Sustainable Agriculture Strategy: Discussion Document

1. Introduction

Food affects the daily lives of everyone. It provides the energy and nutrients needed to live a healthy life, brings together communities, and creates economic growth and jobs along the supply chain. With the global population expected to grow to 9.7 billion by 2050, Canada's continued capacity to support food security is critical.

However, climate change is impacting the way Canada and the world can produce food. Increasingly frequent and more extreme weather events associated with climate change are already having a significant impact on agricultural production, including damages to crops, livestock, and infrastructure, and potential multi-year impacts on soil fertility or herd management. In Canada, the impacts have been felt most recently through hurricane damage in Atlantic Canada, a record-setting drought in western Canada, and floods and fires in British Columbia. Climate change will create further vulnerabilities to new pests and diseases, and require new approaches to enhance the resilience of the agriculture sector to climate change, while bolstering its ability to fight it. At the same time, approaches to address environmental issues must consider the impact on farmer

livelihoods and food production, which will increasingly be relied upon to feed a growing global population and strengthen domestic food systems.

This is why the Government of Canada is proposing to develop a Sustainable Agriculture Strategy, in collaboration with a diversity of partners, to provide an integrated and coordinated approach to improving the agriculture sector's environmental performance and supporting its long-term vitality. A strategy would build on the environmental and innovation successes achieved to date in the sector, leverage opportunities related to increased market focus on sustainable food products, and focus resources to support an environmentally, socially, and economically sustainable sector.

A sustainable agriculture sector in Canada means that Canada's food system is resilient and innovative, sustains our environment and supports our economy, and all people in Canada are able to access a sufficient amount of safe, nutritious, and culturally diverse food, as indicated in the vision of a Food Policy for Canada. It means ensuring that farmers and workers in the agri-food value chain can make a good living from their work. It means maintaining competitiveness and productivity to meet growing demands for food, which in turn depends on a healthy environment to provide important ecosystem services such as soil fertility, water filtration, pollination and pest management. It means supporting environment and climate goals by sequestering carbon, supporting wildlife habitat, and generating renewable energy.

The development of a Sustainable Agriculture Strategy will focus on the environmental pillar of sustainability of Canada's food system, within the broader context of social and economic challenges and opportunities in the sector. With an integrated strategy that sets a clear path forward for collaborative action, Canada will be well positioned to be a world leader in sustainable agriculture while maintaining its role as a global food provider and contributing to global food security. Such a strategy is intended to guide long-term decision-making on policies, programs, and initiatives that advance Canada's commitment towards a net-zero 2050 future. Now is the time to build on past and current successes and to work together to address ongoing climate and environment challenges in the sector while ensuring productivity continues to meet growing demands for food.

2. Developing a Sustainable Agriculture Strategy

A Sustainable Agriculture Strategy will need to be developed within the context of growing demands for nutritious food, supporting farmer livelihoods and strong rural communities, maintaining competitiveness, and improving social issues in the food system including justice, equity, and health. These are important considerations in identifying environment and climate action, to ensure that a Sustainable Agriculture Strategy maximizes positive outcomes and that addressing one environmental issue does not lead to other environmental, social, or economic challenges. In general, a Sustainable Agriculture

Strategy would aim to contribute to the goals and targets of the Federal Sustainable Development Strategy and the United Nations 2030 Sustainable Development Goals.

This section outlines some of the key considerations that will need to be taken into account throughout the development of a Sustainable Agriculture Strategy that aims to improve environmental outcomes in the sector.

Canada needs to continue to contribute to growing demands for food and agriculture products

With current crises such as the war in Ukraine and long-term impacts from a changing climate threatening global supplies of food and agricultural inputs, advancing sustainability while maintaining or growing our food supply is more important than ever. Canada will need to contribute to growing domestic and global food demands, requiring increased production and associated increase in inputs, labour and land. However, this could present a trade-off in terms of higher environmental impacts if this production is not done in a sustainable manner. For example, supplying feedstock for renewable bioproducts and low carbon fuels could contribute to increased demand for overall agricultural production that, in turn, may result in an expansion of cropland and conversion from pasture or grassland, resulting in impacts on biodiversity [1].

Supporting farmer livelihoods will be key to any approaches included in the Strategy

Agriculture is an inherently risky activity. As price takers, farmers

generally have little to no control over the price they receive for their product, leaving little room for increasing costs of production. This dynamic creates incentives to maximize yields, and to use practices that have a low risk to production, are compatible with existing productions systems, and are easy to adopt. The reality is that adopting costly new practices or technologies that improve environmental outcomes, but may take several years to show a direct return, can increase risk and lower incomes for farm families. Strategies included in a Sustainable Agriculture Strategy would need to ensure there are no negative impacts on production, farmer livelihoods, or food safety, and would need to support the overall economic resilience of the sector.

Sustainability is a key factor for maintaining the competitiveness of Canada's agriculture sector in a global context

In order for Canada's agriculture and agri-food sector to maintain and increase its share of the global market, Canada must consider the competitiveness of the sector. Increasingly, competitive advantage is going to countries that can produce more, with less energy, water, and environmental impacts. International competitors have been placing larger emphasis on agri-environment priorities, as well as consumer and investor interest in sustainability and environmental stewardship. Canada's trading partners are taking different, and sometimes diverging, approaches to addressing environmental issues in their agriculture sectors — for example, larger uptake of environmental opt-in programs offered by the United States

Department of Agriculture, compared to the application of Farm to Fork Strategy priorities in the European Union. It is increasingly important for Canada to demonstrate alignment with these shifting market dynamics that reflect a growing global focus on the environment and sustainable food. A Sustainable Agriculture Strategy will need to support efforts to position Canada as a key producer of in-demand sustainable food and agricultural products.

The complexity of food systems means one approach can achieve more than one environmental outcome

Climate, biodiversity, water, and soil health issues are tightly linked, and are themselves influenced by social and economic factors. For example, addressing water issues in the agriculture sector requires considering a diversity of factors including environmental (for example, water quality, water quantity, aquatic habitat), social (for example, drinking water, flood risk, land use) and economic (for example, food, hydropower, tourism). This complicates the design of effective interventions and understanding the impact of individual investments, however it provides opportunities to seek solutions that can address more than one environmental issue at the same time. For example, many agricultural practices that provide environmental benefits, such as sequestering carbon, also support improved farm resilience to climate change impacts. Annex A illustrates how certain on-farm practices support multiple environmental outcomes, while also supporting productivity goals. Addressing these linkages can provide clarity

and coherence in future government direction on agriculture and environment.

Environment and climate action is a shared responsibility in Canada's agriculture sector

Agriculture is a shared jurisdiction in Canada across territorial, provincial, Indigenous, and federal government departments, with provinces and territories having a larger share of responsibility over natural resources in their respective jurisdictions, including related to water, soil, and land use management and planning. Efforts in the private, not-for-profit, and academic sectors also play a role, driving markets and economic opportunities. Indigenous Peoples are critical to conversations and decision-making in areas such as food systems and climate change. It will be important to recognize the shared responsibility for advancing environment and climate outcomes in the agriculture sector and important roles to be played by each actor. Collaborating with Indigenous partners on sustainability and strengthening Indigenous-led food systems will be particularly important.

There are multiple federal initiatives under development that will impact environment and climate outcomes in the sector

Over the past year, there have been multiple concurrent initiatives and engagements underway that aim to positively impact environmental performance in Canada's agriculture sector, including consultations on developing a path towards reducing fertilizer emissions in the sector, a National Adaptation

Strategy, the new Sustainable Canadian Agricultural Partnership, Canada's contribution to the Global Methane Pledge, and the development of the Canada Water Agency. A Sustainable Agriculture Strategy will integrate the feedback from these various processes and consider ways to integrate and bring under one umbrella needed action on environment and climate in the agriculture sector.

Guiding Principles

Given the complex context of food systems in Canada, seven principles are proposed for guiding the development of a Sustainable Agriculture Strategy:

- **farmer-focused:** listening to the needs and concerns of farmers since they know their land best, and ensuring the maintenance or enhancement of farm incomes, as well as economic resilience in the sector as a whole. Approaches must recognize regional diversity across the country and that there is no "one-size-fits-all" solution to addressing environment and climate issues.
- **evidence-based:** ensuring that scientific advice guiding decision-making is based on sound scientific principles and empirical data, accepted methodologies, and professional standards.
- **coordination:** encouraging and facilitating actions and commitments from federal and provincial governments, industry, farmers, and other partners and stakeholders in the agriculture sector.

- **circularity:** applying circular economy principles towards an agriculture and food system that is regenerative, resilient, turns waste into a resource, and offers new domestic and international market opportunities.
- **additionality:** ensuring actions are above and beyond those that are already taking place or that are planned using other funding and resources, while supporting and complementing existing initiatives.
- **transparent and accountable:** placing public good at the centre of all decision making, and making available all records of decisions and actions to the public.
- **supports Reconciliation:** working in partnership with Indigenous Peoples to advance their rights and support implementation of the United Nations Declaration on the Rights of Indigenous Peoples. Supporting reconciliation is proposed as an important principle of a Sustainable Agriculture Strategy, as healthy environments, clean water, and biodiversity allow Indigenous Peoples to continue practicing their collective social, cultural, land use, and self-government rights.

3. Benefits of a Sustainable Agriculture Strategy

Farmers have shown notable environmental leadership over the last 20 years, including improving soil health and doubling production while greenhouse gas (GHG) emissions have

increased only slightly. The sector is taking action to promote stewardship and report on sustainability through improved metrics, certification and assurance schemes, such as the Canadian Roundtable for Sustainable Beef certification, Fertilizer Canada's 4R Nutrient Stewardship, and the Canadian Federation of Agriculture's Canadian Agri-food Sustainability Initiative. Various commodity groups are conducting lifecycle assessments to identify where environmental footprints could be reduced (for example, Egg Farmers of Canada, Chicken Farmers of Canada, Dairy Farmers of Canada, Pulse Canada) and agri-food companies and commodity groups are increasingly making sustainability commitments (for example, to develop the most sustainable protein, to advance regenerative agriculture) and pledges to achieve net-zero emissions by 2050 (for example, Grain Growers of Canada, Dairy Farmers of Canada).

