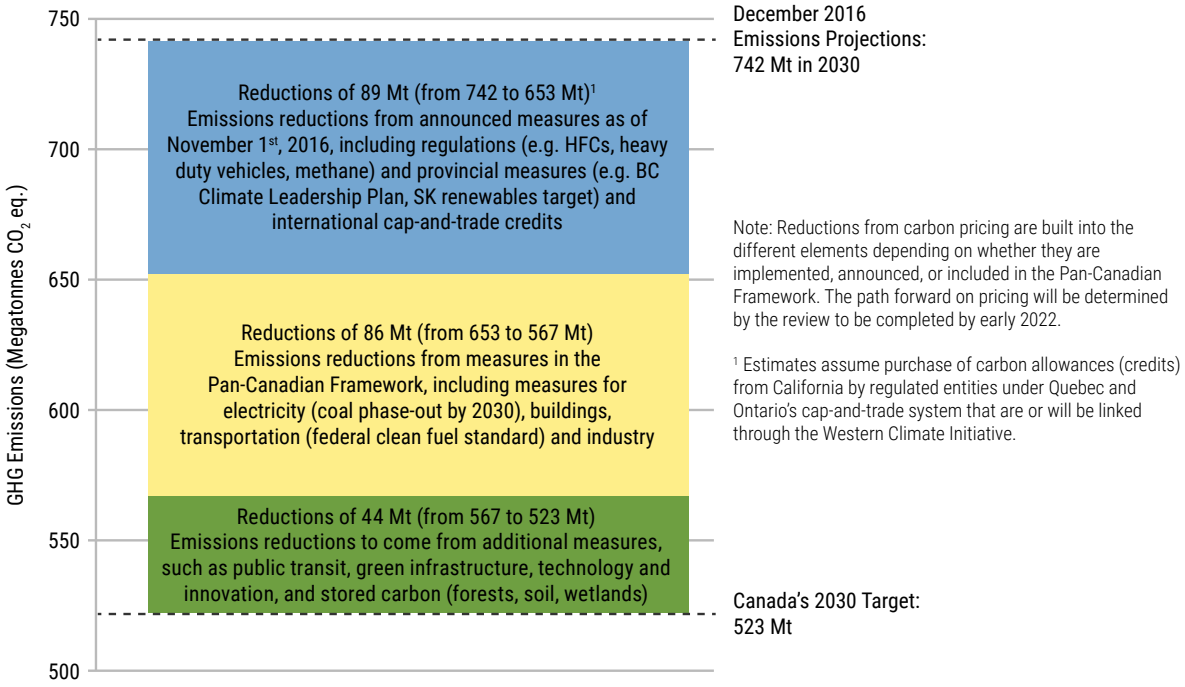
212 Ibid.

The Commissioner of the Environment and Sustainable Development, Julie Gelfand, testified that over the past 25 years, numerous plans to address climate change had been prepared by Canada's various federal governments, and "none of those plans [had] really been properly implemented."[213] She noted that the Pan-Canadian Framework was possibly the best plan created to date, because of the involvement of provinces and territories in its development and because roles and responsibilities for implementation had been developed:

> "The entire community has to be called on if we are to reach our targets in reducing greenhouse gases. Everyone has a role to play and a responsibility to shoulder. The [federal] government cannot do it all alone. Working with the provinces was a good decision, in our opinion.[214]

Environment and Climate Change Canada has stated, however, that even if all the greenhouse gas reduction measures outlined in the Pan-Canadian Framework are implemented, there will still be more emissions reductions needed to achieve Canada's 2030 mitigation target.[215] The figure below shows reductions expected from measures already in place; reductions expected from measures planned in the PCF, and reductions needed from measures that are not yet in place.

**Figure 8 – Estimated Emissions Reductions Required to Meet Canada's Mitigation Target**




Source: Environment and Climate Change Canada. Greenhouse gas sources and sinks: executive summary 2018.

213 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 17 October, 2017 (Julie Gelfand, Commissioner of the Environment and Sustainable Development, Office of the Auditor General of Canada).

214 Ibid.

215 Ibid.

# Areas for government action on climate change mitigation

Witnesses clearly saw a role for government in reducing GHG emissions from agriculture and forestry in Canada and suggested numerous ways the federal government could help.

## RESEARCH AND EXTENSION

Some witnesses stated that funding opportunities were quite siloed, and that multidisciplinary projects were hard to get funded.[216] One witness noted difficulty finding appropriate research funding: "In the discovery grants committees, for example, there is not a committee dealing with either forestry or agriculture […] Instead, we have to compete on things like the ecology and the evolution committee[.]"[217] Anja Geitmann, Dean of the Faculty of Agricultural and Environmental Sciences at McGill University, stressed the importance of having some non-industry-linked funding for pure academic research that might change the way an industry works: "True disruptive innovation is not made with industry matching funds."[218]

One witness pointed out that not all of the mitigation options being considered are equally effective, and not all of them are equally expensive or cheap. He argued that helping the policy community through the science can help to engage stakeholders in a dialogue about the outcomes and their desired future conditions and can help to determine which approaches are most worthwhile.[219]

Stephane McLachlan, Professor in the Department of Environment and Geography at University of Manitoba, reported on research that had found a disconnect between the extension work universities were doing and the high numbers of new, small scale farmers, many of them women, who were using agro-ecological approaches and direct marketing to consumers, noting that these producers would benefit from improved supports from both government and universities.[220]

The Canadian Organic Growers felt that, given carbon pricing, there should be more government support for farmers to adapt, for example by adopting alternative farming approaches such as organic growing that would allow them to reduce their GHG emissions. To this end they wanted to see more extension and knowledge transfer for farmers related to low-carbon farming practices.[221]

Many witnesses felt governments should invest in offering practical support for measures that are already known to reduce GHG emissions,[222] many of which have been listed in earlier sections of this report. This support could take the form of extension, incentives, or investments.

## INCENTIVES FOR GOOD MANAGEMENT PRACTICES IN FORESTRY AND AGRICULTURE

Numerous good management practices exist in both agriculture and forestry that can reduce GHG emissions. For example, forest management practices that reduce the risk of fires or pest invasions can result in fewer GHG emissions from fires and rotting wood. In agriculture, some witnesses noted that precision agriculture can help producers to decrease the use of carbon-intensive

216 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 15 February, 2018 (Anja Geitmann, Dean, Faculty of Agricultural and Environmental Sciences, McGill University).

217 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 4 April, 2017 (Brian Innes, Vice-President, Government Relations, Canola Council of Canada).

218 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 15 February, 2018 (Anja Geitmann, Dean, Faculty of Agricultural and Environmental Sciences, McGill University).

219 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 20 March, 2018 (Werner Kurz, Researcher, Pacific Institute for Climate Solutions, University of Victoria).

220 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 March, 2018 (Stephane McLachlan, Professor, Department of Environment and Geography, University of Manitoba).

221 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 9 May, 2017 (Ashley St Hilaire, Director of Programs and Government Relations, Canadian Organic Growers).

222 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 30 March, 2017 (Cam Dahl, President, Cereals Canada).

inputs by applying only exactly what is needed. For example, one witness referenced a blueberry sprayer that sprays only weeds and not bushes, which saves money while reducing pesticide use.[223] Pork producers noted that direct injection of manure into soil results in substantially lower emissions of nitrous oxide.[224] Incentivizing implementation of good management practices like these will reduce GHG emissions. Incentives could involve payment for ecosystem services, or establishment of carbon credits.

## REGULATORY MEASURES

As carbon pricing is not expected to yield all the GHG emissions reductions needed to reach Canada's targets, governments will need to take complementary actions, including regulatory measures. For example, witnesses from the biofuels sector noted that the Clean Fuel Standard could also reduce GHG emissions, and one witness advocated for an increase in the threshold for renewable fuels to be increased from 2 per cent to 5 per cent.[225] Andrea Kent of Renewable Industries Canada quoted a report by the Conference Board of Canada that stated "… a clean fuel standard that fails to maintain, or expand, current blend mandates for renewable fuels is not recommended."[226]

## EMPLOYING NEW TECHNOLOGIES AND MATERIALS

The federal government can provide incentives for innovation and research to reduce emissions or sequester more carbon.[227] For example, one way to lower GHGs from building is to build with wood,[228] which sequesters carbon, rather than with materials whose lifecycle involves far more GHG emissions. Effective mitigation strategies involve sustainable forest management, and the use of long-lived wood products for carbon storage and for bioenergy.[229]

One federal government official outlined some steps beings taken already; for example, the Green Construction through Wood Program will provide $40 million over 4 years to increase the use of wood in construction.[230] He also noted that in the Canadian Council of Forest Ministers released their Forest Bioeconomy Framework for Canada in 2017, to promote the use of forest biomass for advanced bioproducts and advanced innovation in the forest sector.[231]

223 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 2 October, 2017 (Hon. Keith Colwell, M.L.A., Minister of Agriculture, Government of Nova Scotia).

224 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 6 April, 2017 (Norman Martineau, Second Vice-Chair, Canadian Pork Council).

225 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 4 April, 2017 (Chris Vervaet, Executive Director, Canadian Oilseed Processors Association).

226 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 24 October, 2017 (Andrea Kent, Member of the Board of Directors, Renewable Industries Canada).

227 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 20 March, 2018 (Werner Kurz, Researcher, Pacific Institute for Climate Solutions, University of Victoria).

228 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 21 March, 2018 (Brock Mulligan, Director of Communications, Alberta Forest Products Association).

229 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 20 March, 2018 (Werner Kurz, Researcher, Pacific Institute for Climate Solutions, University of Victoria).

230 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 1 March, 2018 (Matt Jones, Assistant Deputy Minister, Pan-Canadian Framework Implementation Office, Environment and Climate Change Canada).

231 Ibid.

## COLLABORATIVE PROCESSES

Several witnesses emphasized the importance of positive relationships between governments and stakeholders. One hoped to see a partnership-based approach with farmers.[232] One witness noted that collaborative federal, provincial and territorial action related to environmental sustainability and climate change adaptation and mitigation "improves the sector's ability to manage risks, enhances productivity and contributes to economic growth."[233]

A few witnesses suggested that the government could fund and support participation in pre-competitive collaborative platforms like the Provision Coalition and the Canadian Roundtable on Sustainable Beef, in which industry players share information and best practices about effective technologies for improving sustainability.[234]

## RECOMMENDATIONS

**10** **That Agriculture and Agri-Food Canada, Environment and Climate Change Canada and Natural Resources Canada work together and with their provincial/territorial counterparts to implement policies that promote greenhouse gas emissions reductions in agriculture and forestry.**

**11** **That the Government of Canada fully implement the policy measures contained in the Pan-Canadian Framework and seek additional measures to ensure that Canada meets its international commitment on greenhouse gas emissions reductions.**

**12** **That the Department of Innovation, Science and Economic Development expand the amount of research funding available for applied climate change research and multi-disciplinary research.**

**13** **That the Government of Canada:**

a. ensure that research funding is available for high-level assessment to determine the most effective, economical investments in climate change action; and

b. continue to implement programs and initiatives that reduce greenhouse gas emissions by encouraging the use of new materials, such as advanced bioproducts, and new technologies to sequester carbon, like constructing tall buildings with wood.

**14** **That Agriculture and Agri-Food Canada, in collaboration with its provincial and territorial counterparts:**

a. enhance extension services to help farmers reduce greenhouse gas emissions; and

b. support those already using lower-emissions approaches, including organic farming.

**15** **That Agriculture and Agri-Food Canada, Environment and Climate Change Canada and Natural Resources Canada work with their provincial and territorial counterparts to ensure that there are incentives available across Canada for beneficial management practices.**

**16** **That Environment and Climate Change Canada work toward a Clean Fuel Standard that includes an increased blend mandate for ethanol in gasoline, to lower its carbon intensity.**

232 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 28 March, 2017 (Ron Bonnett, President, Canadian Federation of Agriculture).

233 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 11 May, 2017 (Mark Davies, Chair, Turkey Farmers of Canada).

234 Senate, AGFO, Evidence, 1st Session, 42nd Parliament, 15 June, 2017 (Cher Mereweather, Executive Director, Provision Coalition).

# Conclusion

As stewards of the land, people who work in the agriculture, agri-food, and forestry sectors agreed on the importance of efforts to reduce greenhouse gas emissions in Canada. Canada's mitigation targets are ambitious, and these sectors can contribute to meeting them, while competing in an international market and contributing to Canada's economic growth.

Stakeholders in the agriculture, agri-food, and forestry sectors are already adapting to climate change, working towards becoming more resilient, and reducing their GHG emissions. As they continue these efforts, continued support from government, researchers, and industry will be instrumental in helping them succeed.