According to the 2021 Canadian Census of Agriculture, the **agriculture sector** is comprised of 64 million hectares of farmland and 189,874 farms across mostly rural areas of the country, which vary widely in size, the type of commodity produced, and the environmental challenges faced. Given this diversity, there is no one-size-fits-all solution to improving environmental performance on farms.

However, there is room for further improvement, particularly in terms of reducing GHG emissions, improving resilience to climate change impacts, supporting biodiversity in agricultural landscapes, and reducing risks to surface and groundwater

quality.

A Sustainable Agriculture Strategy will serve as a key resource for all actors in the sector — government, industry, farmers, non-governmental organizations, Indigenous Peoples, and more — for taking action on environment and climate issues in the agriculture sector while providing the vital role of responding to growing demands for food and supporting economic growth. The benefits of working together to develop a Sustainable Agriculture Strategy include:

Strengthening collaboration on climate and environment action in the sector

Improved coordination across initiatives addressing agri-environmental issues would advance environmental outcomes and proactively leverage opportunities that also provide economic and social benefits to the sector. Through a Sustainable Agriculture Strategy, opportunities can be leveraged to support progress on agri-environmental outcomes by fostering collaboration across public, private, academic, non-governmental, Indigenous, and other partners, and finding new ways of working together. A Strategy can also ensure coherence with other major initiatives and goals for the sector in Canada.

Supporting the long-term business vitality of the sector

Protecting and enhancing agricultural production and yields depends on a healthy environment and resilience to climate change. Degradation of environmental services (for example, pollination, flood mitigation, water purification, nutrient cycling,

etc.) can lead to higher input costs to maintain production; conserving these resources is key to ensuring sustainable agricultural production and food security over the long-term. A Sustainable Agriculture Strategy would help set a shared direction for collective action to improve environmental performance in the sector over the long-term.

Proactively managing risk of climate change impacts

In 2021, British Columbia experienced disastrous flooding which impacted more than 1100 farms, 15,000 hectares and 2.5 million livestock in the south-western region of the province, with devastating effects on farmers and ranchers. BCfresh reported losing $1.7M in sales in the last two weeks of November 2021.

Adapting management practices to a changing climate and reducing GHG emissions can reduce impacts of extreme and unpredictable weather events and enable farms to recover faster over the long-term. A Sustainable Agriculture Strategy would identify goals and guide actions to ensure the sector is able to recover quickly from extreme events, thrive in a changing climate, and ensure a steady food supply. This will form part of the sector's contribution to the National Adaptation Strategy, in addition to other science, innovation and programming actions under the Sustainable Canadian Agricultural Partnership.

Leveraging economic opportunities for the sector

Consumers around the globe increasingly demand that their

food is produced sustainably [2] [3] [4]. Transitioning to a circular, low-carbon economy can also provide new opportunities in emerging markets with new and innovative products, technologies, and management practices, as well as new uses for agricultural by-products and wastes (for example, bio-based products such as fuels, electricity, chemicals and plastics). A Sustainable Agriculture Strategy would support Canada's position as a key producer of in-demand sustainable food and agriculture products. It will also signal the support for the value-added approaches needed in Canada to retain as much value as possible within our borders — generating wealth for operators and farmers over the long-term.

Maintaining public trust

Loss of public trust can negatively impact the viability, growth, and competitiveness of the sector, while building public trust means re-affirming the high standards and quality of Canadian agricultural products. Environmental sustainability of food has increasingly captured consumer interest, and the COVID-19 pandemic has intensified awareness around food security, the importance of local food systems, resilient supply chains, environmental performance, and social accountability to maintain public trust in the sector. Clear and open reporting on the performance of agri-environmental issues will be important in maintaining public trust in Canada's agriculture and agri-food sector.

Contributing to Canada's international commitments on

environment and climate

A Sustainable Agriculture Strategy will play an enabling role for Canada to meet its commitments under the Paris Agreement which sets out a global framework to avoid the damaging impacts of climate change by limiting global warming to well below 2°C and pursuing efforts to limit it to 1.5°C. Meeting the Paris Agreement commitment will require effort from all sectors across Canada. Commitments to collaborate with farmers who want to reduce GHG emissions from fertilizers and support the Global Methane Pledge will contribute to emissions reduction in the agriculture sector. In addition, Canada and other Parties to the UN Convention on Biological Diversity are actively preparing to negotiate a new Global Biodiversity Framework (GBF) to 2030 in December 2022, which would include targets related to sustainable agricultural production. After concluding negotiations on the GBF, Canada would have two years in which to develop a national biodiversity strategy to outline Canada's contributions to these global goals, while reflecting domestic circumstances. A Sustainable Agriculture Strategy would help to further identify strategies for the agriculture sector to support the achievement of Canada's international environment and climate commitments, grow a sustainable sector, and support the agricultural productivity needed to achieve the Sustainable Development Goal on Zero Hunger (SDG 2).

Advancing agricultural research and innovation that support environment and climate outcomes

Public and private investment in research and science in the

agriculture sector will be critical to unlock solutions for advancing climate and environment outcomes in the sector. The challenges facing the agriculture sector are significant and innovation will be vital to inform and support the magnitude of the changes required to ensure food production systems will be profitable, sustainable and resilient in a future carbon-neutral economy and uncertain growing conditions due to climate change. This includes on-farm technologies as well as other practices such as gene editing and alternative proteins. This also includes linking natural and social sciences to explore innovations that support environment and climate outcomes, as well as working with Indigenous partners to learn more about and integrate traditional knowledge. A Sustainable Agriculture Strategy would help identify research priorities in science and innovation to support agri-environment outcomes and explore ways to overcome challenges in data collection that minimize the reporting burden on farmers.

4. Current state of the agri-environment

Agri-environmental issues in Canada vary across the country, due to diversity in production systems, landscapes, and agroecosystems. This section provides a brief overview of the current status in the five priority issue areas of a Sustainable Agriculture Strategy.

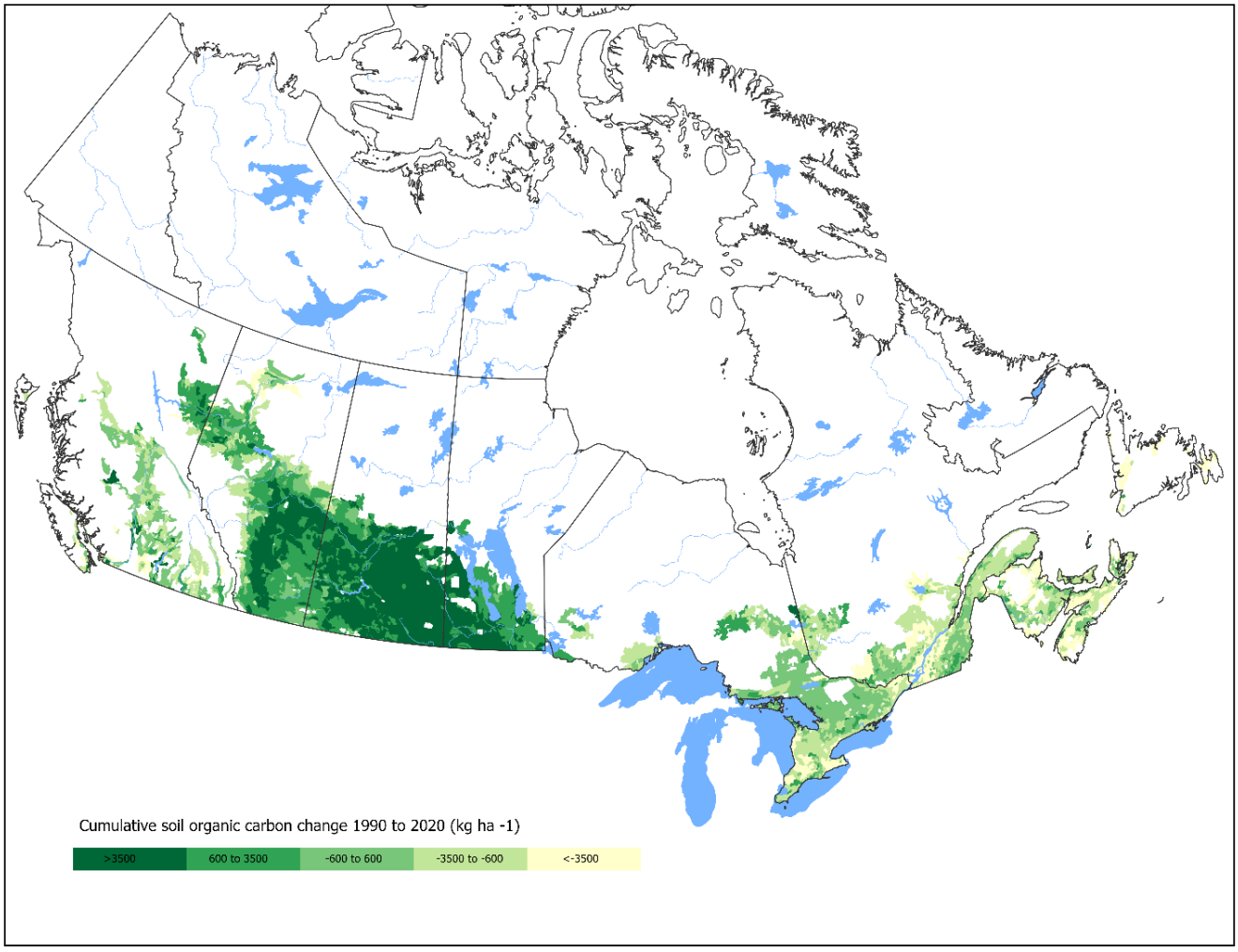
4.1 Soil health

Healthy soils are fundamental to the sustainability of agriculture in Canada. Different factors impact soil health including soil type, soil organisms, and nutrients. Climate change also has an impact on soil health, including increased erosion from high intensity storms, decreased protection from less snow cover, and severe soil water deficits or waterlogged soils from changing precipitation patterns.

Soil organic matter strongly influences many important aspects of soil quality and is a key component of good soil health. It makes the soil less prone to erosion, improves the ability of the soil to store and convey air and water, stores and supplies many nutrients needed for the growth of plants and soil organisms, binds potentially harmful substances, such as heavy metals and pesticides, and acts as a storage reservoir (sink) for carbon dioxide captured from the atmosphere. Higher levels of soil organic carbon can increase yield, crop quality, and improved resilience to drought and other stresses due to higher nutrient and water holding capacity.

Canada has seen positive trends in soil health over the past decade, especially in the Prairies (Figure 1). This has been attributed to Prairie-based farmers switching to no-till or conservation tillage seeding techniques and reduced summerfallow. The increase in soil cover has resulted in the improvement of soil health by reducing erosion and increasing soil moisture, and has provided co-benefits including improved soil biodiversity and carbon sequestration. Increased crop yields since 1990 have resulted in more crop residues returned to the soil, enhancing soil health and sequestering carbon. In contrast to the mainly positive trend in the Prairies, soil carbon levels are now generally decreasing in regions of Canada east of Manitoba. This can be attributed to a trend of converting pastures and hayland to annual crops with the decline in beef cattle production and dairy herds over the past few decades.

Figure 1: Cumulative Soil Organic Carbon Change 1990 to 2020 (kilogram of carbon per hectare) [5]



Practices that support soil health. There are a number of practices that can help support improved soil health on farms, many of which are already in use by a large number of farmers. These practices also provide the additional benefit of supporting the soil's natural ability to absorb carbon, thereby contributing to climate change mitigation:

- including crops with high residues or larger and deeper root systems in crop rotations
- using cover crops or intercropping systems to keep the soil covered year-round (for example, clover, alfalfa, ryegrass, oats and winter wheat)

- increasing soil organic matter through the use of manure, compost and green manures
- reducing tillage through adoption of zero-tillage or conservation tillage systems
- reducing or eliminating summerfallow
- converting cropland (particularly marginal land) to pasture or other permanent cover
- planting trees on agricultural land (for example, shelterbelts, trees next to waterways)
- rotational grazing, which involves moving livestock between defined paddocks to ensure they get extended periods un-grazed to regenerate

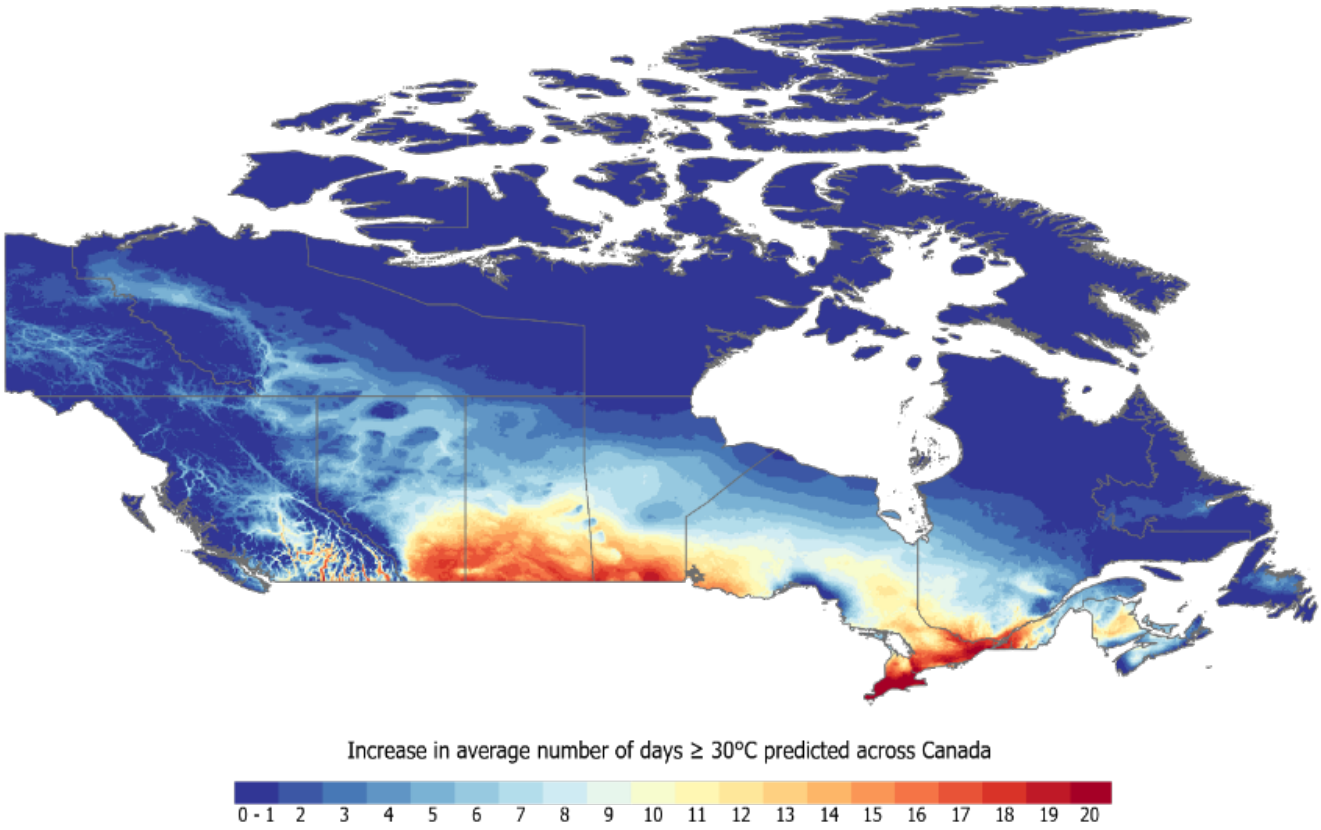
There is also the need for continued research and innovation to identify new opportunities to advance soil health.

4.2 Climate adaptation and resilience

Increased temperatures, longer growing seasons, shifting precipitation patterns and an increase in frequency and intensity of extreme events will bring risks to Canada's agriculture sector (Annex B), affecting costs, yields, and profits. Often, these events impact Indigenous and marginalized farmers and communities more than others, especially in northern and remote regions. Adapting to the natural variability in weather and climate is something farmers and ranchers have always done; however, with the predicted increases in climate and weather-related risks, agricultural systems need to adapt to a new suite of climate change impacts, while considering their interaction with other factors, such as economic and social pressures. According to the

2019 *Canada's Changing Climate Report*, across most of Canada springs will be wetter, summers will be hotter and drier, and winters will be wetter and milder. Figure 2 shows the change in number of very hot days (over 30°C) Canada will experience in 2021-2050 compared to the number of very hot days experienced in the period from 1976-2005.

Figure 2: Increase in Annual Average Number of Days ≥ 30°C Predicted Across Canada In a Business-As-Usual Scenario (change from 1976-2005 period to 2021-2050 period) [6]



▼ Description of Figure 2

A map of Canada showing an increase in annual average number of days with temperatures above 30 degrees Celsius. This is predicted for 2021-2050, and compared to historic trends of the 1975-2005 period. The change in risk is occurring across Canada, particularly in southern regions.

Extreme weather events such as heat waves, wildfires, floods, droughts, intense precipitation events and severe winds have increased across Canada over the last decades. These events have been devastating to agriculture and rural economies. A clear example of this is in 2021 when Prairie farmers and ranchers experienced the most widespread and most severe drought in 70 years. The extremely low precipitation that had occurred since late 2020, along with the record-breaking heatwaves in the summer, resulted in severe to exceptional drought conditions throughout much of Western Canada. Impacts of this drought led to crop yield losses of 30% to 40% in the Prairies, poor pasture and rangeland conditions, widespread livestock feed and water shortages, and a large number of wildfires threatening farming communities [7]. Importantly, the environmental, economic and social impacts of these events can be long-lasting, with implications over more than one season and risks to soil fertility, soil carbon, animal welfare and farmer mental health.

Climate change is also expected to bring shifts in the distribution of crop and pasture land, including the potential for northern

expansion of agriculture in areas where soil conditions allow. Longer growing seasons are anticipated in all farming regions, with the last spring frost occurring earlier in the season and the first fall frost occurring later in the season. However, growing seasons and frost dates will be variable and more unpredictable, increasing risks to operations; farmers will need to determine the relative risks of early planting and late harvesting (for example, tree fruit crops are particularly vulnerable to late frosts occurring during flowering). These shifts also mean new challenges, such as the risk of new pests and diseases migrating to Canada, or shifting viability of crops vulnerable to high heat, impacting yields and export opportunities.

Practices that support adaptation and improved resilience in agriculture. Several practices can support adaptation and improved resilience in the agriculture sector, for example:

- increasing soil cover through cover cropping, permanent cover (for example, trees, pasture)
- increasing the protection and enhancement of grasslands and wetlands, as biodiverse agricultural landscapes are more climate resilient and recover more quickly from extreme weather events (for example, droughts)
- growing/raising crops and livestock that are adapted to climate risks (for example, drought- or heat-resistant crop) or to a warmer climate
- investing in resilient infrastructure (for example, storm barriers, controlled drainage, sustainable irrigation, water reservoirs)
- reducing financial vulnerability through access to production

and revenue insurance and diversifying production
- enhancing resilience of farm operators with mental health support, extension, and training
- making crops more resilient to a more variable and extreme climate by using gene-edited seeds
- implementing climate risk management programs and practices
- investing in training and skills development related to resilience and adaptation

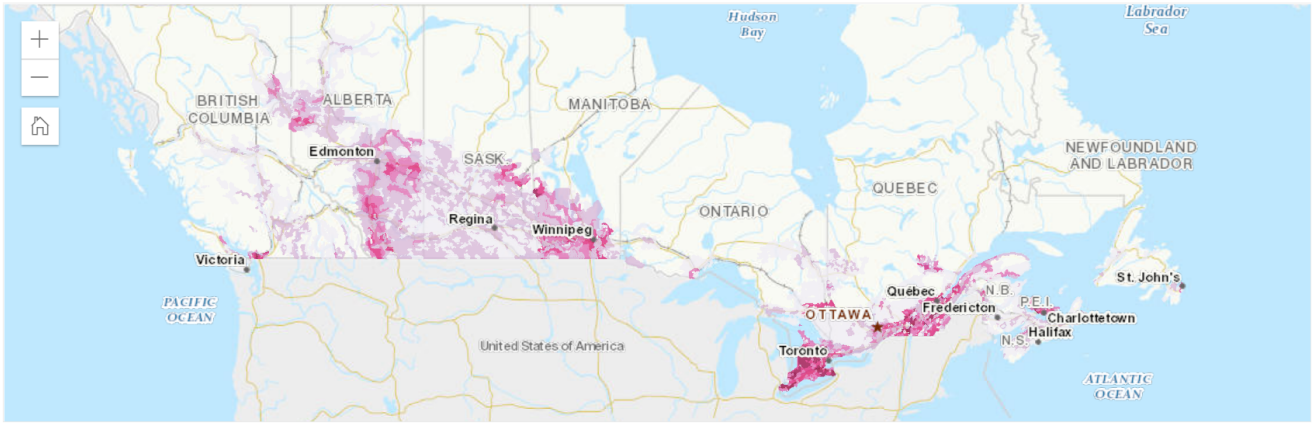
4.3 Water

Water quality. Agriculture is dependent on clean water for production; poor water quality can impact growth and cause disease in animal production. Agricultural production can also impact water quality including through sediment and nutrient loading, pathogens, pesticides, and contaminants such as animal pharmaceuticals. Controlling these impacts can be difficult as unlike other industries or urban sources that mainly deal with point-source pollution (for example, municipalities, textiles and manufacturing), agriculture deals with diffuse sources of pollution where there is often no single point where pollutants enter the downstream receiving system.