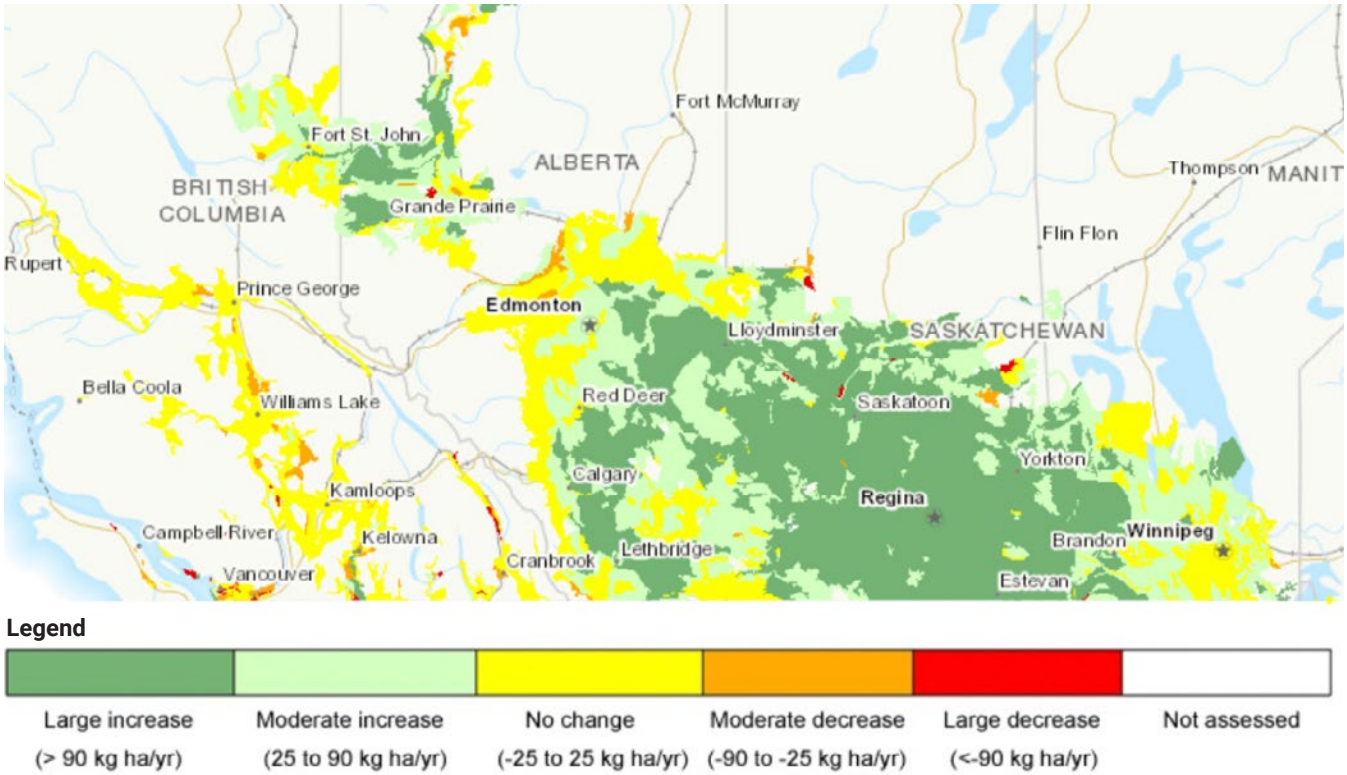
# Appendix A: Soil Organic Carbon Change Indicator

Source: Modified from Agriculture and Agri-Food Canada, Soil Organic Matter Indicator.

The Soil Organic Carbon Change Indicator looks at the rate of change in carbon levels in agricultural soils. Using this indicator we can see where soil organic carbon is increasing or declining, and at what rate it is doing so.

[…] Note that in the Prairies, soil organic carbon is increasing primarily due to a reduction in tillage intensity and area under summerfallow – a practice of leaving fields bare. This increasing trend holds promise for correcting past practices that caused soil degradation and left many Prairie soils with very low organic carbon levels. Conversely, in regions of Canada east of Manitoba, where soil carbon levels were historically much higher, these levels are now generally decreasing due to the steady conversion of tame pastures and hayland to annual crops.

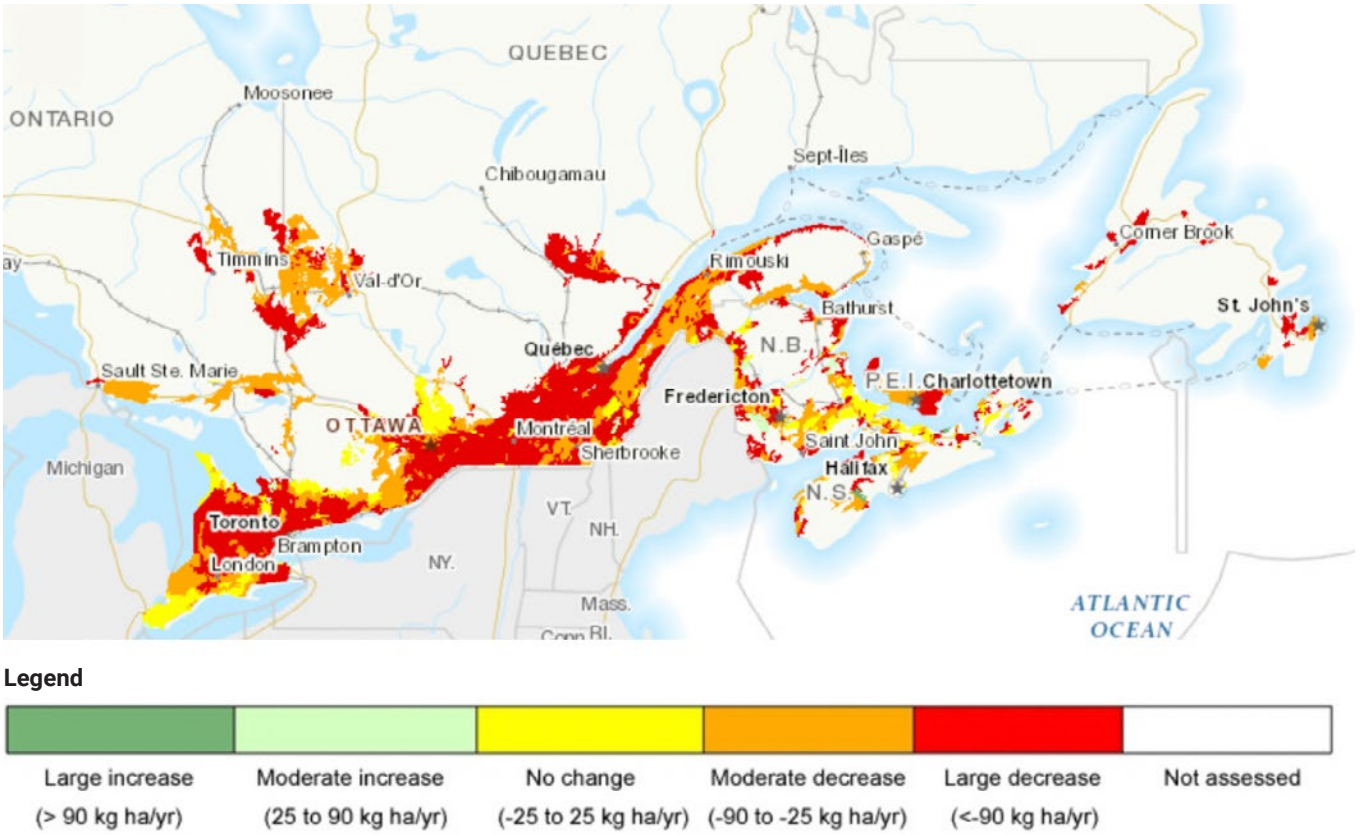
**Figure 1 – Soil organic carbon change (in kilograms per hectare, per year) in Canada in 2011: Prairies**



[…] Since 1981, there has been a significant increase in soil organic matter across the Prairies and a noticeable decline in soil organic matter in much of eastern Canada.