Agriculture has been implicated in several areas of the country where lake and ecosystem health has been impaired. For example, excess phosphorus from sources including runoff from urban and agricultural lands (from organic and inorganic sources) has been linked to water quality impacts in the Great Lakes and in Lake Winnipeg, leading to reduced ecosystem health

and harmful algal blooms. The risk of phosphorus contamination (Figure 3) is higher in regions with greater agricultural concentration, such as the Prairie Provinces, parts of Eastern Canada, and the Lower Fraser Valley Region of British Columbia. Nitrogen contamination of groundwater is also a concern in some regions, such as in parts of Atlantic Canada.

Figure 3: Risk of Contamination of Surface Water by Phosphorus In Canada In 2016 [8]



Legend:

Very Low	Low	Moderate	High	Very High

Water quantity. Farmers depend on reliable sources of water for safe and efficient food production, and variations in the timing and quantity of water can have significant impacts on their operations. Changes in precipitation patterns and phases, shifts in the timing of water availability, and extreme weather associated with climate change will increase the need for enhanced water management in many regions, whether for excess — including spring melt and heavy rains which can cause seeding and/or harvesting delays and disruptions and present risks to infrastructure — or shortages — with droughts reducing crop yields and presenting risks to animal health.

Changes in temperature and precipitation patterns will increase reliance on irrigation, notably across the Prairies and the interior of British Columbia where moisture deficits are greatest, but also in regions where there has not traditionally been a need to irrigate [9]. Approximately 0.95 million hectares are irrigated [10], accounting for less than 2% of Canada's total farm area [11], with over two-thirds of all irrigated land located in Alberta. In other regions the reverse may be true, requiring the need for new or enhanced drainage and water storage infrastructure. Inadequate drainage poses significant challenges to farmers in many regions, particularly when it contributes to flooding. Artificial drainage through surface and subsurface structures is needed to maintain fields for production when natural drainage is not sufficient.

Competition between water users is already a reality in Canada (for example, growing demand for drinking water and hydropower, as well as for mining and processing) is already a reality in some parts of Canada. The predicted impacts to the quantity and quality of freshwater resources have the potential to lead to consequences for Canada's water security, economic growth, and societal well-being. For example, more than 11 million people in Canada and the United States rely on Lake Erie for drinking water, and the Lake also supports more than $50 billion annual income to tourism, recreation, and industry in the region. Adapting to climate change requires watershed-based responses to address regionally specific water issues where consideration of all water users are understood (Annex C).

Practices that support water quality and availability in

agriculture. A variety of practices can help reduce the risks of water shortages or excess and support improved water quality in the agriculture sector. These include:

- nutrient management practices such as optimal timing and subsurface placement of fertilizer; soil testing to determine fertilization needs; and using fertilizers with urease or other nitrification inhibitors
- practices that reduce input runoff (for example, cover crops or reduced tillage)
- use of wetlands or reactive biofilters to trap nutrients
- planting or retaining permanent vegetation around water bodies (riparian zones)
- practices that increase soil organic matter (for example, cover crops, reduced tillage)
- increasing water capture and storage and/or expanding sustainable irrigation and drainage
- selecting plant and animal varieties that are better adapted to climate extremes

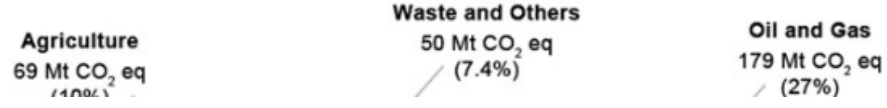
4.4 Climate change mitigation

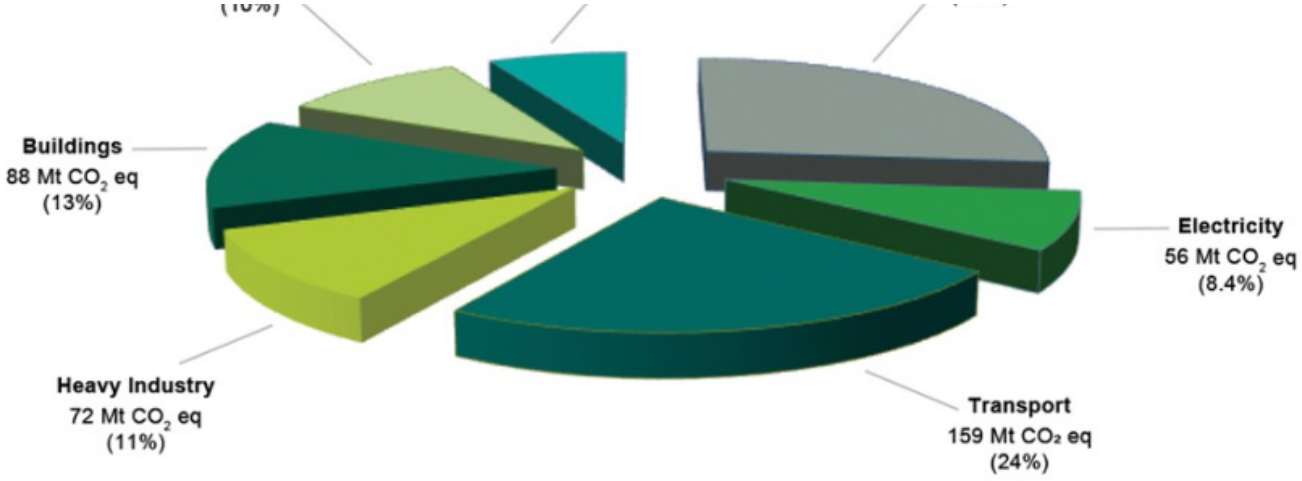
GHG emissions. According to the 2022 National Inventory Report, total agricultural emissions from production within the boundaries of a farm were estimated at 69 Mt CO_2e in 2020, accounting for around 10% of Canada's total emissions (Figure 4) [12]. Agricultural practices release GHG emissions primarily from biological sources, such as livestock production (enteric fermentation), and the application of synthetic nitrogen fertilizers, manure management, and on-farm fuel use (for

example, operation of farm machinery). These practices contribute to carbon dioxide, methane, and nitrous oxide emissions (Figure 4). Agriculture is one of the main sources of Canada's total methane emissions, contributing approximately 30%.

Canada's total agricultural GHG emissions have stayed relatively stable since 2005, while the sector's contribution to Canada's gross domestic product has increased over the same time period; in other words, the emission intensity has been declining [13]. Other trends are visible by sub-sectors. Between 1990 and 2005, emissions associated with animal production [14] increased by 38%, and then declined by 20% between 2005 and 2020. The decline in the livestock sector has been associated with reduced herd size in the dairy and beef sectors and improved productivity per head. Emissions associated with crop production [15] increased by 102% between 1990 and 2020 [16]. Greater nitrous oxide emissions on cropland are driven by an increase in the proportion of farm land under annual crop production (for example, conversion of pasture and forages to land for annual crop production such as grains and oilseeds) and an increase in the area used for the production of more fertilizer-intensive crops (for example, corn, canola). The area used for the production of crops such as canola and corn has expanded considerably since 2001, while the area of some crops requiring lower fertilizer rates, such as wheat, barley, oats and tame hay has decreased.

Figure 4A: Canada's GHG Emissions by Economic Sector





▼ Description of Figure 4A

Canada's GHG Emissions by Economic Sector:

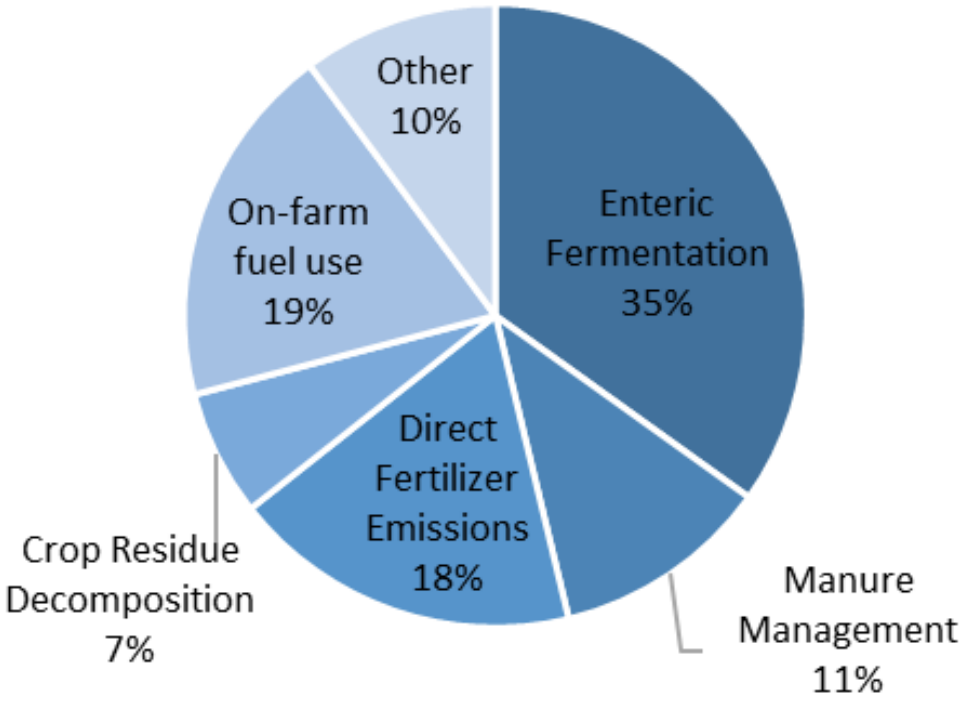
A breakdown of Canada's GHG emissions by six Intergovernmental Panel on Climate Change economic sectors for 2020. These sectors are the following: Energy – Stationary Combustion Sources, Energy — Transport, Energy — Fugitive Sources, Industrial Processes and Product Use, Agriculture, and Waste. Stationary combustion sources contributed 45% to the total national emissions in 2020 followed by Transport (28%). Shares of Industrial processes, agriculture and energy fugitive sources were almost equivalent. The smallest contributor was the Waste sector. The following table displays the breakdown of the GHG emissions (Mt CO_2 eq) for the six sectors for 2020.