Generally speaking, the large improvements in the Prairies can be mainly attributed to the reduction in summerfallow as well as an increase in reduced tillage and no-till practices, which have increased plant residues and led to a build-up of organic matter in the soil. The decline in soil carbon elsewhere can be explained by shifts in cropping practices and crop types. Since 2006, the sharp decline in beef cattle production, as well as a longer-term decline in dairy herds since 1981 has reduced the area under pasture and forage production. Much of the area previously dedicated to these land uses have been converted to annual crops, such as corn, which do not increase soil organic matter as much as perennial crops. These declines in eastern Canada are more than offset by improvements in the Prairie Region and overall, the national trend is very favourable.

**Figure 2 – Soil organic carbon change (in kilograms per hectare, per year) in Canada in 2011: Central and Eastern Canada**




**Legend**

| Large increase (> 90 kg ha/yr) | Moderate increase (25 to 90 kg ha/yr) | No change (-25 to 25 kg ha/yr) | Moderate decrease (-90 to -25 kg ha/yr) | Large decrease (<-90 kg ha/yr) | Not assessed |
|---|---|---|---|---|---|

If soil is well managed over a long period of time, the organic carbon content will stabilize and remain constant over time. An increase in soil carbon is not necessarily better than a stable situation. However, if soil degradation has occurred in the past, a significant increase in soil organic carbon is clearly desirable, as it indicates improvements in soil health and function. A loss of soil organic carbon represents a net release of carbon dioxide into the atmosphere and so is not desirable.

# Appendix B: Witnesses

| DATE OF APPEARANCE | NAME, TITLE | ORGANIZATION |
|---|---|---|
| **Tuesday, April 17, 2018** | David Brock, Assistant Deputy Minister | Ministry of Environment, Government of Saskatchewan |
| | The Honourable Dustin Duncan, Minister of Environment | Ministry of Environment, Government of Saskatchewan |
| | Lin Gallagher, Deputy Minister | Ministry of Environment, Government of Saskatchewan |
| | The Honourable Lyle Stewart, Minister of Agriculture | Ministry of Environment, Government of Saskatchewan |
| | William Greuel, Assistant Deputy Minister | Ministry of Environment, Government of Saskatchewan |
| **Thursday, March 29, 2018** | Gérald Beaulieu, Director | Centre d'expertise sur la construction commerciale en bois |
| | John Masswohl, Director of Government and International Relations | Canadian Cattlemen's Association |
| | Chris White, President and Chief Executive Officer | Canadian Meat Council |
| **Thursday, March 22, 2018** | Vern Baron, Research Scientist, Sustainable Production Systems, Lacombe Research and Development Centre, Science and Technology Branch | Agriculture and Agri-Food Canada |
| | Henry Janzen, Research Scientist, Soil Biochemistry, Lethbridge Research and Development Centre, Science and Technology Branch | Agriculture and Agri-Food Canada |
| | Guillermo Hernandez Ramirez, Assistant Professor, Department of Renewable Resources, University of Alberta | As an Individual |
| | William Shotyk, Bocock Chair for Agriculture and the Environment, Department of Renewable Resources, University of Alberta | As an Individual |
| | Reynold Bergen, Research Director, Beef Cattle Research Council | Canadian Roundtable for Sustainable Beef |
| | Douglas J. Cattani, Department of Plant Science, University of Manitoba | As an Individual |
| | Ross Chow, Executive Director | InnoTech Alberta |

| DATE OF APPEARANCE | NAME, TITLE | ORGANIZATION |
|---|---|---|
| **Thursday, March 22, 2018** | Cherie Copithorne-Barnes, Chair | Canadian Roundtable for Sustainable Beef |
| | Anna De Paoli, Consultant to the Alberta Greenhouse Growers Association | Alberta Greenhouse Growers Association |
| | Graham Gilchrist, Chief Executive Officer | Biological Carbon Canada |
| | Christine Murray, Director, Agricultural Technologies | Alberta Innovates |
| **Wednesday, March 21, 2018** | Danny Blair, Director of Science | Prairie Climate Centre |
| | Stephane McLachlan, Professor, Department of Environment and Geography, University of Manitoba | As an Individual |
| | Maurice Moloney, Executive Director and CEO, Global Institute for Food Security, University of Saskatchewan | As an Individual |
| | Brock Mulligan, Director of Communications | Alberta Forest Products Association |
| | D.J. (Dave) Sauchyn, Research Coordinator | Prairie Adaptation Research Collaborative |
| | Howard Wheater, Professor, Institute for Water Security, University of Saskatchewan | As an Individual |
| | Kevin Bender, Chair | Alberta Wheat Commission |
| | Graham Gilchrist, Director | Alberta Federation of Agriculture |
| | D'Arcy Hilgartner, Chair | Alberta Pulse Growers Commission |
| | Lynn Jacobson, President | Alberta Federation of Agriculture |
| | Todd Lewis, President | Agricultural Producers Association of Saskatchewan |
| | Dan Mazier, President | Keystone Agricultural Producers of Manitoba |
| | Kevin Serfas, Director, Turin and Chair of Government and Industry Affairs Committee | Alberta Canola |
| | Carmen Sterling, Vice-President | Saskatchewan Association of Rural Municipalities |
| | Tom Steve, General Manager | Alberta Wheat Commission |
| | Ward Toma, General Manager | Alberta Canola |
| **Tuesday, March 20, 2018** | Werner Kurz, Researcher, Pacific Institute for Climate Solutions, University of Victoria | As an Individual |