Data table:

Sector	**Mt CO_2 eq**	**% of Total**
Agriculture	69	10%
Waste and Others	50	7.4%

Sector	Mt CO_2 eq	% of Total
Oil and Gas	179	27%
Electricity	56	8.4%
Transport	159	24%
Heavy Industry	72	11%
Buildings	88	13%

Figure 4B: Main sources of Canada's agricultural emissions in 2020



▼ Description of Figure 4B

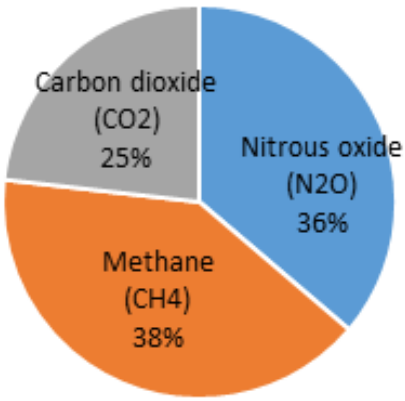
A breakdown of Canada's green house gas emissions by six main sources of agriculture emissions: enteric fermentation, manure management, direct fertilizer emissions, crop

residue decomposition, on-farm fuel use, and other.

Data table:

Agricultural Process	Percentage of Main Sources of Canada's Agricultural Emissions in 2020
Enteric Fermentation	35%
Manure Management	11%
Direct Emissions from Synthetic and Organic Fertilizers	18%
Crop Residue Decomposition	7%
On-farm fuel use	19%
Other	10%

Figure 4C: Types of greenhouse gases emitted by the agricultural sector in 2020



▼ Description of Figure 4C

A breakdown of Canada's GHG emissions in the agricultural sector by three GHG gases: carbon dioxide, nitrous oxide, and methane.

Data table:

Greenhouse Gas	**Percentage of Greenhouse Gases Emitted by the Agricultural Sector in 2020**
N_2O	36%
CH_4	38%
CO_2	25%

The 2030 Emissions Reduction Plan, tabled in March 2022, projects a 1 Mt increase in emissions from the agriculture sector by 2030 without further interventions. This is relative to 2005 levels of 72 Mt [17]. This includes emissions from crop production, animal production, and on-farm fuel use. However, the projection does not include carbon sequestered from agricultural activities — these are captured in the category of Land Use, Land Use Change and Forestry (LULUCF). Recently announced federal measures, including those supporting carbon sequestration from agricultural activities could contribute up to 13 Mt in additional agriculture-related reductions by 2030 [18].

Carbon sequestration. In the early 1990s, Canadian agricultural soils transformed from being a carbon source to a carbon sink

following increased adoption of conservation tillage or no-till in the Prairies, a reduction in summerfallow (keeping cropland out of production but controlling plant growth through ploughing and spraying), and higher crop yields leading to higher carbon inputs into soils. Soil carbon sequestration has fluctuated from year to year depending on climatic conditions and land management practices. In 2020, agricultural soils stored almost 10 Mt CO_2e, meaning that agricultural soils sequestered more than they emitted, counteracting approximately 14% of total annual agricultural emissions [19]. Along with forestry, the agriculture sector has the potential to sequester significant carbon by the 2050 horizon through the increased use of particular management practices such as cover cropping and shelterbelts. These practices can simultaneously support production and other environmental benefits such as decreased soil erosion, increased soil health, and wildlife habitat.

Food loss and waste [20]. Food loss and waste is also a source of emissions associated with the agriculture and agri-food sector, as its decomposition in landfills is a major source of methane. In addition to direct emissions from the decomposition of food waste, the resources (for example, water, energy, inputs, and soil nutrients) used to produce this food are also wasted. Food loss and waste refers to food that is grown, harvested, processed, manufactured or prepared for human consumption, but never eaten by people. Preventable food loss and waste continues to create an unnecessary economic, environmental, and social burden for Canadians. A 2019 study indicated that nearly 11.2 million metric tonnes of avoidable food loss and waste is

generated annually, which could be worth nearly $50 billion at retail [21]. Food waste represents the single largest percentage (23%) of Canadian municipal solid waste disposed [22]. The Government of Canada has identified food loss and waste reduction as a priority action area under the Food Policy for Canada.

Practices that support climate change mitigation. The following table illustrates promising practices to reduce on-farm GHG emissions based on available research and known results, including limited impact on yields.

Table 1: Promising practices to reduce net on-farm GHG emissions

a) Practices that reduce methane emissions

Beneficial Management Practice	Amount of Emissions Reduction Potential by 2030 [1]	Current Adoption Rates
Using methane-inhibiting feed additives	1 Mt	0%
Liquid manure treatment systems for dairy and swine facilities (adding sulphuric acid to empty liquid manure tanks or anaerobic digestion)	1 Mt	0%

Beneficial Management Practice	Amount of Emissions Reduction Potential by 2030 [1]	Current Adoption Rates
Adding high-quality forages, alfalfa, and tannin-rich plants to pastures in grazing cow-calf operations	0.9 Mt	Unknown to low

1 The emissions reduction potential is based on aspirational adoption targets, depending on the maturity of the practice/ technology and the feasibility of adoption. These targets were established to provide a framework with which to assess the potential impact of the practices if adopted at scale where possible across the country. The adoption rates ranged from 25% where practices are more novel to 75% for those that are well-understood and that already have a high level of adoption. In one instance, for reducing tillage in the Prairies, the aspirational adoption rate was set at 90% given existing extensive adoption.

b) Practices that reduce nitrous oxide emissions

Beneficial Management Practice	Amount of Emissions Reduction Potential by 2030 [1]	Current Adoption Rates
Using fertilizers with nitrification and urease inhibitors	1.8 Mt	Very low
Splitting fertilizer applications and side-dress fertilizer	0.5 Mt	Medium
Increasing use of legumes in rotation and accounting for legume nitrogen credit to subsequent crop	0.4 Mt	Medium

Beneficial Management Practice	Amount of Emissions Reduction Potential by 2030 [1]	Current Adoption Rates

1 The emissions reduction potential is based on aspirational adoption targets, depending on the maturity of the practice/ technology and the feasibility of adoption. These targets were established to provide a framework with which to assess the potential impact of the practices if adopted at scale where possible across the country. The adoption rates ranged from 25% where practices are more novel to 75% for those that are well-understood and that already have a high level of adoption. In one instance, for reducing tillage in the Prairies, the aspirational adoption rate was set at 90% given existing extensive adoption.

c) Practices that sequester carbon

Beneficial Management Practice	Amount of Emissions Reduction Potential by 2030 [1]	Current Adoption Rates

Beneficial Management Practice	Amount of Emissions Reduction Potential by 2030 [1]	Current Adoption Rates
Planting trees on agricultural land — for example, shelterbelts, trees next to waterways	1.9 Mt (7 Mt by 2050)	Medium/ low to zero
Converting marginal croplands to grasslands	1.7 Mt	Low
Other practices including increasing alfalfa in pasture and hay, no-till, eliminating summerfallow, rotational grazing, cover crops	3.8 Mt	Variable

Beneficial Management Practice	Amount of Emissions Reduction Potential by 2030 [1]	Current Adoption Rates

1 The emissions reduction potential is based on aspirational adoption targets, depending on the maturity of the practice/ technology and the feasibility of adoption. These targets were established to provide a framework with which to assess the potential impact of the practices if adopted at scale where possible across the country. The adoption rates ranged from 25% where practices are more novel to 75% for those that are well-understood and that already have a high level of adoption. In one instance, for reducing tillage in the Prairies, the aspirational adoption rate was set at 90% given existing extensive adoption.

Clean technology that reduces on-farm GHG emissions can include adopting more fuel-efficient technology, adopting technology that uses alternative fuels (for example, solar heating, biogas digesters, zero-emissions vehicles) and adopting precision agriculture technology and practices. These can include management strategies that gather, process and analyze data and decision support tools and technologies that improve — in real time — input use and nutrient management (for example,

soil sensors, systems and digital infrastructure). Technologies that use agricultural waste, production, and by-products for energy and bio-product generation can also reduce GHG emissions along the supply chain.

More ambitious and long-term scientific research is needed to develop the practices, technologies, products, land uses and inputs, that will enable the sector to meet the net zero challenge, while remaining resilient and profitable under uncertain future climate conditions, and thus able to advance the Canadian and global food security agenda. Time is required for innovative ideas to evolve from inception, to research, and to maturity for implementation at scale.

4.5 Biodiversity [23]

Biodiverse ecosystems benefit agricultural production through nutrient cycling, soil formation, water purification, pest management and pollination. Highly biodiverse agricultural landscapes are more climate resilient and recover more quickly from extreme weather events (for example droughts). Pollination from bees and other insects is vital to the production of many crops, particularly fruit, vegetables, and edible oil crops like canola. In Canada, managed pollination adds a value of over $3 billion per year to crop revenues, and worldwide, 70% of the 124 most important crops for human consumption rely to some extent on pollinators [24].

Agricultural working landscapes can provide important habitat for wildlife through provision of a variety of land cover such as

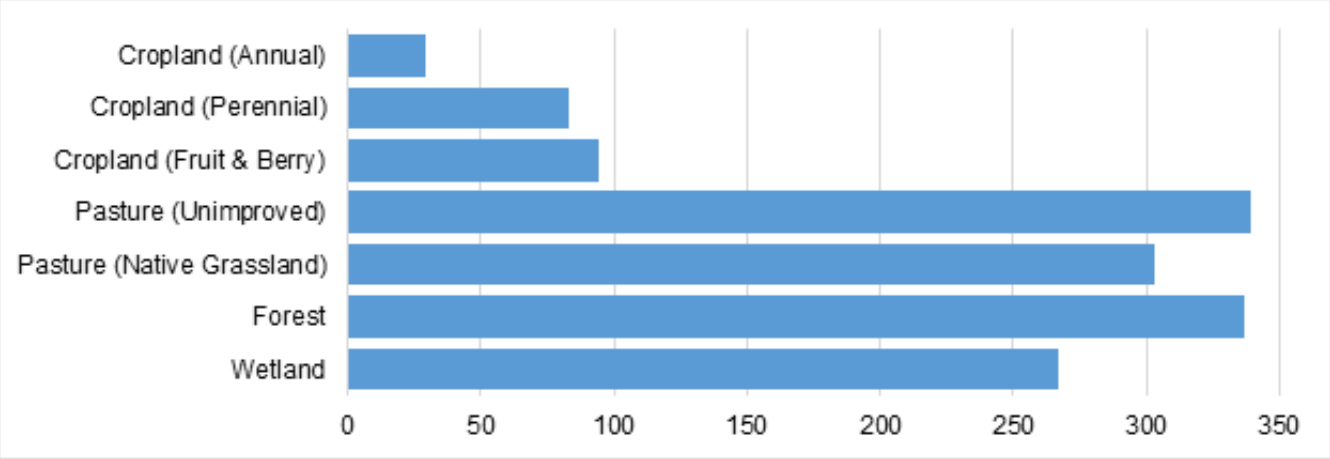
wooded areas, wetlands, shoreline areas and natural pastures. Agricultural grasslands including grazing pastures and hay lands, for example, provide important ecological goods and services, as they help regulate the quantity and quality of water by reducing and filtering run-off, protect fragile soils from erosion, support the cycling of nutrients, and provide habitat for wild animals, plants and soil biodiversity.

Another component of biodiversity, genetic diversity, is the basis of crop and breed selection, and is necessary for resilience in the face of environmental stresses. Globally, genetic diversity in agriculture is in decline as we grow fewer species for consumption. Canada remains vigilant to the conservation of improved crop germplasm and the diversification of breeding materials. Canada currently has a variety of animal breeds used for food, allowing farmers to adjust to local climatic conditions, however, half of the Canadian dairy breeds are classified as endangered or critical.

Declines in biodiversity have resulted from the loss of natural and semi-natural areas that provide critical habitat, such as grasslands, wetlands and forage and pasture lands, as well as from increased annual cropping [25] and urban expansion. Converting natural landscapes to agricultural land has an impact on both biodiversity and GHG emissions. Figure 5 illustrates that while diverse agricultural landscapes that include natural/semi-natural cover types can provide habitat for a greater diversity of species, relatively few species use annual cropland as primary habitat.

Other agricultural practices, such as the use of pesticides and herbicides, can also have impacts on biodiversity, large-scale pollination, and other ecosystem services. Pesticides play an essential role in Canada helping to maintain domestic and global food production, implementing sustainable management practices such as no-till seeding, and controlling invasive weed species. Canada has a rigorous regulatory framework, led by Health Canada, for the registration of pesticides including label instructions for their application in agriculture. In addition, Canada's farmers follow beneficial management practices to sustainably apply and reduce their reliance on these products to minimize impacts. This includes innovations in biotechnology and precision agriculture (for example, crop varieties bred with disease resistance), development and promotion of pesticides (for example, biocides) with less impact on non-target organisms, and implementation of integrated pest management systems that make use of natural controls.

Figure 5: The Number Of Terrestrial Vertebrate Species Using Cover Types on Agricultural Landscapes (2015) [26]



▼ Description of Figure 5

Data table:

Land Cover Type	Number of species using cover type for feeding and reproduction on agricultural land
Wetland	267
Forest	337
Pasture (Native Grassland)	303
Pasture (Unimproved)	339
Cropland (Fruit & Berry)	94
Cropland (Perennial)	83
Cropland (Annual)	29

Note: Graph illustrates the number of terrestrial vertebrate species using cover types on Canadian agricultural lands. Cropland (Perennial) = improved pastures, tame hay, alfalfa for feed and forage; Pasture (Unimproved) = natural unimproved land for pasture; has not been cultivated, seeded, drained, irrigated or fertilized; restricted to geography where native grasslands do not occur. Pasture (Native Grassland) = native grass and shrubs used for cattle grazing; restricted to portions of western Ecozones (Prairies, Boreal Plains, Montane Cordillera, Western Interior Basin).

Practices that support biodiversity in agriculture. Several practices can support biodiversity on farms, while providing other benefits such as maintaining pollinator populations that support productivity. The following are examples of practices that can better support biodiversity in agricultural systems:

- creating "eco-buffers" or wildlife corridors
- planting or maintaining shelterbelts and hedgerows
- improving management of existing wetlands, restoring damaged or drained wetlands, or constructing new wetlands
- establishing permanent cover (for example, trees, pasture, perennial grasses) on lands formerly used to grow annual crops, especially where land is marginal
- maintaining pasture, grasslands, woodlots, or marginal lands (for example, not converting to annual cropland)

5. Existing measures that support environment and climate outcomes in the agriculture sector

In the context of increasing global ambition to address climate, biodiversity, and other environmental challenges, the Government of Canada has developed several broad strategies to frame action on the environment and climate, such as the Strengthened Climate Plan and 2030 Emissions Reduction Plan. Other strategies are under development including a National Adaptation Strategy, Canada's Methane Strategy, the National Biodiversity Strategy and Action Plan, the Freshwater Action Plan, the Climate Science Plan, and strategies to work in partnership

with farmers to decrease emissions from fertilizers while continuing to increase agricultural productivity. The Government of Canada also supports initiatives to advance multiple climate and environment outcomes in the agriculture sector, recognizing the inter-linkages across environmental issues at the farm level, including the Sustainable Canadian Agricultural Partnership, Agriculture Climate Solutions, and Agricultural Clean Technology fund, among others. Government of Canada measures that support environment and climate outcomes in the agriculture sector provides an overview of these and other measures that support environment and climate outcomes in the agriculture sector. A Sustainable Agriculture Strategy would bring climate and environment action on agriculture land together under one umbrella, support improved coordination of public and private action, and address gaps by informing policy and programming that advance environment and climate outcomes and work for farmers.

6. Discussion issues

This section is organized into three discussion issues, each accompanied by a short background and a set of questions.

Issue 1: What do we want to achieve through a Sustainable Agriculture Strategy?

A Sustainable Agriculture Strategy would leverage existing efforts and focus resources and action, providing a clear vision and direction for an environmentally, socially, and economically sustainable agriculture sector that also contributes to advancing

Reconciliation. A clear vision and shared goals would guide the selection and development of approaches needed to advance the sustainability, competitiveness, and vitality of the sector. The vision and goals aim to guide decision-making on which actions to take when there are diverging economic, environmental, and social impacts to consider.

It is proposed that a Sustainable Agriculture Strategy use the vision statement outlined in the Guelph Statement [27], adapted to fit the long-term nature of a strategy. Five proposed goals, developed from early engagement discussion on a strategy, would support the achievement of this vision.

Proposed Vision for a Sustainable Agriculture Strategy:

Canada is recognized as a world leader in sustainable agriculture and agri-food production and drives forward from a solid foundation of regional strengths and diversity in order to rise to the climate change challenge, to expand new markets and trade while meeting the expectations of consumers, and to feed Canadians and a growing global population.

Proposed Goals for a Sustainable Agriculture Strategy:

1. The agriculture sector is resilient to short and long-term climate impacts while growing productive capacity, and has adapted to changing contexts due to climate change.
2. Environmental performance is improved in Canada's agriculture sector, contributing to the environmental, economic, and social benefit of all Canadians.
3. The agriculture sector plays an important role in contributing

to Canada's national 2030 GHG emission reduction and net-zero by 2050 targets while remaining competitive and supporting farmers.

4. A more comprehensive and integrated approach is taken in addressing agri-environmental issues in the agriculture sector, across policy, programming, and partners in the value chain.
5. Canada has addressed data gaps and improved capacity to measure, report on, and track the environmental performance of the agriculture and agri-food sector.

Specific outcomes would be associated with each goal — measurable changes that occur as a result of collective action across existing and new policies, programs, and initiatives within the timeframe of the strategy. Outcomes for a Sustainable Agriculture Strategy that could be considered include:

- production is more resilient to climate change
- GHG emissions in the agriculture sector are reduced
- the sector has increased capacity for carbon sequestration
- use of energy efficient and clean technologies on farms is increased
- biodiversity-rich landscape features are maintained and/or improved on agricultural lands (for example wetlands, grasslands, and treed areas)
- ecological services are measured, maintained, and sustainable
- a more comprehensive approach to water management is taken in agriculture

Discussion Questions

- Which of the proposed goals for a Sustainable Agriculture Strategy do you agree with most? What would you add or change?
- What should a Sustainable Agriculture Strategy aim to achieve in the agriculture sector in terms of:
  - Climate change mitigation
  - Adaptation
  - Biodiversity
  - Water
  - Soil health
- How can a Sustainable Agriculture Strategy support an environmentally, socially, and economically sustainable agriculture sector?

Issue 2: Approaches to overcome barriers and advance environmental outcomes in the sector

From previous discussions with the sector on related environmental issues — including sessions on the fertilizer emissions target, the agriculture workshop as part of the National Adaptation Strategy consultations, and the Sustainable Canadian Agricultural Partnership — the following points were raised most frequently by participants as barriers to adopting beneficial management practices and technologies that support improved environment and climate outcomes:

- uncertainty about economic benefits, costs, and risks of yield changes when adopting particular practices/technologies
- lack of recognition of early adopters of environment and

climate-smart practices
- insufficient knowledge, training, or access to technical expertise/advice to adopt a specific practice/technology
- cost of adoption and maintenance of environment or climate-smart practice/technology
- time required to implement and sustain a particular practice/ technology
- insufficient availability of labour or labour with the right skills (for example for data-intensive production, precision agriculture)
- lack of knowledge and tools required to measure outcomes, such as GHG emissions, or meet reporting requirements for assurance standards
- rising input and output costs
- speed of regulatory processes
- lack of access to rural broadband connectivity
- generational and cultural differences in farm management approaches

Advancing the goals of a Sustainable Agriculture Strategy will require overcoming these barriers using a suite of integrated approaches, that build on existing programs, policies, and initiatives given the diversity of Canada's agriculture sector and range of environmental priorities.