| DATE OF APPEARANCE | NAME, TITLE | ORGANIZATION |
|---|---|---|
| **Tuesday, March 20, 2018** | Kathy Martin, Professor and Senior Research Scientist, Department of Forest and Conservation Sciences, University of British Columbia | As an Individual |
| | Lisa Wood, Assistant Professor, Ecosystem Science and Management, University of Northern British Columbia | As an Individual |
| **Monday, March 19, 2018** | John Church, Associate Professor and Cattle Research Chair, Faculty of Science, Thompson Rivers University | As an Individual |
| | Che Elkin, Associate Professor, University of Northern British Columbia | As an Individual |
| | Sumeet Gulati, Associate Professor, Faculty of Land and Food Systems, Food and Resource Economics Group, University of British Columbia | As an Individual |
| | John L. Innes, BC Chair in Forest Management, Faculty of Forestry, University of British Columbia | As an Individual |
| | Karen E. Kohfeld, Professor, Climate, Oceans, and Paleo-Environments Laboratory, Simon Fraser University | As an Individual |
| | Craig Nichol, Associate Head, Senior Instructor, Earth and Environmental Sciences, University of British Columbia | As an Individual |
| | David F. Scott, Associate Professor, Earth and Environmental Sciences, University of British Columbia | As an Individual |
| | Andrew Campbell, Corporate Performance and Communications Co-op | Forest Practices Board |
| | Pinder Dhaliwal, President | BC Fruit Growers' Association |
| | Reg Ens, Executive Director | BC Agriculture Council |
| | Hannah Horn, Manager of Special Investigations | Forest Practices Board |
| | Glen Lucas, General Manager | BC Fruit Growers' Association |
| | Stan Vander Waal, Chair | BC Agriculture Council |
| **Thursday, March 1, 2018** | The Honourable James Gordon Carr, P.C., M.P., Minister of Natural Resources | Natural Resources Canada |
| | Gervais Coulombe, Director, Excise Taxation and Legislation, Sales Tax Division, Tax Policy Branch | Department of Finance Canada |

| DATE OF APPEARANCE | NAME, TITLE | ORGANIZATION |
|---|---|---|
| **Thursday, March 1, 2018** | Matt Jones, Assistant Deputy Minister, Pan-Canadian Framework Implementation Office | Environment and Climate Change Canada |
| | Sean Keenan, Director General, Sales Tax Division, Tax Policy Branch | Department of Finance Canada |
| | Beth MacNeil, Assistant Deputy Minister, Canadian Forest Service | Natural Resources Canada |
| | Judy Meltzer, Director General, Carbon Pricing Bureau | Environment and Climate Change Canada |
| **Tuesday, February 27, 2018** | Hayden Montgomery, Special Representative | Global Research Alliance on Agricultural Greenhouse Gases |
| **Thursday, February 15, 2018** | Anja Geitmann, Dean, Faculty of Agricultural and Environmental Sciences, McGill University | As an Individual |
| **Tuesday, February 13, 2018** | Karen Beauchemin, Research Scientist, Sustainable Production Systems, Lethbridge Research and Development Centre, Science and Technology Branch | Agriculture and Agri-Food Canada |
| | Shabtai Bittman, Research Scientist, Environmental Health, Agassiz Research and Development Centre, Science and Technology Branch | Agriculture and Agri-Food Canada |
| | Ralph Martin, Professor, Ontario Agricultural College, University of Guelph | As an Individual |
| **Thursday, February 8, 2018** | The Honourable Lawrence MacAulay, P.C., M.P., Minister of Agriculture and Agri-Food | Agriculture and Agri-Food Canada |
| | Chris Forbes, Deputy Minister | Agriculture and Agri-Food Canada |
| **Thursday, December 14, 2017** | Randy Bauman, Board Member | Agricultural Manufacturers of Canada |
| | Leah Olson, President | Agricultural Manufacturers of Canada |
| **Thursday, December 7, 2017** | Ellen Burack, Director General, Environmental Policy, Policy Group | Transport Canada |
| | Michelle Gartland, Deputy Director, Clean Technology | Global Affairs Canada |
| | Judith Gelbman, Director, Environment Division | Global Affairs Canada |
| | Marcia Jones, Executive Director, Legislative Analysis and Development, Policy Group | Transport Canada |
| | Marie-Andrée Lévesque, Deputy Director, Government Procurement, Trade and Environment | Global Affairs Canada |

| DATE OF APPEARANCE | NAME, TITLE | ORGANIZATION |
|---|---|---|
| **Thursday, December 7, 2017** | Ana Renart, Director General - Market access | Global Affairs Canada |
| | Matthew Smith, Director of the Technical Barriers and Regulations | Global Affairs Canada |
| **Thursday, November 30, 2017** | Guillaume Gruère, Senior Policy Analyst, Trade and Agriculture Directorate, Natural Resources Policy Division | Organisation for Economic Co-operation and Development |
| | Ben Henderson, Policy Analyst, Trade and Agriculture Directorate, Natural Resources Policy Division | Organisation for Economic Co-operation and Development |
| **Tuesday, November 28, 2017** | Debbie Murray, Director, Policy and Regulatory Affairs | Association of Canadian Port Authorities |
| | Wendy Zatylny, President | Association of Canadian Port Authorities |
| **Thursday, November 9, 2017** | Philip Bagnoli, Analyst-Advisor | Office of the Parliamentary Budget Officer |
| | Jean-Denis Fréchette, Parliamentary Budget Officer | Office of the Parliamentary Budget Officer |
| | Stephane P. Lemay, Research and Development Director | Institut de recherche et de développement en agroenvironnement |
| **Thursday, November 2, 2017** | Evan Fraser, Canada Research Chair in Global Food Security, Social Sciences and Humanities, University of Guelph | As an Individual |
| **Thursday, October 26, 2017** | Dale Beugin, Executive Director | Canada's Ecofiscal Commission |
| | Emile Frison, Member, (Former Director General of Bioversity International) | International Panel of Experts on Sustainable Food Systems |
| | Bernard Soubry, Doctoral Candidate in Geography and Environment, Environmental Change Institute, University of Oxford | As an Individual |
| **Tuesday, October 24, 2017** | Greg Adams, Manager, Research and Development | J.D. Irving, Limited |
| | Jim Grey, Chair | Renewable Industries Canada |
| | Andrea Kent, Board Member | Renewable Industries Canada |
| **Thursday, October 19, 2017** | Neal Scott, Associate Professor, Associate Head, Geography Graduate Programs, Queen's University | As an Individual |
| | Barry Smit, Professor Emeritus, Department of Geography, University of Guelph | As an Individual |
| | Claudia Wagner-Riddle, Professor, School of Environmental Sciences, University of Guelph | As an Individual |