The following are approaches that could be considered under a Sustainable Agriculture Strategy to help advance the strategy's goals and outcomes and overcome existing barriers. Many of these are already being implemented by the Government of

Canada to support environment and climate outcomes in the agriculture sector (see Government of Canada measures that support environment and climate outcomes in the agriculture sector). A Sustainable Agriculture Strategy would build on current initiatives, filling in any gaps and making adjustments to better support environment and climate outcomes.

- **knowledge transfer and extension** — activities that increase farmers' access to the information, advice, and training they need to effectively implement practices on their farm that advance environment and climate outcomes. For example, agricultural extension, demonstration sites, regional climate risk assessments, on-farm GHG calculators, life cycle analyses.
- **supporting advancements in clean technology and digital adoption** — approaches that invest in and further incentivize the development, demonstration, commercialization and adoption of clean technology in the sector. For example, zero-emission on-farm equipment or machinery, precision agriculture, artificial intelligence, and innovations that enable the use of alternative and bioenergy.
- **financial incentives for adoption of on-farm beneficial management practices** — direct financial incentives to farmers that, for example, cover costs required to establish and maintain on-farm practices that support climate and environment outcomes or support the provision of ecological goods and services.
- **economic instruments** — tools and practices that use markets, price, and other financial incentives and economic variables to reduce or eliminate unintended environmental

impacts. For example, tax incentives, lower interest rates on loans for farmers implementing climate-smart/ environmentally-smart practices, leveraging business risk management programming to incentivize practices and eliminate disincentives for action.

- **market-based opportunities** — market-based benefits that incentivize the adoption of environmentally sustainable practices. For example, industry-led sustainable sourcing and certification schemes, voluntary or regulated carbon offset markets.
- **regulations** — amending existing or establishing new regulations that could establish performance standards and/ or mandate or prohibit use of a specific agricultural practice to efficiently and significantly scale up the adoption of practices or technologies that currently have low levels of adoption. Climate-friendly new practices, technologies and/or products may also require regulatory approval, along with approaches to address any potential hurdles and prolonged timelines.
- **science and research** — filling existing knowledge gaps, improving measurement and monitoring, and developing new varieties of crops and livestock to help advance environment and climate outcomes in the sector.
- **solutions along the supply chain** — supporting solutions along the supply chain that ultimately have a positive impact on on-farm environmental performance, as well as other environmental benefits along the supply chain. For example, advancing the growth of the bioeconomy sector, finding innovative solutions to reducing food loss and waste, and

advancing circularity in the sector.
- **working with Indigenous Partners** — collaborating with Indigenous partners on Indigenous specific policy and programming that supports sustainability in Indigenous agriculture and food systems, including on actions that strengthen Indigenous-led food systems through environmental benefits.

Discussion Questions

- What success stories can you share about approaches to improve environment and climate outcomes in the sector? In what way have those approaches impacted yields or costs?
- What suggestions do you have for additional approaches that could be part of a Sustainable Agriculture Strategy to:
  - Support environment and climate outcomes in the agriculture sector in general?
  - Support the agriculture sector in reaching net-zero by 2050?
- Given the pace of change needed, in which areas could regulatory approaches or changes to existing ones be used to accelerate environment and climate action?
- What type of research should be prioritized to advance environment and climate outcomes in the sector?

Issue 3: Targets and data on environmental performance

Acquiring timely and complete data is essential to understand where practices, programs, or policies are working and where more attention is needed. Measurement of environmental impact

in the agriculture sector is particularly complex due to the high variability of farms, landscapes, and on-farm practices used to support environment and climate outcomes. Farm-level collection of data and common data standards to inform outcomes continues to be a challenge due to cost and complexity of data collection, gaps in existing modelling tools, and the collection of data held by different organizations and jurisdictions. Farmers and other stakeholders have also expressed concerns over privacy, ownership, and security of collected farm-level data, as well as the time burden of data collection.

Ensuring the provision of quality, timely, representative data will require involvement across federal, provincial, and territorial governments, industry and commodity groups, and farmers and farmer groups to develop innovative ways to gather the required information. Areas for improvement that could be included in a Sustainable Agriculture Strategy include advancing the capacity and technology for data collection, modelling, and measurement/verification in agri-environmental outcomes, collecting farmland data and analytics, and measuring and reporting on agri-environmental outcomes at a national level. Opportunities could be explored that expand current market information systems to better respond to the sector's needs, with information that links to sustainability priorities like input usage (for example, fertilizers and pesticides), consumer consumption trends, and advanced retail statistics.

Setting targets with clear actions is another approach that could incentivize action by providing a goal post to reach and against which to measure progress. Targets can also help define results

for improving agri-environmental outcomes and track progress on improved sustainability in the sector. Canada currently has only one environmental target that is specific to the agriculture sector — to reduce emissions from synthetic fertilizers by 30% from 2020 levels by 2030. Other countries and jurisdictions have set targets specific to their agriculture sector related to climate change mitigation, adaptation, biodiversity, water, or soil health, several of which can be found in Annex D.

Discussion Questions

- What kind of data are most important for measuring environmental and climate outcomes in the sector?
- What suggestions do you have for improving how environmental data is collected and shared in the sector?
- What qualitative or quantitative targets do you feel would be realistic, ambitious, and measurable to generate the most action in the following:
    - Reducing GHG emissions or storing carbon
    - Making the sector more resilient
    - Supporting biodiversity
    - Supporting water quality and availability
    - Improving soil health

Final Questions:

- Do you have any other ideas, comments, feedback or suggestions to share on a Sustainable Agriculture Strategy?

7. Next steps

Engagement on a Sustainable Agriculture Strategy will occur in 2022 and early 2023, with feedback informing the goals, outcomes, and actions in the strategy, as well as how to measure progress. A "What We Heard" report will be published following the consultations process, and the draft Sustainable Agriculture Strategy is anticipated in 2023.

Annex A: Environmental co-benefits of certain on-farm beneficial management practices

Note: “X” indicates the presence of a co-benefit

	Climate Change Mitigation		**Adaptation & Resilience**	
Practice	**Increase carbon sequestration**	**Decrease emissions**	**Decrease impacts from weather events**	**Increase farm resilience to weather events**

Practice	Climate Change Mitigation		Adaptation & Resilience	
	Increase carbon sequestration	Decrease emissions	Decrease impacts from weather events	Increase farm resilience to weather events
Planting trees on agricultural land (for example, trees in pastures, shelterbelts, trees next to waterways)	X		X	
Improved fertilizer management	X			
Cover crops or intercropping	X	X		X
Establishing permanent cover on marginal land	X			X

Practice	Climate Change Mitigation		Adaptation & Resilience	
	Increase carbon sequestration	Decrease emissions	Decrease impacts from weather events	Increase farm resilience to weather events
Selecting plant and animal varieties that are better adapted to climate extremes and a warmer climate	X			X
Improving management of existing wetlands	X			X

Annex B: Risks and opportunities due to climate change for the agriculture sector

Climate Change Impact	Risks	Opportunities
Increased frequency and intensity of storms, flooding, droughts, and wildfires	• power outages affecting livestock heating/cooling and automated feeding and milking systems • crop, soil, and infrastructure damage • impacts on Canada's grain handling and transportation system • negative impacts on water quality from field and livestock facility run-off to ditches, streams and other downstream water bodies • increased damage to soil health and quality, leading to increased risks of input runoff	

Climate Change Impact	Risks	Opportunities
Changes in precipitation patterns, warmer weather	• parts of southern Saskatchewan and Alberta may become less suitable for heat-sensitive crops such as canola • delayed seeding with wetter springs • heat stress in livestock, resulting in lower weight gains [28], reduced reproductive rates [29], lower milk [30] and egg production [31] and higher risk of disease • overwinter survival of pests [32] and diseases, as well as a northward expansion of pests and diseases not currently found in Canada • change in plant flowering periods, resulting in a mismatch between flowering and the emergence of	• corn, soybeans and fall-seeded pulse crops that are more resilient to climate extremes may become more suitable and expand in seeded area • longer grazing season and lower heating costs for livestock facilities • regions north of current agricultural extent may become more suitable for new crops (for example, corn, soybean) [34] although this will be limited somewhat by soil suitability

Climate Change Impact	Risks	Opportunities
	pollinators [33] • increased algal blooms and eutrophication of surface waters from increased spring runoff combined with warmer and drier growing season and increasing intense summer precipitation events in some regions • increased risk of water contamination due to changing production systems that can impact nutrient and pesticide inputs • farmworkers are especially vulnerable to heat stress due to the strenuous nature of their work which is performed primarily outdoors • increase risk of adequate supply and	

Climate Change Impact	Risks	Opportunities
	quality of water to support animal production	
Higher CO_2 levels	• increased growth in weeds, which are expected to become more resistant to herbicides under climate change scenarios [35] [36] [37]	• for wheat, barley, canola, soybeans, potatoes and most forage crops, may increase overall yields

Annex C: Regional climate change challenges in the agriculture sector related to water

Pacific Region

- reduced summer stream flows, reduced groundwater recharge and increasing demands for water from other sectors
- higher crop-water demands in the Okanagan Valley from increasing temperatures and longer growing season
- in coastal regions, sea level rise could cause saltwater intrusion into aquifers as well as coastal inundation of

farmland

Prairies

- impacts on groundwater quality and availability
- increased drought frequency and intensity leading to increased demand for irrigation and water supply infrastructure
- increased competition among water users (for example, municipalities, Indigenous communities, hydropower), particularly during years of drought and reduced water availability
- nutrient losses and algal blooms in catchment basins from increased spring floods and intense rain events or lower water levels/warmer water in droughts
- access issues for heavy farm machinery from spring floods