| DATE OF APPEARANCE | NAME, TITLE | ORGANIZATION |
|---|---|---|
| **Thursday, October 19, 2017** | Alfons Weersink, Professor, Ontario Agriculture College, University of Guelph | As an Individual |
| **Tuesday, October 17, 2017** | Julie Gelfand, Commissioner of the Environment and Sustainable Development | Office of the Auditor General of Canada |
| | Andrew Hayes, Principal | Office of the Auditor General of Canada |
| | Kimberley Leach, Principal | Office of the Auditor General of Canada |
| **Thursday, October 5, 2017** | Daniel Bernier, Agronomist, Research and agricultural policy department | Union des producteurs agricoles (UPA) |
| | Claire Bolduc, Member of the Board of Directors | Équiterre |
| | Marc-André Côté, Director General | Fédération des producteurs forestiers du Québec |
| | Andrew Gonzalez, Director | Quebec Centre for Biodiversity Science |
| | Marcel Groleau, President General | Union des producteurs agricoles (UPA) |
| | Richard Hamelin, Researcher | FPInnovations |
| | Pierre Lapointe, President and CEO | FPInnovations |
| | Caroline Larrivée, Team Leader, Vulnerabilities, impacts and adaptation | Ouranos |
| | Patrick Lavoie, Senior Scientist | FPInnovations |
| | Benoit Legault, Director General | Producteurs de grains du Québec |
| | Jean-Pierre Martel, Vice President, Strategic Partnerships | FPInnovations |
| | Jean Nolet, President and Chief Executive Officer | COOP Carbone |
| | Marc-André Rhéaume, Responsible for forest management | Fédération des producteurs forestiers du Québec |
| | Sidney Ribaux, Co-founder and General Manager | Équiterre |
| **Tuesday, October 3, 2017** | Lord Abbey, Assistant Professor, Amenity Horticulture, Department of Plant, Food and Environmental Sciences, Faculty of Agriculture, Dalhousie University | As an Individual |
| | Paul Arp, Professor, Forest Soils, Forestry and Environmental Management, University of New Brunswick | As an Individual |
| | Samuel K. Asiedu, Professor, Department of Plant, Food and Environmental Sciences, Faculty of Agriculture, Dalhousie University | As an Individual |

| DATE OF APPEARANCE | NAME, TITLE | ORGANIZATION |
|---|---|---|
| **Tuesday, October 3, 2017** | Charles Bourque, Professor, Acting Director of Graduate Studies, Forestry and Environmental Management, University of New Brunswick | As an Individual |
| | David Burton, Professor, Department of Plant, Food and Environmental Sciences, Faculty of Agriculture, Dalhousie University | As an Individual |
| | Peter Duinker, Professor and Acting Director, School for Resource and Environmental Studies, Dalhousie University | As an Individual |
| | Don Jardine, Project Manager, Climate Research Lab, University of Prince Edward Island | As an Individual |
| | Gabriela Sabau, Associate Professor, Economics/Environmental Studies, Grenfell Campus, Memorial University of Newfoundland | As an Individual |
| | James Steenberg, Post-doctoral fellow, School for Resource and Environmental Studies, Dalhousie University | As an Individual |
| **Monday, October 2, 2017** | Susannah Banks, Executive Director | New Brunswick Federation of Woodlot Owners |
| | Michael Benson, Climate Action Project Coordinator, Mi'kmaw Conservation Group | Confederacy of Mainland Mi'kmaq |
| | Stacie Carroll, Executive Director | Federation of Nova Scotia Woodland Owners |
| | The Honourable Keith Colwell, MLA, Minister of Agriculture | Minister of Agriculture, Government of Nova Scotia |
| | Angeline Gillis, Senior Director, Mi'kmaw Conservation Group | Confederacy of Mainland Mi'kmaq |
| | Robert Godfrey, Executive Director | Prince Edward Island Federation of Agriculture |
| | Jason Hollett, Executive Director | Department of Environment, Government of Nova Scotia |
| | The Honourable Margaret Miller, MLA, Minister of Natural Resources | Department of Natural Resources, Government of Nova Scotia |
| | David Mol, President | Prince Edward Island Federation of Agriculture |
| | Loretta Robichaud, Senior Director, Advisory Services, Agriculture and Food Operations Branch | Department of Agriculture, Government of Nova Scotia |

| DATE OF APPEARANCE | NAME, TITLE | ORGANIZATION |
|---|---|---|
| **Monday, October 2, 2017** | John Rowe, President | PEI Woodlot Association |
| | John Russell, Environmental Farm Plan Coordinator | Agricultural Alliance of New Brunswick |
| | Bruce Stewart, Manager, Forest Research and Planning | Department of Natural Resources, Government of Nova Scotia |
| | Julie Towers, Deputy Minister | Department of Natural Resources, Government of Nova Scotia |
| | Chris van den Heuvel, President | Nova Scotia Federation of Agriculture |
| | Henry Vissers, Executive Director | Nova Scotia Federation of Agriculture |
| **Thursday, September 28, 2017** | Kristin Baldwin, Director of Stakeholder Relations | Agricultural Institute of Canada |
| | Serge Buy, Chief Executive Officer | Agricultural Institute of Canada |
| | Robert Larocque, Senior Vice-President | Forest Products Association of Canada |
| | Kate Lindsay, Vice-President of Sustainability and Environmental Partnerships | Forest Products Association of Canada |
| **Tuesday, September 26, 2017** | Faris Ahmed, Director of Policy and Campaigns | USC Canada |
| | Dana Collins, Executive Director | Canadian Institute of Forestry |
| | Martin Entz, Professor, Faculty of Agricultural and Food Sciences, University of Manitoba | As an Individual |
| | Genevieve Grossenbacher, Program Manager, Policy and Campaigns | USC Canada |
| | Anne Koven, Adjunct Professor, University of Toronto | As an Individual |
| | Jonathan Lok, Past President | Canadian Institute of Forestry |
| | Fred Pinto, Past President (Canadian Institute of Forestry) | Canadian Institute of Forestry |
| | Martin Settle, Executive Director | USC Canada |
| **Thursday, September 21, 2017** | Nicholas Rivers, Associate Professor, Public and International Affairs, Faculty of Social Sciences, University of Ottawa | As an Individual |
| | Brandon Schaufele, Assistant Professor in Business, Economics and Public Policy, Ivey Business School, The University of Western Ontario | As an Individual |
| | Tony Shaw, Professor of Geography, Brock University | As an Individual |