Central Region

- with increased spring runoff, difficulty completing spring seeding and other field operations
- increased risk of runoff of livestock manure and soil nutrients from fields into riparian zones, and increased soil erosion

Atlantic Region

- increased spring precipitation and more rapid thaws could lead to ice jams and flooding, impacting lands around larger rivers
- higher intensity storms and more frequent tropical storms could damage crops and endanger livestock

- increased risk of runoff of livestock manure and soil nutrients from fields into waterways

Annex D: Environment and climate actions and targets in the agriculture sector in other jurisdictions

Country	Target
Climate change mitigation	
France	• 18% reduction in agricultural GHG emissions by 2030; 46% reduction by 2050
Germany	• GHG emissions from agriculture reduced to 58 to 61 million tonnes of CO_2e by 2030 • nitrogen surplus in the gross nutrient balance reduced to 70 kg N/ha between 2028 and 2032, with a clear reduction by 2050
Ireland	• reduce agricultural emissions by 22-30% from 1990 levels by 2030 • reduce the management intensity of at least 40,000 ha of peat-based agricultural soils to reduce CO_2 loss
Netherlands	• Reduce nitrogen emissions by 50% by 2030 [38] and one third reduction in livestock herd across the country to reduction nitrogen

Country	Target
New Zealand	• emission reduction targets of 10% below 2017 levels by 2030, and then by 24%-47% by 2050 for biogenic methane
United Kingdom	• cut by 1/5 the GHG intensity of food and drink consumed in the UK
Biodiversity	
United States	• enroll up to 4 million new acres in the Conservation Reserve Program to preserve topsoil, sequester carbon, reduce nitrogen runoff, provide healthy habitat for wildlife
Quebec	• double agricultural land managed favourably for biodiversity (for example, riparian strips, windbreaks); no net loss of wetlands and water bodies in Québec by 2030
Water	
European Union	• reduction in overall use and risk of chemical pesticides by 50% and reduce the use of more hazardous pesticides by 50% by 2030 • reduce nutrient losses by at least 50% by 2030, while ensuring that there is no deterioration in soil fertility • reduce fertilizer use by 20% by 2030

Country	Target
Finland	• goal of sustainably processing 50% of manure and sludge by 2025 that may affect the Baltic sea and surrounding water systems
United States	• reduce national nitrogen and phosphorus losses from farmland by 30% by 2050
Ontario	• a 40% reduction (from 2008 levels) in phosphorus loadings to the central basin, with a new binational loading target of 6,000 tonnes per year of total phosphorus • a 40% reduction (from 2008 levels) in spring loads of total phosphorus and soluble reactive phosphorus for priority tributaries to minimize harmful algal blooms in the nearshore areas
Quebec	• 15% decrease in nitrogen fertilizer inputs on cropped land (Sustainable Agriculture Plan 2020-2030)
Soil health	
European Union	• 25% of farmland under organic farming by 2030 • EU-wide soil health targets in development
France	• annual growth rate of 0.4% in the soil carbon stocks, or 4% per year, in the first 30-40 cm of soil

Country	Target
United States	• enroll up to 4 million new acres in the Conservation Reserve Program to preserve topsoil, sequester carbon, reduce nitrogen runoff, provide healthy habitat for wildlife
Ontario	• at least three crop families in rotation (annual crop system) by 2030 • 50% of a farmer's cropland has a cover crop by 2030
Quebec	• 75% of cultivated lands covered by crops or crop residues in winter • 85% of agricultural soils have a soil organic matter content of 4% or higher

Endnotes

1 Note that the Government of Canada has designed Land Use and Biodiversity Criteria for fuels and feedstock to ensure they are sustainably produced.

2 Ekos Research Associations Inc. 2019. "2019 Survey on Consumer Perceptions of Food". Ottawa, Canada.

3 Li, S., Kallas, Z. 2021. "Meta-analysis of consumers' willingness to pay for sustainable food products". *Appetite 163*.

4 Wageningen University & Research. 2021. "Demand for sustainable products rising; supply increasing too".

5 Custom map created using data from Canada's National Inventory Report 2022.

6 Data from Climate Atlas of Canada.

7 Canada: Outlook for Principal Field Crops, 2021-12-17.

8 Agriculture and Agri-Food Canada. 2022. "Environmental Sustainability of Canadian Agriculture: Agri-Environmental Indicator Report Series – Report #5."

9 Government of Canada. 2020. "Climate change impacts on Agriculture".

10 Statistics Canada. 2022. "Land inputs, manure and irrigation, Census of Agriculture, 2021".

11 Statistics Canada. 2022. "Land use, Census of Agriculture, 2021".

12 Government of Canada, 2022. "Greenhouse gas sources and sinks in Canada: executive summary 2022.", *Canada's official greenhouse gas inventory*. ECCC. Note that this figure does not include land use and land use change (LULUCF) figures.

13 AAFC calculations based on data from the 2022 National Inventory Report and Statistics Canada, Gross Domestic Product at Basic Prices (2022).

14 Animal production is considered here as animal housing, manure storage, manure deposited by grazing animals, and application of manure to managed soils and includes enteric fermentation emissions. As defined in Environment and Climate Change Canada, 2022. "Canadian Environmental Sustainability Indicators: Greenhouse gas emissions."

15 Crop production is considered here as application of biosolids and inorganic nitrogen fertilizers, decomposition of crop residues, loss of soil organic carbon, cultivation of organic soils, indirect emissions from leaching and volatilization, field burning of agricultural residues, liming, and urea application. As defined in Environment and Climate Change Canada, 2022. "Canadian Environmental Sustainability Indicators: Greenhouse gas emissions."

16 Environment and Climate Change Canada, 2022. "National Inventory Report 1990-2020: Greenhouse Gas Sources and Sinks in Canada".

17 Based on the 2019 NIR numbers.

18 See Annex 5 of the Canada's 2030 Emissions Reduction Plan (pp. 190-191).

19 Environment and Climate Change Canada, 2022. "National Inventory Report 1990-2020: Greenhouse Gas Sources and Sinks in Canada".

20 Food loss refers to losses that occur during production, processing, distribution and transportation. Food waste refers to losses at the retail, food service, institutions, and household stages of the supply chain.

21 Gooch, M., Bucknell, D., LaPlain, D., Dent, B., Whitehead, P., Felfel, A., Nikkel, L., Maguire, M. 2019. "The Avoidable Crisis of Food Waste: Technical Report; Value Chain Management" *International and Second Harvest*; Ontario, Canada.

22 Environment and Climate Change Canada, 2020. "National Waste Characterization Report: The Composition of Canadian Residual Municipal Solid Waste." Government of Canada Publications. ECCC.

23 "Biological diversity" means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (Convention on Biological Diversity).

24 Klein, A-M., Vaissière, B.E., Cane, J.H., Steffan-Dewenter, I., Cunningham, S.A., Kremen, C., Tscharntke, T. 2007. "Importance of pollinators in changing landscapes for world crops." *Proceedings of the Royal Society*, 274, pp. 303-313.

25 Government of Canada. 2018. "Canada's Sixth National Report to the United Nations Convention on Biological Diversity (PDF)".

26 Agriculture and Agri-Food Canada. 2022. "Environmental Sustainability of Canadian Agriculture: Agri-Environmental Indicator Report Series — Report #5." In press.

27 The Guelph statement is a Vision for the agriculture sector developed in collaboration by federal, provincial and territorial partners. It states that: "Canada is recognized as a world leader in sustainable agriculture and agri-food production and drives forward to 2028 from a solid foundation of regional strengths and diversity, as well as the strong leadership of the Provinces and Territories, in order to rise to the climate change challenge, to expand new markets and trade while meeting the expectations of consumers, and to feed Canadians and a growing global population".

28 Chase, L.E. 2006. "Climate Change Impacts on Dairy Cattle (PDF)". Cornell University, Ithaca, NY.

29 Sejian, V., J.B. Gaughan, B. Raghavendra and S.M. Naqvi. 2016. "Impact of climate change on livestock productivity". *Feedipedia Broadening Horizons* 26: 1-4.

30 Key, N., S. Sneeringer and D. Marquardt. 2014. "Climate Change, Heat Stress, and U.S. Dairy Production (PDF)". USDA.

31 Rozenboim, I., E. Tako, O. Gal-Garber, J. A. Proudman, Z. Uni. 2007. "The Effect of Heat Stress on Ovarian Function of Laying Hens, Poultry". *Science*. 86(8): 1760–1765.

32 Olfert, O., R.M. Weiss and R.H. Elliott, 2016. "Bioclimatic approach to assessing the potential impact of climate change on wheat midge (Diptera: Cecidomyiidae) in North America". *The Canadian Entomologist* 148: 52-67.

33 Kudo, G. and T.Y. Ida. 2013. "Early onset of spring increases the phenological mismatch between plants and pollinators". *Ecology*, 94(10): 2311-2320.

34 Campbell, B. M., D. J. Beare, E. M. Bennett, J. M. Hall-Spencer, J. S. I. Ingram, F. Jaramillo, R. Ortiz, N. Ramankutty, J. A. Sayer, and D. Shindell. 2017. "Agriculture production as a major driver of the Earth system exceeding planetary boundaries." *Ecology and Society* 22(4), 8.

35 Beckie, H.J. R.E. Blackshaw, R. Low, L.M. Hall, C.A. Sauder, S. Martin, R.N. Brandt, and S.W. Shirriff. 2013. "Glyphosate- and Acetolactate Synthase Inhibitor–Resistant Kochia (*Kochia scoparia*) in Western Canada." *Weed Science*, 61(2):310-318.

36 Archambault, D.J., 2007. "Efficacy of herbicides under elevated temperature and CO_2." In: *Agroecosystems in a Changing Climate* [Newton, P.C.D., A. Carran, G.R. Edwards, and P.A. Niklaus (eds.)]. CRC Press, Boston, MA, USA, pp. 262-279.

37 Manea, A., M.R. Leishman, and P.O. Downey, 2011. "Exotic C4 grasses have increased tolerance to glyphosate under elevated carbon dioxide." *Weed Science*, 59: 28-36.

38 While this target is not agriculturally specific, it impacts the agricultural sector significantly given the share of nitrogen oxide attributed to the sector in the Netherlands.

Date modified:
2024-02-23