| DATE OF APPEARANCE | NAME, TITLE | ORGANIZATION |
|---|---|---|
| **Thursday, June 15, 2017** | Gérald Gauthier, Vice President | Railway Association of Canada |
| | Lee Jebb, Vice President | Cando Rail Services |
| | Cher Mereweather, Executive Director | Provision Coalition |
| **Thursday, June 8, 2017** | Stephen Laskowski, President | Canadian Trucking Alliance |
| | Chris Masciotra, Director, Corporate Affairs | Soy Canada |
| | Jim Millington, Director, Market Development | Soy Canada |
| **Tuesday, June 6, 2017** | Clyde Graham, Senior Vice President | Fertilizer Canada |
| | Garth Whyte, President and Chief Executive Officer | Fertilizer Canada |
| **Thursday, June 1, 2017** | Michael Bourque, President and Chief Executive Officer | Railway Association of Canada |
| | Janet Drysdale, Vice President, Corporate Development | CN |
| | Michael Gullo, Director, Policy, Economic and Environmental Affairs | Railway Association of Canada |
| | Yves Leduc, Director, Policy and International Trade | Dairy Farmers of Canada |
| | Ron Maynard, Member of Board of Directors | Dairy Farmers of Canada |
| | David Miller, Assistant Vice President, Government Affairs | CN |
| | Robert Taylor, Assistant Vice President, North American Advocacy | Canadian Pacific |
| **Tuesday, May 30, 2017** | Ian Affleck, Executive Director, Plant Biotechnology | CropLife Canada |
| | Andrew Casey, President and Chief Executive Officer | BIOTECanada |
| | Dennis Prouse, Vice President, Government Affairs | CropLife Canada |
| **Thursday, May 11, 2017** | Phil Boyd, Executive Director | Turkey Farmers of Canada |
| | Mark Davies, Chair | Turkey Farmers of Canada |
| | Mike Dungate, Executive Director | Chicken Farmers of Canada |
| | Jessica Heyerhoff, Communication and Policy Coordinator | Chicken Farmers of Canada |
| | Tim Lambert, Chief Executive Officer | Egg Farmers of Canada |

| DATE OF APPEARANCE | NAME, TITLE | ORGANIZATION |
|---|---|---|
| **Thursday, May 11, 2017** | Roger Pelissero, Chair | Egg Farmers of Canada |
| **Tuesday, May 9, 2017** | Derek Lynch, Associate Professor, Faculty of Agriculture, Dalhousie University | As an Individual |
| | Ashley St Hilaire, Director of Programs and Government Relations | Canadian Organic Growers |
| **Thursday, May 4, 2017** | Ted Bilyea, Chair | Canadian Agri-Food Policy Institute |
| | Ron Davidson, Senior Vice-President, International Trade and Public Affairs | Canadian Meat Council |
| | Louis Thériault, Vice President, Industry Strategy and Public Policy | The Conference Board of Canada |
| | Troy Warren, Chair of the Board of Directors | Canadian Meat Council |
| | Tulay Yildirim, Director, Policy Research Partnerships | Canadian Agri-Food Policy Institute |
| **Tuesday, April 11, 2017** | Lydia Carpenter, 1st Vice President (Policy) | National Farmers Union |
| | Jason McLinton, Vice President, Grocery Division and Regulatory Affairs | Retail Council of Canada |
| | Rod Scarlett, Executive Director | Canadian Honey Council |
| | David Wilkes, Senior Vice President, Grocery Division and Government Relations | Retail Council of Canada |
| **Thursday, April 6, 2017** | Barbara Johnstone-Grimmer, Director, British Columbia | Canadian Sheep Federation |
| | Bob Lowe, Chair, Environment Committee | Canadian Cattlemen's Association |
| | Normand Martineau, 2nd Vice Chair | Canadian Pork Council |
| | John Masswohl, Director of Government and International Relations | Canadian Cattlemen's Association |
| | Corlena Patterson, Executive Director | Canadian Sheep Federation |
| | Gary Stordy, Manager, Public Relations | Canadian Pork Council |
| **Tuesday, April 4, 2017** | Jack Froese, President | Canadian Canola Growers Association |
| | Brian Innes, Vice-President, Public Affairs | Canola Council of Canada |
| | Chris Vervaet, Executive Director | Canadian Oilseed Processors Association |
| | Rick White, Chief Operating Officer | Canadian Canola Growers Association |
| **Thursday, March 30, 2017** | Gordon Bacon, Chief Executive Officer | Pulse Canada |
| | Cam Dahl, President | Cereals Canada |
| | Phil de Kemp, Executive Director | Barley Council of Canada |

| DATE OF APPEARANCE | NAME, TITLE | ORGANIZATION |
|---|---|---|
| **Tuesday, March 28, 2017** | Drew Black, Director of Environment and Science Policy | Canadian Federation of Agriculture |
| | Ron Bonnett, President | Canadian Federation of Agriculture |
| | Rebecca Lee, Executive Director | Canadian Horticultural Council |
| | Justine Taylor, Science and Government Relations Manager | Ontario Greenhouse Vegetable Growers |

# Appendix C: Fact-Finding Missions

## Halifax, NS and Montreal, QC - October 1-6, 2017

| ORGANIZATION | NAME, TITLE |
|---|---|
| **Dalhousie University** | Lord Abbey, Assistant Professor, Amenity Horticulture Department of Plant, Food, and Environmental Sciences Faculty of Agriculture |
| | Samuel K. Asiedu, Professor, Department of Plant, Food, and Environmental Sciences Faculty of Agriculture |
| | David Burton, Professor, Department of Plant, Food, and Environmental Sciences, Faculty of Agriculture |
| | Chris Cutler, Professor, Associate Dean Research, Faculty of Agriculture |
| | David Burton, Professor, Department of Plant, Food, and Environmental Sciences, Faculty of Agriculture |
| | Derek Lynch, Professor, Department of Plant, Food, and Environmental Sciences, Faculty of Agriculture |
| | Pushp Sheel Shukla, student |
| | Emily Peters, student |
| | Pramod Rathor, student |
| | Jie Yang, student |
| | Sophia He, Associate Professor, Department of Engineering |
| | Kathleen Walker, student |
| | Andres Fish, student |
| | Carolyn Marshall, student |
| | Jay Woodworth, Graduate Student Advisory Committee |
| | Abdir Haiye, student |
| | Gurwinder Singh, student |
| | Sara Murphy, Research and Development Coordinator |
| | Peter Havard, Department Chair and Associate Professor, Department of Engineering |
| | Mike Main, Faculty of Agriculture |
| | Jolene MacEachern, Manager, The Office of Industry Liaison and Innovation, Faculty of Agriculture |

| ORGANIZATION | NAME, TITLE |
|---|---|
| **Dalhousie University** | Jean Lynds, Staff member, graduate and volunteer, Faculty of Agriculture |
| **Nova Scotia Community College** | Paul Little, Principal of Ivany Campus |
| | Alain Joseph, Director of Applied Research |
| | Tim Webster, Lead Research Scientist of Applied Geomatics |
| | Mathew Van Koughnett, Lead Research Scientist of Environmental Technologies |
| | Bill Livingstone, Project Manager of Applied Research |
| | Jeffrey Taylor, Associate Vice-President of Research and Innovation |
| | Jeremie Bernardin, Research Associate |
| | Etienne Mfoumou, Research Scientist |
| | Hazem Ajlani, Casual Research Associate |
| **Arbora Condo Development** | Gérald Beaulieu, Director, Centre d'expertise sur la construction commerciale en bois (Cecobois) |
| | Richard Poirier, Architect, Centre d'expertise sur la construction commerciale en bois (Cecobois) |
| | Guy St Jacques, Vice-President Construction, Sotramont |
| | William Munoz, Technical Services, Nordic Structures |
| **Lufa Farms** | Mohamad Hage, Co-founder |

## Vancouver, BC and Calgary, AB - March 19-23, 2018

| ORGANIZATION | NAME, TITLE |
|---|---|
| **Schoolyard Market Gardens** | Lee Green,Cafeteria Chef Instructor, Vancouver School Board |
| | Janet Fraser, Trustee, Chair, Vancouver School Board |
| | Christina Custer, Elementary School Teacher, French Immersion, Vancouver School Board |
| | Silvie Custer |
| **University of British Columbia** | Philip Steenkamp, Vice-President, External Relations |
| | John Innes, Dean, Faculty of Forestry |
| | Sally Aitken, Associate Dean Research and Innovation |
| | Lori Daniels, Professor, Forest and Conservation Sciences |
| | Vanessa Comeau, Student |
| | Allan Carrol, Professor, Forest and Conservation Sciences |

| ORGANIZATION | NAME, TITLE |
|---|---|
| **University of British Columbia** | Stan Pokorny, Student |
| | Richard Hamelin, Professor, Forest and Conservation Sciences and Senior Research Scientist, Natural Resources Canada |
| | Kiah Allen, Student |
| | Haris Gilani, Postdoctoral Research Fellow |
| | Tongli Wang, Assistant Professor, Forest and Conservation Sciences |
| | Rickey Yada, Dean |
| | David Kitts, Associate Dean, Research |
| | Sean Smukler, Assistant Professor, Applied Biology and Soil Science, Junior Chair, Agriculture and the Environment |
| | Siddhartho Paul, Student |
| | Andy Black, Professor, Applied Biology |
| | Patrick Pow, Student |
| | Sumeet Gulati, Associate Professor, Food and Resource Economics |
| | Zoran Nesic, Senior Research Engineer, Biometeorology and Soil Science |
| | Nick Grant, Research Facilitator |
| | Lori Daniels, Professor |
| | Kelsey Copes-Gerbitz, Student |
| | Vanessa Comeau, Student |
| | Wesley Brookes, Student |
| | Spencer Bronson, Student Research Assistant |
| | Ian Mott, Student Research Assistant |
| | Danielle Saele, Student Research Assistant |
| | Andy Black, Professor |
| | Katie Neufeld, Laboratory and Research Coordinator, Sustainable Agricultural Landscapes Lab |
| **Brock Commons Tallwoods House, University of British Columbia** | John Metras, Asociate Vice President, Campus Facilities |
| | Mike Cheung, Residence Life Manager |
| | Angelique Pilon, Director, Urban Innovation Research |
| | Kelsi Wall, Government Relations office |
| | Eerol Ilves, Senior Advisor, Government Relations |
| | Ruth Hobbs, Government Relations Officer |

# Appendix D: Written Submissions Received by the Committee

| ORGANIZATION | SUBMITTER |
|---|---|
| **Agricultural Producers Association of Saskatchewan** | Todd Lewis |
| **Agriculture and Agri-Food Canada** | The Honourable Lawrence MacAulay, P.C., M.P. |
| | Shabtai Bittman |
| | Karen Beauchemin |
| **Alberta Federation of Agriculture** | Graham Gilchrist |
| | Lynn Jacobson |
| **Alberta Forest Products Association** | Brock Mulligan |
| **Alberta Greenhouse Growers Association** | Anna De Paoli |
| **Alberta Innovates** | Christine Murray |
| **As an Individual** | Paul Arp |
| | Charles Bourque |
| | David Burton |
| | Douglas J. Cattani |
| | John Church |
| | Peter Duinker |
| | Che Elkin |
| | Anja Geitmann |
| | Don Jardine |
| | Karen E. Kohfeld |
| | Werner Kurz |
| | Derek Lynch |
| | Kathy Martin |
| | Ralph Martin |
| | Maurice Moloney |
| | Craig Nichol |

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| **As an Individual** | Guillermo Hernandez Ramirez |
| | Brandon Schaufele |
| | David F. Scott |
| | Neal Scott |
| | Tony Shaw |
| | William Shotyk |
| | Barry Smit |
| | Howard Wheater |
| | Lisa Wood |
| **BC Agriculture Council** | Reg Ens |
| | Stan Vander Waal |
| **BC Fruit Growers' Association** | Glen Lucas |
| | Pinder Dhaliwal |
| **Canada's Ecofiscal Commission** | Dale Beugin |
| **Canadian Agri-Food Policy Institute** | Ted Bilyea |
| **Canadian Canola Growers Association** | Jack Froese |
| **Canadian Federation of Agriculture** | Ron Bonnett |
| **Canadian Oilseed Processors Association** | Chris Vervaet |
| **Canadian Organic Growers** | Ashley St Hilaire |
| **Canadian Sheep Federation** | Barbara Johnstone-Grimmer |
| **Canadian Trucking Alliance** | Stephen Laskowski |
| **Cando Rail Services** | Lee Jebb |
| **Canola Council of Canada** | Brian Innes |
| **Centre d'expertise sur la construction commerciale en bois** | Gérald Beaulieu |
| **Cereals Canada** | Cam Dahl |
| **Chicken Farmers of Canada** | Mike Dungate |
| **CN** | Janet Drysdale |
| **COOP Carbone** | Jean Nolet |
| **Dairy Farmers of Canada** | Ron Maynard |
| | Yves Leduc |
| **Egg Farmers of Canada** | Tim Lambert |
| **Équiterre** | Sidney Ribaux |

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| **Fédération des producteurs forestiers du Québec** | Marc-André Côté |
| **Forest Practices Board** | Andrew Campbell |
| | Hannah Horn |
| **FPInnovations** | Pierre Lapointe |
| **Institut de recherche et de développement en agroenvironnement** | Stephane P. Lemay |
| **J.D. Irving, Limited** | Greg Adams |
| **National Farmers Union** | Lydia Carpenter |
| **Natural Resources Canada** | The Honourable Jim Carr, P.C., M.P. |
| **New Brunswick Federation of Woodlot Owners** | Susannah Banks |
| **Office of the Parliamentary Budget Officer** | Jean-Denis Fréchette |
| **Prairie Adaptation Research Collaborative** | D.J. (Dave) Sauchyn |
| **Prairie Climate Centre** | Danny Blair |
| **Producteurs de grains du Québec** | Benoit Legault |
| **Provision Coalition** | Cher Mereweather |
| **Pulse Canada** | Gordon Bacon |
| **Quebec Centre for Biodiversity Science** | Andrew Gonzalez |
| **Transport Canada** | Ellen Burack |
| | Marcia Jones |
| **Union des producteurs agricoles (UPA)** | Daniel Bernier |
| | Marcel Groleau |
| **USC Canada** | Genevieve Grossenbacher |

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